Activity Tracker Measurement of Physical Activity and Sedentary Time in the Workplace Including an Intervention Involving Reminders to Move

Cassie Dance
Utah State University

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ACTIVITY TRACKER MEASUREMENT OF PHYSICAL ACTIVITY AND
SEDENTARY TIME IN THE WORKPLACE INCLUDING AN
INTERVENTION INVOLVING RemINDERS TO MOVE

by

Cassie Dance

A dissertation submitted in partial fulfillment
of the requirements for the degree

of

Doctor of Philosophy

in

Psychology

Approved:

______________________  ____________________
M. Scott DeBerard, Ph.D.  Susan L. Crowley, Ph.D.
Major Professor  Committee Member

______________________  ____________________
JoAnn Tschanz, Ph.D.  Michael Levin, Ph.D.
Committee Member  Committee Member

______________________  ____________________
Edward Heath, Ph.D.  Richard S. Inouye, Ph.D.
Committee Member  Vice Provost for Graduate Studies

UTAH STATE UNIVERSITY
Logan, Utah
2019
ABSTRACT

Activity Tracker Measurement of Physical Activity and Sedentary Time in the Workplace Including an Intervention Involving Reminders to Move

by

Cassie Dance, Doctor of Philosophy
Utah State University, 2019

Major Professor: Dr. M. Scott DeBerard
Department: Psychology

Sedentary time and physical inactivity have negative impacts on health, healthcare costs and workplace wellbeing. There is evidence that people are more sedentary and engage in less physical activity on work days. Additionally, sedentary behavior has been found to increase distress and negative mood. Activity trackers are a useful way to collect and intervene on sedentary behavior and potentially impact other factors of workplace wellbeing in real time and promote self-monitoring.

The purpose of the present study was to examine the impact of an intervention on sedentary time at work with Fitbit reminder to move prompts and what impact the intervention had on other factors of workplace wellbeing including depression, positive and negative affect, job stress, and productivity. Participants were 69 university employees who spent over four hours a day sedentary at work. Participants wore a Fitbit device for three weeks and completed pre- and post-study measures. For the first week, the Fitbit displayed only the watch screen with no access to other data, to establish baseline data. For the second week, the Fitbit device and app allowed for self-monitoring by displaying the activity being tracked, including steps, distance, calories expenditure,
and stairs walked. For the third week, the sedentary time reduction intervention was implemented by activating the Fitbit application “Reminder to move.” This caused the Fitbit to vibrate at the 50-minute mark of the hour if the participant had not moved 250 steps in that time interval.

Results show that having the reminders to move activated decreased sedentary time at work and increased steps throughout the day on work days. These changes in sedentary time significantly contributed to changes in depression. On average, from the start of the study to after the intervention, participants reported significantly less depression, negative affect, and stress and significantly more positive affect, affect balance, social functioning, physical functioning, and productivity at work. This study demonstrated the utility and acceptability of an intervention on sedentary time at work using existing time and cost effective reminder to move prompts on Fitbits. Implication, limitations, and future directions were discussed.

(113 pages)
PUBLIC ABSTRACT

Activity Tracker Measurement of Physical Activity and Sedentary Time in the Workplace Including an Intervention Involving Reminders to Move

Cassie Dance

Sedentary time and physical inactivity have negative impacts on health and health costs as well as an impact on workplace wellbeing. There is evidence that people are more sedentary and engage in less physical activity on work days. Additionally, sedentary behavior has been found to increase distress and negative mood. Activity trackers such as Fitbits are a useful way to collect and intervene on sedentary behavior and potentially impact other factors of workplace wellbeing in real time and promote self-monitoring. The reminder to move prompts that are now part of Fitbit models provide an innovative and simple way to intervene on workplace sedentary behavior with hourly movement prompts.

This study examined the impact of an intervention on sedentary time at work with Fitbit reminders to move and what impact the intervention had on other factors of workplace wellbeing including depression, positive and negative affect, job stress, and productivity. Participants were university employees who wore a Fitbit device for three weeks and completed pre- and post-study measures. For the first week, the Fitbit displayed only the watch screen with no access to other data. This was done to establish baseline data. For the second week, the Fitbit device and Fitbit app allowed for self-monitoring by displaying the activity being tracked, including steps, distance, calories expenditure, and stairs walked. For the third week, the sedentary time reduction was
implemented by activating the Fitbit application reminder to move. This caused the Fitbit to vibrate at the 50-minute mark of the hour if the participant had not moved 250 steps in that time. Results show that having the reminders to move prompt activated decreased sedentary time at work and increased steps throughout the day on work days. These changes in sedentary time significantly contributed to decreases in depression. From the start of the study to after the intervention, on average participants reported significantly less depression, negative affect, and stress and more positive affect, affect balance, social functioning, physical functioning, and productivity at work. The benefits of in the moment self-monitoring and an intervention around sedentary time with Fitbits on factors of workplace wellbeing are discussed as well as limitations, and future directions.
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CHAPTER I
INTRODUCTION

It has been well established that physical inactivity is related to a host of preventable health challenges. Lack of physical activity contributes directly to increased incidence of obesity, cardiovascular disease, cancer, chronic lung diseases and diabetes, which combined are estimated to kill three in five people worldwide (World Health Organization, 2012). A strong relationship has been found between increased sedentary time and mortality and morbidity, particularly in the context of diabetes, cardiovascular disease, obesity, and metabolic syndrome (Hamilton, Hamilton, & Zderic, 2007). The 1998–2008 National Health Interview Survey found that 81.8% of U.S. adults did not participate in minimum recommended levels of aerobic and muscle-strengthening activities (Carlson, Fulton, Schoenborn, & Loustalot, 2010). It was also estimated 56.5% of U.S. adults did not engage in aerobic activity at all during their leisure time (Carlson et al., 2010). Additionally, it was estimated that U.S. adults spent an average of over half their time in sedentary behavior (Healy et al., 2008b; Healy, Matthews, Dunstan, Winkler, & Owen, 2011b). The World Health Organization (WHO, 2012) has recognized the critical importance of physical activity in preventing non-communicable disease and specified a goal of 10% reduction in physical inactivity by 2025.

Physical inactivity has become an increasing challenge in workplace settings, particularly as many jobs have become more sedentary. Fifty years ago, half of the jobs in U.S. private industry required moderate-intensity physical activity, and now less than 20% of U.S. jobs demand this level of activity. It is estimated that daily work-related energy expenditure has decreased by over 100 calories during this fifty-year period, and
this likely accounts for a significant increase in body weight for both women and men (Church et al., 2011). For example, it was estimated that the work-related energy expenditure decreased by 142 calories for men and this resulted in a mean lifetime weight increase of 28.2 pounds (Church et al., 2011). Systematic reviews have also found trends of declining work related activity (Brownson, Boehmer, & Luke, 2005; Knuth & Hallal, 2009). Additionally, a study comparing sedentary time on work days and non-work days found that people sit more, spend less time walking, and walk at a lower velocity on work days than on non-work days (McCrdy & Levine, 2009). Many studies show that at least 70% of time at work is sedentary and that most of that time is made up of prolonged bouts of sedentary time (Parry & Straker, 2013).

Given the increasing sedentary time in the workplace and the evidence that this increased sedentary time is likely contributing to worsened physical health, the workplace appears to be an ideal venue to examine and intervene for physical inactivity. There is a long history of workplace interventions to improve physical activity and overall health and in general, results from such interventions have been mixed (Abraham, & Graham-Rowe, 2009; Conn, Hafdahl, Cooper, Brown, & Lusk, 2009; Dugdill, Brettle, Hulme, McCluskey, & Long, 2008; Malik, Blake, & Suggs, 2014). A meta-analysis of workplace physical activity and nutrition interventions found only modest improvements in a six month to one year follow-up with an estimated pooled effect size of a decrease of 2.8 pounds across nine randomized controlled trials and a decrease of 0.05% of BMI across six randomized controlled trials (RCTs) (Anderson et al., 2009). The three RCTs that intervened on physical activity alone had a pooled effect size of a 2.24 pound loss (95% CI -6.49, 2.00). Another meta-analysis of workplace interventions for physical activity
(Conn et al., 2009) utilized primary studies (unpublished and published) of interventions across 38,231 subjects in 138 reports. They found small mean effect sizes ($d = 0.21$) for physical activity interventions and moderate effect sizes for reducing job stress ($d = 0.33$), but physical activity was rarely objectively measured resulting in comparison difficulties between studies in this meta-analysis.

These comparison difficulties highlight the challenges of measuring physical activity and sedentary time. Studies commonly measure them through either objective physical measurements or by self-reporting. There are significant measurement variances between these two methods. Objective physical activity measurements with accelerometers have historically been done with ActiGraphs, a research device that includes a gyroscope, magnetometer, and secondary accelerometer to deliver valuable information about movement, rotation, and body position, or with other lab-based procedures. Self-reported physical activity measurements have often been done periodically and retrospectively.

Accelerometers are thought to be a more accurate and objective means for measuring physical activity versus self-report (Evenson, Goto, & Furberg, 2015; Meyer & Hein, 2015b). Data from a more objective measure of physical activity reveals significantly smaller prevalence rates of meeting physical activity guidelines. Tucker, Welk, and Beyler (2011) reported that the percentage of adults meeting the guidelines of moderate to vigorous physical activity in 2008 was 62.0% based on self-report measures and 9.6% for accelerometry measures of physical activity. Rates of meeting 2008 federal physical activity guidelines measured objectively with accelerometers range from a half to a tenth of the self-report rates (Bauman, Pedišić, & Bragg, 2016). A systematic review
of 37 RCTs and quasi-experimental studies found a small effect of workplace physical activity interventions with a weighted average effect size ($d_s$) of 0.20 but this effect was lower when objective fitness measures were utilized in the RCT ($d_s = 0.15$) rather than when self-report measures ($d_s = 0.23$) were used (Abraham, & Graham-Rowe, 2009). Additionally, retrospective self-report measures that assess physical activity once a week or every two weeks are vulnerable to overestimation and social desirability in reporting (Rennie & Wareham, 1998). With self-report data, small but important changes like breaks in sedentary time can go undetected. Objective tracking measures are thought to provide more nuanced information of how people spend their time and how it impacts their health (Healy et al., 2008a).

Consumer wearable monitors create a way to address these measurement issues and provide self-monitoring and new opportunities for in-the-moment intervention on sedentary behavior. Wearable accelerometers, first introduced in 2009, have the potential to provide these objective physical activity measurements in real time and throughout the day. The use of wearable, activity tracker technology that can continuously measure heart rate, current and cumulative physical activity, and sedentary time is becoming more widely accepted (Fox & Duggan, 2013). In 2016, 102.4 million wearable devices were shipped, which is up 25% from 2015 (Maslakovic, 2017). The companies and models of activity trackers have proliferated across the last few years with estimated sales of 33.9 million units for the 4th quarter of 2016 alone (Maslakovic, 2017). Objective physical activity feedback that occurs in the moment to inform behavior and allow the opportunity for behavior change has not been comprehensively examined in the research literature.
Activity trackers monitor and report physical activity and sedentary time objectively and continuously. They can be worn in most workplace settings and provide easily accessible data to the user in real-time. Additionally, activity trackers can continuously track and display graphs or counts of behavior compared to goals to provide individual motivational information and automatic self-monitoring (Wang et al., 2016). There is evidence that automatic self-monitoring can improve health behaviors such as physical activity (Aittasalo, Miilunpalo, Kukkonen-Harjula, & Pasanen, 2006; Michie, Abraham, Whittington, McAteer, & Gupta, 2009).

The increasingly sedentary workplace provides a definable environment to assess and intervene on physical activity and sedentary time. The application of activity trackers to objectively and continuously measure physical activity in a person’s workplace eliminates self-reporting bias. This application also allows for real-time self-monitoring against goals with in-the-moment intervention reminders. Intervention with activity trackers can be implemented with low cost and effort and has a high potential for growth (Bacigalupo et al., 2013).

Wearable trackers like Fitbits can be used to explore the relationship of multiple outcomes related to physical inactivity at work (Mark, Czerwinski, Iqbal, & Johns, 2016). It makes sense to see if physical inactivity or sedentary time at work impacts other domains of workplace wellbeing such as mood, productivity, quality of life, and job stress.

One purpose of the present study was to objectively measure a person’s workplace physical activity level as well as its relationship with overall health, productivity, job satisfaction, job stress, and mood, utilizing commercially available
wearable technology. Secondly, this study determined if hourly movement prompts delivered via wearable technology at work decreased sedentary time in the workplace.
CHAPTER II

LITERATURE REVIEW

Relationship of Physical Activity and Sedentary Time to Health

Physical activity has numerous health benefits including increased efficiency of the cardiorespiratory system, increases in slow wave sleep, optimization of body weight, improved immune system functioning, decreases in negative mood, improved cholesterol level, improved stress tolerance, increased longevity, and reduction in other health compromising behaviors (Physical Activity Guidelines Advisory Committee, 2015; Penedo & Dahn, 2005). Thirty minutes of physical activity a day has been found to decrease the risk of heart disease and cancer (Warburton, Nicol, & Bredin, 2006). Regular exercise has been found to improve mood and quality of life and has been used successfully as a treatment for depression (Paxton, Mod, Aylward, & Nigg, 2010; Babyak et al., 2000). However, physical inactivity is an important cause of many chronic diseases and conditions including type 2 diabetes and coronary artery disease, and it is estimated that physical inactivity causes up to 20-30% of depression and may also induce increases in anxiety (Booth, Roberts, & Laye, 2012).

The Physical Activity Guidelines Advisory Committee (2008) reported that physical inactivity increases mortality rates by 30%, or over 720,000 deaths annually in the U.S. The health costs for inactivity in the U.S. are estimated to be $700 annually for each person in the U.S. Additionally, if the majority of the U.S. population regularly engaged in 30 minutes of moderate physical activity per day, annual health care costs could be reduced by $100 billion (Booth, et al., 2012).
Sedentary time has been defined as time spent sitting or in reclining posture during waking hours with little to no energy expenditure (Sedentary Behaviour Research Network, 2012). Examples of sedentary behavior include time spent watching television, reading, on a computer, working at a desk, and sitting while traveling. Healy and colleagues (2008b) found that in studying 169 people who wore accelerometers for seven days, participants spent the majority of their time in sedentary behavior (57%) or light-intensity activity (39%) like walking slowly or stretching. They also found that sedentary time was significantly positively related to waist circumference, triglycerides, and metabolic risk. These findings were replicated in a large representative sample of the U.S. civilian population (Healy et al., 2011a). An analysis of sedentary time and mortality in a large sample in Canada found that increased time sitting was associated with higher risk of mortality and increased cardiovascular disease (Katzmarzyk, Church, Craig, & Bouchard, 2009). This study found that even for individuals fulfilling suggested physical activity guidelines, there remained a strong association between their sedentary time and mortality. This illustrates the need to intervene directly on sedentary time.

In addition to the benefits from increased physical activity there are also benefits from physical activity breaks in the duration of sedentary time periods, operationalized as standing, walking or moving to increase energy expenditure (Healy et al., 2012). A study examining the benefits of metabolic risk from breaks in sedentary time found that increased brief breaks were associated with smaller waist circumference, BMI, triglycerides, and glucose levels (Healy et al., 2008a). Other research has demonstrated that even a two-minute break in sedentary time every hour increases energy expenditure enough to impact weight management and that these two minute breaks would lead to a
loss of 9.4 pounds a year (Swartz, Squires, & Strath, 2011). Also, walking breaks in sedentary time lower glucose and insulin levels in overweight/obese adults (Dunstan et al., 2012). Another study found that short periods of physical activity throughout the day lead to positive changes of gene expression related to carbohydrate metabolism, cellular growth, and development and may reverse the expression of genes induced by prolonged inactivity (Latouche et al., 2012). Mailey and colleagues (2016) found that frequent breaks from sitting at work over eight weeks led to small to moderate declines in total cholesterol, triglycerides, and fasting blood glucose. These findings suggest that promoting a reduction in the duration of sedentary time periods could be another area of health recommendation, along with the guidelines for physical activity that are already in place.

**Physical Activity and Sedentary Time in the Workplace**

Analysis of global physical activity trends from the 1970’s to the mid-2000’s reveals that physical activity in leisure time is likely increasing while work-related physical activity is declining (Knuth & Hallal, 2009). Despite some observed increases in physical activity in leisure time, overall physical activity levels are low globally for adults (Knuth & Hallal, 2009). More specifically, in 2000 only 26.2% of adults in the U.S. were engaged in the recommended levels of physical activity during their leisure time. Additionally, during these decades there was a large increase in low-activity occupations. By the year 2000, twice as many people were employed in low-activity occupations such as managers, administrators, computer programmers and information technology workers versus high-activity occupations such as construction trades, cleaners, servers, and machine operators (Brownson et al., 2005). This study also found
that overall sedentary time at work was increasing. However, the study also noted that more comprehensive, accurate, and easily collectable measurements were needed to replace self-reported sedentary time.

Research examining physical activity and sedentary time in the workplace has shown that work hours are mostly spent in sedentary time, meaning time spent sitting or in reclining posture during waking hours with little energy expenditure (Brownson et al., 2005; Thorp et al., 2012). A study of 193 employees in Australia who wore an accelerometer for eight days found that 77% of work hours were sedentary and close to half of that sedentary time involved prolonged bouts of sedentary time, meaning over 30 consecutive minutes of sedentary time (Thorp et al., 2012). Another recent study using accelerometers in Australia found that sedentary time accounted for 81.8% of work time for office workers and that sustained sedentary bouts of over 30 minutes uninterrupted sedentary time were greater during work hours (Parry & Straker, 2013). This is comparable to a study of 170 workers in the U.K. who wore an accelerometer for seven days that found 71% of work hours were sedentary. Additionally, this study found that those who were more sedentary at work were more sedentary in general and did not compensate by being more physically active outside of work (Clemes, O'Connell, & Edwardson, 2014). This was consistent with Parry and Straker (2013) finding that office workers spent most of their time in sedentary behavior or light activity at work (97.1% time) and outside of work (95.7% time) and very little time in moderate-to-vigorous physical activity. Also, a study of a national representative sample of workers in Australia using self-report data found that workers who spent most of their time sitting during work had higher amounts of sedentary time in their leisure time than those in more
active jobs (Chau, van der Ploeg, Merom, Chey, & Bauman, 2012). Chau et al. also found that those with mostly sedentary jobs had a significantly higher risk of being overweight or obese independent of physical activity and leisure-time sitting (RR=0.88, 95%, CI: 0.82-0.95).

**Workplace Interventions for Sedentary Time**

Based on the health risks associated with sedentary time and the decreasing amount of physical activity at work, there is a clear need for workplace interventions to help increase workers’ physical activity and reduce sedentary time. There is some evidence that interventions focused on reducing sedentary time cause statistically significant reduction in sedentary time (SMD = −1.28 [95% CI: −1.68, −0.87]) but little evidence that physical activity interventions cause statistically significant reductions in sedentary time (Prince, Saunders, Gresty, & Reid, 2014).

In 2010, a systematic review of workplace interventions to reduce sitting found only six studies meeting inclusion criteria and all had a primary emphasis on increasing physical activity with measured reduction in sedentary time as a secondary focus using self-report forms, some of which had limited or no evidence of reliability or validity (Chau et al., 2010). Only one intervention study in this systematic review specifically examined sedentary time at work and found a non-significant decrease in sedentary time at work (Chau et al., 2010). None of the studies in the review showed a significant reduction in sedentary time in relation to comparison or control groups. The authors suggested that encouraging breaks from sedentary time would be a promising avenue to
explore and that using objective measurement tools to measure sedentary time and physical activity would also be beneficial (Chau et al., 2010).

Another systematic review of workplace interventions revealed four studies that determined structured breaks significantly reduced overall physical discomfort and eye strain while not negatively impacting work productivity (Healy et al., 2012). These authors suggested the need for more controlled interventions of structured breaks in workplace settings and more objective measurement of sedentary time.

A 2016 review of workplace interventions designed to decrease sedentary time (Shrestha et al., 2016) found 20 RCTs and quasi-randomized controlled trials where the main outcome was sedentary time. Nine studies examined physical changes like standing desks and active workstations with treadmills or pedaling and found low-quality evidence that alternative workstations might decrease workplace sitting. Computer prompting to reduce sitting time had mixed evidence in two studies. This review emphasized the need for more research about reducing sedentary time using control groups and lower cost options versus many of the physical changes to workstations. It was also suggested that cognitive awareness and interventions addressing habitual inaction be investigated and perhaps implemented in workplace settings.

**Challenges in Measuring Physical Activity and Sedentary Time**

Challenges in measuring physical activity and whether people are meeting federal physical activity guidelines include gathering accurate, objective results in real-time in day-to-day settings. A review of physical activity measurement tools found that self-report measures can be easy to administer and can measure whether participants have met
physical activity guidelines (Ainsworth, Cahalin, Buman, & Ross, 2015). However, there are documented recall and reporting biases with these self-report measures. While log or diary based self-reporting can resolve some recall issues they place a large burden on participants (Ainsworth et al., 2015).

Self-reported measurements’ divergence from objective measurements of physical activity levels is consistent and pervasive across a number of studies. For example, a study comparing the widely used International Physical Activity Questionnaire (IPAQ) with Fitbit activity trackers for step data and calculating calories burnt in physical activity for eight participants for 50 days found that the activity trackers had stronger correlation with activity logs than the IPAQ (Meyer & Hein, 2015b). This finding is reinforced by another review that reported a correlation of .09 to .39 between IPAQ short form and objective measures (Lee, Macfarlane, Lam, & Stewart, 2011). Additionally, the IPAQ tended to overestimate physical activity by an average of 84% as measured by VO2max, a measurement of the maximum amount of oxygen that an individual can utilize. A large study of 1751 adults in Norway that compared IPAQ reported physical activity and sedentary time with seven days measured by accelerometers found that, in general, participants reported more vigorous physical activity and less sedentary time than measured on an accelerometer (Dyrstad, Hansen, Holme, & Anderssen, 2014). In this study, 67% of participants were categorized by self-reporting as meeting physical activity guidelines in the IPAQ while only 22% of participants were classified from accelerometer data as meeting these guidelines. Self-report measures of sedentary time have similar difficulties (Healy et al., 2011a). One study found that 131 more minutes a day were sedentary when measured by objective tracking than self-reported measures.
(Dyrstad et al., 2014). A systematic review of workplace intervention for sedentary time has reported the limitations of outcomes as measured only by self-report data (Dugdill et al., 2008; Chau et al., 2010).

These results highlight the benefits of wearable accelerometers for objectively measuring physical activity and sedentary time (Ainsworth et al., 2015). They noninvasively monitor frequency, intensity, duration, and patterns of physical activity and sedentary time in a relatively precise manner. They also provide these measures with lower participant burden and lower cost.

**Use of Wearable Activity Trackers**

Wearable technology is a growing area. Fitbit with 23.2 million active users is the industry leader. Their number of users continue to grow and they continue to add to the information available to users (Business Wire, 2017). The Fitbit Charge 2 was the number one selling health and fitness device in the last quarter of 2016 (Business Wire, 2017). In an examination of clinical trials using Fitbits, there are 132 clinical trials with 4,510 participants and Fitabase research library records 275 studies using Fitbits (Fitabase, 2017; Ramirez, 2017). Fitbits are the most popular device being used in the clinical trials (Wright, Hall Brown, Collier, & Sandberg, 2017). Fitbits are relatively low cost, provide easy long-term use, provide more information than pedometers or many other measures, and data can be viewed in real time about many health behaviors including physical activity, sedentary time, and energy expenditure (Meyer, Fortmann, Wasmann, & Heuten, 2015a). Continuous assessment in free living conditions can help
refine interventions and recommendations for physical activity and sedentary time (Wright et al., 2017).

Compliance rates are typically fairly high for Fitbit use in research. For example, in a study where 500 Fitbit Charge devices were worn by college freshman for six months to collect information about sleep and physical activity, the study found that overall compliance was 86% when the students synced their Fitbits regularly (Purta et al., 2016). Another study of 25 overweight/obese women over 16 weeks found 95% wore the device for 10 hours or more a day. There was no significant decline in compliance across the length of this study (Cadmus-Bertram, Marcus, Patterson, Parker, & Morey, 2015). In order to maximize compliance rates, it is suggested that researchers have at least one contact with participants prior to providing the device in order to answer questions and problem-solve issues that could arise during the wearing period (Trost, McIver, & Pate, 2005). This could also provide an opportunity to show participants examples of sample data which could further increase study buy-in and compliance.

A systematic review of the validity and reliability of consumer wearable activity trackers found 22 studies where 20 studies looked at Fitbit devices, two looked at Jawbone devices, and six utilized both (Evenson, et al., 2015). Criterion validity was established by comparing the devices to manual step counting or ActiGraph measurement. In general validity was high for steps counted and lower for energy expenditure. Validity for distance traveled and physical activity were based on a limited number of studies. Inter-device reliability was high for steps (interclass correlations from .86 to .99), distance traveled (interclass correlations from .90 to .99), and energy expenditure (interclass correlations from .91 to .97). No studies were found looking at
intra-device reliability (Evenson et al., 2015). Another review reported that activity monitors like Fitbits are comparable to research grade physical activity monitors for measuring steps and are comparable to polysomnography recording for total sleep time (Wright et al., 2017). There is no decisive evidence pointing to one accelerometer being more valid or reliable, instead it is suggested that practical and technical issues be considered along with comparability with other studies when selecting devices.

Regarding usability of Fitbits, research indicates that activity trackers have good usability and that dedicated activity trackers are preferred over phone applications because devices are easy to use long term, are wearable, and unobtrusive (Meyer et al., 2015a). Fitbit devices can also increase adherence and engagement in research studies. Participants report that they engage well with Fitbits, that they are motivating, and easy and convenient to use (Kiessling & Kennedy-Armbruster, 2016).

The ability of wearable devices to track health behaviors has implications for strategies to improve health. It is suggested that just using the devices themselves can facilitate changes in health behaviors and lead to opportunities for real time interventions in the moment (Case, Burwick, Volpp, & Patel, 2015; Wright et al., 2017). A six-week randomized trial of 67 overweight/obese adults into two groups, one with a Fitbit with text message physical activity prompts and one with a Fitbit only, found that the device was easy to use and helped increase physical activity as measured by steps per day. The text message prompts in themselves were not successful in increasing physical activity (Wang et al., 2016). A review of using wearable devices as a physical activity intervention found significant improvements in five of nine studies for physical activity (Lewis, Lyons, Jarvis, & Baillargeon, 2015). However, this review also stated a need for
more randomized trials examining the issue. And it did not examine devices as an intervention for sedentary activity. Additionally, it has been suggested that the use of activity trackers at work can change the perspective of employees to consider their workplace wellbeing and activity patterns (Schulte et al., 2015). Workplace wellbeing or mood has been thought of as including physical activity patterns, productivity, job satisfaction, duration of time spent on email, and quality of life or stress levels (Mark et al., 2016).

**Self-Monitoring with Activity Trackers as an Intervention**

It is hypothesized that activity trackers may be an agent of change in themselves because of self-monitoring and increasing self-regulation that leads to change (Wang et al., 2016). Self-monitoring, which includes understanding and tracking the behavior, has been found to be a behavior change strategy in and of itself (Taylor, 2012). Self-monitoring can impact people’s health because it increases awareness of their behavior, evaluation of it, and influences self-regulation and tracking progress. Albert Bandura states that self-regulation is the basis of purposeful behavior and self-monitoring is an essential component in self-regulation (Bandura, 1991). Bandura also indicates that self-monitoring has several important functions beyond informing goal setting and progress towards goal. It allows for self-diagnosis and pattern awareness and has a self-motivating function.

A meta-analysis of effective techniques in healthy eating and physical activity interventions examined what behavior change techniques improve outcomes. One hundred twenty-two studies with a total of 44,747 participants were included in the
analysis. The majority of the studies focused on changing physical activity only (51 studies) or a combination of physical activity and healthy eating (18 studies). The five techniques of self-regulation that were examined were intention formation, feedback on performance, prompted self-monitoring, goal setting, and a review of goals. Results indicated that self-monitoring was the most important behavior technique and explained the greatest amount of variation among studies. Interventions utilizing self-monitoring were more effective than other without self-monitoring with an average effect size of 0.41 with self-monitoring versus 0.26 without (Michie et al., 2009). In line with these data, a randomized intervention of physical activity involving self-monitoring in a primary care setting utilizing pedometers, logs, and five-day feedback found that compared to controls, self-monitoring increased weekly physical activity by 217 minutes on average (Aittasalo et al., 2006).

An analysis of behavior change techniques in wearable trackers found that most of the behavior techniques involved self-monitoring and self-regulation, which have been linked with improved physical activity and decreases in physical inactivity (Mercer, Li, Giangregorio, Burns, & Grindrod, 2016). Activity trackers prompt self-monitoring of activity levels and health behavior, review successes and goals, and provide feedback about behavior. The fidelity, regularity, and temporal proximity of self-monitoring leads to its success. Also, people's values and the perceived function of the behavior impact how people attend to self-monitoring that behavior (Bandura, 1991). Self-monitoring from consumer wearable devices allows for regular and immediate feedback and tracking of behavior, and provides information the participant may not have thought to track themselves, but then becomes part of their perception of their health and activity. This is
supported by the fact that Fitbits have been found to encourage high levels of self-monitoring that were sustained across 16 weeks in a sample of 25 overweight/obese women (Cadmus-Bertram et al., 2015). Another study found a significant increase of 2000 steps per day with use of a Fitbit. Participants reported this was due to self-monitoring of behavior (Dunn & Robertson-Wilson, 2018).

**Sedentary Break Prompts at Work**

There have been a few pilot studies using Fitbits or other non-commercial accelerometers to intervene with a text message or messages from an online platform if the wearer has not moved enough steps within an hour (Barwais & Cuddihy, 2015; Finkelstein, Bedra, Li, Wood, & Ouyang, 2015) or received a computer prompt to stand every 30 minutes (Evans et al., 2012). These studies both found a significant reduction in sedentary time across one to four weeks; but these studies have small sample sizes of 18 to 28 participants and one was limited to overweight/obese female participants. However, none of these three studies were specifically focused in work environments.

There have also been a few studies focused on prompting breaks at work using other devices including a study with 10 participants which found that a pedometer and ambient light display to prompt movement increased steps and participants moved more frequently (Fortmann, Stratmann, Boll, Poppinga, & Heuten, 2013). Another study utilized both fixed hourly prompts from a computer and from a wrist worn watch that beeped or vibrated along with an ActiPAL motion and postural assessment monitor attached to their thigh (Swartz et al., 2014). They found a reduction in average duration of sitting bouts, the number of 60 minutes or more sedentary time, and total sitting time,
which supports using device prompts at work. However, the study was based on fixed hourly prompts and not in the moment intervention based on participants’ actual behavior. The technology in activity trackers now enables a simpler way using one device to examine this.

**Other Variables Related to Workplace Wellbeing Related to Sedentary Time**

Physical activity and sedentary time are linked to wellbeing. Sedentary behavior is part of the picture of workplace wellness and may be linked with other factors that are also important in workplace wellbeing. Workplace wellbeing can be defined as feeling safe, healthy, satisfied and engaged at work and is linked with concepts of physical and emotional health and with work productivity. Increased sedentary time has been found to result in negative mood independent of changes in activity level and this change in mood was associated with stress reactivity (Endrighi, Steptoe, & Hamer, 2016).

Another study looked at 30 sedentary adults who had one control day of prolonged sedentary time, one day with a onetime incident of 30 minutes of physical activity and one day with hourly breaks in sedentary time (Bergouignan et al., 2016). Breaks in sedentary time had more beneficial results than exercising for 30 minutes a day. Breaks in sedentary time were also significantly associated with higher energy levels, productivity, mood, and decreased fatigue.

Another study utilizing mobile phones found that breaks in sedentary time correlated with positive mood (Matic, Osmani, Popleteev, & Mayora-Ibarra, 2011). This study recommended analyzing wellbeing implications of sedentary time to possibly provide persuasive feedback to encourage breaks in sedentary time in participants.
Wearable trackers can be used to get a picture of workplace wellbeing along with measures of mood, productivity, job satisfaction and stress. Activity trackers at work can change the perspective of employees to consider the bigger picture of workplace wellbeing and activity patterns (Schulte et al., 2015).

**Overview of Proposed Study**

Sedentary time and physical inactivity have negative impacts on health, healthcare and workplace wellbeing. There is evidence that people are more sedentary than in the past and engage in less light physical activity on work days. Those that are more sedentary at work are also more sedentary outside of work (Clemes et al., 2014). The workplace is an ideal place to intervene on this behavior. Consumer wearable monitors are a useful way to collect and intervene in real time and promote self-monitoring. Research suggests that there is a need for further device-based measurement studies in workplaces with a focus on breaking up sedentary time, in addition to increasing physical activity (Parry & Straker, 2013; Thorp et al., 2012). The reminder to move prompts that are now part of Fitbit models like the Charge 2 provide an innovative and simple way to intervene on workplace sedentary behavior in real time and provide real time self-monitoring; however, there is gap in the research using Fitbits to intervene on sedentary behavior in the workplace. As far as the author is aware, this is the first study external to Fitbit examining “Reminders to Move” as well as one of a limited number of studies examining this type of intervention to specifically target workplace sedentary time and physical activity.
Fitbits have also begun to be used to get a picture of workplace wellbeing (Mark et al., 2016) thus a study to see if physical activity or sedentary time impacts other domains such as affect balance, productivity, job stress, and quality of life seems warranted. This points to how Fitbit can be used to explore the relationship of multiple outcomes in relation to physical inactivity at work.

This study examined physical activity and sedentary time in university employees utilizing a commercial activity tracker. Participants had baseline data collected and then had a week with access to Fitbit self-monitoring data and then a week where they received an hourly reminder to move prompt during the work day to intervene on sedentary time. Other aspects of workplace wellbeing were measured to explore the relationship between physical activity or inactivity and other aspects of workplace well-being. The current project addressed the following research questions:

1) What are the average number of steps and amount of sedentary time in a week for workers?

2) Will an in the moment intervention with reminders to move at work result in decrease in sedentary time or an increase in steps?

3) What is the relationship between physical activity and sedentary time with other factors of workplace wellbeing including mood, quality of life, work productivity, and job stress?
CHAPTER III

METHODS

Procedure

Participants were recruited from non-student employees at Utah State University (USU), a public university with a main campus in Logan, Utah. Recruitment material was placed on campus in highly visible public areas and at the USU Employee Wellness Center. Emails of the recruitment flyers were also sent to staff assistants across departments at the university to aid in recruitment (see Appendix A). All participants were self-referred. Based on previous research, participants were excluded if they currently reported less than four hours per day of sedentary time at work, if they were not working over 25 hours a week, if they had a condition that made it unsafe for them to change their activity and sitting behaviors, if they were currently using an activity tracker, and if they did not have access to a smart phone or computer for syncing the device (Barwais & Cuddihy, 2015; Duncan et al., 2016; Finkelstein et al., 2015; Healy et al., 2012). Additionally, participants were excluded if their job requirements made it impossible for them to move every hour, thus not allowing them to participate in the intervention during work. Ninety-five people were screened for the study and 71 people were ultimately enrolled in the study.

The study was completed in cycles of participants due to the number of Fitbit devices and pace of recruitment. There was a goal of 70 total participants completing the study, with a minimum of 50. Participants who completed the pre-and post-study measures were entered in a random drawing for a $50 Amazon gift card, with at least one
being awarded randomly per 15 participants. Seventy-one participants enrolled in the study. One person dropped out after the first day due to experiencing some irritation because of the Fitbit band and one dropped out before the day of the study because they unexpectedly received another Fitbit device. Sixty-nine people completed the study. The participants consisted of 69 university employees (average age = 43.72 yrs., 72.5% female) who spent over four hours a day sedentary at work and were not already using an activity monitor like a Fitbit (see Table 1). There were four rounds of data collection that were conducted from June through September.

Once individuals were recruited they were screened for exclusion factors through an online survey or via phone or e-mail, according to the participant’s preference. If they met the inclusion criteria, they met with a researcher to provide their informed consent, learn about the study procedures, complete pre-study survey measures, and become familiarized with the Fitbit. Participants also were sent the pre-survey measures on-line through REDCap (Harris et al., 2009) after coming to the initial meeting and completing the informed consent. Participants could choose to complete the materials on-line or in person, but all participants chose to complete them online. Then they were assigned an ID number to be used for their Fitbits and their surveys so that all information collected was separated from any identifying information. Contact information and their ID number were stored with encryption and separated from the other data.

After the initial meeting, participants were asked to begin continuously wearing the Fitbit device for a baseline period one week. The Fitbit only displayed the watch screen during this time period with no access to other data. After the initial one week baseline period, participants were contacted by email for troubleshooting or problem
solving of any data collection or device issues. The majority of participants kept the
automatic sync turned on so that their devices synced automatically multiple times a day.

Following the baseline week, the Fitbit devices were activated for the display
screen to show the activity being tracked, including steps, distance, calories expenditure,
stairs walked, and number of active minutes, to allow for self-monitoring. Participants
were given access to the self-monitoring data provided by Fitbit on the Fitbit and the
Fitbit app. The participants wore their device for a week with access to this self-
monitoring data.

At the beginning of the third week participants were notified via email of another
Fitbit device change. The sedentary time reduction was initiated by activating the Fitbit
application “Reminders to Move.” This caused the Fitbit to vibrate at the 50-minute mark
of the hour if the participant had not moved 250 steps in that time period. The screen
displayed number of steps needed to reach 250 that hour. It also vibrated again if the
participant walked the remaining 250 steps before the end of the hour. A positive
reinforcement statement was displayed on the screen if the 250 steps were completed. No
vibration or statement was displayed on the screen if the participant did not complete 250
steps during this time. It is estimated that two to three minutes of walking or other
movement would be 250 steps. It was expected that “Reminders to Move” could change
behavior in the moment, so one week was determined to be sufficient time to explore the
feasibility and impact of using Fitbits in this way.

Following this sedentary time intervention, all participants returned their Fitbits
for use by the next cycle of participants. The participants completed post-study surveys
either in person or online through REDCap. An outline of the data collection across time
is illustrated in Figure 1. An outline of changes in the Fitbit device set up can be seen in Figure 2.

The Fitbit data were collected with the use of Fitabase, a data management platform used for collecting, aggregating, and exporting the data while maintaining participant confidentiality (Fitabase, 2017).

**Materials**

**Demographics and Contact Information**

Participants completed a basic demographic questionnaire that included weight to accurately set up their Fitbit. Their estimated sedentary time at work, years at this job, and hours per day spent working was also collected. Contact information was also collected for text or e-mail reminders and to allow for contact by the researchers. All study measures are located in Appendix B and the informed consent form is located in Appendix C.

**Pre- and Post-Study Measures**

**Job satisfaction.** A one-item measure was used to assess overall job satisfaction on a seven point Likert-scale where 1 = extremely dissatisfied to 7 = extremely satisfied. A single item measure has been found to have a reliability estimate of .90 when compared to a multi-item job satisfaction questionnaire that has an internal consistency of .92. A single item measure also has established concurrent and construct validity compared with the multiple-item measures (Dolbier, Webster, McCalister, Mallon, & Steinhardt, 2005).
**Depression.** The Patient Health Questionnaire Depression Scale (PHQ-9; Kroenke & Spitzer, 2002) is a nine item self-report inventory to briefly assess symptoms of depression during the past two weeks. The scale items have a 4-point scale (0 = "not at all" to 3 = "nearly every day") about how bothered a participant feels with specific symptoms of depression. Scores range from 0 to 27. The score of 5 represents mild depression, 10 moderate depression, 15 moderately severe depression, and 20 severe depression. There is also an additional rating of how difficult these symptoms make it to function occupationally and socially from “not at all” to “extremely difficult”. In a sample of 6,000 patients with a PHQ-9 score at or above 10 had a sensitivity of 88% and a specificity of 88% for major depression (Kroenke, Spitzer, & Williams, 2001). The PHQ-9 has good internal reliability with a Cronbach’s $\alpha$ ranging from .86 to .89 and the test-retest reliability of the PHQ-9 is .84 (Kroenke, et al., 2001). The construct validity of the PHQ-9 is demonstrated by its correlation of .73 with the mental health scale of 20 item Short Form Health Survey. It’s criterion validity is supported by a correlation of .84 between the PHQ-9 and mental health provider interviews (Kroenke & Spitzer, 2002).

**Anxiety.** The General Anxiety Disorder questionnaire (GAD-7; Spitzer, Kroenke, Williams, & Löwe, 2006) is a seven item self-report measure to assess anxiety. The items are rated from 0 to 3 with 0 = not at all and 3 = nearly every day. The cutoff for mild anxiety is 5, for moderate anxiety is 10 and for severe anxiety is 15. Scores range from 0 to 21. At the threshold score of 10 the GAD-7 has a sensitivity of 89% and a specificity of 82% for GAD. It is also able to screen for other anxiety disorders including panic disorder and social anxiety disorder (Kroenke, Spitzer, Williams, Monahan, & Löwe, 2007). The GAD-7 has excellent internal consistency with a Cronbach’s $\alpha$ of .92 and
good test-rest reliability with a correlation of .83 (Spitzer et al., 2006). The GAD-7 also has good construct validity with the GAD-7 scores being similar to mental health provider interviews (interclass correlation = .83).

**Average mood.** The Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988), a self-report measure of positive and negative affect or activation, was used to measure mood. The PANAS has 10 items measuring positive affect and 10 items measuring negative affect. Each item is scored on a 1 to 5 Likert-scale where 1 is slightly or not at all experiencing that emotion and 5 is extremely experiencing it at the selected point of time (in the moment, past day, week, month, year, or on average). The measure is also brief and easy to administer and complete. The scores for each scale range from 10-50 with higher scores indicating higher levels of that mood (PA or NA). The PA scale and NA scale have good internal reliability with a Cronbach’s $\alpha$ of .89 and .85, respectively (Crawford & Henry, 2004; Watson et al., 1988). There is also support for the external validity of the PANAS as the Hopkins Symptoms Checklist, a measure of distress, is modestly negatively correlated with the PANAS PA scale ($r= -.29$) and positively correlated with the NA scale ($r=.65$). Confirmatory factor analysis largely supports the construct validity of the PANAS scales (Crawford & Henry, 2004; Watson et al., 1988). A score for affect balance is found by subtracting the negative affect from the positive affect scale score. Affect balance scores range from -40 to +40 with positive scores indicating positive affect balance relative to negative mood. Affect balance has been used to describe the relationship of positive and negative mood to each other and is thought to be a stronger picture of mood than using them alone (Harding, 1982; Koydemir & Schütz, 2012).
Quality of life. The Short Form Health Survey (SF-36; Ware et al., 2007) is a 36-item self-report measure to assess health status and quality of life. The SF-36 examines eight aspects of health: physical functioning, role limitations due to physical health, bodily pain, general health perceptions, vitality, social functioning, role limitations due to emotional problems, and mental health. These 8 subscales are combined into a physical component summary (PCS) and a mental component summary (MCS; Ware, 2000). Norm based scoring leads to all scores above or below 50, and standard deviation of 10, being interpreted as above or below the general population norm. Higher scores on the SF-36 indicate greater quality of life. The SF-36 has good reliability and validity (Ware et al., 2000). The internal reliability Cronbach’s $\alpha$ range from .83 to .95 for the scales, and reliability estimates for the composite physical and mental summary scores exceed .90 (Ware, Kosinski, & Keller, 1994; Ware, Kosinski, Dewey, & Gandek, 2000).

Productivity. A self-reported productivity index consisting of six items about efficiency, satisfaction, time management, and quality of work was completed (Mark et al., 2016). Item responses are on a seven point Likert-scale were used to score the responses where 1 = not at all and 7 = extremely. Based on the correlations between items found in previous studies with correlations ranging from .68 to .94 the items were added together for a productivity index.

Stress. The Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983), a 10-item self-report measure contains items about unpredictable, uncontrollable, and overloaded response people find their lives. Item responses are on a Likert-scale with 0 = never and 4 = very often, which are summed yielding scores ranging from 0 to 40. Higher scores indicate greater stress. Evidence for validity of the PSS includes higher
scores that were associated with a greater vulnerability to stressful life event elicited symptoms of depression, more colds, and failure to quit smoking, and correlated with other measures of stress and lower self-reported health status. Norm scores for men were a mean score of 12.1 with a SD of 5.9 and for females a mean score of 13.7 with a SD of 6.6 (Cohen et al., 1983; Cohen & Williamson, 1988).

**Post-study physical activity changes and use of Fitbit evaluation.** At the end of the study, participants completed a four item self-report indicating whether they felt their physical activity had changed and if they wanted to keep using the Fitbit (Han et al., 2016).

**Continuous Measures**

**Physical activity level.** The Fitbit Charge 2 was used to collect number of steps in a day and level of intensity with the number of minutes lightly active, fairly active or very active during work.

**Sedentary time.** The Fitbit Charge 2 was used to record the number of work hours where there were less than 250 steps in an hour. During the week, the reminders to move are activated on the device the prompt will be sent if they have not moved 250 steps yet in the hour as that would be considered a sedentary hour. Total minutes sedentary at work will also be collected as that is a common metric reported in other studies.

*Figure 1.* Measures to be administered across time.
<table>
<thead>
<tr>
<th>Time Point</th>
<th>Data to be Collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Meeting</td>
<td>Informed Consent&lt;br&gt;Demographics Form&lt;br&gt;Contact Information&lt;br&gt;1 item Job Satisfaction Measure&lt;br&gt;PHQ-9&lt;br&gt;GAD-7&lt;br&gt;PANAS&lt;br&gt;SF-36&lt;br&gt;6 item Productivity Measure&lt;br&gt;10 item Stress Measure</td>
</tr>
<tr>
<td>At the End of the Study (3 weeks later)</td>
<td>1 item Job Satisfaction Measure&lt;br&gt;PHQ-9&lt;br&gt;GAD-7&lt;br&gt;PANAS&lt;br&gt;SF-36&lt;br&gt;6 item Productivity Measure&lt;br&gt;10 item Stress Measure&lt;br&gt;4 item Evaluation of Physical Activity Changes</td>
</tr>
</tbody>
</table>

*Figure 2.* Participant contact points and changes in Fitbit device set up.
Initial Meeting
- Collect pre-study measures
- Participants given Fitbit which is setup like a watch

1 Week Later
- Check-in about device functioning
- Fitbit device set up so self-monitoring data is visible

Another Week Later
- Check-in
- Reminders to move activated on the Fitbit device

After 3 Weeks
- The device is returned
- Post-study measures are completed

Analysis Plan

Power Analysis

A priori power analyses were conducted using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007). For a .05 alpha level at 80% power seeking a moderate effect size to detect differences in a one-way repeated measures ANOVA (1 group, 3 measurement time points), a minimum of 18 participants was needed. For a .05 alpha level at 80% power seeking a small effect size to detect differences in a one-way repeated measures ANOVA (1 group, 3 measurement time points) a minimum of 81 participants was needed. No extremely similar studies with Fitbit were found to estimate effect sizes. Prior
Fitbit literature tended toward smaller sample sizes than the size here, often less than 30 participants, while workplace interventions tend to have larger sample sizes. Because of financial and time restrictions due to the number of devices and the length of the intervention, the goal was 70 participants with a minimum of 50.

**Preliminary Analyses**

Data were analyzed in IBM SPSS Version 24.0. The descriptive statistics for all the study measures were calculated. The distributional properties of the measures analyzed in the study were graphically assessed with frequency histograms, bar plots, and probability plots and found to be reasonably normal. They were assessed for skewness, kurtosis, and linearity. Univariate outliers were sought using boxplots and z-scores and there were no z-scores outside of the expected normal distribution so no outliers were found. The changes in means between pre- and post-study measures were explored with paired-samples t-test, and Cohen’s d effect sizes were calculated.

**Research Question #1**

To answer the first research question the average amounts of steps, time spent in light, moderate, and vigorous activity, and sedentary time per work day were calculated at the three time points baseline, with Fitbit feedback, and with reminders to move. Descriptive statistics of the pre- and post-study survey measures of other factors of workplace wellbeing including mood, quality of life, work productivity, job satisfaction, and job stress as well as paired t-test were also run to further explore the data.
Research Question #2

The second research question is whether an in-the-moment intervention with reminders to move at work result in decrease in sedentary time and increase in steps. One-way repeated measures ANOVA were used to answer this. First a one-way repeated measures ANOVA was run with weekly total sedentary hours at work as measured by the reminder to move criteria of less than 250 steps per hour as the within-subjects factor. A second one-way repeated measures ANOVA was run with weekly total steps on work days, including steps during and outside work that day, as the within-subjects factor. Given that other research often looks at sedentary minutes, a third one-way repeated measures ANOVA was run with weekly total sedentary minutes at work as the within-subjects factor. There were no extreme outliers in the data and distributions appeared normal as assessed by histograms, boxplots, Q-Q plots and by Shapiro-Wilk's test ($p > .05$). Pairwise comparisons were run to examine the difference between the three weeks for each significant $F$ test using the Helmert method. This is an orthogonal contrast that compares each category (except the last) to the mean effect of all subsequent categories. This was chosen because the hypothesis was that the outcomes would change from baseline and that in week three they would change more than in week two because the reminders to move were turned on in week three.

Multilevel modeling (MLM) was used to explore what more could be learned by examining more of each individual’s data points. MLM was proposed because of the increased power available with days nested within a person for the dependent variable and because it allows for variation within and between participants. MLM was used to test whether the participants sedentary time or steps changed across time and to test
whether the reminders to move being activated led to a different trajectory. All multilevel analysis was performed using R. Data were also screened for outliers and, similar to other research data points, were removed if there had been a day with 0 steps or 0 sedentary minutes because that was considered a non-valid wear day (Mark et al., 2016). After this exclusion of non-valid wear times a majority of the missing time points were on weekends (3.0% of total time points) which were not examined in this study. There was no discernable pattern in other non-valid work day wear times (2.5% of total time points) and multilevel modeling can flexibly address missing data.

Separate linear growth models or linear mixed effect models were run with steps as the outcome and sedentary time as the outcome to analyze their trajectories over time. Days were nested within participants. Models were run using random and fixed effects. Final models used a random intercept for participants, fixed effects for time, and a time varying covariate if the reminder to move was activated (1 for yes in week 3) or not (0 for no in weeks 1 or 2). Maximum likelihood estimation was used in the models. Models with and without the time varying predictor of the reminders to move being activated or not were compared using a chi-squared difference test of the log likelihood values and based on this the final models for steps and for sedentary hours both had the time varying covariate of reminders to move being activated or not in the final model. Given the exploratory nature of this study, statistical significance for all tests was set at \( p < .05 \).

**Research Question #3**

The third research question concerns the relationship between physical activity and sedentary time with other factors of workplace wellbeing. Two series of regressions were run to examine the change in sedentary time at work or total steps on workday
between baseline and week three and their relationship to change in other factors of workplace wellbeing including mood, quality of life, work productivity, and job stress.

To assess linearity a scatterplot of the change in each factor of workplace wellbeing (depression, affect balance, productivity, stress, physical and emotional quality of life) against change in weekly steps across the study with superimposed regression line was plotted. To assess linearity a scatterplot of the change in each factor of workplace wellbeing (depression, affect balance, productivity, stress, physical and emotional quality of life) against change in weekly sedentary hours across the study with superimposed regression line was plotted. Visual inspection of these plots indicated a linear relationship between the pairs of variables. There was homoscedasticity and normality of the residuals. One participant was a singular outlier in change in steps. Regression analysis was run with and without the outlier and the results were not substantially changed so the outlier was kept in the analysis.
CHAPTER IV

RESULTS

Participants

The participants were 69 university employees (average age = 43.72 years, 72.5% female) who spent over four hours a day sedentary at work and were not already using an activity monitor like a Fitbit (see Table 1). The majority of the sample identified as White, married, and had a college degree or graduate degree. They worked an average of 42.81 hours a week, had been at their job for 8.59 years on average, and sedentary 8.12 hours a day at work by self-report. The age of the sample ranged from 23 to 69 years old and the self-reported weight ranged from 96 to 281 pounds. All participants completed all questions of the pre- and post-survey measures, thus there was no missing survey data. Participants appeared to consistently wear and sync their Fitbits with a few participants needing email prompts to sync the device. All participants were sufficiently sedentary to have received reminder to move prompts the majority of the days of the study, and all participants received reminder to move prompts everyday during the intervention period. Only 10 out of the 69 participants had one day in the intervention period where they were active enough to not need any reminder to move prompts on a workday.
Table 1

Descriptive Statistics of the Sample

<table>
<thead>
<tr>
<th>Patient Characteristics</th>
<th>Frequency</th>
<th>Percentage</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>19</td>
<td>27.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>50</td>
<td>72.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td>43.72</td>
<td>12.36</td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single, never married</td>
<td>7</td>
<td>10.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Separated</td>
<td>1</td>
<td>1.4</td>
<td></td>
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<tr>
<td>Divorced</td>
<td>6</td>
<td>8.7</td>
<td></td>
<td></td>
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<tr>
<td>Widowed</td>
<td>2</td>
<td>2.9</td>
<td></td>
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<tr>
<td>Married</td>
<td>53</td>
<td>76.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>67</td>
<td>97.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>1</td>
<td>1.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>1.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Indian/Alaska Native</td>
<td>1</td>
<td>1.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>67</td>
<td>97.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than one race</td>
<td>1</td>
<td>1.4</td>
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<td>Education</td>
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<td></td>
</tr>
<tr>
<td>HS degree/GED</td>
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<td>4.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some college</td>
<td>8</td>
<td>11.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>College degree</td>
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<td>36.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Graduate degree</td>
<td>33</td>
<td>47.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average number of hours worked a week</td>
<td></td>
<td></td>
<td>42.81</td>
<td>8.77</td>
</tr>
<tr>
<td>Number of years employed at current job</td>
<td></td>
<td></td>
<td>8.59</td>
<td>9.13</td>
</tr>
<tr>
<td>Weight in pounds</td>
<td></td>
<td></td>
<td>168.78</td>
<td>36.25</td>
</tr>
<tr>
<td>Estimated number of sedentary hours a day at work</td>
<td></td>
<td></td>
<td>8.12</td>
<td>3.70</td>
</tr>
</tbody>
</table>

Change in Pre- and Post-Study Measures

Tables of the descriptive statistics of the pre- and post-study survey measures of other factors of workplace wellbeing including mood, quality of life, work productivity, job satisfaction, and job stress are presented in Tables 2 and 3. Paired-samples t-tests were run to assess whether the pre- and post-study measure changes were significant. On average, participants after the three week intervention on sedentary time reported
significantly less depression ($d = -0.35$), negative affect ($d = -0.26$), and stress ($d = -0.29$). They also had significantly more positive affect ($d = 0.24$), affect balance ($d = 0.32$), social functioning ($d = 0.28$), physical functioning ($d = 0.25$), and productivity ($d = 0.50$). Productivity had a medium effect size and the rest had small to medium effect sizes. However, the average changes in the decrease of anxiety, increase in job satisfaction, and the quality of life measure of mental health were not significant.

Table 2

<table>
<thead>
<tr>
<th>Workplace Wellbeing Pre- and Post-Survey</th>
<th>Pre-Mean</th>
<th>Pre-SD</th>
<th>Post-Mean</th>
<th>Post-SD</th>
<th>Paired t</th>
<th>P-value</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression</td>
<td>5.16</td>
<td>4.40</td>
<td>3.62</td>
<td>3.54</td>
<td>4.47</td>
<td>&lt;.001</td>
<td>-0.35</td>
</tr>
<tr>
<td>Anxiety</td>
<td>3.52</td>
<td>3.97</td>
<td>3.12</td>
<td>3.91</td>
<td>1.28</td>
<td>.355</td>
<td>-0.10</td>
</tr>
<tr>
<td>Negative affect</td>
<td>16.54</td>
<td>6.26</td>
<td>14.90</td>
<td>6.09</td>
<td>4.06</td>
<td>&lt;.001</td>
<td>-0.26</td>
</tr>
<tr>
<td>Positive affect</td>
<td>31.32</td>
<td>7.11</td>
<td>33.06</td>
<td>6.39</td>
<td>-3.00</td>
<td>.004</td>
<td>0.24</td>
</tr>
<tr>
<td>Affect balance</td>
<td>14.78</td>
<td>10.40</td>
<td>18.16</td>
<td>9.62</td>
<td>-4.68</td>
<td>&lt;.001</td>
<td>0.32</td>
</tr>
<tr>
<td>Stress</td>
<td>14.75</td>
<td>6.33</td>
<td>12.90</td>
<td>6.31</td>
<td>4.00</td>
<td>&lt;.001</td>
<td>-0.29</td>
</tr>
<tr>
<td>Productivity</td>
<td>28.07</td>
<td>6.88</td>
<td>31.48</td>
<td>6.35</td>
<td>4.37</td>
<td>&lt;.001</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Table 3

<table>
<thead>
<tr>
<th>SF36 Pre- and Post-Survey</th>
<th>Pre-Mean</th>
<th>Pre-SD</th>
<th>Post-Mean</th>
<th>Post-SD</th>
<th>Paired t</th>
<th>P-value</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical functioning</td>
<td>52.27</td>
<td>5.87</td>
<td>53.37</td>
<td>4.52</td>
<td>-1.892</td>
<td>.063</td>
<td>0.19</td>
</tr>
<tr>
<td>Role limit/physical</td>
<td>49.67</td>
<td>8.93</td>
<td>51.81</td>
<td>6.54</td>
<td>-2.697</td>
<td>.009</td>
<td>0.24</td>
</tr>
<tr>
<td>Role limit/emotional</td>
<td>47.47</td>
<td>10.13</td>
<td>48.06</td>
<td>11.92</td>
<td>-.450</td>
<td>.654</td>
<td>0.06</td>
</tr>
<tr>
<td>Vitality</td>
<td>44.63</td>
<td>8.99</td>
<td>46.65</td>
<td>8.98</td>
<td>-2.392</td>
<td>.020</td>
<td>0.22</td>
</tr>
<tr>
<td>Mental health</td>
<td>49.13</td>
<td>9.40</td>
<td>50.42</td>
<td>8.30</td>
<td>-1.954</td>
<td>.055</td>
<td>0.14</td>
</tr>
<tr>
<td>Social functioning</td>
<td>48.34</td>
<td>9.64</td>
<td>51.02</td>
<td>8.35</td>
<td>-2.838</td>
<td>.006</td>
<td>0.28</td>
</tr>
<tr>
<td>Bodily pain</td>
<td>47.32</td>
<td>8.28</td>
<td>49.61</td>
<td>6.50</td>
<td>-3.784</td>
<td>&lt;.001</td>
<td>0.28</td>
</tr>
<tr>
<td>General health</td>
<td>48.83</td>
<td>9.72</td>
<td>50.26</td>
<td>8.94</td>
<td>-2.135</td>
<td>.036</td>
<td>0.15</td>
</tr>
<tr>
<td>Physical summary</td>
<td>50.24</td>
<td>7.78</td>
<td>52.18</td>
<td>5.98</td>
<td>-3.827</td>
<td>&lt;.001</td>
<td>0.25</td>
</tr>
<tr>
<td>Mental summary</td>
<td>46.57</td>
<td>10.55</td>
<td>47.88</td>
<td>10.42</td>
<td>-1.497</td>
<td>.139</td>
<td>0.12</td>
</tr>
</tbody>
</table>
Research Question 1: What are the average amounts of steps and sedentary time on work days for workers?

To answer the first research question the average amounts of steps, time spent in light, moderate, and vigorous activity, and sedentary time per work day were calculated at baseline, with Fitbit feedback, and with reminders to move (see Table 4).

Table 4

<table>
<thead>
<tr>
<th>Fitbit Data</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steps in a work day Week 1</td>
<td>8456.12</td>
<td>3339.95</td>
</tr>
<tr>
<td>Steps in a work day Week 2</td>
<td>8493.79</td>
<td>3263.46</td>
</tr>
<tr>
<td>Steps in a work day Week 3</td>
<td>8997.263</td>
<td>3375.87</td>
</tr>
<tr>
<td>Minutes of light activity in a work day Week 1</td>
<td>207.05</td>
<td>61.54</td>
</tr>
<tr>
<td>Minutes of light activity in a work day Week 2</td>
<td>209.59</td>
<td>72.53</td>
</tr>
<tr>
<td>Minutes of light activity in a work day Week 3</td>
<td>222.16</td>
<td>63.40</td>
</tr>
<tr>
<td>Minutes of moderate activity in a work day Week 1</td>
<td>15.21</td>
<td>14.74</td>
</tr>
<tr>
<td>Minutes of moderate activity in a work day Week 2</td>
<td>14.12</td>
<td>10.69</td>
</tr>
<tr>
<td>Minutes of moderate activity in a work day Week 3</td>
<td>15.64</td>
<td>14.81</td>
</tr>
<tr>
<td>Minutes of vigorous activity in a work day Week 1</td>
<td>19.27</td>
<td>19.04</td>
</tr>
<tr>
<td>Minutes of vigorous activity in a work day Week 2</td>
<td>18.29</td>
<td>19.80</td>
</tr>
<tr>
<td>Minutes of vigorous activity in a work day Week 3</td>
<td>19.14</td>
<td>20.50</td>
</tr>
<tr>
<td>Minutes sedentary at work per day Week 1</td>
<td>459.58</td>
<td>45.55</td>
</tr>
<tr>
<td>Minutes sedentary at work per day Week 2</td>
<td>459.04</td>
<td>47.58</td>
</tr>
<tr>
<td>Minutes sedentary at work per day Week 3</td>
<td>445.74</td>
<td>48.23</td>
</tr>
</tbody>
</table>

Research Question 2: Will an in-the-moment intervention with reminders to move at work result in decrease in sedentary time or an increase in steps?

The second question examined whether the reminder to move prompts created a significant decrease in sedentary time at work or increase in overall steps. Means and
standard deviations for each week and each repeated measures ANOVA can be seen in Table 5. Repeated measures ANOVA assumptions were met.

Table 5

<table>
<thead>
<tr>
<th>Variables</th>
<th>Week 1</th>
<th></th>
<th>Week 2</th>
<th></th>
<th>Week 3</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Sedentary hours at work</td>
<td>20.19</td>
<td>6.86</td>
<td>19.58</td>
<td>7.42</td>
<td>16.09</td>
<td>8.19</td>
</tr>
<tr>
<td>Overall steps across the work day</td>
<td>42281</td>
<td>16700</td>
<td>42469</td>
<td>15817</td>
<td>44986</td>
<td>16879</td>
</tr>
<tr>
<td>Sedentary minutes at work</td>
<td>2298</td>
<td>228</td>
<td>2295</td>
<td>238</td>
<td>2229</td>
<td>241</td>
</tr>
</tbody>
</table>

**Sedentary Hours at Work**

A one-way repeated measures ANOVA was conducted to see if there was a significant difference across the three weeks in weekly total sedentary hours at work, as measured by the reminder to move criteria of less than 250 steps per hour as the within-subjects factor. There were no outliers and the data was normally distributed at each time point, as assessed by boxplot and Shapiro-Wilk test \((p > .05)\), respectively. The assumption of sphericity was met, as assessed by Mauchly's test of sphericity, \(\chi^2(2) = .26, p = .88\). There was a statistically significant difference over the three weeks in weekly total sedentary hours at work, as measured by the reminder to move criteria of less than 250 steps per hour, \(F(2, 136) = 15.92, p < .001\), partial \(\eta^2 = 0.18\) with weekly sedentary hours decreasing from 20.19 ± 6.86 hours at baseline to 19.58 ± 7.42 hours with
the Fitbit device feedback and to 16.09 ± 8.19 hours with the reminder to move intervention (see Figure 3). There was a statistically significant decrease from baseline to intervention weeks two and three, $F(1,68) = 11.80, p = .001$. There was also a statistically significant decrease in sedentary hours at work from week three compared to week two, meaning that the reminders to move in week three contributed to a statically significant decrease in sedentary time in week three, $F(1,68) = 18.62, p = < .001$ (see Table 6).

*Figure 3.* Repeated measures ANOVA of sedentary hours at work.
Table 6

One-Way Repeated Measures Within-Subjects Results

<table>
<thead>
<tr>
<th>Variables</th>
<th>Week 1 vs. Weeks 2 &amp; 3</th>
<th>Week 2 vs Week 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$F$</td>
<td>Partial $\eta^2$</td>
</tr>
<tr>
<td>Sedentary hours at work (less than 250 steps)</td>
<td>11.80*</td>
<td>.15</td>
</tr>
<tr>
<td>Overall steps across the work day</td>
<td>1.15</td>
<td>.02</td>
</tr>
<tr>
<td>Sedentary minutes at work</td>
<td>2.94</td>
<td>.04</td>
</tr>
</tbody>
</table>

*p < .05

Overall Steps on Work days

A one-way repeated measures ANOVA was conducted to see if there was a significant difference across the three weeks in weekly total steps on work days as the within-subjects factor. There were no outliers and the data was normally distributed at each time point, as assessed by boxplot and Shapiro-Wilk test ($p > .05$), respectively. The Greenhouse-Geisser estimate of departure from sphericity was $\varepsilon = 0.85$. There was not a statistically significant difference over the three weeks in weekly total steps on work days, $F(1.69, 115.10) = 2.63, p = .085$, partial $\eta^2 = 0.037$ with weekly overall steps on work days increasing from $42280.61 \pm 16699.79$ weekly steps at baseline to $42468.93 \pm 15817.32$ weekly steps with the Fitbit device feedback and to $44986.28 \pm 16879.34$ weekly steps with the reminders to move intervention (see Table 6 and Figure 4).

Although the main effect was not significant given that the MANOVA multivariate test statistics were all significant ($V = 0.08, F(2,67) = 3.20, p = .047$) suggesting significant differences across time so the Helmert contrasts were reported in Table 6. These show that while there was not a significant increase in steps between week one and the average
of weeks two and three, there was a significant increase in steps in week three when the reminders to move were turned on, compared to week two where there were no reminders turned on, $F(1,68) = 6.06, p = .016$. The post hoc analysis with a Bonferroni adjustment revealed no additional significant difference between the weeks.

**Figure 4.** Repeated measures ANOVA of steps on work days.

![Graph showing the mean total steps on workdays across three weeks with error bars.](image)

**Sedentary Minutes at Work**

A one-way repeated measures ANOVA was conducted to see if there was a significant difference across the three weeks in weekly total sedentary minutes at work as
the within-subjects factor. There were no significant outliers and the data was normally
distributed at each time point, as assessed by boxplot and Shapiro-Wilk test \((p > .05)\),
respectively. The assumption of sphericity was met, as assessed by Mauchly's test of
sphericity, \(\chi^2(2) = 2.35, p = .31\). There was a statistically significant difference over the
three weeks in weekly total sedentary minutes at work, \(F(2, 136) = 5.91, p = .003\), partial
\(\eta^2 = 0.08\) with weekly sedentary minutes at work decreasing from 2297.90 ± 227.74
minutes at baseline to 2295.22 ± 237.90 minutes with the Fitbit device feedback and to
2228.68 ± 241.14 minutes with the reminders to move intervention. There was not a
statistically significant decrease from baseline to the average of the intervention weeks
two and three, \(F(1,68) = 2.94, p = .091\). However, there was a statistically significant
decrease in sedentary minutes at work from week three, \(F(1,68) = 9.74, p = .003\), when
reminders to move was turned on, compared to week two, when reminders to move were
not activated (see Table 6 and Figure 5). The post hoc analysis with a Bonferroni
adjustment revealed that beyond the significant decrease in sedentary minutes in week
three from week two, sedentary minutes significantly decreased from week one to week
three \((p = .003)\) when the reminders to move were turned on, while sedentary time did not
significantly decrease from week one to week two \((p = .92)\) when the Fitbit devices were
providing feedback but the reminders to move were not yet turned on.
Growth Models of Sedentary Time

First the MLM data for sedentary hours at work was explored by examining individual plots for a random 15 participants (see Figure 6) and individual fitted ordinary least squares trajectories (Figure 7). These appeared to indicate a range of variation in the rate of change in sedentary hours and demonstrate no reason to believe these are not linear trajectories. The interclass correlation coefficient revealed that about 20.21% of the total variance in sedentary hours at work is attributable to difference between participants. The effect of time was significant, $b = 0.03$, $t(1306) = 2.09$, $p = .04$, indicating that sedentary time on workdays significantly changed over the three weeks (see Table 7). The effect of
reminders to move was that when reminders to move were activated there was an average
decrease of 1.04 sedentary hours. This was a significant decrease in sedentary time,
$t(1306) = -5.12, p = <.001$. There was variance in the baseline number of sedentary hours
between participants with a $SD = 0.96$ and for the effect of time across people (slope) the
standard deviation was 0.003. However, the model could not load 95% confidence
intervals so it is difficult to see if the variance in slopes or intercepts across participants
was significant.

*Figure 6. Growth modeling for 15 random participants’ sedentary hours.*
**Figure 7.** Regression estimate lines for participants’ sedentary hours during work.

![Regression estimate lines for participants’ sedentary hours during work.](image)

**Table 7**

*Results of Multilevel Model for Sedentary Hours at Work*

<table>
<thead>
<tr>
<th></th>
<th>b</th>
<th>SE_{b}</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>3.77 (0.17) ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>0.03 (0.02) *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reminders Activated</td>
<td>-1.04 (0.20) ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC</td>
<td></td>
<td></td>
<td>5858.50</td>
</tr>
<tr>
<td>BIC</td>
<td></td>
<td></td>
<td>5900.32</td>
</tr>
<tr>
<td>Log Likelihood</td>
<td></td>
<td></td>
<td>-2921.25</td>
</tr>
<tr>
<td>Number of Observation</td>
<td></td>
<td></td>
<td>1377</td>
</tr>
<tr>
<td>Number of Groups</td>
<td></td>
<td></td>
<td>69</td>
</tr>
</tbody>
</table>

*** p < 0.001, ** p < 0.01, * p < 0.05
Growth Models of Steps

First the MLM data for sedentary hours at work was explored by examining individual plots for a random 14 participants (see Figure 8) and individual fitted OLS trajectories (Figure 9). These plots appeared to indicate a range of variation in the rate of change in steps and provided no reason to believe these are not linear trajectories. The interclass correlation coefficient revealed that about 44.82% of the total variance in steps on work days is attributable to difference between participants.

Figure 8. Growth modeling for 14 random participants’ steps on work days.
The effect of time was highly significant, $b = -76.02$, $t(1306) = -2.73$, $p < .001$, indicating that steps on workdays significantly changed over the three weeks (see Table 8). The effect of reminders to move was that when reminders to move were activated there was an average increase of 1389.36 steps. This was a highly significant increase in steps, $t(1306) = 4.26$, $p < .001$. There was significant variance in baseline number of steps between participants with a $SD = 2908.15$ (95% CI: 2361.62, 3581.15) and for the effect of time across people (slope) the standard deviation was 92.43 (56.77, 150.51), and the slopes and intercepts were moderately negatively correlated (correlation = -0.46).
Since neither confidence interval crosses zero it is implied that the variance in intercepts and slopes across participants was significant.

Table 8
Results of Multilevel Model for Steps on Workdays

<table>
<thead>
<tr>
<th></th>
<th>b</th>
<th>SE_b</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>8747.00 (402.34) ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>-76.02 (27.81) **</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reminders Activated</td>
<td>1389.36 (325.93) ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC</td>
<td></td>
<td>26281.78</td>
<td></td>
</tr>
<tr>
<td>BIC</td>
<td></td>
<td>26323.60</td>
<td></td>
</tr>
<tr>
<td>Log Likelihood</td>
<td></td>
<td>-13132.89</td>
<td></td>
</tr>
<tr>
<td>Number of observation</td>
<td></td>
<td>1377</td>
<td></td>
</tr>
<tr>
<td>Number of groups</td>
<td></td>
<td>69</td>
<td></td>
</tr>
</tbody>
</table>

*** p < 0.001, ** p < 0.01, * p < 0.05

Research Question 3: What is the relationship between physical activity and sedentary time with other factors of workplace wellbeing including mood, quality of life, work productivity, and job stress?

Sedentary Time

A linear regression established that change in weekly sedentary hours at work from intervention to baseline could statistically significantly predict change in depression, $F(1, 67) = 4.51, p = .04$. The change in weekly steps on work days accounted for 6.3% of the explained variability in change in depression scores, with adjusted $R^2 =$
4.9%. The regression equation was: predicted change in depression = -1.97 + -0.11 x (change in weekly sedentary hours at work from intervention period to baseline).

A series of other regressions were run to see if change in weekly sedentary hours during work in the intervention period predicted change in other aspects of workplace wellbeing like affect balance, stress, productivity, and quality of life. The results of these were not significant.

**Steps**

A linear regression established that change in weekly steps from intervention to baseline could statistically significantly predict change in depression, \( F(1, 67) = 11.20, p = .001 \) and the change in weekly steps on work days accounted for 14.3% of the explained variability in change in depression scores, with adjusted \( R^2 = 13.0\% \). The regression equation was: predicted change in depression = -1.77 + 0.000086 x (change in weekly steps on work days from intervention period to baseline).

A series of other regressions were run to see if change in weekly steps in the intervention period predicted change in other aspects of workplace wellbeing like affect balance, stress, productivity, and quality of life. Again, the results of these were not significant.

**Post-study Participants Feedback and Self-Report Sedentary Time**

Participants completed a brief post-study questionnaire (see Table 9). In general, the majority of participants reported that physical activity had become much more important to them, and they had walked more during the study then was typical for them in the past. They also agreed they were able to incorporate the Fitbit into their daily
activities and wanted to continue wearing this device to track their physical activity and inactivity. Participants reported their average sedentary time at work in the pre-survey ($M = 8.12, SD = 3.70$) and again in the post-survey ($M = 5.78, SD = 1.75$). A paired samples $t$-test found there was a significant reduction in self-reported sedentary time at work after the study with mean decreases in sedentary time of $2.34 \pm 4.06$ ($t(68) = 4.78, p < .0001$). This represented an effect size of $d = -0.6$.

Table 9

<table>
<thead>
<tr>
<th>Post-study Feedback</th>
<th>%not at all</th>
<th>%moderately</th>
<th>%definitely</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have walked more than I usually have</td>
<td>23.2</td>
<td>47.8</td>
<td>29.0</td>
</tr>
<tr>
<td>It has become more important to me to be more active</td>
<td>13.0</td>
<td>42.0</td>
<td>44.9</td>
</tr>
<tr>
<td>I was able to incorporate this device into my daily activities</td>
<td>11.6</td>
<td>33.3</td>
<td>55.1</td>
</tr>
<tr>
<td>I would want to continue wearing this device</td>
<td>14.5</td>
<td>17.4</td>
<td>68.1</td>
</tr>
</tbody>
</table>
CHAPTER V
DISCUSSION

Outcomes

This study aimed to answer the following research objectives: (1) gathering objective data about sedentary time, steps, and intensity of physical activity for workers (2) to assess the impact of an in-the-moment intervention with reminders to move at work to decrease sedentary time and possibly increase steps, (3) to examine the relationship between physical activity and sedentary time with other factors of workplace wellbeing including mood, quality of life, work productivity, and job stress. Post-study feedback about the feasibility and self-reported impact of the Fitbit and intervention were also collected and assessed.

Objective Data About Sedentary Time and Steps for Workers

Participants on average were sedentary 459.58 minutes at work per day ($SD = 45.55$) and stepped 8456.12 steps per work day ($SD = 3339.95$) at baseline. Daily average steps on work days increased in the third intervention week and average sedentary minutes during work decreased. This is comparable to another study looking at sedentary time at work for office workers, that found an average of 341.6 minutes per workday of sedentary time at baseline (McGuckin, Sealey, & Barnett, 2017). The mean step count in this study was slightly higher than a U.S. national sample of step counts that found a mean daily step count of 7683 overall, 8420 for men, and 7291 for women (Patel et al., 2017).
Impact of the Reminders to Move Intervention

Based on one-way repeated measures ANOVA, significant differences were found in sedentary time at work in week three when reminders to move were turned on and in weeks 1 and 2 when they were not. Multilevel modeling was also run to explore the growth patterns of sedentary time throughout the study and whether there was a significant impact from the reminders to move being activated in the third week. Linear mixed modeling of sedentary time during work did find support for it decreasing over the study time period. It also found that the reminders to move being activated in the third week contributed to a significant decrease in sedentary hours on average for participants. The effect of reminders to move was that when reminders to move were activated there was an average decrease of 1.04 sedentary hours.

While the focus of this study was on reducing sedentary time at work there was a significant increase in steps overall on work days in the intervention period, which appears to be an additional related benefit. One-way repeated measures ANOVA of steps on work days also found significant differences between week three when the reminders were activated and weeks one or two, but not significant differences between weeks one and two. Linear mixed modeling of sedentary time during work did find support for it decreasing over the study time period and that the reminders to move being activated in the third week contributed to a significant increase in steps on average for participants. The effect of reminders to move was that when reminders to move were activated there was an average increase of 1389.36 steps. It also found significant variance in intercepts and slopes across participants, indicating that other factors that were not explored here might help explain some of the variance between participants.
Impact of the Intervention on Workplace Wellbeing

On average, participants initially reported depression and anxiety in the mild to normal range and had generally positive affect. However, their ratings for stress were above the norm of 12.90. Their quality of life ratings were also near the mean of 50. Several aspects of workplace wellbeing changed during the course of the study while participants were wearing a Fitbit tracker with reminders to move. Depression, negative affect, and stress significantly decreased on average and more positive affect, social functioning, physical functioning, and productivity significantly increased. Most of these effect sizes were small to medium effects with productivity having the largest effect size ($d = 0.50$). Also, given concerns in prior research about participants’ beliefs that interventions to reduce sitting time at work would decrease work productivity (Niven & Hu, 2018) it is important to emphasize that on average participants’ estimation of their productivity significantly increased during this study and had a medium effect size. However, the average changes in the decrease of anxiety, increase in job satisfaction, and the quality of life measure of mental health were not significant.

A series of regressions that were run to examine whether the average change in weekly sedentary time predicted the changes found in other aspects of wellbeing found that the sedentary time change significantly predicted the change in depression only. The same result was found for the relationship between the change in steps and change in depression scores. This supports the connection between depression and physical activity or sedentary time, given that significant changes were found for pre- and post- survey data measures of workplace wellbeing during the study on average. Future research seems warranted to explore the impact of baseline scores in measures of workplace
wellbeing on the between subject variation of growth modeling of sedentary time or steps.

**Participant Feedback**

Participants had a high compliance rate with wearing and syncing the device. The majority of participants highly rated the feasibility and impact of wearing the Fitbit. Recruitment, measurement, and the delivery of the intervention all were feasible and acceptable. The majority of participants also expressed a desire to continue to wear the device, which indicates that a longer study period would not have been perceived as burdensome. This is supported by a cross-sectional study of 237 activity tracker users who had used their tracker for sustained period of at least five months and intended to continue using them (Maher, Ryan, Ambrosi, & Edney, 2017). The cross-sectional study also found that participants highly valued the real time feedback and long-term monitoring of their devices, which appears to support the findings of the current study.

**Implications**

To date only a few studies have examined prompting breaks in sedentary time at work (Fortmann et al., 2013; Swartz et al., 2014). Much of the workplace interventions focused on physical activity instead of sedentary time (Prince et al., 2014). Focusing on physical activity improvement or simply wearing a tracker has not been found to change sedentary time in other studies (Sloan et al., 2018). Given the health cost of sedentary time (Healy et al., 2008b; Healy et al., 2012) this study contributes to the literature supporting a reminder to move prompt as being a successful intervention on sedentary time at work.
A brief intervention of wearing a Fitbit at work can result in significant differences in sedentary time at work, significant increases in steps throughout a work day, and impact workplace wellbeing, including depression. The reminder to move Fitbit program appears to be effective in decreasing sedentary time and increasing mood in sedentary employees. Trackers can provide real time self-monitoring and in the moment prompts to change behavior. They should be considered as part of the picture in intervening on sedentary time at work. Also, the changes in sedentary time in this study occurred without use of an active workstation which suggests that an alternative low cost and widely available intervention can be effective.

It has also been demonstrated that self-regulation can be increased in studies of reducing sedentary time when prompts to move or activity trackers were utilized to reduce sedentary time (Luo et al., 2018; McGuckin et al., 2017). These studies found increases in self-monitoring and raised awareness of behavior. This could explain why this study found significant changes in sedentary time at work.

This study also provides support for the suggestion that activity trackers at work can change the perspective of employees to consider the bigger picture of workplace wellbeing and activity patterns. This has implication for employees’ health and overall wellbeing. This is supported by another study of worker wellbeing and step count which found that wearing of activity trackers led to a significant increase in wellbeing and found a relationship between use of the tracker, step count and worker wellbeing (Giddens, Leidner, & Gonzalez, 2017).

Participants in this study were also interested in and perceived benefit from using the devices, which is reflected in a lack of drop out, the high number of usable time
points, and the ability to recruit a sample. No one who completed a day of the study dropped out. Only two participants dropped out of the study before completing a day, one due to receiving another tracker as a gift, and one due to irritation from wearing the device.

The use of a platform to monitor if participants were syncing their devices, battery level, and other results, and allowed for email reminders if participants had not synced recently may have been a factor in the resultant limited missing data. Also, the fact that pre- and post-surveys online were structured to prohibit participants from moving forward or submitting without answering every question led a 100% response rate. Participants appeared to value engaging in research as evidenced by their questions about the research and their conscientiousness about wearing the device. Some participants even contacted the researchers to report their steps when they had forgotten to wear their tracker.

**Limitations**

There were some limitations of the study including the briefness of the intervention period. Additionally, the sample was predominately white and the study was conducted in one workplace, although in many different buildings and settings across the university. Also, examination whether there was maintenance of the behavior change in this study could have enriched the study and may be an area of future study.

Additionally, there are some limitations causal inference due to potential threats to internal validity from this type of design including history, meaning that there might have been an impact from an unanticipated event occurring during the experiment that
may have affected the dependent variable. However this is less likely given the short time frame of the study. The data was collected in four rounds from June to September, however, which could have impacted the results. Another possible threat to internal validity is the impact of testing, meaning that giving the pretest can impact the outcomes of the second test. To address some of these limitations a controlled study might be conducted with a control group who wore the Fitbit as a watch for the duration of the study while the other group had the feedback from the Fitbit and then the reminders to move activated.

Nevertheless, this study demonstrates that reminders to move from the Fitbit device were an effective intervention for sedentary time. The findings are supported by a few other studies looking at prompts to reduce sedentary time (Barwais & Cuddihy, 2015; Swartz et al., 2014).

**Future Directions**

Future research could include longer periods of study to determine the long-term impacts of activity trackers on workplace wellbeing and physical activity. Future directions could also include implementing and assessing the impact of activity tracker interventions in work settings outside of a university setting. There is also room to explore potential characteristics of participants that explain between participant variance in individual growth models of sedentary time at work. These factors could include baseline levels of depression, stress, sleep, or other non-measured factors. For example, age and weight could be included as predictors. Also, future studies could control for the baseline level of sedentary time at work or baseline steps on workdays or the initial level
of depression to see how the results might be impacted. Additional modeling of the workplace wellbeing in MLM might also lead to a better picture of workplace wellbeing and intervention’s impact on it.

Another possible direction for future studies is to more directly measure the self-efficacy to see if that changes with the intervention and to see if there is support for the hypothesis self-efficacy being why the Fitbit data and reminders to move lead to changes in sedentary behavior.

Additionally, the current study has no measures of health outside steps and sedentary time so including objective measures of health might be helpful in the future. Given that cardiovascular fitness, which is an attribute showing how efficiently your cardiorespiratory system functions is an indicator of your health, has a stronger and more beneficial association with reductions in cardiovascular morbidity and mortality than physical activity it might be interesting to include a measure of cardiovascular fitness in future studies. Cardiorespiratory fitness might also be interesting to study in conjunction with sedentary time in future studies to see if a reduction in sedentary time has an expected impact on improving cardiorespiratory fitness.

**Conclusion**

The current study explored the impact of the measurement of sedentary time at work and if that behavior could be impacted by utilizing the reminder to move prompts on Fitbit devices. It also explored the impact of this intervention on other factors of workplace wellbeing including depression, anxiety, affect balance, quality of life, productivity, and stress. Participants were 69 university employees who completed pre-
and post-study measures and wore the Fitbit device for three weeks, one week for baseline data, one week with the self-monitoring feedback from the device, and a third week with the reminders to move activated. Participants overall reported high feasibility for continuing to use the device after the study and that post-study it was more important to them to be active.

This study showed that having the reminders to move activated decreased sedentary time at work and increased steps throughout the day on work days. These changes in sedentary time significantly contributed to changes in depression. On average from the start of the study to after the intervention, participants reported significantly less depression, negative affect, and stress and significantly more positive affect, affect balance, social functioning, physical functioning, and productivity at work. The utility and acceptability of an intervention on sedentary time at work using existing time and cost effective reminder to move prompts on Fitbits was demonstrated. Future studies can build on this intervention by testing the intervention for longer periods and exploring characteristics of participants that explain between participant variance in individual growth models of sedentary time at work.
REFERENCES


Cadmus-Bertram, L., Marcus, B. H., Patterson, R. E., Parker, B. A., & Morey, B. L.
(2015). Use of the Fitbit to measure adherence to a physical activity intervention among overweight or obese, postmenopausal women: self-monitoring trajectory during 16 weeks. JMIR mHealth and uHealth, 3(4), e96.


Katzmarzyk, P. T., Church, T. S., Craig, C. L., & Bouchard, C. (2009). Sitting time and


APPENDICES
Appendix A

Recruitment Flyer
Interested in trying a Fitbit?

HTTP://J.MP/2GJCAYU
OR CONTACT
CDANCE@AGGIEMAIL.USU.EDU OR
CALL/TEXT 801-671-6314

You could become more aware of your physical activity and sedentary time, which may lead to changes. It is possible that a brief intervention from the Fitbit device may reduce your sedentary time.

We are recruiting non-student employees who would be interested wearing a Fitbit device for 3 weeks and helping with a research project about sedentary time at work.

You will have an opportunity to win a $50 Amazon gift card with at least 1 being randomly given for each group of 15 completing the study.

Utah State University - IRB Protocol #9183
If you have any questions or concerns about the recruitment contact Dr. Scott DeBerard at scott.deberard@usu.edu
Appendix B

Survey Instruments
Demographic Questionnaire

1) Age (years)  

2) Ethnicity  
- Hispanic or Latino  
- NOT Hispanic or Latino  
- Unknown / Not Reported

3) Race  
- American Indian/Alaska Native  
- Asian  
- Native Hawaiian or Other Pacific Islander  
- Black or African American  
- White  
- More Than One Race  
- Unknown / Not Reported

4) Sex  
- Female  
- Male  
- Other

5) Marital Status  
- Single, never married  
- Separated  
- Divorced  
- Widowed  
- Married (including common law)

6) Education Level  
- Less than high school  
- Some high school  
- High school diploma/GED  
- Some college  
- College degree (Associate's, Bachelor's)  
- Graduate degree (Master's, Doctorate)

7) Employed:  
- Full time  
- Part Time

8) Average number of hours worked in a week  

9) Number of years employed at current job  

10) Weight in pounds  

11) Estimated number of hours of daily sedentary time (time sitting or lying down) at work  

Job Satisfaction Measure

1. Taking everything into consideration, how do you feel about your job as a whole?
Rate on a seven-point Likert scale (1 extremely dissatisfied, 7 extremely satisfied).
# The Patient Health Questionnaire (PHQ-9)

**Patient Name ___________________________ Date of Visit _____________**

<table>
<thead>
<tr>
<th>Over the past 2 weeks, how often have you been bothered by any of the following problems?</th>
<th>Not At all</th>
<th>Several Days</th>
<th>More Than Half the Days</th>
<th>Nearly Every Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Little interest or pleasure in doing things</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2. Feeling down, depressed or hopeless</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3. Trouble falling asleep, staying asleep, or sleeping too much</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4. Feeling tired or having little energy</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>5. Poor appetite or overeating</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>6. Feeling bad about yourself - or that you’re a failure or have let yourself or your family down</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>7. Trouble concentrating on things, such as reading the newspaper or watching television</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>8. Moving or speaking so slowly that other people could have noticed. Or, the opposite - being so fidgety or restless that you have been moving around a lot more than usual</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>9. Thoughts that you would be better off dead or of hurting yourself in some way</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

**Column Totals**  
______ + ______ + ______

**Add Totals Together**  
__________

---

10. If you checked off any problems, how difficult have those problems made it for you to  
Do your work, take care of things at home, or get along with other people?  
☐ Not difficult at all ☐ Somewhat difficult ☐ Very difficult ☐ Extremely difficult
Anxiety Measure

### Generalized Anxiety Disorder 7-item (GAD-7) scale

<table>
<thead>
<tr>
<th>Over the last 2 weeks, how often have you been bothered by the following problems?</th>
<th>Not at all sure</th>
<th>Several days</th>
<th>Over half the days</th>
<th>Nearly every day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Feeling nervous, anxious, or on edge</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2. Not being able to stop or control worrying</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3. Worrying too much about different things</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4. Trouble relaxing</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>5. Being so restless that it's hard to sit still</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>6. Becoming easily annoyed or irritable</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>7. Feeling afraid as if something awful might happen</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

*Add the score for each column* + + +

Total Score (*add your column scores*) =

If you checked off any problems, how difficult have these made it for you to do your work, take care of things at home, or get along with other people?

Not difficult at all __________
Somewhat difficult __________
Very difficult __________
Extremely difficult __________
PANAS Questionnaire
This scale consists of a number of words that describe different feelings and emotions. Read each item and then list the number from the scale below next to each word. **Indicate to what extent you feel this way right now, that is, at the present moment OR indicate the extent you have felt this way over the past week (circle the instructions you followed when taking this measure)**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very Slightly or Not at All</td>
<td>A Little</td>
<td>Moderately</td>
<td>Quite a Bit</td>
<td>Extremely</td>
</tr>
</tbody>
</table>

_________ 1. Interested _________ 11. Irritable
_________ 2. Distressed _________ 12. Alert
_________ 3. Excited _________ 13. Ashamed
_________ 5. Strong _________ 15. Nervous
_________ 7. Scared _________ 17. Attentive
_________ 8. Hostile _________ 18. Jittery
_________ 9. Enthusiastic _________ 19. Active
_________ 10. Proud _________ 20. Afraid

**Scoring Instructions:**
Positive Affect Score: Add the scores on items 1, 3, 5, 9, 10, 12, 14, 16, 17, and 19. Scores can range from 10 – 50, with higher scores representing higher levels of positive affect. Mean Scores: Momentary = 29.7 ($SD = 7.9$); Weekly = 33.3 ($SD = 7.2$)
### Quality of Life Measure (SF-36 V.2)

**INSTRUCTIONS:** This set of questions asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities. Answer every question by marking the answer as indicated. If you are unsure about how to answer a question please give the best answer you can.

1. **In general, would you say your health is:** (Please tick one box.)
   - Excellent
   - Very Good
   - Good
   - Fair
   - Poor

2. **Compared to one year ago, how would you rate your health in general now?** (Please tick one box.)
   - Much better than one year ago
   - Somewhat better now than one year ago
   - About the same as one year ago
   - Somewhat worse now than one year ago
   - Much worse now than one year ago

3. **The following questions are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?** (Please circle one number on each line.)

<table>
<thead>
<tr>
<th>Activities</th>
<th>Yes, Limited A Lot</th>
<th>Yes, Limited A Little</th>
<th>Not Limited At All</th>
</tr>
</thead>
<tbody>
<tr>
<td>3(a) Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3(b) Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3(c) Lifting or carrying groceries</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3(d) Climbing several flights of stairs</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3(e) Climbing one flight of stairs</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3(f) Bending, kneeling, or stooping</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3(g) Walking more than a mile</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3(h) Walking several blocks</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3(i) Walking one block</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3(j) Bathing or dressing yourself</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

4. **During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?** (Please circle one number on each line.)

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>4(a) Cut down on the amount of time you spent on work or other activities</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>4(b) Accomplished less than you would like</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>4(c) Were limited in the kind of work or other activities</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>4(d) Had difficulty performing the work or other activities (for example, it took extra effort)</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

5. **During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (e.g. feeling depressed or anxious)?** (Please circle one number on each line.)

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>5(a) Cut down on the amount of time you spent on work or other activities</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>5(b) Accomplished less than you would like</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>5(c) Didn’t do work or other activities as carefully as usual</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
6. During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbours, or groups? (Please tick one box.)

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Slightly</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Extremely</th>
</tr>
</thead>
</table>

7. How much physical pain have you had during the past 4 weeks? (Please tick one box.)

<table>
<thead>
<tr>
<th>None</th>
<th>Very mild</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Very Severe</th>
</tr>
</thead>
</table>

8. During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)? (Please tick one box.)

<table>
<thead>
<tr>
<th>Not at all</th>
<th>A little bit</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Extremely</th>
</tr>
</thead>
</table>

9. These questions are about how you feel and how things have been with you during the past 4 weeks. Please give the one answer that is closest to the way you have been feeling for each item.

<table>
<thead>
<tr>
<th>(Please circle one number on each line.)</th>
<th>All of the Time</th>
<th>Most of the Time</th>
<th>A Good Bit of the Time</th>
<th>Some of the Time</th>
<th>A Little of the Time</th>
<th>None of the Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>9(a) Did you feel full of life?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>9(b) Have you been a very nervous person?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>9(c) Have you felt so down in the dumps that nothing could cheer you up?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>9(d) Have you felt calm and peaceful?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>9(e) Did you have a lot of energy?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>9(f) Have you felt downhearted and blue?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>9(g) Did you feel worn out?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>9(h) Have you been a happy person?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>9(i) Did you feel tired?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

10. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives etc.) (Please tick one box.)

<table>
<thead>
<tr>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
</table>

11. How TRUE or FALSE is each of the following statements for you?

<table>
<thead>
<tr>
<th>(Please circle one number on each line.)</th>
<th>Definitely True</th>
<th>Mostly True</th>
<th>Don’t Know</th>
<th>Mostly False</th>
<th>Definitely False</th>
</tr>
</thead>
<tbody>
<tr>
<td>11(a) I seem to get sick a little easier than other people.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11(b) I am as healthy as anybody I know</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11(c) I expect my health to get worse</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11(d) My health is excellent</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Daily Work Productivity Measure

1. How much did you accomplish today based on what you had planned to accomplish?

2. How efficient do you feel you were today in performing your work?

3. How satisfied were you in what you accomplished today?

4. How effectively do you feel you managed your time today?

5. How would you evaluate the quality of the work you did today?

6. Overall, how productive do you feel you were today?

All responses are measured on a 7-point Likert scale, with 1=not at all, and 7=extremely.
**Stress Measure**

**PERCEIVED STRESS SCALE**

The questions in this scale ask you about your feelings and thoughts during the last month. In each case, you will be asked to indicate by circling *how often* you felt or thought a certain way.

| Name ___________________________________________________________ | Date __________________________ |
| Age ________ Gender (Circle): M F Other __________________________ |

0 = Never 1 = Almost Never 2 = Sometimes 3 = Fairly Often 4 = Very Often

1. In the last month, how often have you been upset because of something that happened unexpectedly?
2. In the last month, how often have you felt that you were unable to control the important things in your life?
3. In the last month, how often have you felt nervous and "stressed"?
4. In the last month, how often have you felt confident about your ability to handle your personal problems?
5. In the last month, how often have you felt that things were going your way?
6. In the last month, how often have you found that you could not cope with all the things that you had to do?
7. In the last month, how often have you been able to control irritations in your life?
8. In the last month, how often have you felt that you were on top of things?
9. In the last month, how often have you been angered because of things that were outside of your control?
10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?
Physical Activity Changes and Usability of Fitbit

**During the past 4 weeks:**

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>Moderately</th>
<th>Definitely</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I have walked more than usual in the past</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2. It has become more important to me to be more physically active</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3. I was able to incorporate this device into my daily activities</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4. I would want to continue wearing this device to track my activity</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
Appendix C

IRB Approved Informed Consent Form
Informed Consent

Activity Tracker Measurement of Physical Activity and Sedentary Time in the Workplace

Introduction
You are invited to participate in a research study conducted by Dr. Scott DeBerard, an Associate Professor in the Psychology Department at Utah State University and Cassie Dance a doctoral student in the Psychology Department at Utah State University. The purpose of this research is to measure physical activity and sedentary or sitting time using a wearable activity tracker (Fitbit), particularly at work and to see if this is related to other health behaviors like mood. Additionally, this study will use the technology of the activity trackers to see if reminders to move on the device impact physical activity and sedentary or sitting time by comparing those with the reminders activated on their device and those without the reminders on their device.

This form includes detailed information on the research to help you decide whether to participate in this study. Please read it carefully and ask any questions you have before you agree to participate.

Procedures
Your participation will involve wearing a Fitbit device on your wrist for 3 weeks and having access to a phone or computer you can upload your data to, which you will receive instruction about. On completion, you will be required to return your Fitbit. There will be surveys to be completed at 2 time points, once before you begin using the Fitbit, once after you finish using the Fitbit, which should each take 35 minutes to complete. You will have to meet briefly to get the device and after the 3 weeks to return the device. Weekly after getting the device you will be contacted to remind you to sync your device and tell you about the new settings and data you will get from the device. We anticipate that approximately 50 to 75 people will participate in this research study in several cycles.

Risks
This is a minimal risk research study. That means that the risks of participating are no more likely or serious than those you encounter in everyday activities and moderate walking. There is possibility of minor skin irritation associated with wearable devices. We recommend taking it off occasionally, not wearing it too tightly, and keeping it clean and dry. If you experience any irritation remove the device and contact a member of the study team. If you have a bad research-related experience please contact the principal investigator of this study right away at 435-797-1462 or scott.deberard@usu.edu.

Benefits
Participation in this study may directly benefit you by making you more aware of your physical activity, steps, and sedentary time, which may lead to changes in these behaviors. More broadly, this study will help the researchers learn more about physical activity and sedentary time in the workplace and may help to promote health and reduce prolonged sedentary time.

Confidentiality
The researchers will make every effort to ensure that the information you provide as part of this study remains confidential. Your identity will not be revealed in any publications, presentations, or reports resulting from this research study.

We will collect your information either through a secure online system REDCap and forms from in person sessions where Fitbits will be distributed. You may choose whether you’d like to fill them out in person or online. Fitbit data will be collected and hosted on Fitabase, a comprehensive data management platform and not linked to any identifying data. Data will be securely stored in a restricted-access folder on Box.com, an encrypted, cloud-based storage system which is USU’s recommendation for all digital content, and in a locked drawer in a restricted-access office which is USU’s recommendation for all physical content. Any identifying information will be kept separate from the rest of the data and will be destroyed after completion of the
study and compensation is awarded. This form will be kept for three years after the study is complete, and then it will be destroyed.

It is unlikely, but possible, that others (Utah State University, or state or federal officials) may require us to share the information you give us from the study to ensure that the research was conducted safely and appropriately. We will only share your information if law or policy requires us to do so.

The research team works to ensure confidentiality to the degree permitted by technology. It is possible, although unlikely, that unauthorized individuals could gain access to your responses because you are responding online. However, your participation in this study involves risks similar to a person's everyday use of the Internet.

**Voluntary Participation, Withdrawal**

Your participation in this research is completely voluntary. If you agree to participate now and change your mind later, you may withdraw at any time by contacting the PI or Student Investigator by phone or email and returning your Fitbit. If you choose to withdraw after we have already collected information about you, completely anonymous participation cannot be withdrawn, as we will be unable to determine whose data is whose but any identifying information or related data will be destroyed. If you decide not to participate, the services you receive from USU will not be affected in any way. The researchers may choose to terminate your participation in this research study if you are not utilizing the Fitbit device.

**Compensation**

For your participation in this research study, you will receive an opportunity to win a $50 Amazon gift card with one being randomly given for each group of 15 participants. Compensation will occur if the randomly selected participant completes all the pre and post study surveys.

**Findings & Future Participation**

If the researchers learn anything new during the course of this research study that might affect your willingness to continue participation, you will be contacted about those findings. This might include changes in procedures, changes in the risks or benefits of participation, or any new alternatives to participation that the researchers learn about.

**IRB Review**

The Institutional Review Board (IRB) for the protection of human research participants at Utah State University has reviewed and approved this study. If you have questions about the research study itself, please contact the Principal Investigator at (435) 797-1462 or scott.deberard@usu.edu. If you have questions about your rights or would simply like to speak with someone other than the research team about questions or concerns, please contact the IRB Director at (435) 797-0567 or irb@usu.edu.

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Scott DeBerard, Ph.D.  
Principal Investigator  
(435) 797-1462; scott.deberard@usu.edu

Cassie Dance, M.A.  
Student Investigator  
(801) 671-6314; cdance@aggiemail.usu.edu

By signing below, you agree to participate in this study. You indicate that you understand the risks and benefits of participation, and that you know what you will be asked to do. You also agree that you have asked any questions you might have, and are clear on how to stop your participation in the study if you choose to do so. Please be sure to retain a copy of this form for your records.

Participant’s Signature  
Participant’s Name, Printed  
Date
CURRICULUM VITAE

CASSIE DANCE
Doctoral Candidate in Clinical and Counseling Psychology
Curriculum Vita
(801) 671-6314
cdance@aggiemail.usu.edu

EDUCATION

Ph.D.  Utah State University
2019  Logan, Utah
       Combined Clinical/Counseling/School Psychology Program, APA-Accredited
       Dissertation: Activity Tracker Measurement of Physical Activity and Sedentary Time in the Workplace Including an Intervention Involving Reminders to Move
       Thesis Equivalence: Pain Acceptance Mediates the Relationship Between Pain Catastrophizing and Post-Surgery Outcomes Among Compensated Lumbar Fusion Patients
       Chair: Scott DeBerard, Ph.D.

M.A.  Boston College
2008  Newton, Massachusetts
       School Counseling
       Honors: Passed the Masters Comprehensive Exam “With Distinction”

B.S.  Brigham Young University
2006  Provo, UT
       Major: Psychology
       Honors: Graduated Cum Laude
CLINICAL EXPERIENCE

8/18—8/19
Doctoral Psychology Intern
VA Salt Lake City Healthcare System (APA Accredited)

Medical Psychology Consultation-Liaison Service
August 2018 – November 2018
Responsibilities: Collaborated as a member of an interdisciplinary behavioral health team to address consult requests and coordinate patient care from a variety of inpatient medical settings including telemetry, acute medicine, and MICU, conducted brief assessments (e.g., MoCA), brief interventions, in inpatient medical settings, provided brief health-focused interventions for patients with co-occurring mental and physical health concerns, co-facilitated weekly group-based Cognitive-Behavioral Therapy for Chronic Pain, conducted presurgical evaluations and trained in conducting evaluating transplant candidate appropriateness.
Supervisor: Amber Martinson, Ph.D.

Cognitive Processing Therapy (CPT) Training and Consultation
September 2018 – February 2019
Responsibilities: Completed three-day EBT CPT training program and participated in weekly group consultation led by Dr. Weinstein.
Supervisor: Harrison Weinstein, Ph.D.

Comorbid PTSD/SUD Psychotherapy
August 2018 – February 2019
Responsibilities: Trained in Cognitive Processing Therapy treatment for trauma and addictions, assessment and case conceptualization of those seeking treatment for SUD or co-morbid mental health concerns and SUD, engaged in relapse prevention planning and motivational interviewing, co/facilitation of group therapy, and interdisciplinary team meetings.
Supervisor: Jonathan Codell, Ph.D.

Whole Health/Mindfulness Center
Responsibilities: Co-facilitated weekly mindfulness groups including a mindfulness group on residential treatment program, a mindfulness meditation outpatient group, a Mindfulness-Based Cognitive Therapy Group, conducted individual psychotherapy to Veterans with chronic mental and physical health conditions utilizing Mindfulness-based Therapy, and provided psychoeducation on Mindfulness-Based Therapies to Veterans.
Supervisor: Brandon Yabko, Ph.D.
Neuropsychology Assessment
Responsibilities: Administered neuropsychological assessment batteries and clinical interviews in an outpatient medical setting addressing referral questions related to differential diagnosis of neurocognitive, mental and physical health concerns, integrated data from chart review, clinical interview, and assessment results in a comprehensive report, provided feedback to clients and to consulting treatment teams and medical providers.
Supervisor: John Hecker, Ph.D.

National Telemental Health Hub
Responsibilities: Developed proficiency using telehealth services, provided individual therapy and assessment to diverse veterans who are often from underserved areas and/or geographically isolated.
Supervisor: Alethea Varra, Ph.D.

Home-Based Primary Care
Responsibilities: Collaborated as a member of interdisciplinary primary care services in the homes of those with complex and chronic disease, participated in providing assessment and intervention to individuals and families to address psychological issues that are interfering with their medical care or reducing their quality of life, provided interventions to increase compliance with and adjustment to treatment regimens and work with caregivers to improve patient well-being and treatment compliance.
Supervisor: Lauren Masuda, Ph.D.

6/15—6/18
Graduate Assistant Therapist
Neuropsychology Center of Utah
Clinton, UT
Responsibilities: Intake assessments, individual counseling services primarily with children and adolescents, adult counseling, parent training sessions, neuropsychology testing and report writing.
Total Hours: 2152, Direct Contact Hours: 1450
Supervisor: Adam Schwebach, Ph.D.

5/15—5/16
Student Therapist
Salt Lake City VA
Responsibilities: Helped staff a PTSD walk-in clinic, completed weekly PTSD assessments, collaboratively developed an integrated PTSD assessment, piloted the integrated PTSD assessment and report process, participated in group supervision and didactic trainings.
Total Hours: 384, Direct Contact Hours: 89
Supervisor: Jinna Lee, Ph.D.
8/13—8/15

**Student Therapist and Graduate Assistant Therapist**
Utah State University Student Health and Wellness Center
Logan, UT

*Responsibilities:* Screened patients for mental health needs, provided individual psychotherapy, liaised with medical staff as a behavioral health consultant in a primary care setting, attended weekly medical team meetings.

*Total Hours:* 1210, *Direct Contact Hours:* 471

*Supervisor:* Scott DeBerard, Ph.D.

6/14—6/15

**Student Therapist and Graduate Assistant Therapist**
Huntsman Cancer Center at Logan Regional Hospital
Logan, UT

*Responsibilities:* Provided brief individual supportive counseling services for adults diagnosed with cancer.

*Total Hours:* 29, *Direct Contact Hours:* 12

*Supervisor:* Scott DeBerard, Ph.D.

7/14—5/15

**Student Therapist**
Avalon Hills Eating Disorder Treatment Center - Adolescent House
Logan, UT

*Responsibilities:* Led ACT and DBT groups for female adolescents in a residential treatment setting, co-led process groups about body image and a lunch time eating process group, administered and interpreted results from psychoeducational assessments, experiential therapy (co-therapy), generated treatment plans, collaborated with multidisciplinary treatment team.

*Total Hours:* 318, *Direct Contact Hours:* 162

*Supervisor:* Sara Boghosian, Ph.D.

8/12—8/13 & 5/14—8/14

**Student Therapist and Graduate Assistant Therapist**
Psychology Community Clinic, Utah State University

*Responsibilities:* Provided individual therapy to children, adolescents, and adults, parent training, intake interviews, psychological evaluations, attended weekly individual supervision and group supervision.

*Total Hours:* 626, *Direct Contact Hours:* 166

*Supervisors:* Susan Crowley, Ph.D.; Gretchen Gimpel Peacock, Ph.D.

**PROFESSIONAL EXPERIENCE**

6/08—6/12

**School Counselor**
Tooele School District, Tooele, UT
Responsibilities: Provided individual and crisis counseling services to students, led the Teacher Assistance Team, developed and lead a variety of counseling groups for students, including: academic success, social skills, anger management, and grief and loss, administered academic and cognitive assessment, conducted yearly small-group and large-group data project for presentation to school faculty and administration.

PROFESSIONAL SERVICE

6/08—6/12  
Student Representative (Elected by Peers)  
Utah State University Combined Psychology Program  
Responsibilities: Acted as a liaison between graduate students and the faculty, co-led monthly student meetings, participated in faculty meetings twice a month.

8/05—4/06  
Elected Psi Chi Chapter President

8/04—4/05  
Elected Psychology Association President

8/04—4/06  
Elected Psychology representative on the Student College Council

TEACHING EXPERIENCES

8/13—5/14  
Graduate Assistant  
Psychology Community Clinic, Utah State University  
Responsibilities: Provided assessment training and edited beginning students’ treatment notes and assessment reports, administered and interpreted results from psychoeducational assessments, attended individual supervision and practicum meetings and presented on topics such as sleep hygiene and psychiatric medication.  
Supervisors: Susan Crowley, Ph.D.; Gretchen Gimpel Peacock, Ph.D.

1/13—8/13  
Graduate Teaching Assistant: Psychology 1010, Introduction to Psychology  
Utah State University  
Responsibilities: Led student discussion groups, proctored examinations, held office hours with students, provided supplementary lab sessions.  
Supervisors: Jennifer Grewe, Ph.D.

8/12—12/12  
Graduate Teaching Assistant: PSY 6130 Evidence Based Practice In the Schools  
Utah State University  
Responsibilities: Graded exams, papers, and other assignments, held office hours with students, taught lectures on Problem Solving Training and Behavioral Interventions.  
Supervisor: Marietta Veeder, Ph.D.
RESEARCH EXPERIENCE

9/06—6/07 Graduate Research Assistant
ADHD Research Group, Psychology Department, Boston College, Newton, MA
Responsibilities: Coordinated and supervised a tutoring program between Boston College and local elementary schools, administered and compiled data evaluating the Boston Connects program, a university and public school partnership.
Supervisor: Mary Walsh, Ph.D.

PEER REVIEWED PUBLICATIONS


PROFESSIONAL PRESENTATIONS

Evaluating The Construct Validity of the Opioid Abuse Risk Screener (OARS) Across Healthy, Pain Treatment, and Substance Abuse Samples. Poster presented at a meeting for the Society of Behavioral Medicine, Philadelphia.


PROFESSIONAL TRAINING ATTENDED

Good Clinical Practice (GCP) for Social and Behavioral Research Training, NIH, online January 2017.

Understanding and Treatment of Psychological Trauma - Trauma and the Brain, Utah State University Counseling and Psychological Services, March 28, 2014.


Acceptance and Commitment Therapy Workshop, USU Logan, UT, September 7-8, 2012.


Suicide Prevention Conference, Brigham Young University, Provo, UT, December 3, 2010.

PROFESSIONAL AFFILIATIONS

American Psychological Association, Student Member
APA Division 38 Healthy Psychology, Student Member
Society of Behavioral Medicine, Student Member

AWARDS AND FUNDING

Graduate Student Travel Award, Spring 2017
Full-Tuition Academic Scholarship, 2002-2006
Elected to Psi Chi International Honor Society in Psychology
Elected to The Honor Society of Phi Kappa Phi

**ADDITIONAL EXPERIENCES**

11/16—12/18 **Volunteer Crisis Counselor for Crisis Text Line (CTL)**  
**Responsibilities:** Completed online month long training module in crisis counseling, work weekly 4-hour shift responding to and supporting those in crisis.