

ABSTRACT

WORKSITE INTERVENTION TO REDUCE SEDENTARY TIME.

By

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Background: Prevalence of sedentary occupations is on the rise and sedentary time is independently associated with an increased risk for chronic diseases. Interventions conducted in the work site have potential for reducing prolonged bouts of sedentary time amongst employees working in sedentary jobs. The purpose of this study was to test the efficacy of a 12-week, worksite intervention for reducing time spent sedentary amongst full-time, sedentary employees. **Methods:** Forty, full-time, sedentary, employees working at desk dependent jobs were randomized to either: 1) an intervention group (N=23; 47.6±9.9 yrs; 94.1% female; 33.2±4.5 kg/m²); 2) or wait list control group (N=17; 42.6±8.9 yrs; 86.9% female; 31.7±4.9 kg/m²). Participants in the 12-week intervention group received an under the desk, portable pedal exercise machine, a pedometer, and access to an internet-based program designed to improve self-efficacy, self-monitoring and social support for physical activity. Time spent sedentary was measured objectively by a StepWatch activity monitor. **Results:** The intervention group significantly reduced daily minutes sedentary time (P<0.01) and percent daily time spent sedentary (P=0.03) compared to the control group from baseline to 12 weeks. The intervention group also significantly increased percent daily

time spent in moderate intensity activity ($P=0.04$) compared to the control group.

Conclusions: Findings from this study suggest that the intervention was efficacious at reducing time spent sedentary amongst full-time sedentary employees. These findings are significant due to the growing number of sedentary jobs in the U.S. and the potential of for this technology to be implemented in large-scale work site health programs.

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TABLE OF CONTENTS

LIST OF TABLES.....	viii
LIST OF FIGURES.....	ix
CHAPTER 1: INTRODUCTION.....	1-6
Research Hypothesis.....	4
Significance.....	4
Limitations & Delimitations.....	5
Definitions.....	5-6
CHAPTER 2: REVIEW OF THE LITERATURE.....	7-31
Sedentary Behavior.....	7-8
Health Risks Related to Sedentary Behavior.....	8-15
Prevalence and Trends of Sedentary Behavior.....	16-21
Theoretical Application of Intervention.....	21-26
Worksite Physical Activity Intervention.....	26-31
Chapter 3: METHODS.....	32-44
Subjects.....	34-36
Procedures.....	36-37
Baseline Measures.....	37-40
Group Description.....	40-43
Design/Statistical Analysis.....	43-44
CHAPTER 4: RESULTS.....	45-51
CHAPTER 5: DISSCUSSION.....	52-60
REFERENCES.....	61-67

APPENDIX A: INSTITUTIONAL REVIEW BOARD APPOROVAL	
LETTER.....	68
APPENDIX B: INFORMED CONSENT.....	69

LIST OF TABLES

1. Baseline characteristics between groups Mean \pm S.D.....	45
2. Two way repeated measures ANOVA for sedentary and physical activity behavior (N=40).....	46
3. Two way repeated measures ANOVA for behavioral constructs...	48
4. Intervention compliance amongst intervention completers.....	49
5. Linear regression analysis between intervention compliance and change in sedentary/physical activity behavior.....	50
6. Participants' perceived usefulness of intervention features.....	51

LIST OF FIGURES

1. Participant recruitment schematic.....	35
2. Screenshot of StepWatch activity monitor software output demonstrating stepping rate in various physical activity intensities..	38
3. Screenshot of A. MagneTrainer portable pedal exercise machine, B. Magnetraider FitFX Activity Tracking Software, C. Pedal Activity monitor feedback.....	41
4. Screenshot of Walker Tracker motivational website.....	42

Chapter 1: Introduction

Sedentary behavior, commonly described as physical inactivity, is that in which an individual generates very low energy expenditure (Pate et al., 2008). The term sedentary behavior has also recently been defined simply as “sitting without otherwise being active” (Owen et al., 2011). However, sedentary behaviors include activities such as lying down, sitting during transportation and/or during leisure time activities such as computer use, and standing still. Sedentary behaviors are equivalent to <1.5 metabolic equivalent threshold (METs) as opposed to moderate intensities such as walking briskly (i.e. 3-6 METs) or vigorous intensities like running, swimming or biking (i.e. 3-9 METs) (Ainsworth et al., 2011). It has been reported that prolonged periods of sedentary time increase risk for impaired health outcomes including elevated body mass index (BMI), waist circumference, and high blood pressure (Healy et al., 2010; McCrady et al., 2009; Mummery et al., 2005).

Sedentary behavior plays a substantial role in the current worldwide obesity epidemic. Obesity is known to be a precursor to many health related problems such as cardiovascular disease, metabolic syndrome, heart disease, type II diabetes, some types of cancer and even premature death (NIH, 1998; Flegal et al., 2005; Hamilton et al., 2007; Sanjib et al., 2010). In 2000, the number of obese adults had reached over 300 million worldwide (WHO, 2000). Owen et al. (2009), also suggests that serious health consequences such as type 2 diabetes, cardiovascular disease, breast and colon cancer, and obesity may come from too much sitting time (Owen et al., 2009). Current physical activity recommendations for healthy adults suggest engaging in 2 hours and

30 minutes (150 minutes) of moderate-intensity aerobic activity (i.e., brisk walking) every week and muscle-strengthening activities on 2 or more days a week that work all major muscle groups (legs, hips, back, abdomen, chest, shoulders, and arms) (CDC, 2008). It is recommended that physical activity be accumulated in bouts of at least 10 minutes in duration (Haskell et al., 2007). Currently, however, less than half of U.S. adults currently are meeting the CDC/ACSM physical activity recommendations and 23.7% of adults reported absolutely no leisure-time activity (Haskell et al., 2007). Additionally, dropout rates of interventions promoting moderate to vigorous intensity physical activity have ranged from 9% to 87% and it has been reported that of those that begin an exercise program, half or less continue with the program (Marcus et al., 2006). Therefore, recent calls have been made for interventions aimed specifically at reducing sedentary time as a means of reducing risk for chronic diseases (Owen et al., 2011). Specifically, interventions conducted in the worksite have been recommended as most adults spend a large portion of their wakeful time at work. While limited data exists, there are a few recent studies that suggest reducing sedentary time is associated with improved health. In a study by Healy et al. (2010) higher numbers of breaks in sedentary time was associated with health benefits in waist circumference and body mass index (Healy et al., 2010).

Over the past half century, the number of labor intensive occupations has decreased while the number of sedentary occupations has increased in the United States (Brownson et al., 2005; McAlpine et al., 2007). According to self-reported data in a study by Miller et al. (2004), 185 fulltime Australian employees (>35 hrs/week) were sitting 75% of their days. The employees wore a pedometer for 7 days and recorded

their number of steps and time spent sitting. The average time spent sitting during the weekdays was 9.4 hours; half of that time was at their worksite (Miller et al., 2004). Much of this shift is due to the role technology has played in occupational activity recently. Technological developments have resulted in less physically demanding time and more sitting time during working hours (Straker et al., 2009). Over the past 30 years the prevalence of computer-based jobs, desk dependent jobs has risen dramatically (McAlpine et al., 2007). Additionally, the average U.S. adult now spends about fifty percent of the typical weekday working and full time employees are now working an average of 40-46 hours per week (Allman-Farinelli et al., 2010; Engbers et al., 2005). Taken together, these changes in occupational physical activity have impacted total levels of physical activity and the health of U.S. adults.

As sedentary time during working hours continues to rise, it is important that research begin to start looking at how we can use technology to reintroduce physical activity into our daily lives. For example, before factories, physical labor was the way of life for every survival task. For example, laundry used to be done by using a washboard and human labor, now we have a faster and easier way with washing machines and dryers. Now that we are in a high technological society with easier, faster, and more efficient ways of living there is only more advancements going to be made. With a large portion of our time spent in sedentary occupational activities (Owen et al., 2000), it makes sense to examine ways to decrease sedentary time in the workplace. It has been suggested that implementing changes to the work environment may be helpful in promoting energy expenditure in the workplace (Beers et al., 2008; Owen et al., 2011). Introducing short physical activity breaks throughout the day may be a more feasible

means of meeting the physical activity guidelines for many populations that sit for prolonged periods of time such as those that work in primarily sedentary/sitting occupations. Worksite interventions may be a useful means to solve the problem of sedentary behavior in the workplace.

Therefore, the specific aim of this project is to test the efficacy of a worksite physical activity intervention called Pedal@Work for reducing sedentary time amongst sedentary, overweight, full-time employees. The following review of literature will: 1) define sedentary behaviors and describe the health risks associated with sedentary behaviors; 2) describe the prevalence and trends of sedentary behaviors among U.S. adults; and 3) review the literature of physical activity interventions that have been conducted in the worksite to reduce sedentary behaviors.

Limitations

It has to be assumed that the participants in this study were interested in increasing physical activity to decrease their health risks; therefore the generalizability of this study may have been limited to such individuals. In addition, a presumption was made that the subjects will follow all instructions given to them by the authors of this study, such as directions to follow for use of the WalkerTracker program, FitXF program, and the Magnetraider exercise pedal machine.

Delimitations

This study was delimited to 40 apparently healthy but sedentary, overweight adults working in full time sedentary, desk dependent occupations between the ages of 21 and 65 years in the greater Greenville area of North Carolina. The study was also delimited to 12 weeks in duration.

Definition of Terms

Sedentary: Using the Stepwatch activity monitor, sedentary is defined as activity of 0 steps per minute.

Light intensity: Using the Stepwatch activity monitor, light intensity is defined as activity of 1-45 steps per minute.

Moderate intensity: Using the Stepwatch activity monitor, moderate intensity is defined as activity 45-60 steps per minute.

Vigorous intensity: Using the Stepwatch activity monitor, vigorous intensity is defined as activity of 61+ steps per minute.

Web Compliance: Compliance of the website was calculated as the percent of days participants logged on the website during the 12-week intervention (84 total days).

Pedal Compliance: Compliance of the pedal machine was calculated as percent of total working days (60 days) participants used the pedal machine during the 12-week intervention.

Chapter 2 - Literature Review

Sedentary Behavior

It has been well established that regular physical activity can significantly improve physical (Pate et al., 2008), mental and emotional health (Lee et al., 2003) and result in overall improvements in quality of life (Booth et al., 2008). However, the prevalence of sedentary behaviors in the typical American lifestyle has increased tremendously over the past century resulting in less physical activity (Straker et al., 2009; WHO, 2004). Potential reasons for increased sedentary behaviors include declines in occupational, leisure-time, and transportation physical activity. The present literature review will focus primarily on occupational sedentary time.

Expenditure of energy is often described in terms of oxygen uptake and METs. MET levels are determined as a ratio of the metabolic rate of the activity being performed to the resting metabolic rate (Owen et al., 2009). One MET is the energy cost of resting quietly and equates to oxygen uptake of $3.5 \text{ mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ (Pate et al., 2008). Moderate intensity activities include activities such as walking at 3.0-4.5 mph or biking at 5.0-9.0 mph that exert energy levels of 3.0-6.0 METs. Vigorous intensity activities include activities such as running 5.0 mph or faster, biking more than 10.0 mph, or high impact aerobics are those that require more than 6.0 METs (Ainsworth et al., 2011). Sedentary behavior is a term used to describe activities that expend low amounts of energy. Specifically, sedentary behaviors are defined as those activities that expend energy levels of less than 1.5 METs and include activities such as lying down and sitting. Sedentary behavior has been defined as “sitting without otherwise being active” (Owen et al., 2011). Use of screen-based technologies such as watching television

and using a computer also fall under the category of sedentary behaviors (Owen et al., 2010).

Health Risks Related to Sedentary Behaviors

Researchers of the last decade have begun exploring the impact sedentary behaviors and determined that many adults are spending too much of time engaged in sedentary behaviors such as sitting and prolonged sedentary time has a negative impact on health outcomes independent of time spent exercising (Owen et al., 2009). While these may seem to be the same problem, they are unique and may require different behavioral strategies for improving health. For example, while it is important to exercise 30 minutes each day, it is also important remove the amount of prolonged bouts of sedentary behaviors such sitting throughout the course of the day.

A sedentary lifestyle is an independent risk factor for many chronic diseases including cardiovascular and metabolic diseases (Dunstan et al., 2010; Ford et al., 2005; Hu et al., 2003) as well as certain types of cancer (WHO, 2004; Huo et al., 2004; Kohl et al., 2001). Sedentary behavior has also been associated with several risk factors for disease including elevated blood pressure, obesity (Shields et al., 2008; Hu et al., 2003; Petersen et al., 2004; Buchowski et al., 2010; Hamilton et al., 2007), and high triglyceride and cholesterol levels (WHO, 1998; Lee et al., 2003; Wartonburg et al., 2006).

According to the Behavioral Risk Factor Surveillance System, approximately 72.5 million U.S. adults are obese (CDC, 2010). Sedentary behavior and obesity are strongly associated with each other. In a study conducted by Buchowski et al. (2010), known as

the Southern Community Cohort Study (SCCS), 22,948 black women and 7,830 white women living in the southeastern U.S. were recruited to explore specific associations between BMI and time spent in sedentary and active behaviors between the years 2002 and 2006. Cross-sectional data was collected by trained interviewers who conducted in-person baseline interviews. Self-reported data included questions about time spent in sedentary activities and time spent in physical activity split up into categories of light, moderate, and hard (vigorous) intensity. The results indicated that time spent in sedentary behaviors was positively related to BMI, whereas time spent in active behaviors such as moderate and vigorous physical activity was negatively related to BMI, with stronger associations for whites than blacks. These findings suggest reductions in sedentary time may result in lower obesity rates (Buchowski et al., 2010).

A study done by Levine et al. (2005) measured 10 lean (BMI 23 T 2 kg/m²) and 10 mildly obese (BMI 33 T 2 kg/m²) sedentary volunteers and measured participants' body postures and movements every half-second for 10 days. This study examined the role of non-exercise activity thermogenesis (NEAT) on obesity. Researchers collected 25 million data points on posture and movement for each volunteer in the 10 days. Data showed that obese individuals were seated 2.5 more hours per day than lean individuals (Levine et al., 2005) suggesting increased sedentary sitting may be a precursor to obesity.

Sedentary behavior has also been associated with cardiometabolic diseases and cancer mortality. In the Australian Diabetes, Obesity and Lifestyle (AusDiab) Study, 8,800 (3846 men, 4954 women) young adults with a mean age of 25 years were recruited to explore television-viewing time in relation to subsequent all-cause,

cardiovascular disease and cancer mortality. All measurements were self-reported; including time spent watching television or videos for the previous 7 days. Results indicated that high levels of television viewing time were associated with an increased risk for cardiometabolic risk factors. With the exception of cancer mortality, these associations remained significant for all-cause mortality ($P=0.03$) and showed borderline significance for CVD mortality ($P<0.05$) for the highest television viewing time category (>4 h/d) after adjustments for other covariates, including exercise and waist circumference (Dunstan et al., 2010).

In the Scottish Health Survey, 4,512 participants (1,945 men) were followed to study all cause mortality and cardiovascular disease (CVD) events. Screen time and moderate to vigorous activity were two main exposures examined in this study. Two hundred fifteen CVD events and 325 any-cause deaths occurred during 19,364 follow-up person-years. The covariable adjusted hazard ratio (HR) for all-cause mortality was 1.52 (95% confidence interval [CI]: 1.06 to 2.16) and for CVD events was 2.30 (95% CI: 1.33 to 3.96) for participants engaging in ≥ 4 h/day of screen time relative to <2 h/day. Adjusting for physical activity attenuated these associations only slightly (all-cause mortality: HR: 1.48, 95% CI: 1.04 to 2.13; CVD events: HR: 2.25, 95% CI: 1.30 to 3.89) (Stamatakis et al., 2010).

A study by Wen et al. (2011) examined the effects on all cause mortality and cancer. This cohort study consisted of 416,175 participants, (199,265 men and 216,910 women) aged 20 years or older. Each participant completed a self-administered questionnaire including medical history and lifestyle information and was asked three multiple-choice questions to determine the leisure time physical activity level of the

participant: inactive, low, medium, high, or very high activity. The third question asked about the level of activity at their work, which categorized them into one of four different activity levels: low level to high level of hard physical labor. Participants were encouraged to visit yearly where they would re-complete the questionnaires. The data suggests that individuals that were inactive had a 17% increased chance of all cause mortality risk than those in the low-volume activity group and an 11% increased cancer mortality risk (Wen et al., 2011).

Similarly, a study conducted by Buman et al. (2010) suggests that recommending lighter intensity activities may have health benefits for adults. Participants included 862 male and female adults living in either Seattle/King County, Washington or Baltimore, Maryland. Each participant wore an accelerometer for seven days for at least 10 hours per day at baseline and at post-test, which was six months after baseline. Accelerometer data placed participants in categories based on activity levels: moderate/vigorous, high-light, low-light, and sedentary. Results showed that high-light physical activity were positively related to physical health ($P < 0.001$) and well being ($P < 0.001$). An increase of 30 minutes/day in high-light physical activity was associated with a 0.46 standard deviation in physical health score (Buman et al., 2010).

According to the American Heart Association (AHA), metabolic syndrome affects over 50 million people in the United States (AHA, 2010). By its definition, sedentary time is a key component of metabolic syndrome (Ford et al., 2005; Alberti et al., 2005; Hamilton et al., 2007; Wannamethee et al., 2007). In a study by Gardiner et al. (2011), 1,958 Australian participants' were asked to self report their television viewing time. Results indicated that overall sitting time was highly associated with abdominal obesity

in women, greater risk of high triglyceride levels in men and women, and low HDL-C levels in men (Gardiner et al., 2011) suggesting increased sedentary time may be a cause of metabolic syndrome.

In an interesting cross sectional study conducted by Healy et al. (2008), the authors explored the association between the number of breaks in objectively measured sedentary time with biological markers of metabolic risk. A total of 168 participants with a mean age of 53.4 years wore an accelerometer for seven consecutive days during waking hours to assess moderate to vigorous activity, sedentary time, and breaks in sedentary time. Fasting plasma glucose, 2-h plasma glucose, serum triglycerides, HDL cholesterol, weight, height, waist circumference, and resting blood pressure were also measured. Results indicated that the number of breaks in sedentary time was associated with significantly lower waist circumference, BMI, triglycerides, and 2-h plasma glucose. On average, participants had a 5.35 cm lower waist circumference ($P=0.025$). Overall, reductions in sedentary time in the form of small breaks resulted in reductions in the risk for the developing metabolic syndrome (Healy et al., 2008).

In another study by the same group, Healy et al. (2008) examined the dose-response associations of television-viewing time with continuous metabolic risk variables of physically active adults. Data was collected from 2031 men and 2033 women aged 25 years or over that reported at least 2.5 hours per week of moderate- to vigorous-intensity physical activity. Television-viewing time was defined as sitting time and was self-reported by the participants. Physical activity was measured by using the Active Australia Questionnaire. Results found that although these were healthy adults who met the public health guideline for physical activity, increased sitting time was

associated with an increased risk for the measured metabolic risk factors (Healy et al., 2008).

Sedentary time is also associated with risk of developing type 2 diabetes. It has been estimated that one in every ten U.S. adults has been diagnosed with type 2 diabetes (CDC, 2010). According to the American Diabetes Association, diabetes contributed to a total of 231,404 deaths in the United States in 2007 alone. In 2010, 1.9 million new cases of diabetes were diagnosed in adults aged 20 years and older (ADA, 2011).

In the Nurses' Health Study, a cohort study conducted among 50,277 women (excluding women with diagnosed cardiovascular disease, cancer, or diabetes) investigated the longitudinal relationship between several sedentary and light-intensity activities and the risk of obesity and type 2 diabetes. Television viewing and time spent sitting at work were found to be highly associated with an increased risk of type 2 diabetes. Participants were asked to self-report their sitting time and physical activity at home and work. They were also asked to self-report their height and weight to determine body mass index, which are potential limitations of this study. Of the 50,277 women investigated, there were 1,058 cases of type 2 diabetes that were diagnosed during a 6 year follow-up, those who were the least active with the most amount of television time had a significantly increased risk of type 2 diabetes. Also found, was that for every 2-h increment spent sitting there was a 20% increased risk of type 2 diabetes (Hu et al., 2001).

In another study by Hu et al. (2003), data was used from a large prospective cohort study, the Health Professionals' Follow-up Study and found that increasing TV

watching is strongly associated with obesity and weight gain. The data obtained suggests that men who watched TV more than 40 h per week had a nearly threefold increase in the risk of type 2 diabetes compared with those who spent less than 1 h per week watching TV (Hu et al., 2003). A study by Thorpe et al. examined the relationship between sedentary time and diabetes of the 2,103 men and 2,761 women. This study was designed to explore the prevalence of diabetes and associated health behaviors included 2,761 women and 2,103 men that were not clinically diagnosed with diabetes. Waist circumference, BMI, resting blood pressure, triglycerides, HDL cholesterol, fasting and 2-h post load plasma glucose, and fasting insulin were measured. Thorp and colleagues determined sitting time by asking participants to report separately for a typical weekday and weekend day on the following question: “How many hours and/or minutes did you spend sitting down while doing things like visiting friends, driving, reading, watching TV, or working at a desk or a computer?” Participants who reported ≥ 2.5 h of leisure-time physical activity per week were classified as meeting the public health guidelines for physical activity. There was a significant positive correlation between sitting time and television time for women (Spearman's $r = 0.32$, $P < 0.001$) and men (Spearman's $r = 0.25$, $P < 0.001$). Television viewing time was also associated with waist circumference, BMI, glucose (fasting and 2-h postload), and fasting insulin in both men and women. Sitting-time was measured by means of self-report data of a “typical” weekday and weekend day, while TV viewing time was measured by self-report data of the participant’s most recent 7 days (Thorp et al. 2009).

Research suggested that watching more than 4 hours of television per day doubled the likelihood of being overweight when compared to those who reported

watching less than 1 hour of television per day (Kronenburg et al., 2000; Jakes et al., 2003). Prevalence for obesity has been shown to significantly increase for men and women who watch 21 or more hours of television per week (Shields et al., 2008). Relationships between TV time and the metabolic syndrome have also been demonstrated (Dunston et al., 2005; Sisson et al., 2009; Chang et al., 2008).

Prevalence and Trends of Sedentary Behaviors

Despite the health risks associated with sedentary behavior, less than half (49.1%) of U.S. adults met the CDC/ACSM physical activity recommendation in 2005 (CDC, 2006). It is recommended that healthy adults achieve 2 hours and 30 minutes (150 minutes) of moderate-intensity aerobic activity (i.e., brisk walking) every week and muscle-strengthening activities on 2 or more days a week that work all major muscle groups (legs, hips, back, abdomen, chest, shoulders, and arms). These recommendations also support achieving the recommendations through the accumulation of short 10 minutes bouts of activity (ACSM, 2007).

Unfortunately, the U.S. population is becoming increasingly sedentary (Matthews et al., 2008, WHO, 2004). In the 2003–2004 National Health and Nutrition Examination Survey, a study by Matthews et al. (2008), 6,329 participants wore an activity monitor for an average of 5 days to determine their daily sedentary time. Participants who wore the monitor for an average of 10 hours were included for analyses. The average monitor-wearing time was 13.9 hours/day (SD, 1.9), and 79.2 percent of participants provided 3 or more days of observation. Results found that participants spent 54.9% or 7.7 hours per day, of their monitored time, in sedentary behavior. Sedentary time

increased by about 2 hours/day between the ages of 30 and 39 years (men: 50.8 percent, 7.2 hours/day; women: 53 percent, 7.3 hours/day). Adults aged 70–85 years were the most sedentary group in the population (men: 67.8 percent, 9.5 hours/day; women: 66.3 percent, 9.1 hours/day) indicating sedentary time is positively associated with age. A limitation to this study was that it was not clear as to what days the participants wore the monitors (weekdays, weekends, a typical work week, etc) (Matthews et al., 2008).

“Sitting time” is a term used in parallel with sedentary behavior as humans spend a large amount of their sedentary time sitting. Research has shown that adults that meet physical activity recommendations but also spend long periods of time in low-level metabolic energy expenditure may still be facing increased health risks (Owen et al., 2010; Healy et al., 2008). This has been referred to as “the Active Couch Potato phenomenon”. To confirm this theory, Healy et al. (2008) measured time spent in sedentary, light-intensity, and moderate-to-vigorous intensity activity, in 169 AusDiab study participants. Results found that participants spent, on average, the majority of accelerometer wearing time in either sedentary (56%) or light-intensity activity (39%) with only 4% of wearing time in moderate-to-vigorous intensity activity. On average, the participants’ majority of waking hours (>90%) were spent either in sedentary or in light-intensity activity (Healy et al., 2008). Collectively, these findings suggest that it may be just as important to stress breaks in sedentary time as it is in encouraging individuals to meet moderate to vigorous physical activity recommendations.

Although the scientific study of sedentary behavior is relatively new, Marshall et al. (2011), has built a research framework that includes five phases to help outline a

systematic approach to developing, evaluating, and implementing behavior change interventions for improving health. An overview of these five phases includes determining if a dose-response relationship exists between levels of occupational sitting and all cause mortality, independent of MVPA, developing methods for accurately assessing sedentary behavior, Identify factors that influence levels of sedentary behavior, Evaluate interventions to reduce levels of sedentary behavior, implementing worksite interventions that reduce the amount of sitting time throughout the day (Marshall et al., 2011).

Leisure time Activity

Changes in sedentary behaviors have occurred primarily due to changes in leisure time activity, transportational activity and occupational activity (Levine et al., 2005). Increases in sedentary time during leisure time physical activity has been due to increased rates of television viewing time (Healy et al., 2008). Television viewing time has increased significantly in recent years (CDC, 2001; Owen et al., 2000; Hu et al., 2003). In 1950, only about 10% of U.S. households had a television (Putnam et al., 1994). Now, 98% of all households in America have at least one television and the average U.S. household increased its TV watching by 36 min every 10 years (Brownson et al., 2005). According to the Bureau Labor Statistics, television viewing is the most popular leisure time activity. U.S. adults average 2.8 hours of television viewing time per day, which accounts for about half of all leisure time for those, age 15 and over (USDHHS, 2010).

The 2007 Canadian Health Survey conducted by Shields et al. (2008) examined leisure- time sedentary behaviors among 42,612 total participants (19,811 men and 22,801 women) between the ages of 20 and 64 years. Of the three primary leisure activities (television viewing, computer use, and reading) measured, television viewing was the most popular. Approximately one-quarter of both sexes (27% of men and 24% of women) reported watching television for 15 or more hours per week and 16% of men and 15% of women reported 21 or more hours per week. Results also found that television viewing was associated with obesity for both sexes. Among men, the prevalence of obesity rose from 14% of those who averaged 5 or fewer hours per week to 25% of those averaging 21 or more hours a week. Similar results emerged for women, with the prevalence of obesity rising from 11% of those reporting 5 or fewer hours to 24% of those reporting 21 or more hours per week (Shields et al., 2008).

Computer and Internet usage are also commonly reported leisure sedentary behaviors (Owen et al., 2000). Vandelanotte et al. (2009) conducted a study among 118 Australian adults to assess how much time participants spent on the computer during leisure time and to determine if there was an association with obesity. Participants completed a questionnaire, answering items about height, weight, and past seven-day recall of leisure-time physical activity, Internet and computer use, and other leisure-time sedentary behaviors. Leisure-time Internet and computer use was categorized into no use, low use (less than three hours per week), or high use (three hours or more per week). Average leisure-time Internet and computer use was 125.3 minutes per week (SD: 273.3). Adults with high leisure-time Internet and computer use were more likely to be overweight or obese. Compared to participants that reported no Internet and

computer use, participants with low Internet and computer use were 1.3 times more likely to be overweight and 1.4 times more likely to be obese, and participants with high Internet and computer use were 1.5 times more likely to be overweight and 2.5 times more likely to be obese (Vandelanotte et al., 2009).

Transportation Activity

Changes in transportation behaviors have also had a major influence on the prevalence of sedentary time (Frank et al., 2004; Lopez-Zetina et al., 2006). In general, Americans are spending more time driving than in past years (Owen et al., 2010). Time spent sitting in cars can result in significant damage to health. In the Strategies for Metro Atlanta's Regional Transportation and Air Quality (SMARTRAQ) study, Lawrence et al. administered a travel survey to 10,878 participants in 13 counties in the Atlanta, Georgia area to evaluate the relationship between the built environment and travel patterns. It was found that every hour spent in a car resulted in a 6% increase in the risk for obesity (Booth et al., 2001).

Occupational Activity

There is much data demonstrating that technology has decreased human manual labor and in turn our daily physical activity (Frank et al., 2008; Booth et al., 2008). In the early 1900's the U.S. Industrial Revolution provided people more leisure time due to time saving technologies. New technology included faster ways to travel such as trains and automobiles, faster ways to communicate with the wireless telegraph, and factories to make things faster and more efficient. Although these progressions have been beneficial in many ways and have led to even further technological advances, they have

been shown to have a profound effect on our physical activity behaviors (Straker et al., 2009).

Today, Americans spend approximately half of their waking day at work. The average American works 40-46 hours per week (Allman-Farinelli et al., 2010). According to the 2008 U.S. Bureau of Labor Statistics, American adults work an average of 7.6 hours/day during the typical workweek (USBLS, 2010; (Brownson et al., 2005). In a review of 41 articles exploring temporal trends of physical activity, Knuth et al. (2009) determined occupational physical activity has steadily decreased over the past century (Knuth et al., 2009). In a study conducted by McCrady et al. (2009), exploring time spent sitting across the week, it was found that participants sat approximately 110 minutes/day more during their workdays than on their leisure days (McCrady et al., 2009). This suggests adults are more sedentary during working days than during non-working days.

Many jobs have decreased physical workloads due to technological advances to improve productivity (Straker et al., 2009). An increase in the number of computer based desk jobs have had a major impact on the declining number of active occupations (McCrady et al., 2009). The 2000 Census reported an eligible population of 216.9 million persons aged 16 or older, of which 136.7 million were in the labor force (63.0% participation rate). Among those eligible to work, 26.8% or 58.2 million were in low activity occupations and 14.3% or 30.9 million were in high activity occupations in their current or most recent job.

In 1950, there were approximately 4% more persons in high activity occupations than low activity occupations, compared with 2000 when there were approximately twice

as many persons employed in low activity occupations than in high activity occupations (Brownson et al., 2005). This has led some researchers to observe how different types of jobs impact our health. In a seminal study by Dr. Jerry Morris in 1958 exploring the incidence of coronary heart disease (CHD) among workers of varying activity levels, it was found that men with more physically active jobs were less likely to suffer from coronary heart disease compared to men in sedentary jobs (Morris et al., 1953).

Another study by Allman-Farinelli et al. (2010) examined the differences in BMI and prevalence of overweight and obesity by occupation. Data from 14, 618 adults (7466 males and 7152 females) was recorded via the National Health Survey in Australia (2005). Participants were asked a series of lifestyle behavior questions including those about occupation. Results showed that male occupational groups such as professionals, tradespersons, elementary clerical sales and service workers and laborers had significantly lower mean BMI. For females, significantly lower mean BMI is found in managers and administrators, professional and associate professional, advanced clerical and service workers and intermediate and elementary sales and service workers. Assessments of sedentary behaviors at work and at home were not included in this Health Survey therefore this is a limitation to the study. Activities outside of the workplace might have had an effect on BMI measures (Allman-Farinelli et al., 2010).

Theoretical Application of Intervention

The behavior targeted in this study is sedentary behavior and the theories used to guide this study include the Learning Theory, Behavioral Change Theory and Social

Cognitive Theory. Participants will complete a series of questionnaires pre and post intervention targeting multiple constructs within these theories. Therefore, secondary outcomes will examine which theoretical constructs, if any, change from participating in the intervention.

Learning Theory

According to Skinner et al. (1953) the learning theory suggests that people are more likely to engage in a behavior when they come across pleasurable circumstances at a convenient time and when there are not negative consequences as a result of the behavior (Skinner et al., 1953). For example, a person is more likely to continue to be physically active if they have already set aside time for a 30 minute jog at a fitness center near their worksite, after already experiencing a sense of accomplishment from fitting in a 30 minute jog on a previous day.

There are three main constructs that fall within the learning theory, which are shaping, rewards, and reinforcement. Shaping, or progressing slowly toward smaller goals and gradually increasing, is essential to changing a behavior (Marcus et al., 2009) such as being sedentary. By setting smaller, achievable goals for being less sedentary, people are more likely to continue to progress toward success. Self-monitoring is a program strategy used within this specific construct to help clients visually set smaller goals for themselves. According to the learning theory, achieving goals requires a reward system, at least in the beginning of the change process (Marcus et al., 2009). Rewards can be anything from cash prizes for meeting goals to encouraging and positive feedback acknowledging the client's successful progresses.

Behavior Choice Theory

Behavior Choice Theory is useful for understanding the decision making process and has been applied to interventions to understand physical activity choices. This theory has been applied to sedentary individuals by suggesting that given the choice between a sedentary activity and a physically active activity they will choose the sedentary option. Epstein et al. (1998) suggests that the cost of the activity has a significant effect on an individual's choice of activity; the higher the cost the less likely an individual is to choose that activity. Therefore, reducing the participant's perceived cost of sedentary behaviors may be a way to reduce time spent in sedentary behaviors (Epstein et al., 1998).

Accessibility has also been positively correlated with activity levels (Sallis et al., 1990; King et al., 2003). For example, King et al. (2003) examined the relationship between walking levels of an older female, Caucasian population (mean age of 74.2 years) and the convenience of the destination. Results suggested that the more convenient the destination and favorable the neighborhood, the more physical activity the women accumulated (King et al., 2003). This suggests that by increasing options for physical activity may result in decreased sedentary behaviors.

Social Cognitive Theory (SCT)

The Social Cognitive Theory (SCT) explains how people acquire and maintain certain behavioral patterns through personal factors and the environment. Behavioral factors, personal characteristics, and environmental factors all possess the ability to

affect behavior change (Bandura et al., 1986). An important construct within this theory that may play a role in decreasing sedentary behavior is direct positive reinforcement (Marcus et al., 2009). The definition of reinforcements, according to Glanz and colleagues (2002), is the “responses to a person’s behavior that increase the likelihood of reoccurrence”. Examples of reinforcing factors include social support, peer influence, and vicarious reinforcement (Glanz et al., 2002).

Another construct within the SCT that has been associated with physical activity behavior is self-efficacy. Self-efficacy is very commonly evaluated in behavior change interventions (White et al., 2011; French et al., 2011) and is defined as an individual’s confidence to successfully perform a specific behavior (Bandura et al., 1986). SCT also states the type of situation and environment an individual is in also has an effect on behavior (Parraga et al., 1990). The social environment includes family, friends, coworkers, or peers in the classroom while the physical environment might include the temperature, the accessibility of walking or biking trails, and location to fitness centers from home or work, to name a few. A situation refers to how a person feels about their environment or their perception of their surroundings (Glanz et al., 2002). Modifying an individual’s modified or perceived environment may open up opportunities to change behaviors such as being sedentary.

Understanding that the environment plays a detrimental role in a population’s physical activity is a key to finding ways to promote activity. Decreasing barriers and increasing opportunity within a population by using these constructs may show great improvements in activity levels and decreasing sedentary time. Many health educators and behavioral scientists have used theory-based constructs within interventions to

study behavior change, more specifically studying whether certain constructs result in behavior change (Glanz et al., 2002). Integrating the successes of each theory's constructs within an intervention seems to be a logical strategy to help adults reduce their sedentary behavior

Application of the Theories

This intervention will use a combination of constructs from the Learning Theory, Behavioral Choice Theory and Social Cognitive Theory to guide the intervention. For example, we will use the Shaping construct of the Learning Theory by providing the participants pedometers and pedal machines to self-monitor their physical activity behavior. As the participants monitor their progress they will be able to gradually increase their physical activity levels when they are ready. The clients in the intervention group will also be provided with daily and weekly feedback through the WalkerTracker Program. WalkerTracker will send positive feedback for logging physical activity steps and minutes. For example, after entering 10,000 steps, a participant may receive a message like "Congratulations, you walked 2,000 steps more than yesterday!" Also, the participants will be able to monitor their daily and weekly physical activity at their own personal convenience. Participants in the intervention group will be entered in a group competition as well called the 'Walk Across America' competition. There will be five groups of five, each with a unique name and mascot (Team Black Beard). After entering daily steps, the mascot will progress across a virtual map of America. The goal is to move your team mascot from Nags Head, NC to San Francisco, CA first. Group

members will be encouraged to give each other praise and to engage in-group discussions.

Worksite Physical Activity Interventions

Physical activity interventions conducted in the worksite to reduce sedentary time and improve health is an emerging field of study (Dugdill et al., 2008; Owen et al., 2011). The idea of worksite physical activity interventions is fairly new but its importance is increasing (Engbers et al., 2005) as occupational sedentary behavior is growing (Shields et al., 2008; Healy et al., 2008). Recent evidence suggests adults spend more than half of their waking hours in an occupational setting highlighting the need for worksite interventions to reduce daily sedentary time (Dugdill et al., 2005). While advances in technology have led to declines in occupational activity, technology can also be used to reduce occupational sedentary time. Besides increased physical activity levels, health promotion efforts conducted in the workplace have demonstrated other important outcomes including reduced absenteeism among employees, reduced back pain, increased productivity, increased stress tolerance and improved decision-making (Kreis et al., 2004). These findings are important as they appeal to employers who must first provide clearance for employees interested in participating in such programs. Worksite physical activity interventions may be a viable solution to decrease sedentary time for improved health.

Dugdill et al. (2007) recently reviewed 33 randomized controlled trial worksite physical activity interventions, 14 of which were graded according to the level of quality they provided about worksite interventions. The intervention studies that were reviewed

covered many areas such as promoting walking, promoting stair use, and promoting active transport. Other interventions included within this review involved active programs, health screens and counseling sessions as a way of promoting physical activity. The studies reviewed demonstrated positive findings for the efficacy of worksite interventions aimed at promoting physical activity. This review suggests that the effectiveness of stair walking interventions was short lived but the studies that included the use of pedometers show increased daily step counts, but only if paired with motivators such as goal setting, diaries, and self-monitoring (Dugdill et al., 2007).

Worksite physical activity programs may have health benefits and improve workplace outcomes. One such study by Thomas et al. (2006) examined the implementation and outcomes of a pedometer-based workplace intervention with a sample of 1,195 volunteer staff members from the Department of Human Services in Australia. For four weeks, participants were encouraged to aim for 10,000 steps per day in order to achieve the National Physical Activity Guidelines for Australians (30 minutes of moderate intensity activity on most days of the week). Emails were sent weekly to encourage and motivate participants to reach the 10,000-step goal. Participants self-reported their pedometer steps into a diary. Out of the 1,195 staff members, 859 returned their diaries completed. Results showed that steps increased from the first week (8,501) to the fourth week (9,374), which is a 25% increase. Thirty-eight percent of the participants averaged 10,000 steps during the fourth week, a 52% increase from the first week (Thomas et al., 2006). This study suggests that the use of pedometers and/or frequent motivation emails is a positive way of increasing daily steps.

Recently, Conn et al. (2009) conducted a meta-analysis in which they examined the effect sizes of health and physical activity behavior interventions conducted in the worksite between 1969 and 2007. A total of 7,251 papers, reports, and reviews were included in the meta-analysis with a total of 38, 231 subjects. Sample sizes varied dramatically from 12 to 5038 subjects among the studies observed. Standardized mean difference (d) effect sizes were synthesized and positive effects were observed for physical activity behavior (0.21); fitness (0.57); lipids (0.13); anthropometric measures (0.08); work attendance (0.19); and job stress (0.33) (Conn et al., 2009). The results of this analysis indicate that worksite interventions are a feasible and effective setting for delivering physical activity interventions.

In a 6 month intervention Strijk et al. (2012) evaluated the effectiveness of a worksite vitality intervention on vigorous physical activity (VPA), fruit intake, aerobic capacity, mental health and need for recovery after work among older hospital workers. The study included 575 workers who had adequate data (intervention: n=367; control: n=363). The intervention group received the Vital@Work intervention containing: a Vitality Exercise Program, which included yoga sessions, instructional resistance training workouts, unsupervised aerobic exercise and free fruit, combined with three visits to Personal Vitality Coach. Questionnaires, accelerometers, and the 2k-walk test were used to measure outcomes such as (1) lifestyle behaviors: sports, vigorous physical activities, fruit intake and (2) vitality-related outcomes: aerobic capacity, mental health and the need for recovery after a day of work. Results found that the intervention group increased their sport activity 75.3 min/week which was a statistically significant change compared to the control group who had only increased 35.1 min/week. The

intervention group workers improved their fruit intake significantly more when compared to the control group (5.7 vs 2.7 pieces/week). And although there were no significant effects found on aerobic capacity or mental health, the intervention group did show a significant decrease in need for recovery time compared to the control group (Strijk et al., 2012).

Although past interventions have shown to be somewhat successful in promoting physical activity within the workplace, no interventions to date have focused specifically promoting reduced sedentary time while individuals are actually working. However, recent studies have tested the feasibility of specific products for reducing sitting time and increasing energy expenditure in the workplace (Chan et al., 2010). One such study by Thompson et al. (2007) tested the feasibility of a walking workstation in a real life work setting. Participants from four different occupations (nurses, secretaries, appointment secretaries, and clinical assistants) from the Executive Health Program at the Mayo Clinic in Rochester, MN were recruited for participation. Three treadmills were implemented into specifically designed workstations within the workplace for the subjects to use at their convenience. There were no specific guidelines given, only a two-week acclimating period for learning and adjusting to the workstations. Participants increased their steps during the workday from 2200 steps per day (prior to the intervention) to 4200 steps per day (during the actual treadmill testing period). The increase in steps equated to an extra 30 minutes of walking per day (Thompson et al., 2008). This study was the first to test the feasibility of introducing a physical activity device directly into the real life work setting to increase occupational activity. However,

this study was limited in that treadmills are not practical for including in most office settings due to cost, size and noise limitations.

In a similar study, McAlpine et al. (2007) explored the energy expenditure of using a portable office-place stepping device (Discovery Electronic MiniStepper) in the workplace. The stepping device used was an inexpensive, quiet device that fits under most desks which is a limitation of the walking treadmill. In this study, the authors measured the energy expenditure of 9 lean and 10 obese subjects assessed at rest, while sitting, while walking, and while using the office-stepper. The lean subjects averaged 39 ± 11 steps/minute while the obese subjects averaged 40 ± 12 steps/minute on the stepping device. Participants increased their energy expenditure above resting by 289 ± 102 kcal/hour. This study demonstrated the use of the office stepper to be potential tool for increasing energy expenditure while sitting at a desk or computer (McAlpine et al., 2007). However, this study was conducted in a controlled laboratory setting and did not test the feasibility of the device in a real life work setting.

In another study, Carr et al. (2010) tested the feasibility and use of a portable pedal machine within a real life workplace setting. The pedal machine used in this study (Magnetraider, 3D Innovations, Greeley, CO) addresses many limitations of the walking workstation and office stepping device of the previously discussed studies as it is relatively inexpensive, portable and can be plugged into any PC to objectively monitor activity levels. A total of 18 full-time (minimum of 35 hours per week), sedentary (maximum 30 minutes of moderate to vigorous intensity PA per week while at work) employees working in desk/computer dependent occupations were recruited. Each participant was provided with a pedal machine for his or her own personal use for four

continuous weeks. Activity tracking software was installed onto each of the participant's work computers and participants were acclimated to the software and pedal machine before the study began. At the end of four weeks the participants were asked 22 questions about the feasibility of the machine and physical activity use was downloaded from the software. Results showed participants pedaled an average of 12.2 ± 6.6 days of the possible 20 workdays in which they had access of the machine. Participants pedaled an average of 23.4 ± 20.4 minutes per day on the days they used the machine and at an average intensity level of 4.4 ± 1.6 on the Borg 0-10 RPE scale. Participants self reported they would use the machine if provided by an employer and it did not affect productivity or their quality of work (Carr et al., 2010). The findings of this study indicate the pedal machine to be feasible for use in a real life workplace amongst full time sedentary employees. Therefore, the aim of the current project is to recruit sedentary full time employees to test the efficacy of a worksite intervention that incorporates the portable pedal machine for reducing time spent sedentary.

Chapter 3 - Methods

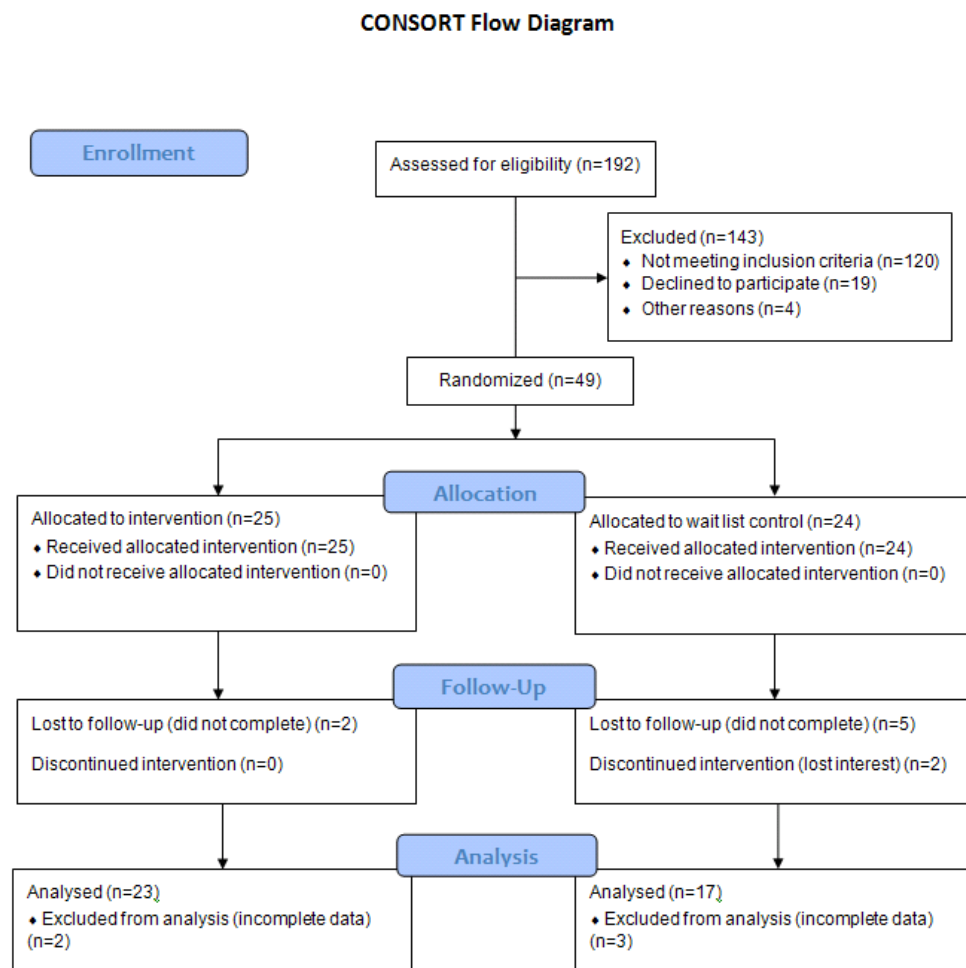
The purpose of this study was to test the efficacy of a worksite intervention to reduce time spent sedentary among full time, sedentary adult employees. Specifically, we examined whether providing sedentary, full time employees with a portable pedal exercise machine (MagneTrainer), a pedometer and a motivational internet-delivered program (Walker Tracker) would efficaciously reduce time spent sedentary at work. Our hypothesis was that sedentary employees randomized to the intervention group would reduce their time spent sedentary while at work when compared to a wait list control group. Outcomes are focused on both sedentary time and MVPA time during working hours and over the course of the entire day (Step Watch). A secondary aim of the study was to examine the relationships between theoretical constructs and the intervention. Our hypothesis was that the intervention group would enhance positive behaviors and decrease negative behaviors according to the theoretical constructs used.

Subjects

We recruited 49, apparently healthy but sedentary, overweight adults working in full-time sedentary, desk dependent occupations between the ages of 21 and 65 years. Participants of all races and ethnic backgrounds were recruited. Employees of East Carolina University were recruited on a rolling basis by advertising to an electronic mailing list serve. Participants were not compensated for participation in the study but those that successfully complete the 12-week intervention were provided a free pedometer valued at \$15.

Out of the 49 enrolled, 40 participants completed both baseline and 12-week assessments, including the physical activity assessment by Stepwatch, cardiometabolic risk factor assessments and behavioral questionnaire data. Nine participants dropped out of the study for reasons of lack of compliance (N=6) and did not provide complete data (N=3) (see Figure 1).

Figure 1. Participant recruitment schematic.



Inclusion Criteria

Research staff members screened participants for eligibility by telephone. Adult participants were included if they: 1) reported participating in less than 60 minutes per week of moderate to vigorous activity, 2) worked 35+ hours/week at a primarily sedentary and desk-dependent occupation, 3) were found healthy as assessed by the health history screening, 4) were devoid of overt complicated or acute cardiovascular, metabolic, respiratory, or neurological diseases, 5) were cognitively capable of understanding what participation in the study entails; 6) were free from ambulatory and exercise limitations; and 7) were between the ages of 21 and 65 years.

Exclusion Criteria

Adult participants were excluded if: 1) limitations or contraindications to ambulatory exercise were present; 2) acute illness or injury was present; 3) cognitive impairment, psychosis, or other diagnosed psychological illness (with the exception of depression and anxiety) was present; 4) participants were taking psychotropic drugs; or 5) had a diagnosed chronic condition such as heart failure or cancer.

Procedures

This study took place in the Activity Promotion Laboratory in the Minges Coliseum at East Carolina University. At baseline testing the participants were provided all the necessary information concerning the study and their responsibilities, risks, and benefits and were asked to sign an informed consent form. Participants were allowed to terminate participation in the study at any time without any penalty. The names of the

subjects were kept confidential and documents containing protected health information data were only available to the research team. Participants were assigned identification numbers and all information was stored on a password protected, secure computer, which was located inside the APL. Once analyzed, the data were then stored on a password protected and secured server, which will be kept in the possession of the primary investigator for five years. The only people who will have access to the data are the principle investigator and his research personnel.

The principle Investigator utilized a randomization software program to create a randomization chart. Participants were randomized to each group based on the order of their enrollment. Completion of two testing sessions: baseline and post intervention (12 weeks) was required for participation. The following description describes the different measures and procedures that were used for the baseline and post intervention sessions.

Baseline Measures

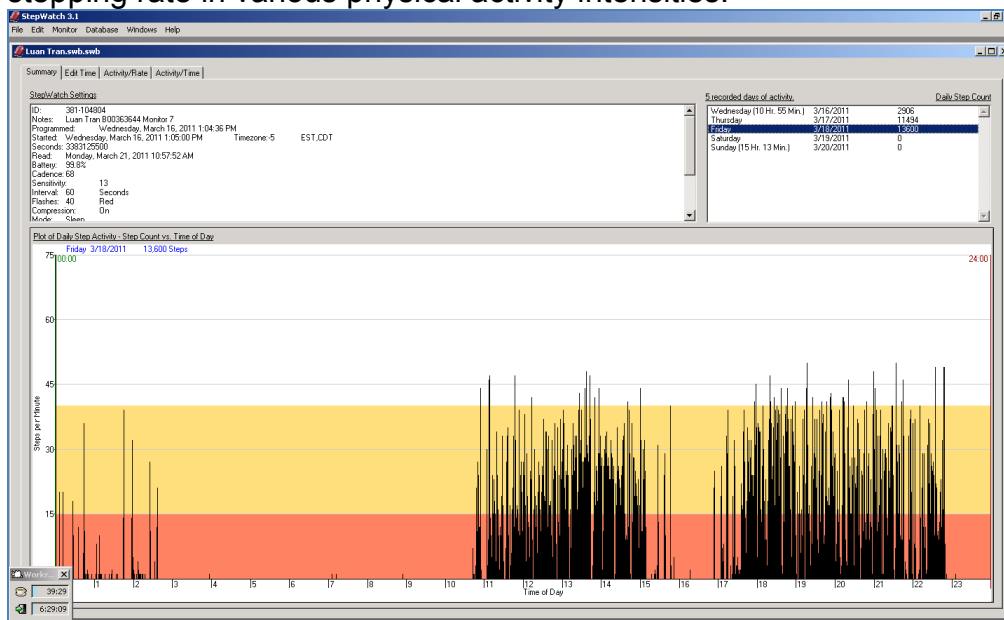
Primary Outcome – Physical Activity

The primary outcome for this study was time spent sedentary as measured by the StepWatch activity monitor. The StepWatch activity monitor is an ankle worn device that has previously been demonstrated as accurate and valid during controlled laboratory settings for measuring walking behavior, estimating energy expenditure and determining time spent in sedentary, light intensity, and moderate to vigorous intensity activity (Figure 1) (Bowden et al., 2007, Foster et al., 2005, Mudge et al., 2010). Mudge et al., demonstrated the test-retest reliability of the StepWatch among 30 healthy adults

(18 years of age or older) over six days of wear time (2 periods, 3 days each). Intraclass correlation coefficients (ICC) for mean steps/day, ranged from 0.32 to 0.86, indicating good test-retest reliability (Mudge et al., 2010).

Participants were asked to wear the StepWatch for seven consecutive days for a minimum of 10 hours per day. After the seven days, monitors were collected and participants were informed of their assigned group (Intervention or Control). For this study, a minimum of four days with at least ten hours of data was required for inclusion in the final data analysis.

Figure 2. Screenshot of StepWatch activity monitor software output demonstrating stepping rate in various physical activity intensities.



Behavioral Questionnaires

Participants completed a series of questionnaires that included: Demographics, Infection and Inflammation, Exercise Goals and Plans, Self-Efficacy for Physical Activity, Social Support for Physical Activity, Outcome Expectations, Physical Activity Processes, Barriers to Physical Activity, Work Productivity and Activity Impairment, and Worksite SEALS.

The Exercise Goals and Plans will assess reinforcement within the Learning Theory. A 5-point Likert scale will be used to assess change in behavior (1- Not at all like me or 5-Just like me). Lower scores will indicate positive behavior and higher scores will indicate negative behavior. The Processes of Change questionnaire will be geared toward assessing the rewards construct within the Learning Theory. A 5 point Likert scale (1-Never and 5-Repeatedly) will determine behavior change. In this case, a higher score will result in positive behaviors and a lower score will indicate negative behavior.

Additional Measures

Additional measures including height, weight, body mass index (BMI), percent body fat by bioelectrical impedance analysis (BIA), estimated cardiorespiratory fitness, total cholesterol, HDL, LDL were also measured at baseline. However, these measures will not be included in the analyses of the present document.

12 Week Post Testing

After 12 weeks, participants returned to the testing facility and re-completed all baseline testing assessments. Compliance and process evaluation measures were also collected from the intervention completers. These measures are explained in more detail later in the document.

Group Descriptions

Wait List Control Group

Participants randomized to the wait list control group (N=24) were asked to maintain their current behaviors for 12 weeks at which time they will be able to cross-over to receive access to the intervention.

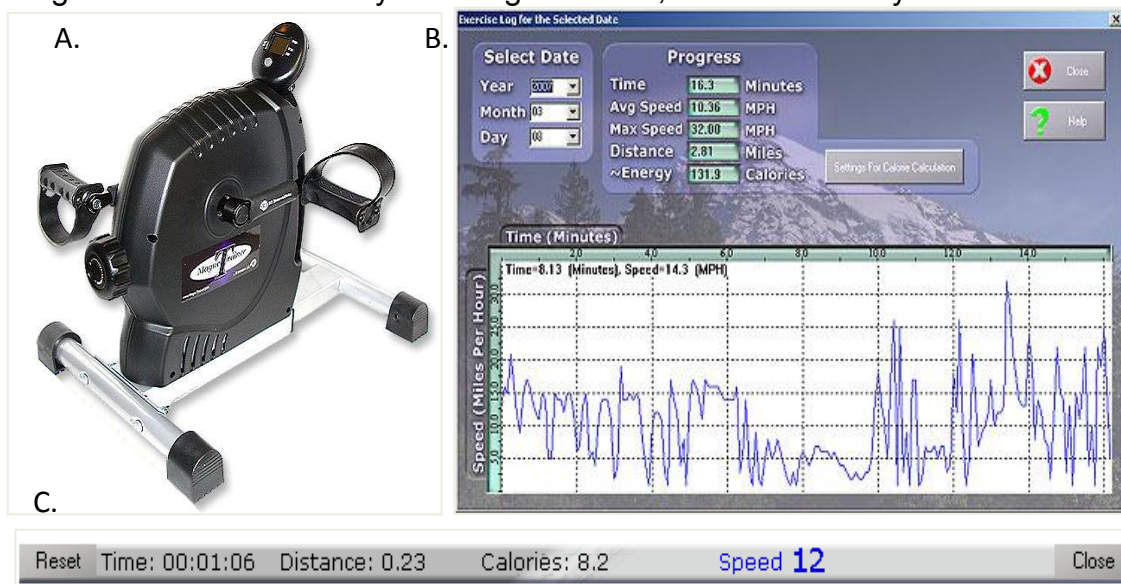
Intervention Group

Participants randomized to the intervention group (N=25) were provided three primary components to reduce time spent sedentary: 1) a portable pedal exercise machine (MagneTrainer); 2) access to a motivational website (Walker Tracker); and 3) a pedometer (Omron HJ-150).

Participants received access to a MagneTrainer pedal exercise machine. The pedal machine connects to the individual's work computer via a USB cable and has complimentary software (FitXF Activity Tracking Software) that allows for objective and automatic monitoring of individual pedal activity. The MagneTrainer is a portable (18" height, 20" length) device that fits under most office desks (Figure 3). The FitXF

software tracks pedal activity and provides users with real-time feedback on pedal time, distance, speed and caloric expenditure, which is displayed on their PC monitor. A member of the research team delivered the pedal machine to the participant's worksite, downloaded the FitXF software to the participant's work PC and worked with the participant to identify the most feasible office set up for the pedal machine. Intervention participants were asked to keep the pedal machine connected to their PC during all working hours.

Figure 3. Screenshot of A. MagneTrainer portable pedal exercise machine, B. Magnetraider FitFX Activity Tracking Software, C. Pedal Activity monitor feedback.



Intervention participants were provided access to a motivational website known as Walker Tracker (Figure 4). Participants were asked to self monitor their daily pedal time and daily steps (via pedometer) by logging onto the Walker Tracker website. The reason for daily monitoring is self-monitoring which is known to predict increased physical activity. Participants were also emailed three theory-based motivational

messages via Walker Tracker each week (9 a.m. on Monday, Wednesday, and Friday) designed to reduce sedentary time through improved goal setting, self-efficacy, and perceived environment. Participants were also entered into a group competition through Walker Tracker with a goal of building social support for physical activity. Similar to Facebook, participants were able to send direct messages to each other and provide each other encouragement throughout the study.

Figure 4. Screenshot of Walker Tracker motivational website.

Pedal@Work ECU
Reducing time spent sedentary...

[Admin](#)

[Add Steps](#) [Your Stuff](#) [Groups / Teams](#) [Competitions](#) [Friends](#) [Dashboard](#) [Help](#)

can1 (edit) | Avg: 9,217 | Diligence: 6% | Level: 3 | [Logout](#)

Log Your Steps

Ahoy!

Let's start the week off great!

This week, try increasing your pedal time to 8 minutes in the morning, 9 minutes at lunchtime, and 9 minutes in the afternoon or before you leave work!! This pedal plan is equal to 4420 steps! That is almost half of your 10,000 daily step goal!!

Have a good week! :)

[Set step reminders](#) [Quick post](#)

6,000: steps you need to walk daily for the rest of the [month](#) to meet your [goal of 6000](#) per day.

Monday, August 15th (Today's Steps)

Steps
9845
[activity converter](#)

Walking Notes
Had a great day today! The weather really helped!
[post entry](#)

Who sees this?
(everyone)

Daily Photo
 [Browse...](#)
add an image. JPG/PNG/GIF files only.

Top friend walks
[friends](#) | [everyone](#)

[more top walkers](#)

Walk Score™
the gold standard in walkability

Friends

RSS

Your Competitions
[Walk Across America](#)

From your groups
[On vacation](#)
can1 8-02 9:08 am
hi
evicani 8-02 5:08 am
[Ahoy Team Calico Jack!](#)
pau1am 8-01 5:08 am
[Ahoy Team Jack!](#)

Intervention Compliance and Process Evaluation

In order to explore the intervention-physical activity dose-response relationship, participant compliance with the intervention was assessed as a secondary outcome. Compliance with the pedal machine (i.e., total minutes pedaled, total days pedaled, average minutes pedaled/day) was assessed objectively via the FitFX exercise tracking software. Pedal activity was downloaded directly from each individual's work computer at the end of 12 weeks. Website use compliance (e.g., percent of workdays user logged on website, number of steps logged on the website, average steps logged/day) was also assessed objectively at the end of 12 weeks via a backend tracking database made available by the Walker Tracker website.

In order to assess which components of the intervention participants 'perceived' as the most useful for reducing their sedentary time, a process evaluation survey was conducted at 12 weeks amongst the 23 intervention completers. Participants rated each intervention component using a five point Likert scale (1=Very Useless; 2=Useless; 3=Neutral; 4=Useful; 5=Very Useful).

Design/Statistical Analysis

The primary outcome of this study was daily time spent sedentary. We measured both relative (% of day) and absolute (total minutes per day) sedentary behavior objectively with the StepWatch Activity Monitor (Carr & Mahar, 2011). We also measured relative and absolute time spent in light, moderate and vigorous intensity physical activity. Secondary outcomes included measuring change in theoretical constructs measured via behavioral questionnaires including physical activity goals,

physical activity plans, processes of change, outcome expectations, perceived barriers to physical activity, physical activity self efficacy and social support for physical activity and work productivity and impairment. A tertiary aim was measuring compliance with the intervention which was assessed by measuring the number of unique logins to the website, time spent on the website, and pedaling activity within the intervention group. Descriptive statistics were calculated for variables of interest including participant characteristics. Paired t-tests were run to test whether any differences existed between the intervention and control groups at baseline (See Table 1). Two-way (Group \times Time) repeated measures analysis of variance (ANOVA) was used to test whether significant differences occurred between groups for the primary outcome measures (time spent in sedentary, light, moderate and vigorous behaviors) and secondary outcome measures (behavioral constructs) (see Tables 2 and 3). Linear regression analysis was used to explore the associations between change in sedentary/physical activity behaviors and measures of intervention compliance amongst the 23 Intervention completers (see Table 4). Statistical significance was set *a priori* at $P < 0.05$.

Chapter 4-Results

The participants' baseline characteristics are presented in Table 1. Overall, participants provided an average of 5.6 out of 7 possible days (80.6%) of physical activity data (minimum 8 hours wear per day). There were no significant differences found between the control and intervention groups for age ($P=0.10$), gender ($P=0.46$), % Non-Hispanic White ($P=0.40$), college education (%) ($P=0.24$), Income > \$40,000 (%) ($P=0.94$) or BMI ($P=0.40$). Likewise, there were no significant differences found for percent time spent sedentary ($P=0.42$) or in any physical activity behaviors between groups at baseline.

Table 1. Baseline characteristics between groups Mean \pm S.D. (N=40)

	Control Group N=17	Intervention Group N=23	P-value
Age (years)	47.6 \pm 9.9	42.6 \pm 8.9	0.10
Female %	94.1%	86.9%	0.46
Height (in)	65.2 \pm 3.2	65.4 \pm 3.4	0.89
Weight (lbs)	201.3 \pm 30.2	194.1 \pm 34.9	0.50
Body Mass Index (BMI)	33.2 \pm 4.5	31.7 \pm 4.9	0.36
Non-Hispanic White (%)	76.5%	63.6%	0.40
College Graduate (%)	71.0%	86.0%	0.24
Income >\$40,000 (%)	62.5%	63.6%	0.94
SW Number Days	5.5 \pm 2.0	5.7 \pm 1.6	0.72
SW Minutes Included/Day	829.6 \pm 93.5	867.1 \pm 142.8	0.35
% Time Sedentary	65.7 \pm 7.5	67.6 \pm 7.2	0.42
% Time Light	31.9 \pm 8.1	30.6 \pm 8.2	0.62
% Time Moderate	2.27 \pm 3.2	1.51 \pm 1.5	0.32
% Time Vigorous	0.14 \pm 0.32	0.27 \pm 0.60	0.42

Mean \pm S.D.

As shown in table 2, the intervention group significantly reduced both the absolute number of sedentary minutes ($P<0.01$) and percentage of time spent sedentary behavior ($P=0.04$) from baseline to 12 weeks when compared to the control group. Although no between group differences were observed for absolute minutes of

moderate intensity activity ($P=0.11$), the intervention group significantly increased their percent time spent in moderate intensity behavior when compared to the control group ($P=0.04$). No between groups differences in either light or vigorous physical activity were observed. Effect sizes were calculated to determine the strength of the relationship between changes in behavior when comparing the intervention and control groups. A modest effect size was found for minutes of sedentary time (0.37) and a small effect size found for percent time spent in sedentary (0.22).

Table 2. Two way repeated measures ANOVA for sedentary and physical activity behavior (N=40).

	Control (N=17)		Intervention (N=23)		P value	
	Baseline	12 Weeks	Baseline	12 Weeks	Group x Time	Effect Size
Minutes Sedentary	544.2 \pm 76.9	599.7 \pm 106.6	584.9 \pm 136.1	526.1 \pm 77.3*†	0.007	0.37
% Time Sedentary	65.7 \pm 7.5	67.5 \pm 8.0	67.6 \pm 7.2	63.9 \pm 7.9†	0.036	0.22
Minutes Light	265.7 \pm 84.0	262.2 \pm 70.8	263.9 \pm 69.5	270.3 \pm 69.5	0.67	-0.05
% Time Light	31.9 \pm 8.1	30.3 \pm 8.4	30.6 \pm 8.2	32.7 \pm 7.6	0.14	-0.15
Minutes Mod	18.6 \pm 25.2	17.4 \pm 23.7	14.5 \pm 18.5	23.3 \pm 28.0	0.11	-0.11
% Time Moderate	2.3 \pm 3.2	2.0 \pm 2.9	1.51 \pm 1.5	2.8 \pm 3.4†	0.04	-0.13
Minutes Vigorous	1.2 \pm 2.6	1.5 \pm 2.7	2.7 \pm 6.4	4.9 \pm 10.9	0.51	-0.21
% Time Vigorous	0.14 \pm 0.32	0.17 \pm 0.30	0.27 \pm 0.60	0.60 \pm 1.3	0.38	-0.22

Mean \pm S.D.

*Significant difference between groups at same time point ($p<0.05$)

†Significant difference within groups compared to baseline ($p<0.05$)

Table 3 describes the changes of behavioral constructs from baseline to 12-weeks. Significant within group changes were observed for physical activity goals and comprehending benefits of physical activity within the intervention group. Significant within group differences were observed for the knowledge of physical activity and perceived social support barriers for physical activity amongst the control group.

Significant group x time interactions were observed for perceived barriers of lack of social support for physical activity ($P=0.01$) and perceived injury ($P=0.03$). Both perceived barriers moved in the expected direction with the intervention group reducing their perceived barriers for physical activity and the control group increasing their perceived barriers.

Table 3. Two way repeated measures ANOVA for behavioral constructs (N=40).

	Control (N=17)		Intervention (N=23)		P value
	Baseline	12 Weeks	Baseline	12 Weeks	Group x Time
Goals	19.7+4.4	18.1+4.9	23.9+7.5	21.3+7.4†	0.61
Plans	-6.1+3.9	-7.3+5.4	-4.0+6.7	-4.6+5.5	0.74
Self Efficacy	2.0+0.7	2.2+0.7	1.9+0.6	1.9+0.7	0.16
Social Support Friends	21.2+11.0	23.1+9.0	20.0+9.6	21.6+13.4	0.94
Outcome Expectations	4.2+0.5	4.4+0.5	4.1+0.7	4.2+0.8	0.90
Processes Knowledge	2.9+0.8	3.3+0.7†	2.8+1.0	3.1+0.9	0.51
Processes Risk Awareness	2.8+0.5	2.8+0.7	2.7+1.0	2.9+1.0	0.32
Processes Care Others	3.1+0.8	3.3+0.7	3.1+0.9	3.2+1.2	0.98
Processes Comprehend Benefits	3.6+0.9	3.8+0.7	3.5+0.9	3.8+0.9†	0.49
Processes Increase Healthy Opportunities	2.8+0.7	3.0+0.7	2.8+0.8	3.0+0.9	0.59
Processes Sub Alternatives	2.6+0.7	2.6+0.8	2.8+0.8	2.7+0.8	0.80
Processes Social Support	2.2+0.8	2.4+0.9	2.4+1.0	2.6+1.0	0.97
Processes Rewarding Self	2.5+0.7	2.3+0.5	2.8+0.8	2.8+0.8	0.65
Processes Committing Self	3.4+0.8	3.4+0.7	3.4+0.8	3.2+0.7	0.28
Processes Reminding Self	2.1+0.6	2.1+0.6	2.1+0.8	2.0+0.7	0.64
Perceived Barriers to Physical Activity					
Barriers Time	7.1+1.6	7.5+1.5	7.0+2.3	7.0+2.4	0.38
Barriers Social Support	6.4+1.9	7.5+1.4†	7.7+1.8	7.5+2.1	0.01
Barriers Lack Energy	6.7+1.6	7.0+2.0	6.8+2.3	6.7+2.2	0.51
Barriers Lack Will Power	4.9+1.8	5.2+1.5	5.7+1.8	5.2+1.9	0.22
Barriers Injury	8.6+1.5	9.2+1.4	10.2+1.2*	9.7+1.1	0.03
Barriers Lack Skill	9.3+1.2	9.2+1.4	8.8+2.1	8.4+2.3	0.63
Barriers Lack Resources	7.9+1.3	7.8+1.0	8.4+1.6	7.9+2.2	0.46
Work Productivity and Activity Impairment					
Exercise Info at Work	9.6+3.0	9.9+3.0	10.9+4.0	10.1+3.5	0.36
Access to Outdoor Facilities	7.1+3.6	8.0+2.8	8.5+3.0	8.7+3.5	0.49
Access to Indoor Facilities	15.2+3.2	15.8+3.6	16.4+3.5	15.8+3.6	0.26
Between Home/Work	5.8+2.8	5.6+2.4	5.8+3.8	5.5+2.3	0.92
Social Support	7.8+2.5	8.7+2.3	7.2+3.4	7.7+3.4	0.67

Mean ± S.D.

*Significant difference between groups at same time point (p<0.05)

†Significant difference within groups compared to baseline (p<0.05)

At the end of 12 weeks, 23 participants completed the intervention and provided compliance data (see Table 4). Intervention participants logged on to the website was an average of 37.4% \pm 24.6% (32.3 days) of all days they had access to the website (including weekends). Intervention participants also logged an average of 7,185 \pm 4,904 steps per day on the website over the 12 weeks.

Participants pedaled an average of 38.8% \pm 32.4% of all days they had access to the pedal machine (excluding weekends). In absolute terms, participants pedaled an average of 809.7 \pm 991.1 minutes on 23.3 days over the 12-week intervention. Therefore, participants pedaled an average of 29.4 minutes per day on the days they used the machine but only 13.5 minutes per day they had access to the machine.

Table 4. Intervention compliance amongst intervention completers (N=23).

	Mean	S.D.
Total Web Entries Over 12 Weeks	32.3	21.6
Web Compliance (% Web Entries/Days with Access)	37.4	24.6
Average Steps Logged Per Day	7185	4904
Total Days Pedaled Over 12 Weeks	23.3	19.5
Pedal Compliance (% Days Pedaled/Days with Access)	38.8	32.4
Total Minutes Pedaled	809.7	991.1
Average Minutes Pedaled/Day Used	29.4	32.2
Average Minutes Pedaled/Day Access	13.5	16.5

Mean \pm S.D.

When examining the relationship between change in sedentary/physical activity behavior and participant compliance with the intervention features (pedal machine, website, steps logged), significant relationships between measures of compliance with the pedal machine and use of the website were observed (see Table 5). Specifically, negative relationships were found between change in percent time spent sedentary and total minutes pedaled ($R = -0.48$, $P = 0.02$) and average minutes pedaled/day ($R = -.46$,

P=0.03). Positive relationships were also found between the change in time spent in light intensity physical activity and total days pedaled (R=0.47, P=0.02), total minutes pedaled (R=0.48, P=0.02), and average minutes pedaled/day (R=0.45, P=0.03). Positive relationships were also found between change in absolute minutes of light intensity activity per day and days pedaled (R=0.49, P=0.01), total minutes pedaled (R=0.56, P<0.001) and average minutes pedaled/day (R=0.53, P<0.001). Positive relationships were found between total steps logged on the website and change in percent time spent in moderate intensity physical activity (R=0.44, P=0.04) and change in percent time spent in vigorous physical activity (R=0.044, P=0.04).

Table 5. Correlations analysis between intervention compliance and change in sedentary/physical activity behavior (N=23).

	Days Pedaled		Total Minutes Pedaled		Avg. Minutes Pedaled/Day		Website Compliance (% Days Logged)		Total Steps Logged		Avg. Steps Logged	
	R	P	R	P	R	P	R	P	R	P	R	P
Δ % Sedentary Time	0.39	0.06	-0.48	0.02	-0.46	0.03	-0.24	0.28	-0.38	0.07	-0.30	0.16
Δ Sedentary Minutes	0.02	0.91	-0.15	0.49	-0.27	0.20	0.11	0.63	0.01	0.94	0.10	0.66
Δ % Light Time	0.47	0.02	0.48	0.02	0.45	0.03	0.19	0.39	0.16	0.46	0.11	0.60
Δ Light Minutes	0.49	0.01	0.56	0.01	0.53	0.01	0.30	0.17	0.29	0.18	0.22	0.30
Δ % Moderate Time	0.11	0.61	0.13	0.55	0.04	0.84	0.13	0.56	0.42	0.05	0.20	0.34
Δ Moderate Minutes	0.02	0.91	0.04	0.86	-0.06	0.77	0.03	0.91	0.28	0.19	0.08	0.70
Δ % Vigorous Time	-0.03	0.89	0.08	0.70	0.11	0.62	0.16	0.47	0.44	0.04	0.35	0.10
Δ Vigorous Minutes	-0.01	0.94	0.02	0.94	-0.01	0.94	0.16	0.47	0.36	0.09	0.26	0.23

At the end of 12-weeks the intervention completers were asked to rate how useful they perceived each intervention feature was for reducing their sedentary time (Table 6) using a 5-point Likert scale (1=Very Useless; 5=Very Useful). All features

were rated at least 3.1 or higher. The FitFX Pedal Exercise Tracking Software, which provided real-time feedback on minutes pedaled, calories burned, etc. and the pedometer rated the highest (mean=4.4). Self- monitoring daily activity using the website was also ranked highly (mean=4.3). Social networking features (e.g. group discussions, direct messages, blogging) (mean=3.3) and access to the WalkScore website (a website that provides information on relative location to a variety of amenities within walking distance) (mean=3.1) were rated the least useful for reducing sedentary time.

Table 6. Participants' perceived usefulness of intervention features (N=23).

	Likert Scale (1=Not Useful; 5=Very Useful)	
	Mean	S.D.
FitFX Pedal Exercise Tracking Software (Minutes pedaled, calories burned, etc.)	4.4	1.2
Wearing the pedometer	4.4	1.0
Self monitoring daily steps and pedal time on website profile	4.3	1.0
Receiving daily emails reminding you to log your steps/pedal time	4.0	1.0
Website/email messages about setting your step/pedaling goals	4.0	0.9
Access to pedal exercise machine under your desk	3.9	1.3
Website/email messages about physical activity (Ex: "Did you know")	3.8	1.0
Website/email messages about where to be active (Ex: "Try this walk on campus")	3.6	1.0
'Walk Across America' Group Challenge on website	3.5	1.2
Social networking features on website (e.g., group discussions, messages, blogging)	3.3	1.1
Access to the 'Walk Score' button on the website	3.1	1.1

Mean \pm S.D.

Chapter 5-Discussion

The primary findings of the present study indicate this worksite intervention was successful at promoting decreased sedentary time over a wait list control group amongst sedentary, overweight, full-time employees. The decreased sedentary time observed amongst the intervention group appears to be have been replaced by an increase in light and moderate intensity activity. These findings are important, as few worksite interventions have been conducted with the aim of reducing sedentary time. This study is one of the first to implement physical changes to the workplace environment (pedal machine) to decrease sedentary behaviors.

A significant effect was observed within the intervention group for the change in sedentary time at pre and post-intervention. Sedentary time was reduced by an average of 59 minutes/day. This is important, as it has been suggested that decreasing sedentary time can result in improved health benefits independent of physical activity level (Haskell et al., 2007; Warburton et al., 2006; Biddle et al., 2004). In the present investigation, moderate intensity activity increased by an average of 9 minutes/day amongst the intervention group. Further investigation will explore whether these changes resulted in significant improvements in health related risk factors although that is not the focus of this document.

When looking at the constructs measured by the behavioral questionnaires given to the participants at baseline and 12-weeks, we observed little change. One significant change observed amongst the control group was

social support as a barrier for physical activity. It is possible these participants did not consider social support a barrier for why they were not meeting activity guidelines until they took the survey. The intervention group reported social support and injury as less of a barrier after completing the 12-week intervention. The lack of change could have been due to a few reasons including not choosing the most appropriate surveys, ineffective motivational emails, or lack of interest from participants to read the motivational emails. A way to improve behavior change would be to create messages that tailor to the specific needs or interests of the participants.

When looking at the relationship between intervention compliance and changes in sedentary/physical activity time, greater use of the pedal machine correlated with decreases in sedentary time and increases in light intensity time. This suggests the pedaling activity conducted in this study was likely of a light intensity as opposed to moderate or vigorous intensity. This would make sense given that a lighter intensity would likely allow participants to maintain efficient work productivity. Because these participants worked in desk dependent jobs and were full-time employees, we can speculate that access to the pedal machine in their office was a direct cause for the declines in sedentary time during the workday. These findings are important considering recent findings by Buman et al. (2011), which suggest replacing 30 minutes/day of sedentary time with equal amounts of low-light or high-light physical activity is associated with better physical health amongst older adults (all $P < 0.0001$) (Buman et al., 2011).

When comparing pedal machine compliance of the current study to the feasibility study conducted by Carr et al. (2010), we see compliance declined more slowly over 12-weeks than the decline observed in the 4-week feasibility study. This suggests that the intervention had a positive impact on pedal machine compliance which was likely due to motivational messages.

Participant compliance to the website overall was relatively high (32.3 days over 12 weeks) when compared to past internet-delivered physical activity intervention studies which were of greater durations (Carr et al., 2008; Carr et al., 2012; Lewis et al., 2008). For example, Lewis et al. reported participants logged on to a physical activity website a median number of 50 times (or 0.96 times per week) over the course of 12 months (Lewis et al., 2008). Participants of the present study logged in an average of 2.6 times per week over the 12-week intervention suggesting participant engagement with the website was high. Still, while Lewis et al. (2008), found significant relationships between user logins and change in moderate intensity physical activity, no significant relationships were found between website logins and changes in sedentary time, light, moderate or vigorous intensity activities in the present study (Lewis et al., 2008). Our findings suggest logging into the website was not enough to impact behavior change. However, total steps logged onto the website was associated with changes in time spent in moderate and vigorous physical activity. These results suggest that those that logged more steps onto the website, which could be argued is a better measure of intervention compliance than the number of website log-ins, were

more likely to improve their moderate and vigorous intensity physical activity levels.

When looking at the perceived usefulness of the intervention features, participants indicated that the FitFX pedal exercise software and the pedometer were the most useful. These higher rated features should be considered when looking to implement an intervention similar to this one. For example, if a corporate fitness director were interested in replicating this study within their workplace, the pedometer, self-monitoring tools, and motivational email messages would be the most useful for behavior change.

The strengths of this study include the objective data collection methods used such as the Stepwatch activity monitor for sedentary and physical activity behaviors, the FitXF software for measuring compliance with the pedal machine, the WalkerTracker website for measuring compliance with the website (i.e., website logins and steps logged). The FitXF software and the WalkerTracker website proved to be easy to use and reliable sources for measuring compliance. These objective measures could be extremely useful tools for examining what components of the intervention were most effective at reducing sedentary time. Another strength of the study was the novelty of adding an exercise machine to the sedentary work environment to reduce sedentary time. No studies to our knowledge have tested the use of point of care exercise equipment in a real working environment for reducing sedentary behavior. From a recruitment standpoint, we had an overwhelming response of interested participants many of whom wanted to receive the pedal machines.

Limitations of the study include the sample size. Also, the majority of the population studied was middle-aged females limiting the generalizability of our findings. While we attempted to recruit males in by advertising with images of men using the pedal machines, few men responded. This is consistent with past physical activity intervention studies. Future studies are encouraged to identify ways to recruit men into such studies to test the efficacy of this type of program for sedentary males. Suggestions for targeting males for interventions may be to use more masculine features in advertising, use competition or wellness challenge programs, or health related messages that are tailored to males.

Another limitation was the use of the pedal machine itself. A consistently reported issue with a majority of the participants' was the difficulty of pedaling while typing. Many participants reported their knees hitting their desks when trying to pedal and work at their computer. This limitation likely resulted in lower compliance rates with the pedal machine. Future studies are encouraged to continue to identify point of care exercise devices that can be used while the individual types and uses a computer comfortably. The population in the current study may not have been Internet savvy beyond their required knowledge for work related tasks, which may be a potential limitation for this intervention. A way to reduce this limitation may be to have an acclimating period prior to the start of the intervention. Another limitation was the lack of tracking hours per day the participants worked which limited our ability to determine how sedentary time at work specifically changed. Our findings report changes in sedentary time over the entire day and thus are likely conservative estimates of change in sedentary

time. We are currently working towards analyzing changes in sedentary and physical activity behaviors during the working day but have not yet completed these analyses. Future studies are encouraged to track time to work and time leaving work. Another potential limitation may be the drop out rate for the control group (N=7). Having more participants within the intervention may result in overestimating the change in behavior compared to the control group. Also, we did not monitor the control group's activity over the 12 weeks thus we cannot say whether control participants changed their sedentary behavior.

For future studies in which researchers are examining a similar population (sedentary, working adults), they should try to incorporate the features used in this study that were deemed most useful for reducing sedentary time. Some of the features that did not score as high should be looked at again in order to find a way to make them more useful to the population being examined.

A potentially effective method for implementing this intervention in the future would be to use mobile integration methods. For example, self-monitoring physical activity with cell phones may be a useful way to improve compliance. Participants may be more compliant if they are able to log steps and activity without the need to log into a computer. Cell phones could also be used to remind participants to break up sedentary time throughout the workday. The Walker Tracker website allows for cell phone integration but we did not employ this component of the website into this intervention.

Despite the limitations, the findings in this study indicate that the Pedal@Work was successful at reducing sedentary time among sedentary, full

time employees. Our findings suggest participant compliance amongst the intervention group was relatively high for pedal machine use despite the reported limitations of the machine. Compliance with the motivational website was also high compared to past internet-delivered interventions suggesting participants engaged in the program. Future studies are encouraged to use this intervention as a stepping-stone to further decrease sedentary time among sedentary employees.

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APPENDIX A – INSTITUTIONAL REVIEW BOARD APPROVAL LETTER



EAST CAROLINA UNIVERSITY

University & Medical Center Institutional Review Board Office
1L-09 Brody Medical Sciences Building • 600 Moye Boulevard • Greenville, NC 27834
Office 252-744-2914 • Fax 252-744-2284 • www.ecu.edu/irb

TO: Lucas Carr, PhD, Dept. of EXSS, ECU—172 Minges Coliseum
FROM: UMCIRB ~~KK~~
DATE: May 5, 2011
RE: Expedited Category Research Study
TITLE: "Pedal At Work"

UMCIRB #11-0227

This research study has undergone review and approval using expedited review on 4.6.11. This research study is eligible for review under an expedited category number 2, 4, & 7. The Chairperson (or designee) deemed this **Division of Research & Graduate Studies** sponsored study **no more than minimal risk** requiring a continuing review in **12 months**. Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The investigator must adhere to all reporting requirements for this study.

The above referenced research study has been given approval for the period of **4.6.11 to 4.5.12**. The approval includes the following items:

- Internal Processing Form (received date 3.11.11)
- Informed Consent (dated 3.31.11)
- Pedal at Work Phone Screener
- Demographic Questionnaire
- Exercise Goals
- 24 Hour Sedentary Recall Questionnaire
- Satisfaction with Life Scale
- General Happiness Scale
- Physical Activity Self-Efficacy
- Treatment Self-Regulation Questionnaire
- Work Productivity and Activity Impairment Questionnaire
- Health Survey
- Social Support & Exercise Survey
- Qualitative Interview
- Predictive Submaximal Exercise Tests
- Operating and Safety Procedures for DXA Body Composition and Bone Densitometry
- COI disclosure form (dated 3.25.11)
- Flyer

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

The UMCIRB applies 45 CFR 46, Subparts A-D, to all research reviewed by the UMCIRB regardless of the funding source. 21 CFR 50 and 21 CFR 56 are applied to all research studies under the Food and Drug Administration regulation. The UMCIRB follows applicable International Conference on Harmonisation Good Clinical Practice guidelines.

APPENDIX B – INFORMED CONSENT



Informed Consent to Participate in Research

Information to consider before taking part in research that has no more than minimal risk.

Title of Research Study: Pedal@Work

Principal Investigator: Dr. Lucas J. Carr, Ph.D.

Institution/Department or Division: Department of Exercise and Sport Science

Address: 172 Minges Coliseum, Greenville, NC 2758

Telephone #: 252-328-0009

Researchers at East Carolina University (ECU) study problems in society, health problems, environmental problems, behavior problems and the human condition. Our goal is to try to find ways to improve the lives of you and others. To do this, we need the help of volunteers who are willing to take part in research.

Why is this research being done?

The purpose of this research is to test the efficacy of a behavioral intervention designed to reduce sedentary time and improve your health. The decision to take part in this research is yours to make. By doing this research, we hope to learn the best methods for reducing sedentary time and to improve the health of working adults.

Why am I being invited to take part in this research?

You are being invited to take part in this research because you are an apparently healthy volunteer and have indicated an interest in participating in this research study. If you volunteer to take part in this research, you will be one of about 60 people at East Carolina University to do so.

Are there reasons I should not take part in this research?

I understand I should not volunteer for this study if I: am not apparently healthy, not between the ages of 18 and 65 years, not working full time (40 hours/week) in a desk/computer occupation, do not have my supervisor's permission to participate in this study or have any type of disease, disability or health condition that would prohibit me from being regularly active.

What other choices do I have if I do not take part in this research?

You can choose not to participate.

Where is the research going to take place and how long will it last?

The research testing procedures will be conducted in the Minges Coliseum building in the Department of Exercise and Sport Science. You will need to come to Minges room 101 on three separate occasions during the study. The total amount of time you will be asked to volunteer for this study is 12-24 weeks.

What will I be asked to do?

UMCIRB Number: 11-0227
Consent Version # or Date: 3.31.11
UMCIRB Version 2010.05.01

UMCIRB
APPROVED
FROM 4.6.11
TO 4.5.12

Participant's Initials