

A Theory-based Pilot Study to Decrease  
Sitting Time in the Workplace

by

Amanda Gordon

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Graduate Supervisory Committee:

Matthew Buman, Chair  
Pamela Swan  
Cheryl Der Ananian

ARIZONA STATE UNIVERSITY

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## ABSTRACT

The purpose of this pilot randomized control trial was to test the initial efficacy of a 10 week social cognitive theory (SCT)-based intervention to reduce workplace sitting time (ST). Participants were currently employed adults with predominantly sedentary occupations (n=24) working in the Greater Phoenix area in 2012-2013. Participants wore an activPAL (AP) inclinometer to assess postural allocation (i.e., sitting vs. standing) and Actigraph accelerometer (AG) to assess sedentary time for one week prior to beginning and immediately following the completion of the 10 week intervention. Self-reported measures of sedentary time were obtained via two validated questionnaires for overall (International Physical Activity Questionnaire [IPAQ]) and domain specific sedentary behaviors (Sedentary Behavior Questionnaire [SBQ]). SCT constructs were also measured pre and post via adapted physical activity questionnaires. Participants were randomly assigned to receive either (a) 10 weekly social cognitive-based e-newsletters focused on reducing workplace ST; or (b) similarly formatted 10 weekly e-newsletters focusing on health education. Baseline adjusted Analysis of Covariance statistical analyses were used to examine differences between groups in time spent sitting (AP) and sedentary (AG) during self-reported work hours from pre- to post- intervention. Both groups decreased ST and AG sedentary time; however, no significant differences were observed. SCT constructs also did not change significantly between pretest and posttest in either group. These results indicate that individualized educational approaches to decreasing workplace sitting time may not be sufficient for observing long term change in behaviors. Future research should utilize a larger sample, measure main outcomes more frequently, and incorporate more environmental factors throughout the intervention.

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## Chapter 1

### INTRODUCTION

Over the past decades, researchers have devoted considerable attention to moderate-vigorous intensity physical activity (MVPA), its correlates, and ways to promote initiation and long-term maintenance as a means for improving physical and mental health. However, recent studies have shown that the amount of time spent in sedentary behaviors is similarly associated with adverse chronic health effects, independent of physical activity(2, 12, 13, 43, 49, 66, 70).

In observing current societal trends, researchers find that adults and children alike spend a large portion of the waking day (approximately 7.7 hours) in sedentary behaviors at school, work, in their mode of transportation, and for leisure (44). In concert with this rise in sedentary behavior, epidemiological studies have seen a similar increase in the rate of developing chronic diseases such as diabetes, high blood pressure, and metabolic syndrome among others(2, 12, 13, 43,66). While the health benefits of MVPA are indisputable, sedentary behavior may pose an additional threat to public health. While this field of study is just beginning to emerge, studies have begun to identify strong relationships between time spent in sedentary behaviors and a number of chronic health conditions. These conditions include, but are not limited to, cardiovascular disease<sup>1</sup>, diabetes(13), weight gain(49, 70), metabolic syndrome (2, 32 ,33), some cancers (4, 8, 19, 20, 39,43, 51, 55,72) and all-cause mortality (12, 66).

While the correlational and longitudinal evidence suggesting sedentary behavior is detrimentally associated with health outcomes continues to grow, little is known about how to intervene to reduce sedentary behavior, especially in adults. Interventions have

primarily targeted children (11,60,62). In the past 15 years over 200 studies have been published which purport to change sedentary behavior in children (11) while, to our knowledge, only 11 studies have been published to our knowledge in adult populations. Among those 11 studies, 7 were designed to target physical activity behaviors and exclusively used highly subjective self-report measures of sedentary behavior (7,10,14,21,42,52). To our knowledge, only 4 intervention studies have been published that have targeted changes in sedentary behavior in adults (14,21,42,52) and only one utilized a behavioral theory to guide their intervention (21).

### **Purpose, Hypotheses, and Aims**

The purpose of this study was to test the initial efficacy of reducing time spent in sedentary behaviors in a worksite population through a 10-week, social cognitive theory-based intervention targeting workday sitting assessed via objective, device-based wearable sensors, and framed by the RE-AIM planning model.

**Aim 1:** To determine the efficacy of a 10-week social cognitive theory-based intervention to decrease the sitting time during an average work day.

***Hypothesis 1:*** Significant reductions in sitting time as measured by an inclinometer would be observed in intervention participants relative to control.

***Hypothesis 2:*** Significant reductions in sedentary time as measured by an accelerometer would be observed in intervention participants relative to control.

***Hypothesis 3:*** Participants would report reduced sedentary time as measured by a validated measure of domain specific sedentary behavior, specifically in paperwork and office work sitting time, in intervention participants relative to control.



**Aim 2:** To determine the influence of sitting less at work on participant perceptions of work-related productivity and acceptability.

*Hypothesis 1:* No significant differences in work productivity as measured by an acceptability survey would be observed in intervention participants relative to control.

*Hypothesis 2:* Significant improvements in workplace satisfaction as measured by an acceptability survey would be observed in intervention participant relative to control.

**Aim 3:** To determine whether the proposed intervention influenced social cognitive constructs associating with sitting less at work.

*Hypothesis 1:* Significant improvements in self-efficacy, overcoming barriers, and outcome expectations as measured by social cognitive theory-derived questionnaires would be observed in intervention participants relative to control.

*Hypothesis 2:* Changes in the social cognitive constructs would be significantly correlated with changes in the primary outcomes of the interventions (sitting time, sedentary time, and self-reported sedentary behavior).

**Definition of Terms:**

1. Sedentary Behavior: Engaging in activities that do not increase energy expenditure or muscle activation above baseline (1.5 METS), usually sitting behaviors such as driving a car, watching T.V., reading a book, or screen-based activities (61).

2. Social Cognitive Theory: A behavior change theory based on the principles of learning within the human social context and the reciprocal interaction of the individual with their environment, or the ability that each has to influence the other (24).
3. Self- Efficacy: An individual's beliefs about personal ability to perform behaviors that bring desired outcomes (24).
4. Outcome Expectations: Beliefs about the likelihood and value of the consequences of behavioral choices(24).
5. Actigraph accelerometer: an instrument used to measure accelerations in movement. This will provide objective data on the intensity and frequency of activity. Actigraph accelerometers are assessed via counts per minute. Current intensity cut points for the Actigraph are as follows: sedentary (< 99 cpm), light intensity (100- 1951cpm), moderate intensity (1952 – 5724 cpm), and vigorous intensity (> 5725 cpm)(17).
6. ActiPAL: an inclinometer used to assess time spent in various postures such as sitting/lying, standing, and walking. Validated by Grant et al (28), it is considered the gold standard for assessing postural changes in various populations.

**Delimitations and Limitations:**

Inclusionary criteria for this study included the following. Participants were required to be currently employed in a sedentary job as assessed by the Stanford Brief Activity Survey, be employed at a large southwestern University or the surrounding community at the time of enrollment, have satisfactorily completed the Physical Activity Readiness Questionnaire (PAR-Q), and have been cleared to participate in physical activity. This

clearance entailed the absence of uncontrolled chronic diseases such as type 2 diabetes, asthma, and others that would prevent them from participating in regular physical activity. There were some limitations to this study, the first of which was the small sample size. As one of the first interventions of its kind, the number of participants necessary to observe a significant change was unknown. Another limitation to this study may have been the composition of the subject population. As participants were drawn from university occupations, the average education level was higher than those observed in other organizations.

## Chapter 2

### REVIEW OF LITERATURE

#### **SEDENTARY BEHAVIOR**

The term “sedentary behavior” has had various meanings as the study of activity has evolved. Therefore the following section will discuss the current definition of sedentary behavior and the various methods for measuring sedentary time most frequently used in research today.

#### **Defining Sedentary Behavior.**

Ambiguity and inconsistencies in defining sedentary behavior have obscured researchers’ ability to quantify the nature and magnitude of the relationship between sedentary behavior and health (54). Many studies conducted in the past on sedentary behavior have defined it as the absence of moderate- vigorous physical activity (53), which some have contended is not entirely accurate (53,67). This definition incorporates a wider spectrum of behaviors including light-intensity activities and sleep which are not sedentary behaviors and may have additional contributions to optimal health (53). Furthermore, this ambiguity reduces precision in measurement and impairs researchers’ ability to compare one study to another in regards to sedentary behavior.

As the term “sedentary” comes from the Latin word *sedere* meaning “to sit,” Owen et al. (53, p. 106) has suggested sedentary behaviors to be equated with sitting behaviors. Researchers go on to clarify this definition as “waking behaviors in the sitting or reclining position which do not increase energy expenditure or muscle activation ( $\leq 1.5$  METS)(61). The physiological literature supports this definition as muscle-related metabolic dysfunctions observed in prolonged sitting are not seen when replaced with a

light intensity activities such as standing which requires effort to maintain posture (13,3,30).

The Australian Diabetes, Obesity, and Lifestyle study (AusDiab) has similarly found a consistent and predictive relationship between TV viewing time, a common sedentary behavior performed while sitting, and increased waist circumference, blood pressure, and 2-h plasma glucose regardless of time spent in moderate to vigorous physical activity (32). This was true for even seemingly healthy individuals who met public health physical activity guidelines for improved health (150 min/wk of MVPA)(32).

In accordance with Owen and colleagues recommendations (53), we therefore define sedentary behavior as activities during which one is sitting or lying down with low energy expenditure. However, as we note below, there are substantial measurement pitfalls associated with adopting this definition given that valid and reliable methods of quantifying this definition are not fully developed.

### **Methods for Measuring Sedentary Behavior.**

In attempts to quantify sedentary behavior, researchers have utilized “sitting time” and time spent in various sitting behaviors to get a clearer picture of actual sedentariness. Over the years, various measures have been developed to assess “sitting time.” The most commonly used among these measures include questionnaires and device-based wearable sensors.

**Questionnaires.** The use of questionnaires in assessing sedentary behavior is the most easy and readily available option for many researchers. Questionnaires typically ask questions pertaining to a variety of sitting behaviors including TV viewing, computer use,

transportation, sitting entertainment (e.g. reading), and workplace sitting. While there are many different questionnaires available, most were not appropriate for this study.

Reasons for this included domain specific behaviors unrelated to the workplace (T.V. viewing time and non-occupational sedentary behavior), target populations outside the desired sample (e.g, Australian Women Activity Survey targeting women with young children)(15), or had low correlations with total workplace sitting time (e.g., Western Australian Incidental Physical Activity Questionnaire)(47), the outcome of interest in this study. Two of the most commonly used validated measures which exhibit moderate correlations in sedentary behavior include the International Physical Activity Questionnaire (IPAQ)(58) and the Sedentary Behavior Questionnaire (SBQ)(59).

***International Physical Activity Questionnaire.*** Validated in 2003 (9) and more recently in 2008 (58), the IPAQ in its original form assesses activity in 5 domains, including sedentary behavior. The shortened version of the IPAQ, more commonly utilized, assesses the four general categories of activity (vigorous, moderate, light, and sedentary) and can be either researcher- or self- administered. This shortened measure has been shown to be reliable in assessing physical activity time (9). The short IPAQ however exhibits some disadvantages for assessing sedentary behavior. The IPAQ has first and foremost been designed to assess physical activity, as such in its shortened version only two questions directly assess sedentary behavior. One study which compared an objective measure (activPAL) to the IPAQ found that participants underestimated sitting time significantly over a 6 hour period (42).

The IPAQ still provides useful information for understanding participant behaviors and perceptions as well as a general idea of overall behavior. Furthermore, the

IPAQ is inexpensive, easily accessible, and consistent between participants. For these reasons, until more objective measures of sedentary behavior become more readily accessible the IPAQ has utility in the field.

***Sedentary Behavior Questionnaire.*** A more recent measure of sedentary behavior, the Sedentary Behavior Questionnaire (SBQ) has been validated in overweight and healthy populations to more accurately assess time spent in 9 different sedentary behaviors (59). Intraclass correlations revealed moderate to excellent test-retest reliability for both weekdays and weekend days in a convenience sample of 49 participants. In the process of validating this measure, researchers assessed baseline data from 842 overweight men (n= 441) and women (n= 401) in two different studies of physical activity and diet. These results were then compared with those observed in the IPAQ and accelerometer derived inactivity data. Results indicate the SBQ had modest correlations with the IPAQ and low correlation with accelerometer results. Low correlations between self-report measures and criterion measures appear repeatedly throughout the literature (34). However, the specificity of the SBQ to various sedentary behaviors offer an advantage over the IPAQ, as it allows researchers to observe domain-specific contributions to overall sitting time. Researchers have found that breaking up behaviors to specific domains provides a higher correlation with objectively measured sedentary behavior (34). This has become increasingly important in sedentary behavior research to guide intervention designs. However, as with the IPAQ, the SBQ has a few disadvantages; most notably, the highly subjective nature of questionnaires and the difficulty in recalling non-exercise activities. As researchers continue to investigate the

direct effect of sedentary behavior, objectively assessed measures of sedentary time become necessary.

These questionnaires, while useful in understanding the activities during which sedentary time is predominantly accumulated, are highly subjective and relatively unreliable for measuring sedentary behavior (42). When completing self-report questionnaires, participants tend to over-estimate physical activity, and under-estimate sedentary time (41). However, until recently these were the most frequently used and available measures in sedentary behavior research. A review of sedentary behavior studies which indicated a primary or secondary goal of decreasing sitting time in worksite settings found no significant decrease in sitting time (7). Six studies met the inclusion criteria for the study and all employed a subjective measure of sedentary behavior. Of the 6 studies, only one study that used a log-based method of self-reporting approached significant decreases in sitting time (22). One community study to influence physical activity observed a significant decrease in sedentary behavior when using the IPAQ (10). However, authors conclude that the measures used, though helpful in preliminary research, are not sufficient for developing public health guidelines.

**Device-based, wearable sensors.** As technology has progressed, activity sensors have made it possible for researchers to objectively measure sedentary time. Two commonly used devices in sedentary behavior research include accelerometers and the activPAL.

**Accelerometer.** Accelerometers are small devices usually mounted on the hip by a belt which track the intensity of activity over a specified amount of time. The data collected is typically reported in terms of counts per minute (cpm) and provide an



objective measure for differentiating activity levels. Though still under some debate, activity thresholds for differentiating intensity use accelerometer data. As mentioned before one of the major advantages of measuring sedentary behavior using accelerometers is the objective and reliable nature of the device. Variations in sedentary time due to participant bias can therefore be minimized. However, one disadvantage of this device is its inability to differentiate between sitting and standing which under the previous definition is not categorized as “sedentary behavior.” Minimal movement in standing may cause the accelerometer to register low counts similar to sitting. This limitation may erroneously lead researchers to attribute time spent standing as sedentary time.

More recent versions of accelerometers have included an inclinometer, which measures posture (i.e., lying down, sitting, standing). However studies have found this feature provides inconsistent information regarding changes in posture, accurately registering time in various postures only 60% of the time (6). Accelerometers provide valuable data in lifestyle behaviors which allow researchers to observe changes in all activity intensities. However due to the previously mentioned disadvantages researchers in sedentary behavior may wish to use them in conjunction with an inclinometer when possible.

***ActivPAL.*** The activPAL is a small device mounted on the mid-thigh, via an adhesive, which tracks postural changes over the monitoring period, typically 7 days. In a validation study wherein the activPAL was compared to direct observation, researchers found an overall agreement of 95.9% (28). In this experimental study, participants were video recorded in a lab while performing a variety of daily tasks and wearing three

activPAL monitors. Two conditions were employed, a control in which participants sat, stood, and walked for 2-9 minute each, and an “activities of daily living”(ADL) condition. For the ADL section participants performed a variety of daily tasks such as getting a drink, cleaning, watching a video, and preparing and eating food in a randomly assigned order. Each session lasted approximately 20 minutes. At the conclusion of this time, data from the ActivPAL was compared to coding of observations from the recorded footage. In this analysis, researchers found the percent difference between the ActivPAL and observation was 0.19%. ActivPAL inclinometers are therefore considered the criterion measure for differentiating sitting from standing behaviors. Despite the obvious benefit to utilizing this device, there are some disadvantages. One operational flaw observed in practice is the mounting of the device. Manufacturers produce an adhesive which provides variable degrees of security to the participant’s thigh. Theoretically this should be able to adhere to a participant’s thigh for 4-7 days and allow for repositioning, however many participants find this adhesive uncomfortable. Utilizing other kinds of adhesive tape similarly presents a problem in the form of discomfort for the participant due to friction. Also, the activPAL provides information on changes regarding changes in posture and steps, but does not indicate intensity of stepping activities. Therefore if information on physical activity is desired in addition to posture, an accelerometer or similar device is also needed.

While self-report questionnaires tend to underestimate sedentary behaviors, these highly subjective measures help researchers to understand the accumulation and perceptions of sedentary behavior in the target population. Similarly, though these wearable sensors have their flaws and no one device is currently able to obtain all

research variables, these devices provide objective and reliable data on sedentary behaviors. Though each form of measurement has its disadvantages, when used in concert both self-report questionnaires and device-based measures provide valuable perspectives to understanding the phenomenon of sedentary behavior and allow researchers to better construct accurate and valuable guidelines.

## **EPIDEMIOLOGY OF SEDENTARY BEHAVIOR**

Over the last half century the opportunity to engage in sedentary behaviors has risen as technology has improved to provide sedentary options in transportation, occupation, and leisure activities (67). This next section will discuss behavioral trends of sedentary behavior, the progression of diseases associated with sedentary behavior, and possible mechanisms through which it may impact health.

### **Population-based Estimates of Sedentary Behavior in the United States.**

In an observational study of the 2003-2004 cohort of the National Health and Nutrition Examination Survey (NHANES), it was found that the average adult (ages 18-60) in the United States spends roughly 55% of their waking hours in sedentary behavior (44). This equates to an average of 7.7 hours/day in behaviors that require minimal increases above basal energy needs. Some age groups exhibited higher rates of sedentary behavior (e.g. older adolescents and older adults) reaching averages of 8 and 9 hours, respectively, of sedentary time per day. Of all participants, children were the least sedentary and Mexican American adults sat less on average than either Black or White American adults, though not statistically different. Further, women were more sedentary than men during adolescents and adulthood, but less sedentary after age 60. In this study, sedentary behavior was measured objectively via a hip-worn Actigraph accelerometer

and was collected for 6329 participants, 3798 of which were adults over the age of 18. All subjects were asked to wear the accelerometer during waking hours, except when bathing and swimming, for seven consecutive days. Only those who completed this minimum requirement and had 10 hours per day of valid accelerometer data were analyzed. The large sample size and representativeness of the population studied provides a solid foundation for the assertion that on average, the American adult population spends most of their day in sedentary pursuits. This sample however does not differentiate between various types of sedentary behaviors (e.g., television viewing, occupational, transportation, etc) or the behavioral correlates of sedentary behavior.

### **Sedentary Behavior in the Workplace.**

Over time, occupational opportunities across the country have shifted from physical labor to more stationary, office based positions. French and colleagues assessed this shift in various employment industries (18). In this study active occupations (e.g. farming and masonry) decreased 47 to 63% from 1986 to 2000 while those jobs associated with minimal energy requirements (e.g. secretarial and finance positions) increased by 26% during the same time period. More recently, the Department of Labor Statistics projected that almost half of the expected growth in employment opportunities over the next ten years will be in jobs associated with office based occupations, including professional and business, and health care and social assistance sectors which combined equates to approximately 9.4 million new jobs over the next ten years, 4.1 million of which are traditionally office or desk-based positions (37). Examples of these jobs include medical office personnel (1.4 million jobs), management, scientific, and technical consulting positions (575,600 jobs), employee placement positions (631,300 jobs), family

and individual counseling services (851,400 jobs), and computer systems designers (671,300 jobs). These industries already comprise a majority of the American workforce.

The average adult works approximately 8 hours a day (69), thus making a substantial potential contribution to daily sedentary time. In a study of work and leisure time sedentary behavior, researchers found that those who sat during most of the work day did not compensate by being more active during their leisure time (40). Through telephone surveys completed by over 7,000 employees, researchers assessed time spent sitting in four domains in the previous two days. Those working in computerization, commercial services, transportation, banking and insurance, and government and judicial organizations sat significantly longer at work than the average worker by 3.5 hours and were not statistically different in leisure time sedentary behaviors than their more active counterparts.

This shift in occupation-related activity correlates with a dramatic increase in some of the most prominent chronic diseases. In a very early study of bus drivers (i.e., primarily sedentary occupation) and conductors (i.e., a more active occupation) in England in 1953, researchers observed that drivers experienced a significantly higher rate of coronary heart disease (CHD) related death than did conductors (48). Participants occupied positions as drivers or conductors of the central buses, trams and trolleybuses, or the Underground railways. Analysis showed that while the incidence of angina was higher in the conductors, rates of coronary thrombosis were higher for drivers. Furthermore, 80 incidents were recorded in drivers while only 31 were recorded for conductors, all of which occurred in individuals over the age of 45. Of the 80 cardiac events experienced in drivers, 10% were myocardial infarctions in the 35- 44 age group,

and 50% resulted in fatalities (35 deaths). This in comparison to the 9 deaths observed in conductors. Researchers conclude that CHD strikes harder and earlier in drivers than in conductors. Though they note a variety of possible confounding variables, researchers further found that these factors were not observed in those working on the Underground railway with responsibilities more closely resembling drivers. Though the environment between drivers and conductors was similar, the physical demands varied between the two as conductors were required to walk throughout the shift collecting tickets while drivers remained sitting throughout the shift. While Morris et al (48) initially attributed these differences in CHD to less physical activity in the bus drivers than conductors, it is equally plausible that difference may have been due to increased sitting or some combination of physical activity and sedentary behavior.

Additionally, this study of sedentary and physically active occupations was extended to civil servants and postmen (n= 110,000). In this portion of the study researchers observed that those occupying sedentary positions such as telephonists, executives, and clerks, experienced higher rates of CHD than the active postmen. Further, postmen reported fewer incidents of severe CHD than did even the intermediately active occupations of postal supervisors and those of "higher grade," who experienced rates somewhere between the two extremes. Postmen did however report higher rates of angina, similar to conductors in the original study. Though many factors remain unexplained, correlation research continues to find this relationship when considering both sides of the equation, leading many to seriously question the impact of sitting while at work and its impact on health.

## **Sedentary Behavior and Chronic Disease.**

Researchers have continued to find consistent associations between the amount of time spent in sedentary behaviors and risk of developing serious chronic conditions. Among these diseases are the development of metabolic syndrome, type 2 diabetes, cardiovascular disease, some cancers, and all-cause mortality.

*Metabolic syndrome.* While Morris and colleagues provided preliminary evidence to provoke this research, many have more specifically examined the role of sedentary and sitting behaviors and their relationship with chronic diseases. In a sub sample of the 1999-2000 Australian Diabetes, Obesity, and Lifestyle Study (AusDiab) study (n=169), researchers found that sedentary behavior more strongly predicted waist circumference, a marker of metabolic syndrome, than did MVPA in healthy Australian adults.<sup>9</sup> Investigators also found a significant association between all activity intensities and a clustered metabolic risk. Participants spent a majority of waking hours in either sedentary or light intensity activities which were inversely related. This led researchers to assert that substituting light-intensity activities for sedentary behaviors may therefore improve metabolic profiles.

Similarly, another study found a significant correlation between the number of metabolic syndrome markers with the duration of sedentary bouts, percentage of time spent in sedentary behaviors, and total sedentary time, ( $p < 0.01$ ).<sup>4</sup> Data collected from 1,367 participants in the 2003- 2004 and 2005-2006 NHANES survey showed that participants who had more risk factors for metabolic syndrome also participated in significantly more sedentary behaviors than those with fewer risk factors ( $p < 0.05$ ).

Activity patterns were assessed based on 7 days of accelerometer data, and utilized Actigraph accelerometer intensity cut points.

***Diabetes and cardiovascular disease.*** Sedentary time has also been associated with increased risk for cardiovascular disease and diabetes. A recent study published in *Diabetes Care* found that markers of diabetic risk and cardiovascular health improved with minimal increases in activity when initiated periodically throughout the day, (13). This study engaged 20 participants in a crossover research design and measured blood profiles in response to interrupted sitting bouts with light and moderate intensity activity. Improvements in these markers did not differ significantly between moderate and light intensity breaks, but were significantly better than the uninterrupted condition. This study marks the important role decreasing sedentary behavior may have in the development of both cardiovascular disease and type 2 diabetes.

Healy et al (35) similarly found breaks in sedentary time beneficially associated with cardio-metabolic and inflammatory biomarkers. Further analysis of the 03-04 and 05-06 cohorts of NHANES revealed a significant and consistent relationship between sedentary time and waist circumference, C-reactive protein, triglycerides, insulin, and insulin sensitivity. Researchers were particularly concerned with the consistent detrimental relationship between increased sedentary time and waist circumference and C-reactive proteins which were ameliorated to some degree by increased interruptions in sitting time. This trend was generally seen across all genders and races/ethnicities. Due to these findings, especially the role C-reactive protein plays in the development in a number of chronic diseases including CVD, researchers warn that caution should be taken in regards to sedentary time and how it is accumulated. They further assert this is



especially important for worksites considering the increasingly sedentary nature of office based positions today.

In a review of longitudinal relationships between sedentary behavior and various chronic diseases, Thorpe et al. (66) identified associations between sedentary behaviors and diabetes and cardiovascular disease. These relationships however were somewhat inconsistent, authors citing possible confounding variables such as the temporal sequence of the diseases and initial BMI. In relation to diabetes, two of the four studies found the strength of a relationship attenuated when considering BMI and physical activity (16,72).

**Cancer.** In a review of studies investigating the relationship between sedentary behavior and cancer, Lynch et al. (43) found consistent correlations in specific types of cancer, specifically colorectal, ovarian, and prostate cancers. Of the 11 articles which specifically assessed cancer risk and sedentary behavior, 8 found statistically significant positive relationships ( $p < 0.05$ ). One such study investigating sedentary behavior in relationship to colon and rectal cancers found a statistically significant relationship with higher rates of sedentary behaviors such as watching T.V. (39) Data was collected from over 300,000 cancer-free adults from varying locations across the United States. Specifically, participants were asked about time spent in all physical activity intensities as well as time spent in sedentary behaviors. Participants were then followed over 6.9 years for cancer incidence. Analysis revealed a statistically significant ( $p < 0.05$ ) association between higher rates of sedentary behavior and increased risk of colon cancer in men, even after adjusting for physical activity and body mass index (BMI). Associations for women trended in the same direction although they were not significant.

Similarly, Patel et al. (55) observed higher rates of ovarian cancer in postmenopausal women who sat for six hours or more when compared with those who sat less. In this study of 59,000 women researchers analyzed other possible factors such as low intensity PA, moderate/vigorous PA, sedentary time, and BMI. Researchers observed that while no significant association was found in relation to PA intensity, prolonged bouts of sedentary time was significantly associated with ovarian cancer. Researchers therefore counsel that though more information is needed to fully understand this association, prolonged periods of sitting should be minimized.

Further, a study conducted in men by Howard and colleagues (39) found higher cancer rates among those who predominately sat for their occupation and walked or rode a bicycle for less than 30 minutes per day. Through self-administered questionnaires collected at the beginning of the study participants identified PA levels at various ages relating to occupation, housework, walking or cycling, leisure-time exercise and inactive leisure time (e.g., watching TV or reading) in addition to other lifestyle and demographic information. In this study of almost 46,000 men who were followed for 9 years, researchers observed that occupational activity and leisure-time walking or bicycling contributed the most to total energy expenditure. When controlling for these two conditions separately, occupational sitting time provided a greater reduction in risk. Those who sat “less than half the time” at work observed a 28% decrease in risk of prostate cancer when compared to those with predominately sedentary positions and controlling for leisure walking or bicycling. When controlling for occupational activity, those who rode their bicycle or walked for more than 30 minutes per day had a 7% lower risk of prostate cancer than those who were active for less than 30 minutes. Both PA and

sedentary time had statistically significant decreases in risk. However, despite these findings, no recommendations are known to advise decreasing sedentary time either at home or at work for lowering risk of cancer.

Findings from Lynch et al.'s review (43) suggest adiposity and metabolic dysfunction resulting from physical inactivity as potential metabolic pathways through which cancer may develop. Howard and colleagues (39) also speculate that these pathways may be responsible for the increased risk of cancer.

*All-cause mortality.* According to a review of longitudinal studies on sedentary behavior, Thorpe et al. (66) identify a longitudinal relationship is consistently found between self-reported sedentary time and all-cause mortality as well as weight gain in both men and women. Of those studies investigating the relationship between mortality and sedentary time, all found a statistically significant correlation. These observational studies followed large samples of target populations ( $n > 4,000$ ) ranging from 6 years up to 20 years in duration, with all variables self-reported. Overtime, each study resulted in significant associations ( $p < 0.05$ ) of increased risk of all-cause mortality with every one hour increase of T.V. viewing time (12,63,71).

Similarly, significant associations were found with weight gain in adults.<sup>7</sup> In this relationship however, effect sizes were generally small. These relationships persisted after statistically adjusting for time spent in physical activity as measured by total PA, PA status, or domain specific PA. Measures of sedentary behavior generally consisted of self-reported time spent in various sedentary behaviors including T.V. viewing time, total sitting time, and/ or other screen-based behaviors. Only three studies included objective measures of sedentary behavior (accelerometers and heart rate monitor).

Of the 48 studies included in this review (66), 34 studies adjusted for physical activity and only two of these failed to find a significant relationship between sedentary behavior and the health outcome of interest.

While more work is needed to fully understand the influence of sedentary behavior on health, it is clear based upon a review of the epidemiological literature that a relationship exists. Moreover, reducing sedentary time is also unlikely to do harm. In light of the benefits from sitting less and engaging in incidental light intensity activity throughout the day it behooves health professionals to encourage this behavior in the general population.

#### **Putative mechanisms for sedentary behavior impacts on health outcomes.**

A number of pathways have been identified through which sedentary behavior may directly influence health outcomes. Researchers in the field of sedentary behavior put out a call for change to physical activity guidelines in 2008 (31). Hamilton et al. (31) argues that moderate and vigorous intensity exercise is needed to maintain optimal health, but what is done with the rest of the day is just as important but often forgotten. In addition to the observational studies previously reviewed, Hamilton et al. (31) discuss the putative mechanisms which may underpin the relationship between sedentary behavior and health outcomes. The following section will address some of these mechanisms specifically.

One mechanism through which sedentary behavior may influence physical health is the impact of muscle activation. Bey and Hamilton (3) investigated the effect of physical inactivity on skeletal muscle lipoprotein lipase (LPL) activity, an essential enzyme for tissue specific uptake of triglyceride-rich lipoproteins by non-hepatic tissues.

In this animal study, researchers observed that LPL levels significantly decreased in hind limbs after 10 hours of inactivity. Also, these levels increased to levels similar to those in the control group after 4 hours of intermittent ambulatory activity following this inactivity. In this study, rats were allocated to either a control group or an intervention group. Those in the intervention group received hind limb unloading (HU) in which their back legs were suspended from a fishing line but still free to move about the cage. The influence of inactivity was assessed in both acute (12 hour) and chronic conditions (10 hours/day for 11 days) throughout the study, after which analyses were conducted on major muscles in hind limbs. Researchers found that while muscle mass was unaffected, heprin-releasable LPL significantly decreased in response to both acute and chronic inactivity.

Following the acute period of inactivity, rats experienced a reloading phase during which they slowly walked on a treadmill for 30 minutes of every hour for four hours, standing during the remaining time. At the conclusion of this process LPL activity rates were statistically similar to those in the control condition, indicating that this effect could be reversed. Interestingly, researchers note that there was not an accumulated effect in the chronic condition, one day of physical inactivity was not statistically different from 11. Researchers also investigated the impact of inactivity on different muscle types. Observed LPL levels in soleus (slow twitch oxidative), red quadriceps (fast twitch oxidative), and rectus femoris (white glycolytic fast twitch) muscles of the inactive rats were significantly reduced when compared to low-intensity ambulatory controls ( $p= 0.01$ ,  $0.01$ , and  $0.05$  respectively). Researchers go on to infer that LPL inhibiting genes are only activated during inactivity, having no effect in the ambulatory phases. Further, low

levels of HR-LPL inhibits local triglyceride uptake and blood lipid profiles, thus influencing the progression of metabolic diseases. Finally, in reference to the issue of intensity, it appears that there is no minimum intensity required to see improved LPL activity. Even small increases in muscle activation as seen in slow walking and standing were sufficient to see improvements. Though there is still evidence that higher intensities may further increase regulation, ambulatory activities may play a vital role in maintaining an optimal lipid profile.

In a human study of prolonged sitting bouts, Dunstan et al (13) identified that blood glucose and insulin levels were significantly higher following a bout of prolonged sitting when compared to a period of sitting interrupted by light intensity walking over the same amount of time. In this small clinical crossover intervention trial of 19 non-diabetic overweight and obese individuals, researchers found that when participants broke up their sitting time every 20 minutes, for 2 minutes of either light- or moderate-intensity walking, postprandial blood insulin and glucose levels were significantly lower than when sitting time was uninterrupted.<sup>1</sup> In this randomized study, subjects were asked to drink a test beverage and participated in a five hour treatment condition on 3 different days, each 6 days apart. Conditions included (a) an uninterrupted period of sitting, (b) sitting interrupted every 20 minutes by light intensity activity breaks lasting two minutes, and (c) sitting interrupted by moderate-intensity activity breaks at the same frequency and duration as those observed in the light-intensity condition. Breaks consisted of walking on a treadmill at either light or moderate intensity as described by participants utilizing the Borg scale as well as accelerometer data. Blood was drawn on the hour for five hours over the course of the day. Upon evaluation, both activity conditions showed significant

improvements in glucose and insulin levels, but were not statistically different from one another. This supports the role of decreasing sitting time as opposed to focusing predominantly on increasing physical activity. While one may provide health benefits beyond blood biomarkers, the light intensity activity was statistically similar in regulating blood glucose and insulin levels. Investigators indicate that these findings parallel benefits observed by an acute bout of moderate aerobic or strength training exercise in overweight and obese populations. Considering the impact these levels have on the development of cardiovascular disease and diabetes, as well as blood pressure, researchers suggest that interrupting prolonged periods of sitting throughout the day, may be an important factor for improving health markers in previously sedentary populations.

Additionally, researchers argue that the energy exchange of sitting rather than incidental activity may harm physical health. For the 2003- 2004 cohort in the NHANES survey discussed previously (44), who averaged 7.7 hours of sedentary time per day, investigators estimated that just 2 hours spent in sedentary behaviors would conserve approximately 130 kcal/day. They go on to infer that this rate of energy conservation is roughly equivalent to the rate observed in weight gain in an earlier study of obesity (38). It might therefore be assumed that if an individual were to exchange 2 hours of sedentary behaviors with 2 hours of even light-intensity activities over the course of the day, they may have significant influence over the progression of obesity and improved weight maintenance. While speculative, decreasing sedentary time may influence total energy balance in a manner that could decrease risk for many associated chronic health conditions.

Buman et al. found some initial support for this hypothesis (5). In a large observational study of older adults in two metropolitan areas of the United States, Buman et al. found that re-allocating 30 minutes of sedentary time with 30 minutes of “high-light” physical activities (e.g. leisure walking, household chores), as measured by hip-worn accelerometry over two 7-day periods 6 months apart, there was significant improvements in physical and psychosocial well-being. Physical health was defined using a composite score comprised of medication use, self-reported chronic medical conditions, BMI, and a general health rating. The psychosocial health composite included feelings of depression, life satisfaction, perceived stress, and others. Actigraph accelerometer data was assessed based on activity accounts with traditional cut points for sedentary behaviors ( $\text{cpm} < 100$ ) and moderate-vigorous intensity activities ( $\geq 1,952$ ). Light intensity activities were evenly divided into either “low-light” (100-1040 cpm) or “high-light” activities (1041-1951 cpm). This study provides preliminary evidence, based on cross-sectional data, that replacing sedentary behaviors with higher levels of light intensity activities throughout the day may have a substantial health benefit. This may be important for those for which MVPA is difficult.

In the past decade, an increasing number of researchers have called for change to the national guidelines for physical activity (31,53,54). Observational studies have found consistent positive relationships both in cohort studies and over time indicating a need for change. Animal and human experimental studies have begun to identify specific pathways through which physical inactivity clearly inhibits proper functioning and provides fertile environments for serious health complications. Furthermore, technological improvements in the current environment continually promote sedentary



behaviors which may hinder an individual's efforts to change. While more research is needed in these areas to completely understand the underlying mechanisms, behavioral interventions are needed to understand the potential to change activity patterns in society today. These interventions would therefore allow governing bodies to make informed decision regarding constructive and realistic guidelines for the general population.

### **ADULT SEDENTARY BEHAVIOR INTERVENTIONS**

As we begin to understand the epidemiological linkages and potential mechanisms through which sedentary behavior contributes to health and chronic disease, the need for intervention studies that target reductions in sedentary behavior become more important. However, to date few studies have been published in adults. The majority of sedentary behavior interventions have been conducted in pediatric and adolescent populations. While this time period may be influential and predictive of the development of future chronic conditions, it provides little information to aid in improving the quality of life of adults. Furthermore, studies in adult populations until recently have not specifically targeted sedentary behavior as a primary objective but rather focused on increasing physical activity and include a highly subjective measure of sedentary behavior. The following section will discuss these interventions as well as those completed which have targeted sedentary behavior.

#### **Physical Activity Interventions.**

Many interventional studies conducted in the past that assert an influence on sedentary behavior have in fact held a primary focus on increasing physical activity. Though producing little effect on sedentary behaviors, they are the first steps towards

understanding how sedentary behavior interventions may be developed; and therefore occupy an important role in the progression of the science.

One of the most effective of such studies found that those who increased their steps (+ 900 steps) also significantly decreased their sitting time by 12 min/day (10). A 12 month multi-level intervention involving 1,088 randomly selected participants ages 25- 75 encouraged individuals to accumulate 10,000 steps per day. Participants were randomly selected from two demographically similar European towns, one of which served as a comparison (n=440) to the intervention group (n= 648). Based on the social ecological framework, intervention strategies included pedometer goals, a community wide media campaign, a website, and related projects conducted within worksites, older adult community centers, and schools. In the intervention community, those who made an effort to increase physical activity saw a decline in sitting time while those who either maintained or decreased their steps showed no change in sitting time as measured by the International Physical Activity Questionnaire (IPAQ). Conversely, those in a comparison group who increased their step counts also increased their sitting time. Researchers therefore warn that increasing physical activity alone may not be sufficient to decrease sedentary behaviors. They go on further to indicate that some component of the current intervention may have influenced sedentary time, but a definitive conclusion as to which piece could not be given. Also, the subjective nature of self-report measures may interfere with the precision of the intervention effect. De Cocker et al (10) therefore suggest that future studies include an objective measure of sedentary behavior as well as activity intensities.

In a review of workplace interventions that address sedentary behavior in either a primary or secondary capacity, Chau et al (7) found that sitting time was unaffected by current interventions, however none of the studies reviewed included intervention activities or information that targeted sedentary behaviors specifically. Researchers reviewed over 3,000 studies in their search. Of those studies found, only those that met the following criteria were included: (a) were interventions to increase energy expenditure through either increasing physical activity or decreasing sitting time, (b) were conducted within the workplace setting, and (c) measured sitting as a primary or secondary outcome. Of those 3,000 studies, only six met these criteria, five of which were randomized trials. All six interventions focused on increasing physical activity as a primary outcome with sitting time as a secondary aim. In these 6 studies none showed a significant change in sitting time between groups. Each study evaluated adult populations, with the average age ranging from 39 to 45, and addressed various worksite settings including Universities, large worksites, and healthcare companies. The studies included an array of methods of delivery including educational materials, fitness testing, and individual counseling, among others. Sample sizes also had a wide range from 66 participants to 2,121 participants, none of which observed a significant change between comparison groups. However, all measures of sitting time were highly subjective self-report measures which may not be sensitive enough to detect significant changes in sitting time. The most frequently used of these measures was the IPAQ which requires participants to recall over the past 7 days and addresses overall sitting time, not specific to the occupational setting. A more recent study comparing the IPAQ to the ActivPAL has shown participants underestimated sitting time when measured by the IPAQ by

nearly 40 minutes per day on week days and 147 minutes on weekend days (42). Small changes may add up to a significant decrease but go unnoticed if not directly observed. In conclusion, this review found that physical activity interventions implemented in the worksite afforded no change on sedentary behaviors of employee populations.

Researchers go on to assert that interventions to address sedentary behaviors, such as sitting time, as a *primary* outcome and utilize objective measurements in addition to subjective measures are needed to more accurately see changes in this behavior.

One study from this review article provides quite possibly the best road map for future sedentary behavior interventions (22). Though the primary objective of this study was to change physical activity, it also showed the greatest decreases in sitting time This worksite walking intervention, completed at three separate universities, found that participants in an incidental walking group approached significant decreases in sitting time across the first week of the intervention before regressing back towards baseline values. Gilson et al (22) monitored step counts and self-reported workplace sitting time of 179 employees at 3 major universities in three different countries. After completing baseline measures, participants were stratified according to activity level and randomly assigned to one of three study conditions for a 10 week intervention. Research groups included (a) a wait-list control, (b) a route-based walking group which was encouraged to walk for at least 10 minute sessions during work breaks and given information on walking routes around their respective campus, and (c) an incidental walking group. In this last group, participants were encouraged to take advantage of incidental walking opportunities throughout the day. Suggestions included delivering a message to a

colleague in person rather than over the phone and using the farthest restroom on your floor instead of the nearest one.

While the main objective set forth for participants of this study was to increase their step count, subjective measures of sitting time were collected through log books completed daily by participants for five days at three time points in the study (pre-, mid-, and post-intervention). The intervention comprised a number of behavioral techniques based on the social ecological model and included: giving pedometer feedback, self-monitoring tools, goal setting, and strategies for overcoming barriers and changing habits, all of which were delivered at the beginning of the intervention and followed up via “encouragement” group emails on a weekly basis.

Of the three study conditions, only the incidental walking group decreased sedentary time at mid-intervention. However this decrease in sitting time regressed towards baseline values by the end of the 10 week study. Researchers conclude that increases in incidental movement may be effective in decreasing workplace sitting time. One limitation of this study was the absence of objective measures of sitting time which were not available at this time. The authors therefore suggest that future research utilize objective measures for monitoring sitting time in sedentary behavior research.

### **Sedentary Behavior Interventions.**

Despite the overall lack of published intervention studies primarily focusing on sedentary behaviors in adults, there are a few worth noting (14,21,42,52). These studies provide the groundwork for future interventions, but leave room for further investigation in understanding the feasibility of changing this behavior. To date, all studies have been

short in duration with no published data on whether the changes were successfully maintained beyond the initial study.

One such study focused specifically on television viewing time (52). In this study of overweight and obese adults, Otten et al. investigated the physical and nutritional impact of systematically reducing the opportunity to watch television with favorable results. In this randomized control trial, 36 participants were observed for 3 weeks to obtain a baseline for the average amount of time spent watching T.V. during a typical week. Participants were assigned a code which was to be entered when watching television to assess individual viewing patterns. Upon assessing this, participants were stratified according to BMI into one of two conditions: a control group which received no restrictions in television viewing time, and an intervention group. The intervention group utilized a lock-out device that was attached to the T.V. and was programmed to turn the T.V. off after viewing 50% of their baseline viewing time. At which point the T.V. could not be turned back on until the week reset. Participants were then monitored for 3 more weeks. During weeks 3 and 6 participants wore a physical activity armband (Sensewear) to assess energy expenditure. Upon analysis of the data, researchers observed that the intervention group significantly reduced T.V. viewing and the percent of time spent in sedentary behaviors, while increasing energy expenditure. This provides encouraging evidence for the feasibility of decreasing sedentary behaviors.

However, in terms of behavioral changes this study exhibits some limitations. First of all, it did not fully utilize theory-based behavioral components. By using a lock-out device, participants had no choice as to whether or not they reduced their viewing time. Thus it cannot be stated what effect this intervention will have should the

participants have a choice, nor what will happen once the researchers have left. Another limitation is the short duration of the study. Investigators state that similar changes were observed and maintained in studies conducted in children; however it's unclear whether this would translate to the behavioral patterns of adults. Furthermore this study targeted only one of many sedentary behaviors. Though television viewing is a significant contributor to sedentary time among adults in the United States, this intervention would do little to influence other sedentary behaviors including workplace sitting. In fact, Otten et al. indicate that some participants increased time spent in other screen-based entertainment options in exchange for watching T.V., though post-intervention levels of sedentary time decreased even with this exchange. While decreasing time spent watching T.V. may benefit other aspects of health, such as energy intake, the risk associated with sedentary behaviors is the same whether it is accumulated while watching T.V. or using a computer. Therefore, interventions designed to influence multiple areas of sedentary behavior may provide superior results for behavior change.

Another study conducted in older adults provided insight into the use of behavior change theory and objective measurements (21). Gardiner et al. followed participants, ages 60 years and above, over the course of a two week period (one week for baseline assessment and one week for post intervention effect) in a single sample pre-post research study. Participants were eligible to participate in the study if they reported watching more than 2 hours of television, were not currently employed, and lived within 50 km of the research center. During this time, participants wore an accelerometer to objectively assess sedentary time and the number of breaks in prolonged sitting bouts before and after the intervention. The intervention was comprised of (a) one 45 minute

face-to-face consultation with investigators and (b) a tailored mailing for each participant explaining their accelerometer results as compared with a demographically similar average adult. Consultations included a discussion of accelerometer and self-reported sedentary behavior results, sitting time goals, and other theoretical topics including self-monitoring techniques and strategies to overcome barriers. At the conclusion of this study, researchers found that participants significantly decreased the amount of time they spent sitting throughout the day and significantly increased the number of breaks taken per day. Furthermore, 84.7% of participants achieved the desired decrease in sedentary time by 5.6%, approximately 30 minutes, with 22% of those exceeding this target goal. The program also received favorable satisfaction ratings from 97% of participants.

This study lays the groundwork for behavioral interventions in sedentary behavior. Though the first of its kind this study illustrates the effectiveness of using a theoretical model and the possibility for decreasing sedentary behavior in adults. Another strength of this study is the method of monitoring change. Most studies assessing sedentary behaviors to date have addressed T.V. viewing time alone or used a global subjective measure (i.e. IPAQ), which while valuable, may not provide the most accurate assessment of sedentary behavior. This study objectively evaluated all sedentary behaviors, thus providing a clearer picture of changes in behavior. The authors do however suggest the additional use of an inclinometer to ascertain postural changes as accelerometers cannot differentiate between standing and sitting, both of which may register low activity counts.

One suggested improvement to this study may be to include a measure of change in theoretical constructs. While the theoretical components may have played an integral



part in designing the intervention and changing behavior in this population, this cannot be adequately assessed as investigators did not measure change in these theoretical constructs. Also, because the theoretical constructs were not assessed it is difficult to ascertain which components were more effective for changing behavior. Another issue that was addressed by the authors, similar to Otten and colleagues, is the issue of duration. Participants significantly decreased the amount of time spent in sedentary behaviors; however, this was only seen over a relatively short period of time (six day post-intervention) and no follow-up data were collected. Behavior maintenance is therefore unknown.

Additionally, a study investigating the feasibility of decreasing sitting time in an overweight and obese employee population also showed encouraging results for decreasing sitting time (42). In this small single sample study, researchers monitored 20 participant's sedentary behaviors over a two week period. In an intervention similar to Gardiner et al (21), Kozey-Keadle et al observed participants for seven days, after which participants were given the intervention. The intervention entailed giving each participant information addressing the need to change sedentary behaviors, strategies to reduce sitting time, self-monitoring tools, tips for overcoming barriers, and a pedometer. Participants were then monitored for another 7 day period to assess the impact of the program. Each participant wore an accelerometer and an activPAL inclinometer for the full two week study and completed sedentary behavior questionnaires previous to beginning and after completion of the intervention. In this study researchers found that, according to the activPAL inclinometer, sitting time significantly decreased over the 2 week period (- 4.3%,  $p < 0.05$ ). This change equates to approximately 48 minutes less

sitting per 16 hour day and is similar to those observed by Otten et al. and Gardiner et al. From this study we learn that it is feasible to decrease sitting time in an employee population over a short period of time. We also learn that the activPAL is the most sensitive of objective measures for ascertaining changes in sedentary behaviors. When analyzing the data, Kozey-Keadle et al found that the accelerometers overestimated sedentary time on weekend days by almost an hour when compared to the activPAL. One explanation provided by the authors for this finding is the inability of the accelerometer to differentiate between sitting and standing, which may account for this overestimation. Participants on average increased the percent of time spent standing on weekend days by 7% following the intervention which equates to a little over an hour increase in standing per day. Future studies in sitting-time reduction should therefore use the activPAL when possible to assess changes. Additionally, the authors urge caution should be used with subjective measures. Comparative analysis with the activPAL showed that domain specific questionnaires overestimated sedentary time by an hour while the total sedentary time questionnaire underestimated sedentary time by nearly two hours on weekend days. Having established a foundation for sedentary research, future studies should also look to incorporate a larger sample size. While the study originally recruited 20 participants, only 14 were used in the analysis due to invalid data and equipment malfunctions. Furthermore, investigating health outcomes in relation to decreasing time spent in sedentary behaviors would further aid in understanding the health implications of decreasing sedentary behaviors.

Another study investigating worksite sitting time utilized prompting software on computers to encourage participants to break up sitting time through the day with

generally favorable results (14). In this study, researchers recruited 30 participants from a local university, all of which attended an educational meeting on sedentary behavior and received a pamphlet. Participants were then randomly assigned to either a control or an intervention group. The intervention group received the Point-of-Choice software immediately following the education session. Prompts appeared on participants' computer screen every 30 minutes after turning the computer on and remain visible for one minute. Participants were followed for 5 days before and after the educational session, and all wore an activPAL for this amount of time. Analysis showed that though participants in the intervention group didn't decrease their total amount of time sitting during the day, they exhibited more frequent breaks during that time which has been shown to be beneficial as well.

However there are some limitations to this study, among which are the small sample size and the duration of the study. Evans et al indicate that a bigger sample may be required to see a significant influence on total sitting time. They further indicate that the two samples were not statistically similar which may have confounded the outcome. Similar to the other sedentary behavior interventions discussed, this study was short in duration. As a result of this it is not known whether the changes observed would be continued after the study concluded. Lastly, though incorporating some components of behavior theory, this intervention in regards to behavior change is minimal. Investigators indicate that when the prompt appears, what an individual is able to do on their computer is limited by what windows were already open on the computer screen, in essence forcing them to take a break. Prompt windows cannot be minimized. Similar to the lock-out device employed by Otten and colleagues, this device may be effective in breaking up

sitting time initially, however what behavior is observed after the study concludes is unknown.

These studies have furthered our understanding of sedentary behavior and reasonable expectations for sedentary behavior research despite also exhibiting limitations. Future research should build on these findings to inform interventions in public health settings.

### **STAND UP ASU**

Building on these previous studies, we therefore proposed that a theoretically-driven intervention designed specifically for sedentary behaviors conducted over a ten week period would decrease workplace sitting time in an adult population. We further proposed that these changes in worksite sedentary behaviors would not adversely affect worker productivity.

The primary behavioral target of this intervention was to reduce workplace sedentary behavior by 30 minutes per day. While definitive evidence on the amount of change in sedentary behavior needed to produce substantial health benefit were not known, previous studies have observed that decreasing sedentary time by 30 minutes might improve health perceptions and outcomes (5) and that such a goal is feasible in the course of a day (21). Furthermore, this was a goal similar to the changes observed in the only other behavioral intervention conducted within a worksite, though this was not an explicit goal of that study (42).

The intervention proposed was 10 weeks in duration. Sedentary behavioral intervention studies conducted in the past have featured short intervention periods which

have shown significant decreases in sitting time (21,42). However, none have investigated the ability of participants to sustain this practice over an extended period of time. Both those conducted by Gardiner and Kozey-Keadle entailed a 6 and 7 day follow-up period respectively. Furthermore, Gilson et al (22) found that while sitting time initially decreased in their sample, it progressively increased back toward baseline levels over a 10 week period. Though flaws in the design of this study exist, the results still raise the question as to what can be done to sustain change in sedentary behavior. The current study therefore proposed that the intervention be equally disbursed over a 10-week period to explore whether changes would be maintained over time.

This study further utilized the social cognitive theory (SCT) to guide intervention material development. SCT has been shown to be effective in changing physical activity behaviors in employee populations (29) and was utilized effectively by Gardiner et al (21) in their sitting-time intervention for older adults. A description of how SCT constructs were operationalized can be seen in the following chapter (Table 2). To date, this is the first study to utilize this model in an employee population to specifically decrease sedentary behavior and measure changes in theoretical constructs. The measures used assessed changes in three key constructs of SCT which have been shown to be predictive of change in other health behavior areas. Control materials were derived from reputable sources pertaining to the topic of discussion. Topics addressed included nutrition, stress, sleep, oral health, and cancer screening. Sources included the United States Department of Agriculture (USDA), the American Cancer Society, The Center for Disease Control and Prevention (CDC), and webmd.

**RE-AIM.** When developing a behavioral intervention it is important to consider the ability of the prospective setting to sustain the program once the study is complete. The acronym, RE-AIM, refers to the programs components: Reach, Efficacy or Effectiveness, Adoption, Implementation, and Maintenance (24). Reach refers to the percent of potential participants who would have access to the program and how representative they are of the intended population. Efficacy addresses the impact of the intervention on specific outcomes, both positive and negative. Adoption denotes the extent to which a setting will adopt the program as outlined and how well it fits with current practices. Implementation speaks to the ability of the site to disseminate the program as originally intended. And lastly, Maintenance refers to the programs ability to be continued both by individual participants and organizations over time.

The traditional progression of research has found many successful efficacy trials and relatively few successful effectiveness trials (27). Glasgow et al argue that this may be a result of inefficient program planning at inception. The interventions discussed up to this point are no exception to this rule. While each has adhered fairly well to the model, observing adequate reach and employed effective strategies to elicit change in behavior most have over looked various points in the RE-AIM framework; most notably implementation and maintenance of these programs. In order to ensure a more usable program that could potentially be implemented within the proposed real-life setting, proper planning should begin with the end in mind.

When translating interventions to real-life settings; programs should consider the resources available. The study conducted by Gardnier and colleagues produced significant improvements in sedentary time and the number of breaks observed in the

population, however the personnel necessary to operationalize the program may be difficult for individual communities to maintain on their own. The core of this intervention centered on individual counseling which requires time and training for employees in addition to their original responsibilities. A successful efficacy study, however these parameters may require drastic changes to the protocol in order to successfully translate into effectiveness trials and eventually real-life settings.

Similarly, in the study conducted by Otten et al, no efforts were recorded in regards to behavior maintenance. When evaluating an efficacy trial, Glasgow et al suggest documenting participants' behavior following the study (27). Throughout this study, no instructions were given to change behavior, even after the study concluded and no data recorded as to the likelihood that the behavior might continue. This seems that it would decrease the chances for successful maintenance of the behavior observed. Therefore, as an intervention in regards to behavior, this program may not translate into general use effectively.

Kozey-Keadle et al (42) appear to have most closely addressed this model when developing their program. Though the reach of their intervention was not specified, they utilized highly accessible intervention materials, assessed efficacy through objective measures, and provided ways for subjects to monitor themselves with little cost. One thing that could be improved would be assessing negative impacts of sitting less at work. There is no indication as to what impact this had on their working productivity or physical health. A relatively low key intervention, researchers provided information on health and overcoming barriers, setting goals, and self-monitoring tools. This information is widely available on organizational and wellness websites and therefore low expertise

requirements for organizations in adopting and implementing this program. These precautions may therefore indicate a higher probability of success in future trials.

We therefore proposed the utilization of the RE-AIM evaluation model to address program sustainability and the external validity of our intervention design (25,26). This model addressed issues surrounding the implementation of potential programs which may help to bridge the gap between efficacy trials and effectiveness studies (27). A description of the application of this model to the proposed intervention can be seen in Table 1.

In conclusion, today the opportunities to engage in sedentary behaviors are ever present. Every needful thing from transportation to occupational requirements to entertainment can be done from a sitting position. Furthermore, the clinical consequences of participating in such behaviors contributes significantly to the prevalence of the most common chronic and costly conditions currently observed in the United States. As research continues to discover the negative effect these behaviors are having on the health of the adult population it is essential that effective health promotional programs be developed to combat the societal reinforcement for sedentary behaviors. Studies completed to date provide promising evidence that sedentary behaviors can be decreased voluntarily. However, to this point in time, little is known to what extent these behaviors can be and are maintained. Further research is needed to assess the feasibility of these programs to elicit lasting changes in behavior. Chronic conditions require chronic efforts to combat them.



Table 1. RE-AIM framework description and application

	Definition	Application
Reach	Participation rate among those approached and the representativeness of participants.	Target full-time employees with predominantly sedentary occupations. As of February 2012, 80% of American adults used the internet. In 2009, 70% read or sent email on a daily basis.(Pew, 2012)
Efficacy	The impact of an intervention on specified outcome criteria and includes measures of potential negative outcomes as well as intended results.	10 week study, will address both subjective and objective measures to assess how this change impacts work productivity and satisfaction.
Adoption	The percentage and representativeness of organizations or setting that will conduct a given program. (political and cultural fit, cost, resources and expertise required, similarity to current practices).	The cost of the proposed program is minimal; resources require only access to email (which is prevalent) and occasional research to address participant questions. Email delivery is similar to wellness newsletter currently distributed by the company's wellness program. The number of current ASU employees with sedentary positions is currently unknown.
Implementation	Intervention integrity, or the quality and consistency of delivery.	Program would be easily delivered as proposed as emails are already provided and would require little expertise beyond familiarity with email distribution. Also, information is widely available via the internet for answering participant questions

Maintenance and cost	How well a behavior change holds up in long term and the extent to which a treatment or practice becomes institutionalized in an organization.	Organizational wellness software will be encouraged thus providing continuity after the conclusion of the study and utilization of existing resources. Continuing opportunities to self-monitor behavior will increase probability of maintaining the behavior.
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## Chapter 3

### METHODOLOGY

#### **PARTICIPANTS AND STUDY DESIGN**

##### **PARTICIPANTS**

The study recruited 35 male and female volunteers between the ages of 25-65 years who worked for or near Arizona State University (ASU). Twenty subjects were then selected whom meet the inclusion/exclusion criteria 1) did not smoke, 2) were currently employed in a sedentary occupation, and 3) had successfully completed the Physical Activity Readiness Questionnaire (PAR-Q) clearing them to participate in physical activity. Recruitment strategies included strategically placed fliers posted around the ASU Downtown Phoenix Campus, email advertisements delivered to employees through the Employee Wellness Committee, and word of mouth (Appendix A). All procedures were evaluated and approved by the ASU Institutional Review Board and written consent was obtained from subjects prior to participation (Appendix B).

Subjects were identified by a unique number assigned to them at the beginning of the study. These numbers were used throughout the study. A list of participants names and unique number identifier were kept separate from other data collected and located in the Primary Investigators office to protect participant confidentiality.

##### **Sample Size.**

It should be noted that we were not aware of previous research with a similar intervention type, dosage, or behavioral target, therefore we viewed this pilot project as a necessary initial step to obtain effect size estimates to adequately power a larger trial. Sample size was therefore estimated and intervention goals determined based upon the

intervention target goal of reducing sitting time by 30 minutes/day and change estimates in accelerometer-derived sitting time reductions in the published literature (21).

## **STUDY DESIGN**

The study entailed a randomized experimental research design and spanned 10 weeks. Participants were asked to participate in a study designed to test a worksite intervention to reduce sitting time. Following consent to participate in this study, subjects were randomly assigned to one of two conditions, (1) the intervention group or (2) a health education control group. A familiarization day took place prior to the initial intervention wherein researchers obtained baseline measures, such as weight, height, percent body fat, and a health history. Participants then completed a 30 minute orientation to a walking workstation, (Steelcase Company, Grand Rapids, MI). Sedentary and physical activity behaviors were measured both subjectively through questionnaires (SBQ,59 and IPAQ,58) and objectively with an Actigraph accelerometer (17) and ActivPAL inclinometer (28). An accelerometer and inclinometer were worn for a one week period prior to initiating the intervention and for one week following the intervention. Subjects were also asked to complete surveys on Social Cognitive Theory constructs (pre and post intervention) and office work productivity (post intervention only). Surveys were completed electronically via survey monkey available at the research facility.

## **WORKPLACE SITTING TIME INTERVENTION**

After randomization, participants began receiving weekly emails over the course of the 10 week study, for a total number of 5 e-newsletters and 5 frequently asked question (FAQ) emails on alternating weeks. Those in the intervention group received

emails containing psychosocial materials and other available resources based on constructs of the Social Cognitive Theory (SCT) relating to decreasing sedentary behaviors at work (for an example see Appendix C). A description of how SCT constructs were operationalized can be seen in Table 2. The control group received biweekly emails concerning general health topics frequently addressed in worksite settings (Appendix D). Control educational materials were drawn from authoritative sources pertaining to that week's topic. Examples of sources include the USDA, CDC, and the American Cancer Society. As noted previously, both groups received the identical 30 minute orientation to the walking workstation prior to randomization, as well as accelerometer feedback from both pretest and posttest monitoring periods (Appendix E). Feedback included information on time spent in five activity levels including sedentary, light, lifestyle, moderate, and vigorous, the average number of steps taken per day, how the participants activity relates to national averages, as well as biometric assessments of body composition and blood pressure. At the conclusion of the 10 week period, participants were asked to complete posttest measures of accelerometer and inclinometer data, and questionnaires discussed previously. A visual depiction of the intervention is available in appendix F.

## **PROTOCOLS AND PROCEDURES**

### **PROCEDURES**

The procedures of the study consisted of 1.) Recruitment 2.) Completion of a PAR-Q health questionnaire, 3.) Recording medications and health history 4.) Measuring height (cm), weight (kg), and percent body fat (BIA using Tanita; TBF-300WA, Tanita

corporation of America, Inc., Arlington Heights, Il) 5) Familiarization of inclinometer and accelerometer 6.) Orientation to using the Walking Workstation. 7.) Random assignment to condition. 8.)Administration of SCT and sedentary behavior questionnaires. 9.) dissemination of weekly educational emails for 10 weeks. 9.) Posttest measurement of inclinometer, accelerometer, and final questionnaires. All participation visits were conducted in the walking workstation laboratory in the Nursing and Healthcare Innovation 2 building at Arizona State University downtown campus.

## **MEASUREMENT**

All measures were administered prior to the intervention and immediately following the intervention at 10 weeks..

### **Biometrics.**

Biometric measures were analyzed through various avenues. Height was obtained subjectively through self-report. Weight and percent body fat were assessed with BIA (Tanita; TBF-300WA, Tanita corporation of America, Inc., Arlington Heights, Il). Each measure was taken at two different time points, 1) prior to the intervention and 2) following the completion of the intervention.

### **Actigraph accelerometer.**

Participants wore an Actigraph accelerometer (GT3x+ model; Actigraph, LLC, Fort Walton Beach, FL). Participants were instructed to a) secure the unit over the right hip on a provided elasticized belt, b) wear the device while they were awake, and c) take off the unit for swimming or bathing. Data was collected in the raw format (i.e., 40hz) and summarized to the 60s epoch length. Participants were asked to complete an accelerometer log to verify and cross-check obtain accelerometer data and also to

determine work schedule (Appendix G). Standard procedures were used to identify non-wear periods. Sedentary time was determined by using the standard threshold of  $\leq 100$  counts/min to classify sedentary behavior (17).

### **ActivPAL.**

Participants wore an ActivPAL inclinometer (activPAL3, PAL Technologies Limited, Glasgow, UK). Participants were instructed to a) secure the unit to their mid-thigh, b) wear the device while they were awake, and c) take off the unit for swimming or bathing. Data was expressed as an accumulation of seconds spent in anatomical positions (sitting, standing, or walking). Accelerometer logs were similarly used to ascertain occupational sitting time according self-reported work schedule.

**International Physical Activity Questionnaire.** The short International Physical Activity Questionnaire (IPAQ) consists of 7 questions addressing varying levels of physical activity and one question on sitting time over a 7 day period. This measure has been validated and shown to accurately assess average physical activity and sedentary behavior patterns in adults (9,58).

### **Sedentary Behavior Questionnaire.**

The Sedentary Behavior Questionnaire consists of 2 sections assessing weekday and weekend day behaviors in 9 different sedentary activities. This measure has specific questions tapping work-related sedentary behavior. This measure has been validated and shown to accurately assess sedentary behavior in adults (59).

## **Social Cognitive Theory constructs.**

SCT construct measures were adapted from validated measures within the physical activity domain. We are not aware of currently available SCT-based measures that specifically target sitting time.

**Barrier Self-Efficacy.** Barrier Self-Efficacy (BSE; Appendix H) is a 9-item measure of the confidence participants have in their ability to overcome barriers to sitting 30 minutes less per day at work over a 10 week period. This measure was adapted from a well-validated and commonly used measure in the field (45). Concepts within this measure were designed to target commonly cited barriers to reducing sitting time in qualitative research (23). Scoring for this measure is assessed as a combined percentage to indicate overall confidence.

**Sitting Time Self-Efficacy.** Sitting Time Self-Efficacy (STSE; Appendix I) is a 10-item measure of participant's confidence in their ability to perform the intended behavior, sitting 30 minutes less per day at work progressively, week by week, up to 10 weeks. This measure was adapted from a well-validated and commonly used measure in the field (46). Scores indicate an overall percentage of confidence in the participants ability to perform the behavior.

**Sitting Time Outcome Expectations Scale.** Sitting Time Outcome Expectations Scale (STOES; Appendix J) is a 9-item measure of participants belief in the likelihood and value of sitting less. This measure was adapted from a well-validated and commonly used measure in the field (57). The scale is scored by summing the numerical ratings for each response and dividing by the number of responses. OEE scores range from 1 to 5,



with 1 indicative of low outcome expectations for sitting less, and 5 indicating strong outcome expectations for sitting less.

**Productivity.** Employee perceptions of productivity in relation to decreasing sitting time throughout the day was assessed with an 11-item Likert-type survey designed by the research team (Appendix K), with higher scores indicating higher perceptions of productivity.

#### STATISTICAL ANALYSIS

All data was analyzed using the Statistical Software Package for Social Sciences, Version 19 (SPSS). Frequencies, means, and standard deviations were computed on all variables. Values in the text are expressed as means  $\pm$  the standard deviation (SD), unless otherwise indicated. Data was analyzed for normality ( $p > .05$ ) and deemed normally distributed. Intent-to-treat principles were applied, therefore when no values were available at posttest, baseline values were carried forward. Baseline adjusted analysis of covariance was used to examine whether workday sitting time differed between the intervention and control groups. The alpha level of significance was set at .05.

Table 2. SCT construct application within intervention

Construct	Application	Newsletter
Outcome Expectations	Barriers and health benefits of sitting less at work	Week 1, week 5
Self-Efficacy	Goal-setting and barriers to reach goals	Week 3,5,7,9
Self-Regulation	Goal setting, enlisting support from others, self-monitoring; behavioral feedback	Week 1, 3, 7, 9
Facilitation	Environmental change	Week 5, website
Reciprocal Determinism	encourage to change worksite environment	Week 9

## Chapter 4

### DATA ANALYSIS AND RESULTS

#### **ABSTRACT**

The purpose of this pilot randomized control trial was to test the initial efficacy of whether a 10 week social cognitive theory-based intervention could reduce workplace sitting time (ST). Participants were currently employed adults with predominantly sedentary occupations (n=24) working in the Greater Phoenix area in 2012-2013. Participants wore an activPAL (AP) inclinometer to assess postural allocation (i.e., sitting vs. standing) and Actigraph accelerometer (AG) to assess sedentary time for one week prior to beginning and immediately following the completion of the 10 week intervention to objectively measure ST. Self-reported measures of sedentary time were obtained via two validated questionnaires for overall (International Physical Activity Questionnaire [IPAQ]) and domain specific sedentary behaviors (Sedentary Behavior Questionnaire [SBQ]). Social cognitive constructs were also measured pre and post via adapted physical activity questionnaires. Participants were randomly assigned to (a) 10 weekly social cognitive-based e-newsletters focused on reducing workplace ST; or (b) similarly formatted 10 weekly e-newsletters focusing on health education. Baseline adjusted Analysis of Covariance statistical analyses were used to examine differences between groups in time spent sitting (AP) and sedentary (AG) during self-reported work hours from pre- to post- intervention. Both groups decreased their AP sitting time and AG sedentary time; however, no between-group differences were observed. SCT constructs similarly did not change significantly between pretest and posttest in either group. These results indicate that individualized educational approaches to decreasing workplace

sitting time may not be sufficient for observing long term change in behaviors. Future research should utilize a larger and more homogenous sample of workplaces, measure main outcomes more frequently, and incorporate social and physical environmental factors throughout the intervention.

## **INTRODUCTION**

Rates of diabetes, cardiovascular disease, and some cancers have continually increased over the last 50 years(2,12,13,43,66). Adults spend the majority of their day in activities that require only minimal increases in energy expenditure above basal levels, a trend that has temporally mirrored rising prevalence of obesity and other serious health conditions (38). An observational assessment of a nationally representative sample of the NHANES found that adults in the US accumulated an average of 7.7 hours spent sedentary per day, equating to almost half of the waking day (44).

In addition to insufficient physical activity in all intensities, an increasing body of evidence suggests that excessive and extended periods of sedentary time are deleteriously associated with most chronic diseases even after controlling for amount of time spent in moderate and vigorous physical activity (35). This suggests that simply accumulating 30 minutes of moderate- vigorous physical is not enough to stem the tide of chronic disease in the general population. Some studies have further found even short bouts of light activity may be important in managing conditions related to glucose metabolism including diabetes and CVD (13).

Nowhere is sedentary behavior more encouraged than in the workplace. Over time, occupational opportunities across the country have shifted from physical labor to more stationary, office based positions (18). French et al. assessed this shift in various

employment industries and found active occupations (e.g. farming and masonry) decreased 16% from 1986 to 2000 while those jobs associated with minimal energy requirements (e.g. secretarial and finance positions) increased by 26% during the same time period (18). Furthermore, almost half of the expected growth in employment opportunities over the next ten years will be in jobs associated with office based occupations (37).

A number of strategies have recently been proposed to reduce sitting time in the workplace including walking workstations, sit-stand desks, and behavioral interventions(42,1,65). The results of these interventions show initial promise; however, they have typically been of short duration (7-14 days), lack objective measures of sitting, and have not utilized behavioral theory in their design, despite findings to indicate better results in habitual behavior change come from theoretically based programs (24). The purpose of this study was to test the initial efficacy of reducing time spent in sedentary behaviors in an adult working population through a 10-week, social cognitive theory-based intervention specifically targeting workday sitting.

## **METHODS**

### **Design**

We conducted a randomized controlled trial of a 10-week intervention with pre- and post-intervention measurements of sitting and sedentary behaviors, social cognitive constructs relevant to sitting in the workplace, and productivity-related beliefs in self-reported sedentary working populations. All procedures were evaluated and approved by the ASU Institutional Review Board and written consent was obtained from subjects prior to participation. (see Appendix A).

## **Participants**

The study recruited 35 male and female volunteers between the ages of 25-65 years who worked for or near one of four Arizona State University (ASU) campuses. Twenty subjects were then selected whom met the following inclusion/exclusion criteria: a) did not smoke, b) were currently employed in a sedentary occupation defined as self-reported sitting for “most” of their work day, and c) considered safe to perform physical activity as determined by the Physical Activity Readiness Questionnaire (PAR-Q, 64). Recruitment strategies included strategically placed fliers posted around the four ASU Campuses and two University of Phoenix campus locations, email advertisements delivered to employees through the ASU Employee Wellness Committee and employee social media websites (Appendix B and C). Participant flow is described in Figure 1.

## **Measures**

All measures were administered prior to the intervention and immediately following the intervention at 10 weeks. Postural allocation (i.e., sitting vs. standing) was measured using the ActivPAL inclinometer (activPAL3, PAL Technologies Limited, Glasgow, UK). Sedentary time was measured using the Actigraph accelerometer (GT3x+ model; Actigraph, LLC, Fort Walton Beach, FL). Both devices were worn concurrently for one week both prior to receiving the intervention and immediately following the completion of the 10 week intervention. Participants were also asked to complete a daily log to determine work schedule and verify obtained inclinometer and accelerometer data (Appendix G). The commonly used procedure of 60 consecutive zeros was used to identify non-wear periods in the actigraph (68). Wear time in the activPAL was assessed visually via counts registered during active bouts throughout the day (50). Sedentary time

measured by the accelerometer was determined by using the standard threshold of  $\leq 100$  counts/min to classify sedentary behavior (17). Participants also self-reported sedentary behavior via the shortened version of the International Physical Activity Questionnaire (IPAQ, 9) and the Sedentary Behavior Questionnaire (SBQ, 38) to assess overall and domain-specific sedentary behavior, respectively. Both measures have been validated and shown to accurately assess average physical activity and sedentary behavior patterns in adults (9,58). Social-cognitive theory constructs were measured through surveys adapted from validated measures within the physical activity domain including task self-efficacy for sitting less at work (adapted from McAuley, 46), barriers self-efficacy for sitting less at work (adapted from McAuley and Courneya, 45), and outcome expectations for sitting less at work (adapted from Resnick et al, 57). Internal consistency of these measures was .996, .886, and .937, respectively. Lastly, employee perceptions of productivity attributed to decreased sitting time was also assessed with an 11-item Likert-type survey designed by the research team at post-test only (Appendix K).

### **Interventions**

The intervention consisted of a one day orientation to the walking workstation, 5 bi-weekly e-newsletters (delivered by email) specifically targeting workplace sitting behaviors, 5 bi-weekly FAQ's, and access to a study website for intervention content, latest sedentary behavior research, and links for tools for decreasing sitting time at work. Each newsletter addressed key social cognitive constructs (e.g. self-efficacy, outcome expectations, self-regulation, and facilitation) See Table 2 for additional detail. Participants in the control group received similar e-newsletters delivered by email regarding general health topics un related to physical activity including dental health,

cancer screenings, and sleep behaviors. Information for these e-newsletters was drawn from national websites for their respective areas (e.g. cdc.gov).

### **Statistical Analyses**

All data were analyzed using the Statistical Software Package for Social Sciences, Version 19 (SPSS). Frequencies, means, and standard deviations were computed on all variables. Values in the text are expressed as means and standard deviations (SD), unless otherwise indicated. Data was analyzed for normality ( $p > .05$ ) and deemed normally distributed. Intent-to-treat principles were applied, therefore when missing values were present at posttest, baseline values were carried forward. Average sitting and sedentary minutes per day were standardized to an 8 hour work day to account for differences in total work time. The equation (standardized 8-hr day minutes = number of observed sedentary or sitting minutes \* 480 / number of total work time minutes observed) Healy et al (36) employed was utilized for this calculation. Baseline adjusted analysis of covariance was used to examine whether outcome variables (sitting time, sedentary time, and social cognitive constructs) differed between the intervention and control groups at posttest. The alpha level of significance was set at .05. Magnitude of effect sizes were assessed as small, medium, and large ( $\eta^2 = 0.01, 0.06, \text{ and } 0.14$  respectively, 73)

### **Results**

Participants were generally middle-aged, white females who were overweight, had completed college, and were currently working in “professional” positions (Table 3). Most participants reported having “average” health or better. Despite utilizing a randomization design there were some significant demographic differences between groups. Participants in the intervention group were found to have significantly lower



pretest body mass index on average than the control group. Additionally, the intervention group was composed of significantly more “official and managerial” level individuals. Pretest inclinometer monitoring found that the current sample sat an average of 6.35 hours per 8-hour workday at pretest, while accelerometer data identified an average of 6.07 hours of sedentary time over a standardized 8-hour workday (Table 4). Pretest values on all outcome variables did not differ significantly between groups. When assessing the extent to which the intervention was delivered as described, participants were asked to complete a short survey regarding the contents of the newsletter. Analysis revealed that intervention participants read an average of 3.6 of 5 e-newsletters (73.8%) where the control group read an average of 2.5 of 5 e-newsletters (50%), these differences however were not significant.

Both groups modestly decreased their time spent sitting at work as measured by the Activpal inclinometer (Table 5 and Figure 2). Between-group differences indicated the intervention group decreased their sitting by 5 minutes more than the health education control. This was only marginally significant ( $p=0.06$ ), and the magnitude of this effect was small to medium ( $\eta^2=0.06$ , 72). Results indicated both groups also modestly decreased their sedentary time at work as measured by the Actigraph accelerometer, with a medium effect size ( $\eta^2=0.10$ ) . (Table 5 and Figure 3). Between-group analysis indicated no significant differences were observed. Self-reported sedentary time during work related activities however showed no decrease in sedentary time and were not significantly different between groups or by time (Figure 4).

Analysis of SCT construct found no significant changes overtime for either group (Table 6). Similarly, between-group analysis found no significant difference, with

modestly lower scores at posttest for both groups. The effect size for this analysis however was extremely small for all measures ( $\eta^2=0.0$ ).

Post-test assessment of productivity and acceptability of the intervention found that 92% of the intervention group participants found the overall intervention to be acceptable. The majority of participants in the intervention group felt that sitting less increased or highly increased the focus (80%), quality (70%), and productivity (70%) of their work as compared to 50% of the control group, who felt that sitting less had no impact on their work performance (Figure 5). Chi squared analysis found that response rates did not differ significantly between groups for any of the four items assessing work productivity or workplace satisfaction (Table 7).

## **DISCUSSION**

The purpose of this study was to assess the efficacy of a 10 week theory based intervention to decrease sitting time at work. In summary, we found that an individual level approach to decreasing sedentary behavior at work did not significantly reduce sitting or sedentary time as measured objectively or by self-report. Additionally, perceptions of workplace satisfaction and productivity did not differ between groups and theoretical constructs were not significantly affected by the intervention. These results suggest that educational awareness and individualized approaches to decreasing worksite sitting time may not be sufficient to produce long-term behavioral changes in workplace sitting. A variety of factors may have contributed to this result including limited access to standing and walking alternatives, limited social support, and methodological concerns.

Though recent studies of sedentary behavior utilizing individual-focused behavioral change theory and have found favorable results, these studies have been of

short duration and did not assess change to theoretical components. In their study of older adults, Gardiner et al (21) employed behavioral theory via individual counseling addressing goal setting, self-monitoring, and overcoming barriers, as well as tailored feedback from monitoring periods. Participants were observed for a total of two weeks, one week for pretest and one week for posttest. Primary outcomes observed were total sedentary time and the number of breaks observed per day. While the behavioral components are similar to those employed in the current study, both the intervention described and duration of the study were substantially shorter than the current study. To our knowledge, no further monitoring was completed in these subjects therefore the extent to which these changes persisted is unknown. Furthermore, though theory was utilized in planning the program it is unclear as to whether the proposed activities impacted the proposed theoretical constructs.

A second study utilizing behavioral theory and a population similar to our study was completed by Kozey-Keedle et al (42). Participants in this study were overweight and obese office workers from a single department and observed for two weeks. Again, researchers observed significant decreases in percent of time spent sitting, however this was over the full waking day and included behaviors at home and in transportation as well as at work. Once again, this study utilized a single sample design wherein no control groups were observed and no follow-up assessments completed. Both of these studies indicate preliminary support of the efficacy of short interventions to provide short term change but no knowledge of chronic behavior. Short term interventions do not necessarily translate into sustained habitual behavior. In comparison to the studies discussed here, the current study utilized similar techniques and tools to influence change

targeting SCT constructs (including goal setting, educational information about sitting less, overcoming barriers, self-monitoring, and providing quantitative feedback) however the intervention was spaced over a longer period of time providing repeated reminders to sit less at work. Additionally, a comparison group was employed to assess differences between acute and chronic exposure to sitting less at work. Furthermore, as the intervention targeted workplace behaviors, researchers focused on changes during the work day as opposed to all waking hours.

Though the current study exhibits some limitations, lasting changes may be better obtained when social and physical environments support the proposed change. Social cognitive theory and the social ecological model both propose that the surrounding environment plays a large part in habitual behaviors (24). Decades of technological improvements and production deadlines have ingrained in the workforce a belief that in order to be a good employee they must be at their desk (23). A qualitative study of workplace behaviors found the second most common reason for worksite inactivity was pressure to complete tasks timely and efficiently. Providing walking or standing alternatives to traditional workplace furniture in close proximity has shown acceptability and favorable results in decreasing sedentary time in the workplace(1,65). However, novel interventions may not be enough, as individuals are reluctant to leave their desk area. Both groups for this study were exposed to the use of and given access to walking workstations on their respective campuses, however neither group experienced significant decreases in sitting or sedentary time nor returned to the work stations. This may be in part to the distance between their office and the available stations. While the intervention as currently described was met with general approval, most participants expressed a

desire to have had more ready access to a walking workstation, expressing beliefs that if one had been more readily available they would have used it more. However access without understanding would also not produce the desired results. Convenient physical accommodations to promote activity and decrease prolonged sitting in concert with education based interventions may therefore provide superior results to those presently observed.

Furthermore, social environments, or more specifically managerial and coworker support, may similarly provide extra aid in facilitating change. Qualitative interviews with intervention participants revealed that some of those with the easiest access to a walking workstation were prevented the opportunity from utilizing the stations due to denied permission from supervisors or perceived inability to leave their desk. Conversely, those who reported supportive superiors exhibited the greatest enthusiasm and creativity in changing behaviors, some going so far as petitioning their department for a communal walking workstation in their work area and fashioning their own standing desks.

Additionally, individual participants within this study were recruited from a variety of departments and campuses resulting in a lack of coworker support. Future interventions may therefore wish to consider both physical and social environmental components when designing programs and gaining administrative support.

**Future Considerations.** This study exemplifies some limitations including a small sample size, infrequent monitoring, and limitations in monitoring methods.

The small sample size may have inhibited our ability to detect statistically significant changes. As a pilot study and one of the first to investigate longer term change in sedentary behavior the sample size may not have been sufficiently large to

observe a statistically significant change. However, larger studies in sedentary behavior change research have found 30 minutes to be a statistically significant cut point. The current results indicate decreases of only half this time. Therefore, a larger study may have still not found a significant decrease at ten weeks. However future studies should aim to utilize a larger sample.

Additionally, an assessment of behavior midway through the intervention may have allowed a clearer picture as to whether the intervention elicited a more dramatic change initially in behavior. Previous studies in physical activity at work have indicated that participants initially increased their physical activity early in the intervention (weeks 1-3), however by the conclusion of the intervention (week 10) participants had regressed towards baseline levels (22). Having not monitored behavior at some point between pretest and posttest, it is unknown if any change occurred.

Lastly, previous “non-wear” algorithms may introduce a new issue for sedentary behavior monitoring. Though the same self-reported log of work hours was used for both ActivPAL and accelerometer data, the total minutes of observed time reported did not match for all participants. Upon closer inspection it appears that accelerometer algorithms excluded some times during which the participants reported wearing the devices in the middle of the day as “non-wear”, the devices having accumulated 60 consecutive zeros. When comparing these times to self-report logs and activPAL data it appears the devices were in fact being worn. This resulted in at least 60 minutes of sedentary time incorrectly excluded from analysis in a number of participants. Researchers should therefore be aware and consider the extent to which these algorithms are utilized when assessing sedentary behaviors if they choose to use these devices.

This study exhibits a number of strengths including the use of a theory to guide program design, a longer duration of observation, and the use of accurate objective measures of sitting time.

The use of theory in this intervention is a strength as research has shown superior results are obtained and maintained when based on current understanding of the behavior and its determinants (24). Previous attempts to decrease sedentary behavior have featured a wide variety of methods for eliciting change however few have utilized behavioral theory and even fewer have assessed whether the program influenced any theoretical constructs.

Secondly, this is one of the first studies to assess the long term influence of sedentary behavioral interventions. To date only one additional study has been published to our knowledge that has assessed a behavioral theory based interventions impact beyond 14 days (36). This is important as the eventual goal of most, if not all, behavioral interventions targeting habitual behaviors is to incite maintained change.

Lastly, a strength of this study is the use of objective methods for assessing sedentary and sitting time at work. Sedentary research in the past has typically featured subjective self-report measures. As was observed here, these measures while providing a general idea of behavior are not sensitive to small changes which can represent significant improvements in health outcomes over time (13). Furthermore, the use of an accelerometer and the activPAL combined allows for accurate assessment of all facets of participants active and sedentary behaviors in a free living environment such as the home and workplace.

Though the present study exhibits some limitations it also provides valuable information for moving forward. Future researchers should take into consideration the information found in regards to “non-wear” algorithms utilized in accelerometer devices. The extent to which these algorithms exclude actual sedentary time may skew results if not appropriately applied. Secondly, habitual behaviors in the workplace require more than simply increasing awareness and individual information. Though individualized programs are effective in eliciting initial change, changing the environment, especially one so focused on efficiency as opposed to health, may be equally if not more important for behavior change. In qualitative interviews following the completion of the programs participants expressed high acceptability of the intervention and many requested further information to aid in “bottom up” approaches to policy and environmental changes in their work environment. Though assessment of worksite policy is beyond the scope of this study, it is encouraging that participants would take the message of this program to heart in lobbying for change individually which may further facilitate greater change in the future.



**Table 3. Demographic Information**

	Health Education	Intervention	Total
N	11	13	24
Gender (% Female)	50.0	50.0	16
Age, M (SD)	47.2 (13.5)	44.2 (12.5)	45.5 (12.7)
Race			
White (%)	81.8	69.2	75.0
Black (%)	9.1	7.7	8.3
Other (%)	9.1	23.1	16.7
Hispanic or Latino (%)	18.2	15.4	16.7
Body mass index, M (SD)	30.6 (5.0)*	24.1 (3.0)	26.9 (5.1)
Systolic BP, M (SD)	124.5 (10.9)	119.4 (14.1)	121.5 (12.8)
Diastolic BP, M (SD)	75.0 (7.3)	81.1 (9.1)	78.5 (8.7)
Education			
Some college or vocation (%)	10	7.7	8.7
Completed college or university (%)	90.0	92.3	91.3
Job Classification			
Officials/Managers (%)	20.0	25.0	22.7
Professionals (%)	30.0	66.7	50
Administrative Support (%)	50.0	7.7	27.3
Self-rated health			
Good-Excellent (%)	50.0	62.0	56.0
Average (%)	50.0	30.0	39.0
Fair-Poor (%)	0.0	7.9	4.3

\* Differences between groups were significant at the 0.05 level

**Table 4. Pretest Sedentary Behavior**

	Health Education (n=11)	Intervention (n=12)	Total
Activpal inclinometer			
Minutes of sitting at work†, M (SD)	393.1 (55.5)	371.0 (49.1)	381.6 (52.0)
% sitting time at work, M (SD)	81.9 (11.6)	77.1 (10.2)	79.4 (10.9)
Actigraph accelerometer			
Minutes of sedentary at work‡, M (SD)	364.5 (36.0)	364.2 (40)	364.4 (37.3)
% sedentary time at work, M (SD)	75.9 (7.5)	75.9 (8.3)	75 (7.8)
Self-reported measures			
Minutes of sitting at work¥, M (SD)	360 (174.3)	360.0 (178.1)	360.0 (171.7)
Minutes of overall sedentary time€, M(SD)	561.8 (211.7)	537.6 (126.3)	548.7 (167.2)

†Standardized minutes of work= number of observed sitting minutes during workday \* 480/  
Number of total observed work day minutes.

‡ Standardized minutes of work= number of observed sedentary minutes during workday \*  
480/ Number of total observed work day minutes. Sedentary defined as <100 cpm

¥Measured by the Sedentary Behavior questionnaire<sup>38</sup>

€Measured by the International Physical Activity questionnaire<sup>37,39</sup>

**Table 5**  
**Mean (SD) workday sitting and sedentary time over a standardized 8-hour day at pre and post test**

Variable	Control (n=10)	Intervention (n=12)	F	<i>p</i>	Eta Squared
Minutes of workday sitting Time			3.8	0.06	0.06
Pretest <sup>a</sup>	393.1 (55.5)	371.0 (49.1)			
Posttest	383.9 (60.2)	356.3 (69.6)			
% of workday sitting time			3.8	0.06	0.06
Pretest <sup>a</sup>	81.0 (11.6)	77.1 (10.2)			
Posttest	79.9 (12.6)	74.2 (14.5)			
Minutes of workday sedentary time			3.0	0.10	0.10
Pretest <sup>b</sup>	364.0 (36.0)	364.2 (40.0)			
Posttest	358.2 (26.1)	361.8 (50.3)			
% of workday sedentary time			3.3	0.08	0.13
Pretest <sup>b</sup>	75.9 (7.4)	75.9 (8.3)			
Posttest	74.4 (5.5)	75.0 (8.7)			
Self-report work related sedentary time			0.7	.40	.09
Pretest	360 (48.9)	360 (22.6)			
Posttest	360 (122.9)	360 (40.0)			

ANCOVA models were adjusted for baseline values

a. Two Individuals did not have pretest values (1 control, 1 intervention)

b. One Individual did not have baseline values (1 control)

**Table 6**  
**Mean (SD) social cognitive construct measurement scores at pre- and posttest**

Variable	Control (n=10)	Intervention (n=12)	F	<i>p</i>	Eta Squared	Cronbach's Alpha
Task Self-Efficacy			0.0	0.84	0.00	0.99
Pretest <sup>a</sup>	84.4 (32.4)	78.8 (22.8)				
Posttest	72.8 (34.4)	67.9 (24.8)				
Barrier Self-Efficacy			0.1	0.7	0.00	0.88
Pretest <sup>a</sup>	74.9 (24.0)	64.4 (22.3)				
Posttest	55.6 (30.9)	65.6 (24.1)				
Outcome Expectations for sitting less at work			0.1	0.78	0.00	0.93
Pretest <sup>a</sup>	4.5 (0.5)	4.2 (0.6)				
Posttest	4 (0.6)	4.1 (0.6)				

ANCOVA adjusted for baseline values

a. One individual did not have pretest values (1 control)

**Table 7. Percent of participants who responded with "increase" or "highly increase" on the productivity and acceptability survey**

Variable	control	intervention	chi <sup>2</sup>	<i>p</i>
Work satisfaction (%)	55.6	60.0	0.038	0.845
Work focus (%)	66.7	80.0	0.434	0.51
Productivity (%)	33.3	70.0	2.554	0.11
Work quality (%)	44.4	70.0	1.269	0.26

Figure 1. Participant Flow Diagram

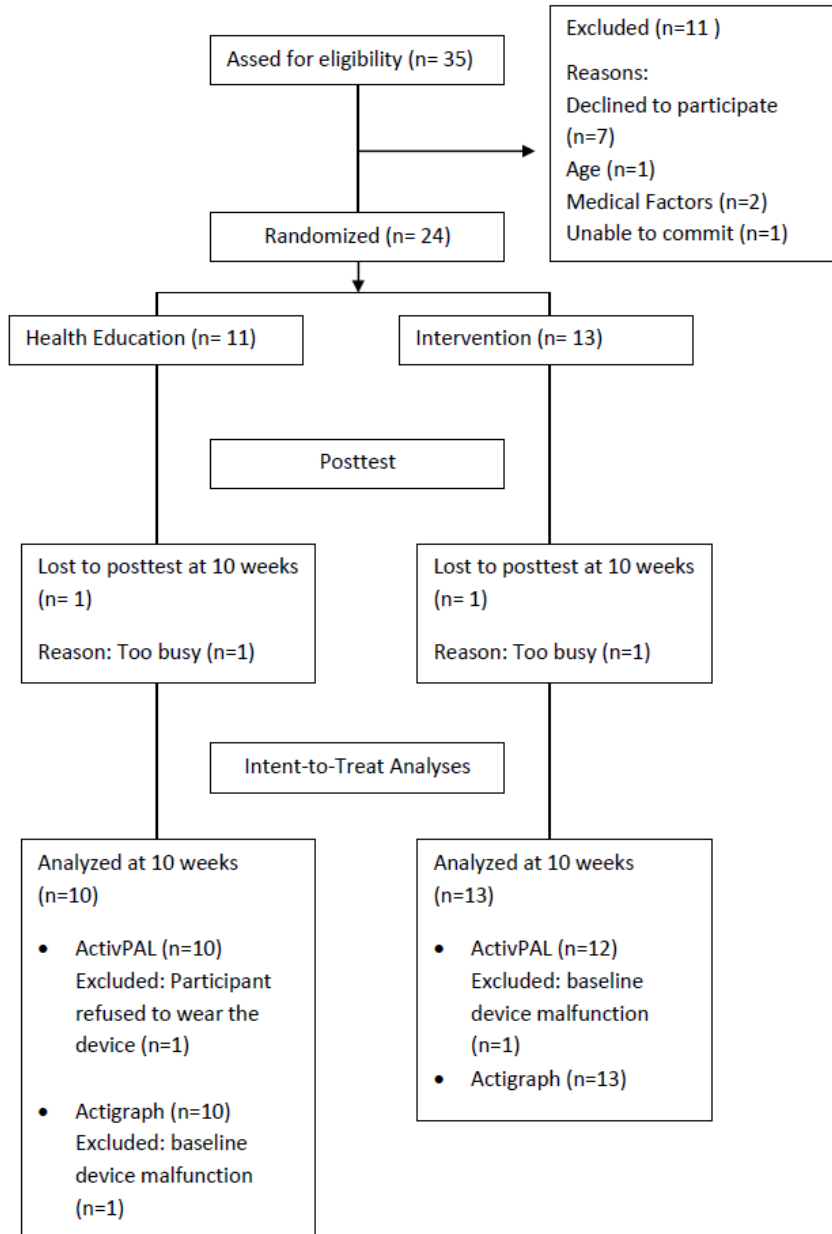
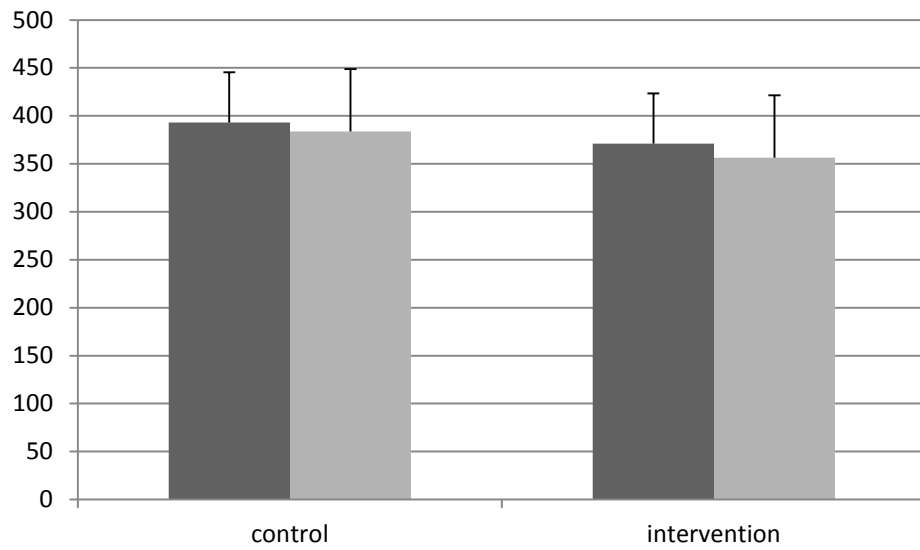
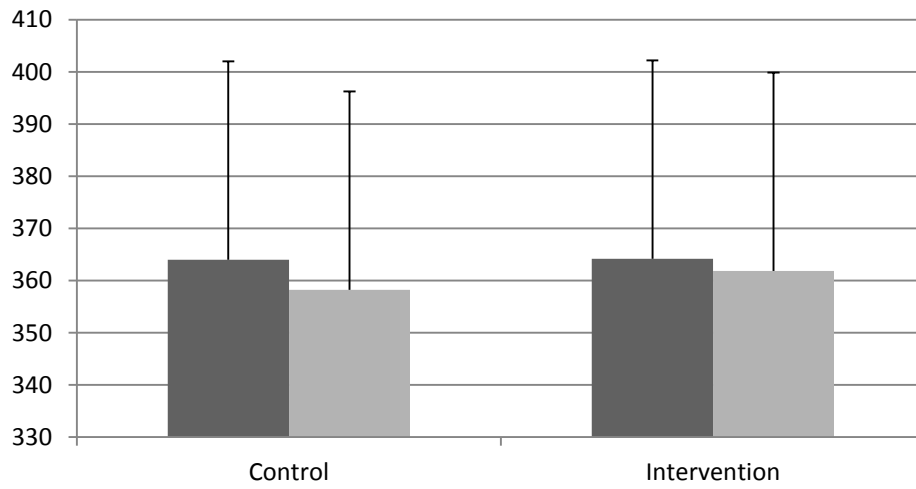


Figure 2. Difference in standardized minutes of sitting time at work over an 8-hour workday by time



Dark gray bars: Pretest, Light gray bars: Posttest

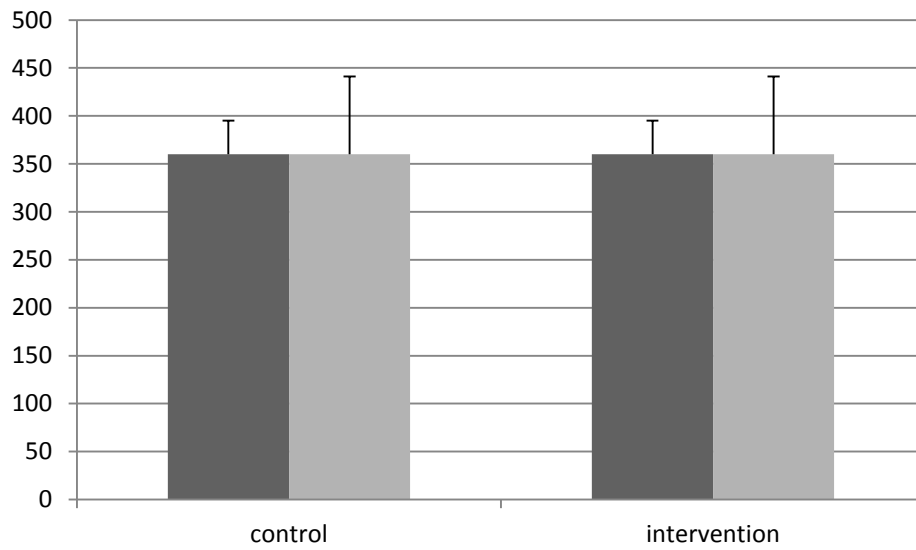
Figure 3. Difference in standardized minutes of sedentary time at work over an 8-hour workday by time



Dark gray bars: Pretest, Light gray bars: Posttest

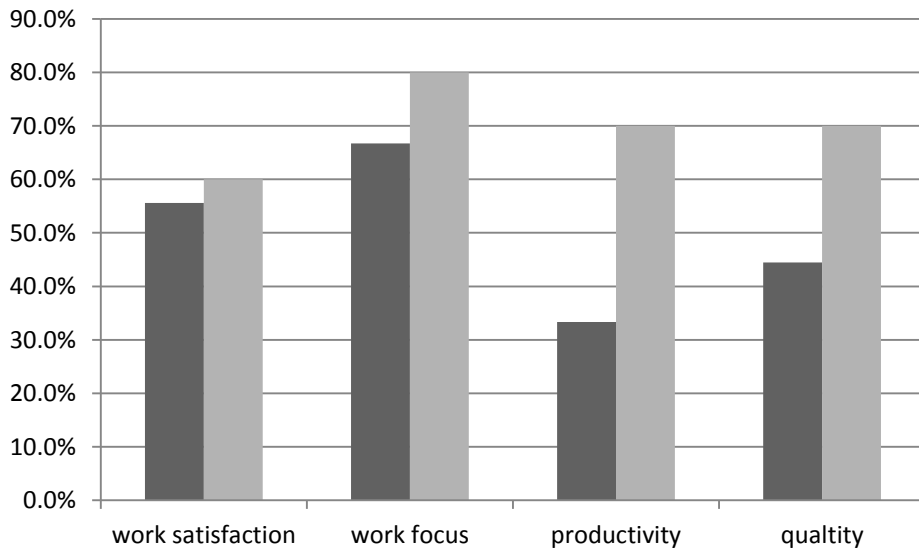


Figure 4. Difference in self-reported sedentary time at work by time (SBQ)



Dark bars: pretest, Light bars: posttest

Figure 5. Between group responses to productivity and acceptability survey



Dark gray: Control group, Light gray: Intervention group

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## Chapter 5

### DISCUSSION

The purpose of this study was to assess the efficacy of a theory based intervention to decrease sitting time at work over a 10 week study. Sitting less at work is important because research indicates excessive amounts of prolonged sitting are deleteriously associated with a number of chronic conditions and poor glucose metabolism. Adult sedentary behaviors are most commonly encouraged in the workplace where an average of 8 hours is spent per day. Thus the worksite represents a key target for initiating change in the area of adult sedentary behavior. Overall, we found an individual level 10 week intervention produced modest decreases in workday sitting and sedentary time. However these differences were not significantly different between groups. Additionally, analysis found no differences were significant for measures of productivity and acceptability. Additionally, no significant changes or differences were observed between groups or by time in SCT constructs.

We found that an individual-level 10 week social cognitive theory based intervention targeting sedentary behaviors at work was not sufficient to induce a statistically significant decrease in sedentary behavior during the average work day. This modest decreases in sitting time for both groups suggests that increased awareness is a good start to decreasing sedentary behavior in the worksite. However, these decreases were not statistically or clinically significant. While a small sample size may have impacted our results, previous work with larger samples found a 30 minute decrease was needed to achieve statistical significance (24,25). The rates observed here were only 1/3

and 1/2 of this decrease which may indicate that even given a larger sample these findings would still not have been significant.

However, research indicates that even these small decreases in sitting time may still benefit some health outcomes (1). In their study of postprandial glucose responses to light intermittent activity, Dunstan et al found that even short 2 minute light activity walking breaks every 20 minutes significantly reduced blood glucose over a five hour work day. The observed effect in this study of normal weight individuals was equivalent to one acute bout of moderate intensity aerobic activity in overweight and obese individuals which has been shown to significantly improve health outcomes. In this context we estimate the observed decreases in sitting time from this study equates to a 12% decrease in blood insulin and glucose and therefore modestly improved metabolic control. In addition to the acute improvements observed, habitually taking short breaks throughout the day may impact the development of diabetes and cardiovascular disease via protection of beta cell and endothelial function, over time (1). Therefore, despite a statistically insignificant decrease in sitting time, the changes observed in this study if maintained may have lasting impact on the development of CVD and diabetes.

In light of the insignificant change in sitting time it appears likely the intervention intensity may have been insufficient given the heterogeneous workplaces involved and the extended duration of the study. One of the central components of social cognitive theory is the idea of reciprocal determinism, meaning factors from a variety of spheres play a part in instigating and maintaining change. In this case researchers hypothesize that an intervention which targets not only the individual, as was done here, but the social and physical environments may elicit a greater and more significant change in long term

sitting behaviors at work. Qualitative studies in employee perceptions found that employees who know that their superiors support and or encourage taking standing and or walking breaks may be more likely to practice these behaviors (65). Similarly, given a physical environment where standing is possible without incurring injury from improper mechanics, such as hunching over a desk to see a screen while standing may further encourage standing and stepping behaviors.

We also found no difference in sedentary time as measured by the Actigraph accelerometer. An inherent drawback to the use of accelerometry in sedentary behavior research may be at the root of this observation. Literature regarding AG validation has found the device to be relatively insensitive to changes in low levels of light activities such as differentiating between sitting and standing (28). Another concern identified in our analysis is the unreliability of the non-wear algorithms for assessing sedentary time. Close inspection of these data found that this algorithm when set at the traditional cut point of 60 consecutive zeros (71) may in fact remove valid sedentary time from the analysis, classifying it as “non-wear time”. When comparing actigraph results to both activPAL data and self-reported work and wear time logs it was found that at least 60 minutes of wear time was removed from a number of participants during their reported work day due to extended periods of minimal movement. This calls into question the reliability of utilizing these algorithms in sedentary research to define wear times. This is consistent with other studies investigating the usefulness of these cut points and algorithms. In their study of optimal non wear algorithms for sedentary behavior research Choi et al found that increasing the cut point to 90 consecutive zeros provided a more accurate analysis of sedentary time.



Self-reported sedentary time as measured by the SBQ also yielded a non-significant result. Despite modest decreases in objectively measured sitting time, self-reported time did not decrease for either group suggesting that self-report variables may not be sensitive enough to detect such small decreases in sedentary working behaviors.

Though changes observed both objectively and subjectively were not as expected, the current study may inform future studies in sedentary behavior research. Researchers should implement a third time point midway through the intervention for measuring major outcomes to assess any initial change and possible regression to the mean. The current sample provides evidence to support more intense behavioral interventions to decrease sitting time as well as the need to better educate the general population regarding the hazards of sedentary behavior and encouraging sitting less throughout the day.

To explore suitability and acceptability for future implementation in worksites, information was assessed regarding the impact this intervention may have on possible workplace outcomes of interest to employers, including three items regarding productivity and one item assessing workplace satisfaction. Analysis of responses to the productivity and acceptability assessment indicated that intervention participants perceived sitting less significantly increased their focus at work ( $p=.004$ ). Other productivity items exhibited modest differences between groups for work quality and overall productivity. Despite these differences, variations between groups were not statistically significant. We therefore cannot definitively state whether a sedentary behavior intervention has any positive impact on perceptions of workplace productivity. However, all participants reported either “no impact on” or a variation of “increases”

productivity indicating that instigating this program had no negative consequences in perceptions of productivity. This is consistent with our proposed primary hypothesis that no differences would be observed between groups in relation to workplace productivity. Though more work is needed to fully understand the extent to which these perceptions might translate into actual productivity and quality. Studies investigating hard outcomes of workplace specific productivity and quality would provide greater support for translating this program to other worksite settings.

However, contrary to our secondary research hypothesis, no significant differences were observed in workplace satisfaction between groups as approximately 50% of participants in each group felt sitting less increased their satisfaction with their work ( $p=0.10$ ). While the inverse of expectations this initially suggests that individualized behavioral interventions may not significantly increase morale more than a novel short term intervention.

As work continues to be done in the area of sedentary work environments, employers will wish to see quantifiable improvements in worksite outcomes. Researchers should therefore look into identifying and utilizing industry specific measures of productivity over longer durations. As with sedentary behavior interventions in the worksite, productivity assessments to date have typically been of short duration, assessing difference over hours or days rather than months. Over the duration of our study as participants theoretically tried to sit less they eventually reported *feeling* that sitting less would or did actually impact their *perceptions* of productivity. Whether these changes are factual or perceptual should be assessed in the future. Additionally, they may provide a key point in employee maintenance and satisfaction in addition to production

outcomes as improved perceptions of ability to perform job specific obligations may also increase workplace satisfaction.

In efforts to further understand the constructs behind sedentary behavior, the current study utilized novel measures of behavioral change constructs related to sedentary behavior to assess their impact on change. The following section will address changes in constructs between time points and their association with decreasing sedentary behavior at work.

Analysis of three new measures of SCT constructs related to sedentary behavior found no significant differences between groups when accounting for baseline assessments. Contrary to the proposed hypothesis, the intervention group produced a lower score for both SE measures at posttest on average than the health education control. One hypothesis as to what has been observed is a ceiling effect wherein baseline assessments were so high that any changes could not be adequately assessed at posttest. Cronbach's Alpha scores supported this theory as analysis on both time points produced extremely high values for each of the three assessments.

A secondary theory is that general beliefs about changing sedentary and sitting behaviors would not be difficult thus producing high self-efficacy scores at baseline. However after increasing awareness of actual sitting time and making attempts to change that behavior, participants realized that habits and perceptions have become so ingrained within the working culture that alterations to these behaviors is not so simple. This realization may therefore have resulted in lower self-efficacy for both the task itself and overcoming barriers to sitting less.

This is important for researchers and program designers to understand in order to more fully understand what participants will face and what the trend is between sedentary behavior and behavior change theory. Much has been done in the field of physical activity and other health behaviors, however as a new paradigm for health promotion more assessments need to be completed to understand how to influence and facilitate changing this behavior. While this study was unable to find significant changes in these constructs it provides a baseline for improving theoretical applications to sedentary behavior. Furthermore, we can infer that similar to physical activity, increasing self-efficacy may be essential for decreasing sedentary behavior at work as neither outcome changed in the direction or proportion expected.

#### **Future Considerations.**

This study exemplifies some limitations including a small sample size and infrequent monitoring. The small sample size may have inhibited our ability to detect statistically significant changes, however the small magnitude of the effect suggests that sample size was in and of itself not the reason for non-significant results. As a pilot study and one of the first to investigate longer term change in sedentary behavior the sample size may not have been sufficiently large to observe a statistically significant change. Future studies may therefore wish to utilize a larger sample.

Additionally, an assessment of behavior midway through the intervention may have allowed a clearer picture as to whether the intervention elicited any change in behavior. Previous studies in physical activity at work have indicated that participants initially increased their physical activity early in the intervention, however by the conclusion of the intervention they had regressed towards their baseline levels (42).

Having not monitored behavior at some point between pretest and posttest it is unknown if any change occurred.

Though the present study exhibits some limitations it also exhibits a number of strengths and provides valuable information for moving forward. Some of the strengths found within this study are the use of a theory to guide program design, a longer duration of observation, and the use of accurate objective measures of sitting time.

The use of theory in this intervention is a strength as research has shown superior results are obtained and maintained when based on current understanding of the behavior and its determinants (58). Previous attempts to decrease sedentary behavior have featured a wide variety of methods for eliciting change however few have utilized behavioral theory and even fewer have assessed whether the program influenced any theoretical constructs.

Secondly, this is one of the first studies to assess the long term influence of sedentary behavioral interventions. To date only one additional study has been published to our knowledge that has assessed a behavioral theory based interventions impact beyond 14 days (36). This is important as the eventual goal of most, if not all, behavioral interventions targeting habitual behaviors is to incite maintained change.

Lastly, a strength of this study is the use of objective methods for assessing sedentary and sitting time at work. Sedentary research in the past has typically featured subjective self-report measures. As was observed here, these measures while providing a general idea of behavior are not sensitive to small changes which can represent significant improvements in health outcomes over time (1). Furthermore, the use of an accelerometer and the activPAL combined allows for accurate assessment of all facets of

participants active and sedentary behaviors in a free living environment such as the home and workplace.

In regards to the future, researchers should take into consideration the information found relating to the “non-wear” algorithms utilized in accelerometer devices. The extent to which these algorithms exclude actual sedentary time may influence the veracity of results if not appropriately applied. Secondly, habitual behaviors in the workplace may require more than simply increasing awareness and individualized information. In qualitative interviews following the completion of the program participants expressed high acceptability of the intervention and many requested further information to aid in “bottom up” approaches to policy and environmental changes in their worksite, citing a desire to have physical access to alternatives to sitting at a desk all day. Though assessment of worksite policy was beyond the scope of this study, it is encouraging that participants would take the message of this program to heart in lobbying for change individually, which may further facilitate greater change in the future. Though individualized programs have been effective in eliciting initial change, additionally changing some aspect of the environment, especially one so focused on efficiency as opposed to health, may be equally if not more important for lasting behavior change in the workplace.

In conclusion, an individual level theory-based sedentary behavior intervention may result in minimally superior decreases in sitting time at work compared to a health education control, however for significant decreases to be seen over time a more intensive intervention is suggested. Such programs may also provide slight improvements in work productivity, though insignificant it would not detract from daily productivity

outcomes. Similarly, SE may or may not be related to decreasing sitting time as the general sample appears to have an alarmingly high SE for both the task itself and overcoming barriers despite only seeing minimal changes in objectively measured outcomes. More research is needed to fully understand this relationship. This program was found to be acceptable to participants and many stated they would participate in a similar program again as well as suggest it to colleagues and coworkers thus supporting continued use of a variation of this program in the future.

As the science continues to build and more is understood of sedentary behavior and its affiliated influence on health, researchers continue to look for “best practices” to implement in various environments. Building on what has been previously found, this study adds to that body of knowledge in suggesting that multicomponent approaches to habitual behaviors may provide the greatest support in facilitating lasting changes to sedentary behavior during the work day. Modest decreases though they may be, the results of this study suggest that it is possible to decrease sitting time at work. When we spend so much time stuck at a desk even small decreases can mean substantial improvements.

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APPENDIX A  
RECRUITMENT MATERIALS

RECRUITMENT EMAIL SCRIPT

**Amanda Gordon a Master's Student in Exercise and Wellness in the School of Nutrition and Health Promotion, is looking for HEALTHY ADULTS who typically sit at a computer during an 8 hour workday to participate in a study on the effects of a using a walking computer workstation on blood pressure.**

**Eligibility:**

- **Men and Women 25-50 years old**
- **Office/ computer worker downtown Phoenix**
- **Sits for most of an 8 hour work day**
- **Has slightly elevated resting blood pressure**  
**Systolic 120-139 or diastolic 80-90 mmHg** (we will screen)
- **Not on blood pressure control medications**
- **No restrictions for participating in physical activity**

**3 visits: Downtown Phoenix ASU Campus-NHI2 building**

- **Visit 1: Orientation session (1 hour)**
- **Visits 2 & 3: 1 work day each (8 hours/each)**
  - On one day (randomly determined) you will be asked to perform your normal office desk tasks (computer, telephone) while walking on a treadmill walking-workstation at very slow speeds for 10 – 30 minutes each hour (total = 2.5 hours per 8 hour day)
  - On the other day you will do your normal sitting office desk tasks at your own office desk (no walking).
  - You will be asked to wear a blood pressure monitor for 24 hours

**BENEFITS:**

**Participants will be given a health assessment and a personalized exercise program.**

**Please contact: Amanda Gordon for more information**  
[standupASU2012@gmail.com](mailto:standupASU2012@gmail.com); **801-597-8836**





## **Working Adults...**

### **Problem:**

Do You sit at a desk all day?  
Do you feel stiff when the day  
is over?

### **Solution:**

**TRY something Different**  
**WALK AT WORK!**

**Recruiting Now for a Research Study**  
**Feasibility of a Sedentary Intervention**  
**to**  
**Decrease Sitting Time at work**

**Who: Healthy non-smoking Men and Women**

**Eligibility:** No restrictions for participating in physical activity

- Currently work in a desk-based job

**What: Requires 3 visits - Downtown Phoenix ASU Campus-NHI2 building**

- Visit 1: we come to you! (30 minutes)
- You will go about your day as you normally do in your own office while wearing monitoring devices for physical activity.
- Visit 2: Orientation session (1 hour)
- Visit 3: Complete Follow-up surveys (30 - 60 minutes) 10 weeks later and wear physical activity monitoring devices

**Between visits 2 and 3 you will also receive weekly health newsletters**

**Benefits: Will be given a health assessment & personalized feedback on physical activity levels.**

**Contact: Amanda Gordon, [standupASU2012@gmail.com](mailto:standupASU2012@gmail.com) or (801) 597-8836**

APPENDIX B  
INFORMED CONSENT

## **INTRODUCTION**

The purposes of this form are to provide you (as a prospective research study participant) information that may affect your decision as to whether or not to participate in this research and to record the consent of those who agree to be involved in the study.

## **RESEARCHERS**

Matthew Buman, PhD (P-I), Pamela Swan, PhD (Co-I), Amanda Gordon (Co-I), and Zachary Zeigler (Co-I) of the School of Nutrition and Health Promotion have invited your participation in a research study.

## **STUDY PURPOSE**

The purpose of the research is to help evaluate a worksite programs impact on sedentary behavior at work, specifically the amount of time employees sit while at work.

## **DESCRIPTION OF RESEARCH STUDY**

If you decide to participate, then as a study participant you will join a study involving research of sitting time within the workplace. This study will be 10 weeks in duration during which you will receive a total of 5 e-newsletters and 5 “frequently asked question” emails. You will be randomly assigned to one of two research groups, either an intervention group or a standard treatment group. Group allocation will be decided by tossing a coin therefore you have a 50% chance of being in either group. At the commencement and conclusion of the study period you will be asked to wear an accelerometer and activity monitor (activPAL) for one week, and complete questionnaires which should take approximately 30 minutes each time. Those in the intervention group may also be asked to complete a short interview with researchers at the conclusion to obtain feedback on the intervention which is estimated to take an additional 30 minutes for a total time of 60 minutes at follow-up. If desired, you can elect to skip questions at any point in this process.

If you say YES, then your participation will last for 10 weeks. Demographic, contact information, blood pressure, and physical activity data will be obtained previous to beginning the 10-week period and at the end. If you participated in a previous study, regarding ‘Blood pressure and walking workstation’ then data collected at the end of that study will be used as your baseline information. If you did not participate in the previous blood pressure study, then you will be asked to provide the above information and wear the accelerometer and activity monitor (activPAL) at the commencement and conclusion of this study. Approximately 20 subjects will be participating in this study locally.

## **RISKS**

There is minimal risk associated with your participation in this research. However, as with any research, there is some possibility that you may be subject to risks that have not yet been identified. You may be asked certain questions that make you feel uncomfortable. You may choose not

to respond to any questions and still continue your participation in the study.

### **BENEFITS**

Although there may be no direct benefits to you, the possible benefit of your participation in the research is the possibility to change the sedentary nature of the workplace and increase overall health and wellbeing of office workers. All participants will receive information about their physical activity levels.

### **NEW INFORMATION**

If the researchers find new information during the study that would reasonably change your decision about participating, then they will provide this information to you.

### **CONFIDENTIALITY**

All information obtained in this study is strictly confidential unless disclosure is required by law. The results of this research study may be used in reports, presentations, and publications, but the researchers will not identify you. In order to maintain confidentiality of your records, Dr. Matthew Buman will use the unique number assigned to each participant in the previous study for data collection purposes, no names or contact information will be recorded on the data sheets.

All signed consent forms, contact information, name-number pairings, and group assignments will be kept in a separate file from the number coded data sheets. All forms and data sheets will be kept in a locked file cabinet in the PI's office and only the investigators will have access to this office. Your data will be retained for five years following the completion of this study after which it will be shredded.

### **WITHDRAWAL PRIVILEGE**

Participation in this study is completely voluntary. It is ok for you to say no. Even if you say yes now, you are free to say no later, and withdraw from the study at any time. Your decision will not affect your relationship with Arizona State University, employment status, or otherwise cause a loss of benefits to which you might otherwise be entitled.

### **COSTS AND PAYMENTS**

There is no payment for your participation in the study.

### **COMPENSATION FOR ILLNESS AND INJURY**

If you agree to participate in the study, then your consent does not waive any of your legal rights. However, no funds have been set aside to compensate you in the event of injury.

**VOLUNTARY CONSENT**

Any questions you have concerning the research study or your participation in the study, before or after your consent, will be answered by Dr. Matthew Buman, School of Nutrition and Health Promotion, Arizona State University, contactable at 602-827-2289.

If you have questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk; you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at 480-965 6788.

This form explains the nature, demands, benefits and any risk of the project. By signing this form you agree knowingly to assume any risks involved. Remember, your participation is voluntary. You may choose not to participate or to withdraw your consent and discontinue participation at any time without penalty or loss of benefit. In signing this consent form, you are not waiving any legal claims, rights, or remedies. A copy of this consent form will be given (offered) to you.

Your signature below indicates that you consent to participate in the above study.

Subject's Signature	Printed Name
Date	

**INVESTIGATOR'S STATEMENT**

"I certify that I have explained to the above individual the nature and purpose, the potential benefits and possible risks associated with participation in this research study, have answered any questions that have been raised, and have witnessed the above signature. These elements of Informed Consent conform to the Assurance given by Arizona State University to the Office for Human Research Protections to protect the rights of human subjects. I have provided (offered) the subject/participant a copy of this signed consent document."

Signature of Investigator\_\_\_\_\_

Date\_\_\_\_\_

APPENDIX C  
INTERVENTION NEWSLETTER

# **STAND UP ASU**

The time you spend sitting during your day can pile up quickly and you might not even realize it. Some of the common activities where we often sit include watching television, driving your car, and working on a computer.

**One place where sitting can really add up is at work.** Work environments of today are vastly different from that of generations past. Since 1950 **desk-based jobs have increased by 83%** and the average work week has increased to 47 hours per week.<sup>1</sup>

**You want to know what else has increased in that time?**

- Overweight and Obesity rates<sup>2</sup>
- Cardiovascular Disease<sup>3</sup>
- Diabetes<sup>4</sup>
- And many more chronic diseases.

Recent research has identified that too much sitting can put you at risk factor for all of these conditions, even if you are meeting the national guidelines for physical activity of 150 minutes of moderate/vigorous activity per week.<sup>5</sup>

**So what can I do about it?** Simple strategies can make a big difference to reduce the time you spend sitting. Work is a great place to try out some of the strategies. Here are a few ideas:



- Try walking to your co-workers desk instead of calling them on the phone or sending an email.
- Set an alarm periodically (perhaps every 30 minutes) to remind you to take a break, stand up, and stretch your legs.
- Try taking your next conference call standing.
- Schedule a time to use the walking workstation on NHI2 4<sup>th</sup> floor.

Breaking up your day with short walks or even just standing as you work can help not only your physical health, but your mental health too. **So do yourself a favor and take a break!**

**Take a brief moment and check in with the research team**

→ [CLICK HERE](#) ←

## **DID YOU KNOW...**

That the average adult in the U.S. sits for 5-7 hours a day?

### **CHALLENGE:**

**TRY TO DECREASE THE AMOUNT OF TIME YOU SIT DURING THE DAY BY 30 MINUTES FOR THE NEXT 3 MONTHS**



APPENDIX D  
CONTROL NEWSLETTER

## Eating well

We all know we should eat healthy foods, get lots of fruits and vegetables, and go easy on the treats, but doing that can sometimes be a challenge. Busy schedules, work deadlines, and quick high-calorie temptations can make healthy eating difficult.

Recently, the USDA released their new visual guide to healthy eating, My Plate. And to go with that, here are a few tips to help you make more healthful choices each day.



- **Eat the right amount of calories for you.**
  - *Take time to fully enjoy your food as you eat it.* Eating too fast or when your attention is elsewhere may lead to eating too many calories. Pay attention to hunger and fullness cues and use them to recognize when to eat and when you've had enough.
  - *Use a smaller plate, bowl, and glass.* Portion out food before you eat and when eating out choose smaller size options, share a dish, or take home part of your meal.
  - *Cook more often at home,* where you are in control of what's in your food.
- **Cut back on foods high in solid fats, added sugars, and salt.**
  - Many people eat foods with too much of these types of elements. Added sugars and fats load foods with extra calories you don't need, and too much sodium may increase your blood pressure. Examples of these foods include cakes, cookies, ice cream, candies, sweetened drinks, pizza, and fatty meats like ribs, sausages, bacon, and hot dogs. Use these foods as *occasional* treats, but don't eat them every day. Also, drinking water instead of soda and energy drinks can help cut back on calories.
- **Build a healthy plate.**

Before you eat, think about what goes on your plate. Foods like vegetables, fruits, whole grains, low-fat dairy products, and lean protein foods contain the nutrients you need without too many calories. Use the USDA My Plate as a guide to filling your plate. Fill half your plate with fruits and vegetables, and make half your daily grains whole grains.

For more information on how to eat healthy, visit [www.ChooseMyPlate.gov](http://www.ChooseMyPlate.gov)

**Take a brief moment and check in with the research team**

➡ [CLICK HERE](#) ⬅

APPENDIX E

PARTICIPANT ACCELEROMETER FEEDBACK FORM

	<b>You Then</b>	<b>National Average</b>	<b>Rating</b>	<b>You Now</b>	<b>Rating</b>
<b>Sedentary<sup>1</sup></b>	hours (minutes)	Hours	Above average, Average, or Below Average	hours (minutes)	Above Average
<b>Light Intensity</b>	hours (minutes)			hours (minutes)	
<b>Lifestyle</b>	minutes			minutes	Improved!
<b>Moderate Intensity<sup>2</sup></b>	minutes	minutes	Below Average	minutes	Below Average but Improved!
<b>Vigorous Intensity<sup>2</sup></b>	minutes	minutes	Below Average	minutes	Below Average
<b>Step Count</b>	steps			steps	Improved!

Matthews CE et al (2008). Amount of Time Spent in Sedentary Behaviors in the United States, 2003- 2004. *Am J Epidemiol*; 167(7): 875-881.

2. Troiano RP et al (2008). Physical Activity in the United States Measured by Accelerometer. *Med. Sci. Sports Exerc*; 40 (1):181–188.

**Baseline Body Composition**

BMI:

% BF:

    Ideal range:

Blood pressure:

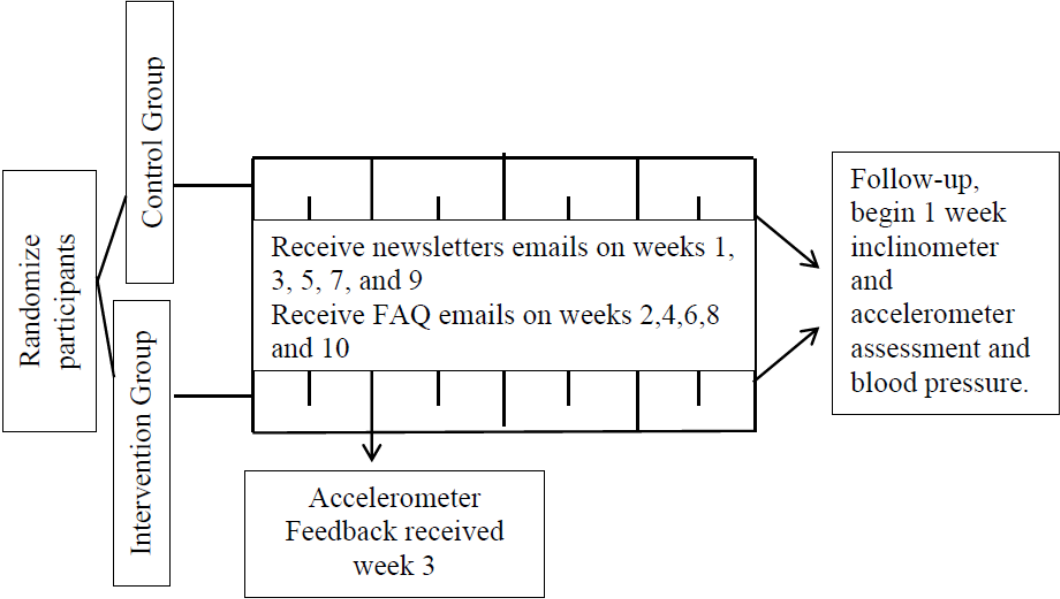
**Follow-Up Body Composition:**

BMI:

% Body Fat:

Blood pressure:

APPENDIX F  
STUDY FLOW CHART



APPENDIX G  
ACCELEROMETER LOG

## **General Information about the accelerometer**

The accelerometer is used to measure your level of physical activity.

Please wear the accelerometer ALL the hours you are awake for the next seven days in a row starting from midnight tonight.

Today's date is: \_\_\_\_\_

- Put the monitor on first thing **tomorrow morning** when you wake up, and take it off at night for bed. Put the sensor somewhere safe, where you will see it in the morning and put it on again right away when you awake.
- The sensor needs to stay dry, so take it off to shower, take a bath or swim. Make sure to put the sensor back on when you are done. If you take the sensor off for more than 20 minutes for any reason during the day, write down what time you took it off and back on and why you did so in your booklet (e.g. swim).
- Please log in your booklet the time you put the sensor on in the morning, any times where you take the unit off for more than 20 minutes, and the time you take the sensor off at night.
- Be careful when changing clothes, going to the bathroom or other types of activities where you could drop the sensor. Please remember when changing your clothes to move the sensor to your new set of clothes.
- It is very important that you go about your normal, everyday activities this week, and you do not make changes to your routines. You should do your daily activities just as you would without the sensor.
- The sensor may or may not have a blinking light; this light does not indicate whether it is or is not functioning properly and you may ignore it.



## Instructions for Wearing the Accelerometer



The sensor should be worn around the body at about hip level on the right side using this elastic belt. To best position the sensor, draw an imaginary line from the center of your right knee cap up the front of your leg to your right hipbone. The sensor should be worn over your right hip at this spot. Once you put the belt on, slide the sensor to this spot. The belt should be snug enough to hold the sensor in place, and you can use the safety pin to secure the pouch to your clothing to help it stay put. Make sure to always wear the belt and use the pin as extra if you want.

### At the end of the seven days

At the end of the seven days, we will come back to get this sensor back from you. It cannot be used by itself, and it has no monetary value if it is lost, stolen or sold.

We will return to pick up your sensor at: \_\_\_\_\_

### Questions?

If you have any questions, please call Amanda Gordon:

\_\_\_\_\_.

**Today's Motion Sensor Record**  
(Circle AM or PM where indicated)

DATE: \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_

TIME ON: \_\_\_\_\_ (AM PM)

WORK ARRIVAL TIME: \_\_\_\_\_ (AM PM)

TIME(s) OFF: \_\_\_\_\_ (AM PM)

Did you take the sensor off for more than 20 minutes during the day? (YES NO)

WHY:

Did you exercise today? (YES NO)

START TIME: \_\_\_\_\_ (AM PM)

STOP TIME: \_\_\_\_\_ (AM PM)

TYPE:

WORK DEPARTURE TIME: \_\_\_\_\_ (AM PM)

TIME OFF: \_\_\_\_\_ (AM PM)

APPENDIX H  
BARRIER SELF EFFICACY

The following items reflect situations that are listed as common reasons for preventing individuals from sitting less. Using the scales below please indicate how confident you are that you could exercise in the event that any of the following circumstances were to occur.

**Please indicate the degree to which you are confident that you could exercise in the event that any of the following circumstances were to occur by circling the appropriate %. Select the response that most closely matches your own, remembering that there are no right or wrong answers.**

For example, in question #1 if you have complete confidence that you could sit less even if ... you would **circle 100%**. If however, you had no confidence at all that you could sit less, if you failed to make or continue making progress (that is, confidence you would not sit less), you would **circle 0%**.

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
NOT AT ALL				MODERATELY					HIGHLY
CONFIDENT				CONFIDENT					CONFIDENT

---

**I BELIEVE THAT I COULD SIT 30 MINUTES LESS PER DAY AT WORK FOR THE NEXT 3 MONTHS IF:**

1. The weather was bad (hot, humid, rainy, or cold).
 

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
----	-----	-----	-----	-----	-----	-----	-----	-----	-----
  
2. I felt pain or discomfort when standing or walking.
 

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
----	-----	-----	-----	-----	-----	-----	-----	-----	-----
  
3. I had a busy day.
 

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
----	-----	-----	-----	-----	-----	-----	-----	-----	-----
  
4. I was under personal stress of some kind.
 

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
----	-----	-----	-----	-----	-----	-----	-----	-----	-----
  
5. My friends or coworkers criticize me for it.
 

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
----	-----	-----	-----	-----	-----	-----	-----	-----	-----
  
6. I was bored by the program.
 

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
----	-----	-----	-----	-----	-----	-----	-----	-----	-----

**Mark your answer by circling a %**

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
NOT AT ALL				MODERATELY					HIGHLY
CONFIDENT				CONFIDENT					CONFIDENT

---

**I BELIEVE THAT I COULD SIT 30 MINUTES LESS PER DAY AT WORK FOR THE NEXT 3 MONTHS IF:**

7. It was not fun or enjoyable.

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
----	-----	-----	-----	-----	-----	-----	-----	-----	-----

8. I felt self-conscious about my appearance when I am not sitting at my desk.

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
----	-----	-----	-----	-----	-----	-----	-----	-----	-----

9. Others do not offer me any encouragement.

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
----	-----	-----	-----	-----	-----	-----	-----	-----	-----

APPENDIX I  
TASK SELF EFFICACY

The items listed below are designed to assess your beliefs in your ability to decrease the amount of time (minutes) you sit per day in the future. Using the scales listed below please indicate how confident you are that you will be able to continue this behavior in the future.

For examples, if you have complete confidence that you could sit 30 minutes less per day for the next 10 weeks, you would **circle** 100%. However, if you had no confidence at all that you could sit 30 minutes less per day for the next 10 weeks (that is, confident you would not sit less), you would **circle** 0%

Please remember to answer honestly and accurately. There are no right or wrong answers.

**Mark your answers by circling a %:**

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
NOT AT ALL			MODERATELY				HIGHLY		
CONFIDENT			CONFIDENT				CONFIDENT		

---

1. I am able to sit 30 minutes less every day at work for the NEXT WEEK  
 0%    10%    20%    30%    40%    50%    60%    70%    80%    90%

2. I am able to sit 30 minutes less every day at work for the NEXT TWO WEEKS  
 0%    10%    20%    30%    40%    50%    60%    70%    80%    90%

3. I am able to sit 30 minutes less every day at work for the NEXT THREE WEEKS  
 0%    10%    20%    30%    40%    50%    60%    70%    80%    90%

4. I am able to sit 30 minutes less every day at work for the NEXT FOUR WEEKS  
 0%    10%    20%    30%    40%    50%    60%    70%    80%    90%

5. I am able to sit 30 minutes less every day at work for the NEXT FIVE WEEKS  
 0%    10%    20%    30%    40%    50%    60%    70%    80%    90%

Please remember to answer honestly and accurately. There are no right or wrong answers.

**Mark your answers by circling a %:**

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
NOT AT ALL			MODERATELY				HIGHLY		
CONFIDENT			CONFIDENT				CONFIDENT		

---

6. I am able to sit 30 minutes less every day at work for the NEXT SIX WEEKS  
 0%    10%    20%    30%    40%    50%    60%    70%    80%    90%

7. I am able to sit 30 minutes less every day at work for the NEXT SEVEN WEEKS  
 0%    10%    20%    30%    40%    50%    60%    70%    80%    90%

8. I am able to sit 30 minutes less every day at work for the NEXT EIGHT WEEKS  
0% 10% 20% 30% 40% 50% 60% 70% 80% 90%

9. I am able to sit 30 minutes less every day at work for the NEXT NINE WEEKS  
0% 10% 20% 30% 40% 50% 60% 70% 80% 90%

10. I am able to sit 30 minutes less every day at work for the NEXT TEN WEEKS  
0% 10% 20% 30% 40% 50% 60% 70% 80% 90%



APPENDIX J

OUTCOME EXPECTATIONS FOR SITTING LESS SCALE

Read the statement below and indicate to what extent you agree or disagree with each stated outcome or benefit of sitting less.

Strongly Disagree      Disagree      Neither agree nor disagree      Agree      Strongly Agree

---

1. Sitting 30 minutes less per day makes me feel better physically.

Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
-------------------	----------	----------------------------	-------	----------------

2. Sitting 30 minutes less per day makes my mood better in general.

Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
-------------------	----------	----------------------------	-------	----------------

3. Sitting 30 minutes less per day helps me feel less tired.

Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
-------------------	----------	----------------------------	-------	----------------

4. Sitting 30 minutes less per day makes my muscles stronger.

Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
-------------------	----------	----------------------------	-------	----------------

5. Sitting 30 minutes less per day makes my day more enjoyable.

Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
-------------------	----------	----------------------------	-------	----------------

6. Sitting 30 minutes less per day gives me a sense of personal accomplishment.

Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
-------------------	----------	----------------------------	-------	----------------

Read the statement below and indicate to what extent you agree or disagree with each stated outcome or benefit of sitting less.

Strongly Disagree      Disagree      Neither agree nor disagree      Agree      Strongly Agree

---

7. Sitting 30 minutes less per day makes me more alert mentally.

Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
-------------------	----------	----------------------------	-------	----------------

8. Sitting 30 minutes less per day improves my endurance in performing my daily activities.

Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
-------------------	----------	----------------------------	-------	----------------

9. Sitting 30 minutes less per day helps to strengthen my bones.

Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
-------------------	----------	----------------------------	-------	----------------

APPENDIX K  
PRODUCTIVITY AND ACCEPTABILITY

Using the scales listed below please indicate how decreasing your sitting time at work influenced your productivity. **Circle the response which most closely matches your feedback.**

Increases Highly      Increases      No impact/ Neutral      Decreases      Decreases Highly      Not Applicable

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1. Overall sitting less impacts the **QUALITY OF MY WORK**:

Increases Highly	Increases	No impact/ Neutral	Decreases	Decreases Highly	Not Applicable
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2. Overall sitting less impacts my **WORK PRODUCTIVITY**:

Increases Highly	Increases	No impact/ Neutral	Decreases	Decreases Highly	Not Applicable
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3. Overall sitting less impacts my **ABILITY TO FOCUS ON MY WORK**:

Increases Highly	Increases	No impact/ Neutral	Decreases	Decreases Highly	Not Applicable
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4. Overall sitting less impacts my **ACADEMIC PRODUCTIVITY**:

Increases Highly	Increases	No impact/ Neutral	Decreases	Decreases Highly	Not Applicable
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5. Overall sitting less impacts my **SATISFACTION WITH ASU**:

Increases Highly	Increases	No impact/ Neutral	Decreases	Decreases Highly	Not Applicable
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6. Overall sitting less impacts my **KNOWLEDGE OF HEALTH**:

Increases Highly	Increases	No impact/ Neutral	Decreases	Decreases Highly	Not Applicable
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7. Overall sitting less impacts my **READINESS TO IMPROVE HEALTH**:

Increases Highly	Increases	No impact/ Neutral	Decreases	Decreases Highly	Not Applicable
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**Circle the response which most closely matches your feedback.**

Increases Highly      Increases      No impact/ Neutral      Decreases      Decreases Highly      Not Applicable

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8. Overall sitting less impacts my ABILITY TO MAINTAIN HEALTH:

Increases Highly	Increases	No impact/ Neutral	Decreases	Decreases Highly	Not Applicable
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9. Overall sitting less impacts my ABILITY TO CONTROL WEIGHT:

Increases Highly	Increases	No impact/ Neutral	Decreases	Decreases Highly	Not Applicable
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10. Overall sitting less impacts my STRESS LEVEL:

Increases Highly	Increases	No impact/ Neutral	Decreases	Decreases Highly	Not Applicable
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11. Overall sitting less impacts my RISK FOR GETTING INJURED:

Increases Highly	Increases	No impact/ Neutral	Decreases	Decreases Highly	Not Applicable
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