ABSTRACT

WILL USING THE WALKSTATION TO INCREASE PHYSICAL ACTIVITY AT THE WORKPLACE DECREASE LEISURE TIME PHYSICAL ACTIVITY?

by Victoria L. DiCello

It was the purpose of this experiment to observe the work environment of individuals in sedentary jobs to determine if changing the environment by placing Walkstations in the office would alter physical activity patterns in leisure time. Nine participants were recruited from an office setting at Miami University and randomly assigned to a control group or experimental (Walkstation) group. All participants were given an Actical accelerometer to monitor daily physical activity patterns. Results showed no difference in leisure time physical activity patterns between the control and experimental group at baseline or Walkstation condition, however, significant differences were observed for the entire day and work day time points. Thus, to change leisure time physical activity patterns requires more than altering the work environment. Future research could include a larger sample size, employees from different offices, and longer monitoring period. The Walkstation does provide a practical solution to decrease sedentary time at the workplace.
WILL USING THE WALKSTATION TO INCREASE PHYSICAL ACTIVITY AT THE WORKPLACE DECREASE LEISURE TIME PHYSICAL ACTIVITY?

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Victoria L. DiCello
Miami University
Oxford, OH
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Advisor: ______________________
Dr. Ronald Cox

Reader: ______________________
Dr. Randal Claytor

Reader: ______________________
Dr. Thelma Horn
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Introduction

Obesity has become a major public health concern in the United States with prevalence rates increasing significantly over the past 10 years from 19.4% in 1997 to 26.7% in 2007 (Retrieved December 1, 2008 from http://www.cdc.gov/nchs/data/nhis/earlyrelease/200806_06.pdf). Obesity is associated with a myriad of deleterious health consequences including cardiovascular disease and diabetes. What is most devastating, and perhaps frustrating, is that obesity related diseases such as these could have been prevented, and lifestyle limitations imposed by these diseases averted, through the adoption of a healthier lifestyle (Retrieved July 31, 2008 from http://www.cdc.gov/nccdphp/).

Physical activity plays a beneficial role in the fight against obesity and in overall health and well-being. The litany of health benefits of being physically active on most days of the week include a reduced risk of developing certain cancers, reduced depression, (U.S. Department of Health and Human Services, 1996) and decreases in total cholesterol, LDL, and SBP (Anderson, Wadden, Bartlett, Zemel, Verde, Franckowiak, 1999). To achieve the associated health benefits physical activity can provide, the Surgeon General recommends minimum activity duration of 30 minutes of moderate intensity exercise on most days of the week. Unfortunately, more than half of American adults, 54.6%, are not active enough to meet these minimum physical activity recommendations (Centers for Disease Control and Prevention [CDC], 2003). A seminal study by Lee, Blair, Jackson (1999) showed that men with low physical fitness levels regardless of being categorized as lean, normal, or obese had a higher degree of body fat, lower cardiorespiratory fitness, and twice the risk of all cause mortality as their more physically fit male counterparts including the physically fit obese men. An additional interesting and rather important finding was that men with low physical fitness levels had a higher all cause mortality risk when compared to males who were obese but in better physical condition.

Influencing behavior change, particularly as it relates to physical activity, is a complex endeavor. Physical activity patterns among adults can be influenced by their environment, enjoyment of physical activity, and lack of perceived barriers to physical activity (U.S. Department of Health and Human Services, 1996). The numerous and well intended health promotion tactics and incentives used thus far only provide a temporary fix at best to this issue. Had these interventions been successful, more than half of Americans, 54.6%, would not have failed to meet the minimal physical activity recommendations (CDC, 2003), and half of people who start an exercise program would not drop out within six months (Dishman, 1982).

The magnitude of the reduction in physical activity levels in our modern society is especially evident when comparing Amish farmers to modern day office employees (Bassett, Schneider, Huntington, 2004). When physical activity patterns, as measured by pedometers, were compared a rather large difference in physical activity emerged. The difference in step count values of the average Amish male worker and the modern day office employee vary by as much as 11,396 steps/day (Chan, Ryan, Tudor-Locke, 2004) to 13,874 steps/day (Hatano, 1993). The differences are quite large and depict just how much our modern lifestyle has negatively impacted the amount of activity obtained on an average day. However, a rather large difference in activity levels exists between different jobs in our modern society as well. When the step counts per day were compared between administrators and high school teachers who both drive
to work pedometer counts were 4,490 and 6,075 respectively; a difference of 1,585 steps/day (Hatano, 1993).

Since the majority of one’s day is spent at work, this is the ideal setting to create an office environment that allows employees to meet the demands of their job in a less sedentary, more active manner. The environmental change to the office setting, namely the Walkstation, would allow employees to be more active during the day and decrease the hours spent sitting at work. This involves a fundamental shift in thinking about the office environment and physical activity. The Walkstation combines a height adjustable work surface with a high quality commercial grade treadmill that replaces the typical office chair (Details Inc. 2008). The treadmill speed does not exceed 2 mph so that users are able to walk comfortably while typing, checking emails, taking phone calls, etc. The whole concept of the Walkstation is not to provide a workout, but to simply decrease the amount of time spent being completely sedentary at work (i.e. sitting).

However, a caveat to this approach exists. The idea of an ‘activitystat’, which regulates how much physical activity an individual engages in on a regular basis, may confound attempts to increase overall PA. A control center somewhere in the central nervous system is thought to exist that carefully regulates physical activity levels (Rowland, 1998). This is demonstrated when examining children’s physical activity patterns. Children who walked to school were found to have a higher level of physical activity the hour before and after school when compared to those children who were driven to school. However, the children who were driven to school seemed to compensate for this difference in physical activity level during the day so no difference in activity level was observed between children who walked or were driven to school (Wilkin, Mallam, Metcalf, Voss, 2006). If such an activitystat does exist, adults who increase their physical activity levels during the day through the use of the Walkstation may compensate for this increase after work by being inactive. This theory would propose a decrease in physical activity if physical activity is increased at work. However, with no further scientific research on the ‘activitystat’ theory to date, it is hypothesized that there will be no change in leisure time physical activity after instituting an occupational environmental change with active Walkstations.

Physical Activity

Physical activity is defined as any bodily movement produced by skeletal muscles that results in an expenditure of energy. (Retrieved July 13, 2008 from http://www.cdc.gov/nccdphp/dnpa/physical/everyone/glossary/index.htm). There are two domains of physical activity. That which relates to occupational physical activity and activity associated with leisure pursuits. Occupational activity refers to the activity associated with the performance of a job usually within an eight-hour work day (Howley, 2001). Leisure time physical activity refers to all activities performed during one’s leisure time and is categorized as structured exercise or lifestyle activity. Structured exercise is planned and purposeful activity with the specific goal to improve or maintain fitness (Howley, 2001); whereas lifestyle physical activity refers to the activities of daily life (Anderson et al., 1999). Whether it is occupational activity, structured exercise, or lifestyle activity, each form of physical activity is an important factor to reduce disease risk and improve quality of life.
The Importance of Physical Activity

Physical activity plays a beneficial role to overall health and well-being. The litany of health benefits of being physically active on most days of the week include: a reduced risk of developing colon cancer, reduced depression and anxiety, reduced risk of developing diabetes, heart disease, and high blood pressure and also helps to build and maintain bone mass, muscle, and joints (U.S. Department of Health and Human Services 1996).

The term metabolic equivalent or MET, as it is often referred to in the literature, is a way to express energy expenditure of activities in simple units. One MET is equal to resting VO$_2$ (approximately 3.5 ml/kg/min) and energy costs of activities can thus be reported as multiples of one MET (multiples of resting VO$_2$) (Powers, Howley, 2007). The MET can also be expressed in terms of the accumulation of hours per week. For example, if an individual walked at 3 METS for one hour 4 days/week the total amount of activity, as expressed in MET hours, would be 12 MET hours/week.

In 2007, an estimated 23.6 million Americans from all age groups had diabetes, with a reported 1.6 million new cases among adults over 20 years of age (CDC, 2008). When a cohort of women were examined from the Nurse’s Health Study, it was found that compared to those women who were completely sedentary (<2 MET hours per week 1986-1988), women who were consistently active (>10.4 MET hours per week in 1986-1988) had the lowest risk of diabetes. Women who increased their physical activity level from 2.1 MET hours in 1986 to 4 MET hours per week in 1988 had a lower risk of diabetes compared to those women who were completely sedentary (Hu, Sigal, Rich-Edwards, Colditz, Solomon, Willett, et al., 1999).

The positive influence of physical activity on disease is further supported by the observation that every 1 h/d increase in brisk walking (4 METs) was associated with a 24% reduction in the risk of obesity and a 12% reduction in diabetes risk. (Hu, Colditz, Willett, Manson, 2003). Hu (2003) also suggests that 30% of obesity cases and 43% of the diabetes cases that occurred between 1992 – 1998 could have been prevented by adopting a relatively active lifestyle (<10 h/wk TV watching and > 30 min/d of brisk walking 4 METs).

Hypertension is a major underlying cause of cardiovascular complications and mortality. Performing physical activity on a regular basis can delay or prevent the development of this disease, and helps to reduce blood pressure among those with hypertension (U.S. Department of Health and Human Services, 2002). However, an acute reduction in blood pressure was observed immediately after a single bout of exercise among those with and without hypertension. This is referred to as post exercise hypotension, and seems to be greater among those with hypertension (Kenney, Seals 1993). Post exercise hypotension has been observed after various exercise intensities ranging from 40% maximal oxygen consumption (a brisk leisurely walk) to 70% maximal oxygen consumption (Cornelissen, Fagard, 2004). The magnitude of post exercise hypotension was similar between cycle ergometry power outputs of 50 – 70% VO$_2$peak (MacDonald, MacDougall, Hogben, 1999). MacDonald et al (1999) also suggests that intensity needs not to be higher than 50% of VO$_2$peak to elicit this acute blood pressure response. The
authors further suggest that acute exercise, even at lower intensities, could play a role in the nonpharmacological control of hypertension.

Since varying intensities of exercise seem to result in similar hypotensive responses, the next step in understanding this hypotensive response would be to look at the effects of exercise duration. A study was conducted on thirteen normotensive recreationally active males (age 22 + 0.8) using a cycle ergometry intensity of 70% \( \text{VO}_{2\text{peak}} \) for varying durations of 15, 30, and 45 minutes. Subjects were monitored for 60 minutes post exercise. The results showed that the post exercise hypotensive response was similar between the 15, 30, and 45-minute exercise bouts. Systolic blood pressure (SBP) began to return to normal values at 60 minutes post exercise after the 15 and 30-minute exercise bouts. However, SBP was declining at 60 minutes post exercise after the 45-minute exercise bout (MacDonald, MacDougall, Hogben, 2000). Since this study only monitored subjects for 60 minutes post exercise, it is difficult to say how long the hypotensive response lasted after the 45-minute exercise session.

The authors were intrigued by their findings of similar hypotensive responses regardless of the exercise duration and thus conducted another experiment focusing on the hypotensive blood pressure response after only 10 minutes of exercise. For the second phase of their study, eight borderline hypertensive recreationally active subjects were selected (2 females and 6 males). Exercise intensity was the same as the previous study (70% \( \text{VO}_{2\text{peak}} \)) and subjects performed cycle ergometry work for 10 and 30 minutes with a 60-minute post exercise monitoring period. Both exercise durations again showed similar hypotensive effects, however once again, after the 30-minute exercise bout SBP tended to be lower during the post exercise monitoring period, though this was not statistically significant. Although more work is needed, an exercise bout of only 10 minutes does appear to elicit a post exercise hypotensive effect similar to that of longer durations (MacDonald et al., 2000).

Since findings under controlled conditions in a laboratory may not translate into real world settings the acute effects of lifestyle activities on blood pressure in normo-tensive, prehypertensive and hypertensive adults were examined (Padilla, Wallace, Park, 2005). The types of lifestyle activities examined included gardening, mowing the lawn, and cleaning. The authors found that the accumulation of activity over a 12-hour day had acute effects on blood pressure in prehypertensive and hypertensive participants. No differences were observed among those with normal blood pressure. However, systolic blood pressure was significantly reduced for 6 hours after the accumulation of activity for prehypertensive and 8 hours after accumulation of physical activity for the hypertensive subjects (12.9 mmHg reduction observed) (Padilla et al., 2005).

Although more research is needed, the findings of a reduction in blood pressure with a relatively low intensity exercise bout, a short duration exercise bout, and after activities of daily life, is promising news for those with hypertension. Presumably, they may not have to exercise at high intensities or for an extended amount of time to reap the hypotensive benefits from exercise. It is also encouraging that everyday activities accumulated over a 12-hour period acutely lowered blood pressure. Thus, the nonpharmacological treatment of hypertension may incorporate efforts to encourage hypertensive patients to take a brisk 10-minute walk and/or to increase daily activities in addition to treatment recommended by their physician. Furthermore, sedentary individuals who may not be hypertensive could also find this information motivating and
possibly begin to make small healthy changes in their lifestyle, such as incorporating a brisk 10-minute walk into their daily routine. Increasing activity levels, be it through a structured exercise program or a lifestyle intervention program, both result in not only significant declines in SBP, but also significant reductions in total cholesterol, LDL, HDL, and triglycerides after 16 weeks of treatment (Anderson, et al., 1999).

Although it seems health benefits can be achieved through low intensity short duration bouts, or increasing daily lifestyle activities, there is still something to be said about improving physical fitness levels. This is still a very important factor to overall health and provides a protective effect against CVD and all cause mortality, even among physically fit obese individuals. One study showed that men with low physical fitness levels regardless of being categorized as lean, normal or obese, had a higher degree of body fat, lower cardiorespiratory fitness, and twice the risk of all cause mortality as their more physically fit male counterparts including the physically fit obese men. An additional interesting and rather important finding was that men with low physical fitness levels had a higher all cause mortality risk when compared to males who were obese but in better physical condition (Lee et al., 1999). One’s level of physical fitness also seemed to transcend the lean, normal, and obese classifications when examining death rates. Death rates were higher among the less conditioned, unfit men when compared to the physically fit men in both the lean and obese classifications. Physically fit men had lower death rates than their unfit counterparts in all categories (lean, normal, and obese). All cause mortality rate of the physically fit obese men was not significantly different from that of the fit lean men. Although the highest all cause mortality rate was seen in the deconditioned obese males, CVD mortality was lower among the physically fit obese men when compared to lean deconditioned men (Lee et al., 1999). Thus, it seems that physical fitness level, and not necessarily the size of the individual, may play a greater role in disease/risk reduction, especially from CVD. Therefore, it may be a matter of fitness and not fatness. These findings underscore the protective role exercise has against disease and mortality and also demonstrates that obese individuals can reduce some of the related health consequences of obesity by attaining a higher level of physical fitness.

The Obesity Epidemic

Despite the well known and numerous health benefits of becoming more physically fit and/or more active, the prevalence of obesity in the United States is on the rise, and has drastically increased over a relatively short period of time. Obesity is the result of chronic excess caloric intake and low caloric expenditure and is defined as having a body mass index (BMI) of 30 kg/m² or above (Retrieved July 30, 2008 from http://www.cdc.gov/nccdphp/dnpp/obesity/trend/maps/). A mere twenty- two years ago, in 1986, no state participating in the BRFFS had a prevalence of obesity greater than 14%. Twelve years later, in 1998, seven states had a prevalence of obesity between 20 – 24% and no state had a prevalence rate of more than 25% (Retrieved July 30, 2008 from http://www.cdc.gov/nccdphp/dnpp/obesity/trend/maps/). However, during this same time the government changed the definition of overweight according to BMI from 27.8 for males and 27.3 for women to 25 for both genders (Center for Consumer Freedom, 2005). This should not lessen the fact that by 2006, only four states had a prevalence of less than 20% and 22 states had...
prevalence 25% or more. Mississippi and West Virginia had the highest prevalence of 30% or higher (Retrieved July 30, 2008 from http://www.cdc.gov/nccdphp/dnpa/obesity/trend/maps/).

Inactivity is defined as not engaging in any regular pattern of physical activity beyond that of daily functioning (Retrieved July 13, 2008 from http://www.cdc.gov/nccdphp/dnpa/physical/everyone/glossary/index.htm). This is a definition that describes a large majority of Americans. The increase in obesity levels coincides with decreases in physical activity. However, since the 1980’s, the prevalence of inactivity has reportedly decreased in the face of increasing obesity prevalence (Figure 1). Thus, it would appear that Americans are expending more energy through activity, but yet they are becoming progressively fatter. Since body weight change is fundamentally about the amount of energy taken in and the amount of energy expended, when looking at this information from this perspective, something does not add up.

One explanation for the decrease in the prevalence of inactivity and the increase in obesity prevalence lies in the methodology of the BRFSS survey questions which were changed in 2001. The new 2001 lifestyle activity questions covered a broader range of physical activities to include not only leisure activities but also household and transportation activity. The 2000 BRFSS survey, only covered leisure activities and did not take into account household or transportation activity. Therefore, the proportion of adults that were considered physically active for health from 2000 (26.2%) to 2001(45.4%) may not be reflective of the ‘true’ physical activity levels (Center for Disease Control and Prevention 2003). Despite the methodological differences in the surveys, more than half of individuals were not active enough in the 2001 BRFSS survey to meet the minimal physical activity recommendations from the Surgeon General’s Report to accumulate 30 minutes of moderate activity on most if not all days of the week (Center for Disease Control and Prevention 2003). Another explanation for the increase in obesity, despite the reported increases in leisure activity, is that there is a substantial decrease in energy expenditure for tasks other than leisure (i.e. occupation) (James, 2008). The influence of occupation will be further explored later.

The amount of energy expenditure and thus, physical activity, among obese individuals is significantly lower than lean individuals (Levine et al., 2008). When sedentary lean and obese subjects were examined under free-living walking conditions, walking was found to be comprised of numerous short duration low intensity walks. The obese subjects were observed to have walked one third less than the lean subjects. The difference between the distances walked by lean versus obese subjects was 3.5 miles/day. Because of this shortened distance of the walking bouts, it is suggested that obesity is associated with a walking deficit of 2 hours per day (Levine et al., 2008). Furthermore, when the authors overfed subjects by 1,000 kcals over weight maintenance needs, they found that the daily walking distance decreased by 1.5 miles/day (Levine et al., 2008). A similar trend was observed in an adult population of Colorado residence where a significant inverse relationship between BMI and steps per day was observed. Overweight individuals took 555 fewer steps per day and obese individuals took 2,393 fewer steps per day compared to normal weight subjects. After adjustment for television watching and sitting time, obese subjects walked an average of 1,633 fewer steps than normal weight individuals (Wyatt, Peters, Reed, Barry, Hill, 2005).
However, this step deficit observed is not only among the lean and obese, but is also observed among differing occupations. Among various occupations the average steps per day ranged from 4,551 (Hatano, 1993) to 7,029 (Chan et al., 2004). The idea of 10,000 steps per day originated in the 1960’s in Japan where walking clubs began to use pedometers manufactured with the name manpe-kei, which translated to ten thousand step meter. Achieving this amount of daily steps is considered by the Japanese as an indicator of adequate activity level (Hatano, 1993). The idea that 10,000 steps/day corresponds to adequate daily activity level has made its way to the U.S. and is endorsed, as in Japan, as a sufficient amount of steps for health. However, further investigation is needed into the number of steps/day to reduce risk of diseases such as diabetes and coronary heart disease (Tudor-Locke, Hatano, Pangrazi, Kang, 2008). Tudor-Locke et al (2004) proposes that steps be categorized into zones relating steps per day and activity categories (Table 1) for ease of use by health professionals and better understanding of step counts by the general population.

The magnitude of the reduction in physical activity levels in our modern society is evident when observing Amish farmers whose lifestyle has not changed much over the past 150 years (Bassett et al., 2004). The average steps per day of Amish males were 18,425 steps/day and that of the average Amish woman was 14,196 steps/day. Comparing these values to the average worker in modern society, a rather significant difference emerges. The average worker has a step/day range between 4,551 (Hatano, 1993) to 7,029 steps per day (Chan et al 2004). Comparing these values to the Amish male workers there is a difference of 13,874 steps/day (Hatano, 1993 values) to 11,396 steps/day (Chan, 2004 values). When compared to the Amish women, the difference is 7,167 steps/day (Chan 2004 values) to 9,645 steps/day (Hatano 1993 values). The differences are quite large and depict just how much our modern lifestyle has negatively influenced the amount of activity obtained on an average day. Clearly, a change is needed to lessen this gap and increase activity levels to minimize the negative consequences inactivity has on health.

**Physical Activity Measurement**

The accurate assessment of physical activity is a necessity to any scientific analysis. Several methods exist to assess physical activity including subjective measures such as surveys and questionnaires and more objective measures such as accelerometry. Each has its benefits and limitations. Surveys and questionnaires are good for large population based analyses but have the drawback of self-report error and the risk of individuals misunderstanding the questions, especially about physical activity intensity. Most individuals tend to over report time spent in activity thus portraying a different portrait of one’s activity level and jeopardizing the reliability of the measure. Accelerometry provides a more objective assessment of activity patterns and intensity levels.
Physical Activity and Disease/Obesity

Increasing physical fitness levels can reduce the risk of all cause mortality even in obese men (Lee et al., 1999). One’s level of physical conditioning seems to transcend the weight classifications of normal, overweight, and obese. Lee et al (1999) observed that the physically fit obese men in his study had lower all cause mortality rates, especially from CVD, when compared to the less physically conditioned lean males. Heart disease, diabetes, and cancer are quite costly and have become all too common among Americans. It has been estimated that 1 out of every 10 Americans experience significant limits in daily functioning and increased mortality from these diseases. Perhaps the most unfortunate fact about these diseases is that they could be prevented by choosing to consume healthier food, and increasing one’s physical activity (Retrieved July 31, 2008 from http://www.cdc.gov/nccdphp/). For individuals to attain the health benefits of physical activity the Surgeon General recommends that a minimum of 30 minutes of moderate physical activity be performed on most if not all days of the week. The majority of Americans, unfortunately, are not achieving this minimum recommendation.

The consequences of our physically inactive lifestyles are reflected in the leading causes of death. In the year 2000, the leading cause of death was cigarette smoking with an attributed 435,000 deaths followed closely by physical inactivity and poor diet with 400,000 deaths. Physical inactivity may soon surpass cigarette smoking as the number one cause of death in the United States (Mokdad, Marks, Stroup, Gerberding, 2004). Controversy does exist regarding the exact numbers of attributable deaths to obesity with the numbers ranging from 400,000 to 112,000 (Couzin, 2005). However, this controversy over ‘numbers’ should not reduce our concern that obesity is a serious problem in the United States which needs serious attention by all levels of society.

The Influence of Environment/Technology

The life of ancient hunter/gatherers was one where physical activity was necessary for survival. The evolution of humans can be characterized as a complex interaction between humans and the environment. The environmental and biological changes occurred in unison up until 200 years ago with the industrial revolution and 25 years ago to present with the technological revolution. Within the past two generations, a surge in cultural development and technological advances occurred which further exacerbated the difference between the environmental demand for energy and our biological capacity to generate it. The cultural and technological development resulted in decreased physical activity and better access to food due to the advances in manufacturing. The mismatch between small environmental demands for energy expenditure and our biological capacities has resulted in the development of diseases such as cardiovascular disease, diabetes, and obesity (Malina, Little, 2008).

The modern environment has resulted in significantly less caloric expenditure in day-to-day activities. Take for example, an activity as simple as washing dishes or clothing. We now have the modern conveniences of machines to do the work at the price of expending fewer and fewer calories. Incidental activities such as washing dishes and clothing have been replaced with the convenience of dishwashers and clothes washers. The metabolic cost of washing dishes by hand was determined to be 1.83 kcal/min compared to 1.31 kcal/min when the dishwasher was
used, and 2.07 kcal/min when washing clothes by hand compared to 1.32 kcal/min when using the washing machine (Lanningham-Foster, Nysse, Levine, 2003). On a daily basis, these subjects would expend 45 extra calories by washing dishes and clothes by hand when compared to using dishwashers and washing machines. This may seem like a relatively small amount of calories but washing dishes and clothes by hand adds roughly an additional 300 kcals/week [45 kcal x 7 days] of energy expenditure (Lanningham-Foster et al., 2003).

Within a relatively short period of time farming chores were replaced with machines, automobiles reduced the need to walk, and televisions provided an excuse to sit. With these technological advances, especially television watching, significant negative health consequences have resulted (Jakes et al., 2003). The consequences observed included a significantly higher BMI, waist to hip ratio, and percent body fat among men and women who spent the most time watching TV. Specifically, men and woman had a 1.44 kg/m$^2$ and 1.92 kg/m$^2$ higher BMI compared to men and women who watched less than 2 h/day of television and engaged in an hour of vigorous activity (Jakes et al., 2003). Jakes et al., (2003) also observed an inverse relationship between television viewing and vigorous activities among both genders. Compared to the men and women who watched the least amount of television, those who watched the most had systolic blood pressures that were higher by 3.4 mm/Hg systolic and 2.4 mmHg diastolic in men and higher by 3.1 mm/Hg systolic and 2.9 mm/Hg diastolic in women (Jakes et al., 2003). Independent of age, alcohol intake, smoking status, use of antihypertensive medication, and BMI, the risk profile of CVD markers was worse in those who watched more television and the profile was better in those who engaged in more vigorous activity (Jakes et al., 2003).

Time spent sitting, especially watching television, was also significantly associated with elevated risk of obesity and type two diabetes (Hu et al., 2003). Specifically, for every 2h/d increase in television watching the risk of becoming obese increased 23%, and diabetes risk increased by 14%. Compared to women who were the most active and watched the least amount of TV (accumulated 21 METs/wk of physical activity, watched < 6 h/wk of TV), women with the lowest MET level and lowest activity level (> 20 h/wk television watching) significantly increased their risk of obesity (RR 1.90) and type 2 diabetes (RR 2.89) by 14% (Hu et al., 2003) Participants with the metabolic syndrome tended to spend less time engaged in moderate or vigorous activity and more hours watching television or using the computer. Those who did not engage in any moderate or vigorous activity had twice the odds of having the metabolic syndrome than those who engaged in >150 min/wk of moderate or vigorous activity (Ford, Kohl, Mokdad, Ajani, 2005).
**Occupational Influence**

Few jobs in modern society now require high amounts of energy expenditure and primarily involve high amounts of sitting. Transportation to and from work by walking or cycling was negatively related to BMI and waist circumference. Subjects who reported 10 MET h/wk as cycling or walking to work, equivalent to walking for 30 minutes each day, had a mean BMI 0.31 kg/m² and waist circumference 1 cm lower than those who did not walk or cycle to work regularly (Wagner et al., 2001) Among a population of 24,454 employed adults from the 1995 Australian Health Survey, (Table 2) 16,555 or 67.7% were classified as being insufficiently active for health.

For the females in this survey, no trend was observed between hours worked per week and participation in sufficient amounts of physical activity for health benefit regardless of occupational classification (blue-collar, white collar, professionals). However, 49% of male professionals spent more than 50 hours/wk at work compared to only 27% of white collar and blue-collar workers who spent 50 hrs/week at work. Professionals worked longer hours but were more likely to engage in sufficient activity for health thus questioning lack of time as a barrier to physical activity (Burton, Turrell, 2000).

**Increasing Physical Activity – How to Create Behavior Change**

Leisure time activity takes up only a small portion of one’s day with the majority of the waking day spent at work (Figure 2) typically at a rather sedentary job. The leisure time that employed persons do have is largely spent watching television, averaging 2.6 hours each day (Figure 3). Of the 5 hours of leisure time available on an average day, only 17 minutes of that time are spent being physically active (Figure 3), falling short of the recommended daily activity duration of 30 minutes. These recommendations state the minimum amount of activity to achieve health benefits associated with physical activity and are not a recommendation for weight loss. Even though some activity is better than none, to tackle the obesity problem individuals need to create a negative energy balance to lose weight.

James (2008) has suggested that promoting leisure time activity alone is not an appropriate strategy to combat the obesity epidemic, and that a fundamental shift in thinking is needed. Specifically, we need to reshape the built environment in such a way where walking is encouraged and safe. This will require a partnership between national and local governments, communities, scientists and businesses. The magnitude of change needed is unlike anything that has been tried before and must involve multiple levels of societal change.

The devastating effects of diseases such as cardiovascular disease and diabetes could be prevented, and the major lifestyle limitations these diseases impose could be reduced (Retrieved July 31, 2008 from http://www.cdc.gov/ncedphp/) through a seemingly simple behavior change. Specifically by consuming healthier food and being more active. The influences on behavior change are multifaceted and complex involving self-efficacy, environment, and other barriers. More specifically, physical activity patterns among adults can be influenced by their ability to engage in regular physical activity, enjoyment, support from others, positive beliefs regarding the benefits of physical activity, and lack of perceived barriers to physical activity. Some
interventions to increase physical activity have been successful in communities, worksites, health care settings and at home (U.S. Department of Health and Human Services, 1996).
However, these interventions have not been successful enough to curb the obesity epidemic and related diseases because more than half of Americans, 54.6%, are not active enough to meet the minimum physical activity recommendations (CDC, 2003).

With half of people who start a structured exercise program dropping out within six months (Dishman, 1982) the health promotion tactics and incentives used thus far only provide a temporary fix at best to this issue. The knowledge that scientists have gained throughout the years about the positive health benefits of physical activity, while widely published in the media, has done little to change this trend. In short, knowledge alone is not enough to produce behavior change.

Diseases such as diabetes, hypertension and cardiovascular disease are unfortunately all too common in the U.S. adult population. What is most unfortunate about these diseases is that they can be reduced through habitual moderate intensity physical activity and healthy eating patterns (Retrieved July 31, 2008 from http://www.cdc.gov/nccdphp/). With today’s advances in technology, many jobs involve high amounts of time spent sitting. This sedentary work environment can prove detrimental to a worker’s health because most of the worker’s are not meeting minimal physical activity recommendations in their leisure time. Full time workers spend 4 hours per day seated at work or in travel to and from work and this accounts for one third of total sitting time. Company fitness programs have assisted workers in becoming more physically active but had not changed sedentary behaviors (Jans, Proper, Hildebrandt, 2007).

With time and productivity lost due to chronic illness, employers may financially benefit (Mummery, Schofield, Steele, Eakin, Brown, 2005) if the Walkstation leads to increased productivity and healthier employees. Thus, it only makes sense to now look at the one thing we have not tried: changing the daily working environment.

An approach where activity is accessible to all and where more people feel comfortable and confident in their ability to become more physically active is needed. Some individuals may not partake in worksite wellness programs for fear of being stigmatized and are uncomfortable with the idea of going to the gym. With most individuals stopping a structured exercise program within 6 months of starting (Dishman, 1982), a more radical approach is needed. Creating something that is part of the office environment may reach those who feel uncomfortable with the idea of ‘exercise’. The support of coworkers and bosses may result in an increase in physical activity among individuals reluctant to adopt structured exercise programs. Considering the scope of the obesity problem, to now create lasting behavior change, focus needs to be less about individual changes and more about the collaborative efforts of all levels of society to change the current ‘obesogenic’ environment into one where walking and physical activity is promoted and easily accessible to everyone (James, 2008). Since the majority of one’s day is spent at work, this is an optimum setting to incorporate this fundamental shift in thinking, namely, to reinvent the sedentary ‘desk job’ by injecting physical activity into the mix through the introduction of the Walkstation.
The Walkstation combines a height adjustable work surface with a high quality commercial grade treadmill that replaces the typical office chair (Details Inc. 2008). The treadmill speed does not exceed 2 mph so that users are able to walk comfortably while typing, checking emails, taking phone calls, etc. The whole concept of the Walkstation is not to provide a workout, but to simply decrease the amount of time that is spent being completely sedentary at work. This may initially be perceived as a radical idea; however, with the scope of the obesity problem and related diseases, an environmental change is needed. What better place to start than in the work environment.

It is the purpose of this experiment to observe the work environment primarily of individuals in sedentary jobs. This observation will consist of two phases. The first phase will be the collection of baseline data using accelerometers to determine physical activity patterns. The second phase will be the monitoring of physical activity patterns once the Walkstation is introduced into the work environment. Specifically of interest will be the activity patterns after a day of work when the Walkstation was used. If by becoming more active during the day, individuals actually become less active in the hours after work, then the intention of the Walkstation, which is to promote more active time, may be lost. On the contrary, if increasing activity during the day results in more active time after work, the Walkstation may have exceeded expectations as to how much activity levels would increase as a result of use.

A theory does exist of an ‘activitystat’ that regulates how much physical activity an individual engages in on a regular basis. A control center somewhere in the central nervous system is thought to exist that carefully regulates physical activity levels (Rowland, 1998). This is demonstrated when examining children’s physical activity patterns. Children who walked to school have been found to have a higher level of physical activity the hour before and after school when compared to those children who were driven to school. However, the children who were driven to school seemed to compensate for this difference in physical activity level during the day so no difference in activity level was observed between children who walked or were driven to school (Wilkin et al., 2006). If such an activitystat does exist, adults who increase their physical activity levels during the day through the use of the Walkstation may compensate for this increase after work by being inactive. This theory would propose a decrease in physical activity if physical activity is increased at work. However, with no further scientific research on the ‘activitystat’ theory to date, it is hypothesized that there will be no change in leisure time physical activity after instituting an occupational environmental change with active Walkstations.
Methods

Participants

Study participants included 9 individuals (7 female and 2 male) who were current employees in the Registrar's Office at Miami University in Oxford, Ohio. Participants ranged in age from 40 to 59 years of age (M = 51.00, SD = 5.87), in height from 142 to 183 meters (M = 161.97, SD = 13.20), in weight from 48.5 to 98.0 kilograms (M = 77.81, SD = 16.17), and in Body Mass Index from 22.4 to 46.6 (M = 29.88, SD = 7.30).

All participants completed a health history questionnaire (Appendix A) and informed consent (Appendix B) prior to participation. Exclusion criteria included any existing injuries that would affect one’s ability to walk or existing medical conditions. All participants of this study participated on a strictly volunteer basis. All procedures were approved by the Miami University IRB.

Study Design

A repeated measures experimental design was used in this study to determine if study participants’ leisure time physical activity levels would change from before the intervention of the Walkstation to after Walkstation intervention. To assess possible changes in physical activity levels due to Walkstation use, study participants were randomly assigned to either a control group (n = 5) or an experimental (Walkstation) group (n = 4). Baseline measurements of all participants’ physical activity levels were taken for 11 days. Then, participants assigned to the experimental group were exposed to the Walkstation protocol, and their physical activity levels were again assessed during 11 days of Walkstation use. Corresponding assessments of the control group participants’ physical activity levels were conducted for the 11 days of baseline and an additional 5 days for comparison with the Walkstation data obtained for the experimental group.

Demographic characteristics for the study sample as a whole and for the experimental and control groups separately are presented in Table 3. Independent t-tests conducted to compare the two groups on all characteristics revealed no significant group differences (p > .05).

Apparatus

Three Walkstations were placed in the office area in the Registrar’s office, and used at the participants’ discretion. The Walkstation combines a height adjustable work surface with a high quality commercial grade treadmill that replaces the typical office chair (Details Inc. 2008). The treadmill speed does not exceed 2 mph so that users are able to walk comfortably while typing, checking emails, taking phone calls, etc.
Study Procedures

Each participant was visited at his or her office before given an accelerometer. At that time, accelerometer programming information was collected that included age and self-reported measures of height and body weight. Self reported measures of height and body weight were appropriate and acceptable since height and body weight do not influence the accelerometer counts, and the information was used only to program the device. Once the accelerometers were programmed, each participant was met individually at his or her office again to receive the accelerometer and further instructions. All of the participants were given specific instructions to wear the accelerometer at the hip during waking hours, and to secure the accelerometer to their clothing at all times using the belt clip and safety pins provided. Participants were also given an accelerometer log (Appendix C), and asked to record the time they put the accelerometer on, the time they took the accelerometer off for any reason during the day, and the time they took the accelerometer off at the end of each day. They were also asked to record any leisure time activity (gardening, walking, etc) along with the time they started and stopped the activity. At the beginning of each week, the logs were collected.

Those in the experimental and control groups were instructed to go about their normal routines and not to engage in more activity than they would normally. Those in the experimental group were also instructed to use the Walkstation for 2 hours a day in 10 – 15 minute bouts. After 11 days of baseline data collection, the accelerometers were collected from those in the experimental group, and the information downloaded onto a computer in the exercise physiology lab. The accelerometers were then reprogrammed and given back to the participants for 11 days of Walkstation use. The control groups’ accelerometers were worn for a total of 16 days (11 days of baseline and 5 days of comparison data).

Assessment of Physical Activity Levels

The Actical activity monitor was used to collect information about each participant’s physical activity patterns. The Actical activity monitor is an omnidirectional accelerometer used to collect data on physical movements and intensity of movements. Amplitude and frequency of motion are integrated by the sensor to produce an electrical current that varies in magnitude (Mini Mitter Company, 2003). Information about each subject (age, height, and body weight) was entered into a computer and downloaded to an accelerometer that collected data in 1-minute epochs.

The accelerometer data was divided into three time points for analysis: entire day, work day, and non-work day. The entire day was defined as the first indication of activity from the accelerometer data in the morning until the last in the evening. The work day was defined according to the Registrar’s Office summer hours of 7:30 AM – 4:30 PM. This time frame was used as a general guide when examining the raw accelerometer data. The non-work category included any and all non-work related activities performed throughout the day. There were a few subjects both in the experimental and control groups who walked during lunch, thus, lunch time was considered ‘leisure’ or non-work related activity. Since the majority of the subjects in this study took their lunches at different times each day, the raw data was used to estimate when lunch would have been taken. The non-work category also included the time from when they got
up in the morning to when work began, and additionally included the time from when work ended for the day until the accelerometer was taken off for the day. The physical activity data collected using these procedures were collated and averaged to create three dependent variables for each of the two time periods under study (at baseline or before Walkstation use and during Walkstation use). The three dependent variables calculated to represent each of the two time periods included: counts per minute for entire day, counts per minute for work day and counts per minute for non-work (leisure) day.

**Statistical Analyses**

All data obtained from the study procedures were collated and entered into an Excel software package and were subsequently transferred to an SPSS Version 16 data file for statistical analyses. A series of independent and dependent means comparison tests were used to assess the study purpose. Specifically, to compare the experimental and control groups at baseline, a series of independent samples t-tests were conducted. To determine if the experimental group exhibited changes in physical activity patterns from baseline to the Walkstation condition, a series of paired samples (or dependent) t-tests were conducted. Finally, to compare the experimental and control groups during the Walkstation condition, a series of independent t-tests were conducted. For all of the statistical analyses, the dependent variables were the three measures of physical activity: counts per minute for entire day, counts per minute for work day, and counts per minute for non-work (leisure) day.
Results

Descriptive Analyses

Descriptive analyses were conducted for all obtained measures of physical activity across both study groups. Examination of this data revealed significant skewness in the data obtained for the control group sample. Further examination of the data revealed one extreme outlier in the control group. Thus, all subsequent study analyses were conducted twice, once with this outlier included in the analyses and once with the outlier removed. No differences in results were obtained. Thus, in the following sections of this paper, the statistical analyses obtained with the outlier removed are reported.

Baseline Comparisons of Control and Experimental Groups

A series of three independent samples t-tests were conducted to compare the control and experimental groups on their physical activity levels during the 11-day baseline time period. Specifically, the three scores that were calculated to represent participants' average level of physical activity (counts per minute for entire day, counts per minute for work day, and counts per minute for non-work day) across the 11-day time period served as the dependent variables, and group (control or experimental) was the independent variable. The results of these group comparisons are presented in Table 4. As indicated in the last column of this table, the two groups did not differ significantly in physical activity levels either during work, non-work, or entire day. Thus, no differences were found to exist in the physical activity levels of the experimental and control groups during the 11-day baseline time period.

Changes from Baseline to Walkstation Use: Experimental Group

To determine whether the experimental group exhibited changes in level of physical activity from baseline to Walkstation usage, a series of paired samples t-tests were conducted. The dependent variables for these analyses were the three measures of physical activity (counts per minute for entire day, counts per minute for work day, and counts per minute for non-work day) taken for the baseline period (11 days) and for the Walkstation time period (11 days). The data for these analyses are presented in Table 5. As these results show, significant differences (p<0.05) in counts per minute for the entire day and work day time points were found. In contrast, no significant differences were found between the baseline condition and Walkstation condition in the non-work time point. These results show that individuals in the experimental group exhibited significant increases in physical activity levels from baseline to Walkstation time point as measured during the work day and during the entire day. However, no changes in physical activity level were observed for the non-work (leisure time) day.

Comparison of Control and Experimental Groups: Walkstation Condition

The physical activity levels of the two study groups (experimental and control) were compared at the Walkstation time point. For the experimental group, these scores represented the 11 days of Walkstation usage. For the control group, these scores were computed from the five days of physical activity data that were collected after the 11 days of baseline. These group
scores are presented in Table 6. As the results show, individuals in the experimental group (Walkstation) exhibited higher levels of physical activity than did the control group for the entire day and for the work day time periods. However, no group differences were found for the non-work time period.

**Discussion**

It was the purpose of this experiment to observe the work environment of individuals in sedentary jobs to determine if changing the environment by placing Walkstations in the office would alter physical activity patterns in leisure time. The results support the null hypothesis showing no change in leisure time physical activity patterns from before Walkstation use to during use. Thus, to change leisure time physical activity patterns seems to require more than altering the work environment.

The results of this study do seem to support Rowland’s (1998) theory of the existence of a control center somewhere in the central nervous system, termed the ‘activitystat’, that carefully regulates physical activity levels. A study by Wilken et al. (2006) comparing physical activity patterns of children who were driven to school versus those that walked to school, does seem to support this theory. The findings from this study showed that children who walked to school had higher physical activity levels the hour before and after school compared to the children who were driven to school. However, the children who were driven to school seemed to compensate for this difference in activity level by being more active during the day. Thus, when looking at the total physical activity levels for the entire day in both groups of children, no difference in physical activity level was found. Since no difference was observed in this study between the two groups, the ‘activitystat’ theory seems like a good explanation. However, with few studies on the ‘activitystat’, it remains only a theory.

There may be other explanations besides the activitystat theory for the findings in this study. What influences one’s choice to engage in more activity in leisure time is complex. Participation in sedentary behaviors seems to be related to perceived physical activity barriers (Salmon, Owen, Crawford, Bauman, Sallis 2003). In a study examining the physical activity barriers in overweight women, the most commonly perceived barriers to physical activity were time, weather, and family commitment (Jewsen, Spittle, Casey 2008). Among employed women from blue-collar jobs to professionals, obesity, those with dependent children, smoking status (previous, former, or, never smoked) and age all were factors that influenced their engagement in the amount of physical activity required for health benefits (Table 2). For men in this study, age, work category (blue collar to professional), having dependent children, smoking status, and obesity all negatively influenced their participation in the minimum activity recommended for health benefits (Burton, Turrell 2000). According to a review article on the factors that influence employee participation in physical activity, self-efficacy or the belief that the individual can perform a health behavior, was the best predictor of physical activity among employees (Kaewthummanukul, Brown 2006). Another study showed that individuals in an occupation with low physical activity levels were less likely to be active and more likely to be sedentary during leisure time (Kruger, Yore, Ainsworth, Macera 2006) Clearly, what influences one’s choice to engage in physical activity in their leisure time is complex and multifaceted and involves more than altering the work environment.
While no affect on leisure time activity levels was observed in this study, physical activity levels did significantly increase both for the entire day and work day when the Walkstation was introduced. The possible health benefits of increasing physical activity levels by using the Walkstation during the work day could be significant and should be explored in future studies. Independent of total sedentary time, the total number of breaks in sedentary time (average duration < 5 minutes) was significantly associated with lower waist circumference, BMI, and triglyceride levels (Healy, Dunstan, Salmon, Cerin, Shaw, Zimmet, Owen 2008). Although more research is needed, presumably employees who use the Walkstation in frequent short bouts throughout the day may be able to improve their health. Women who had higher physical activity levels at work were observed to have a lower mortality rate compared to women with sedentary occupations (Andersen, Schnohr, Schroll, Hein 2000). Moreover, it has been suggested that activity derived from physically active occupations can reduce the likelihood of being obese, especially for those who do not participate in leisure time physical activity (King, Fitzhugh, Bassett, McLaughlin, Strath, Swartz, Thompson 2001).

The Walkstation does provide a practical way to positively change the work environment. According to James (2008), in order to gain control of the current obesity epidemic, an environmental change involving multiple levels of society is required. This study does illustrate the complexity involved in changing physical activity patterns, especially in leisure time. Clearly, more research on the Walkstation is needed, but this may, in effect, be the way of the future in office settings and is the only practical solution to create environmental change in the workplace to date.

The limitations of this study include gender distribution (only 2 males in the study), small sample size, technical error, and some missing days. Future studies could include a larger sample size, better gender distribution, and include employees from different office settings.
References


Details Inc. (2008). *The Walkstation a healthy step in the right direction [brochure]*. Grand Rapids, MI:


Appendix A. Health History Questionnaire

Physical Activity Readiness Questionnaire (PAR-Q) and You

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly:

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
<th>1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2. Do you feel pain in your chest when you do physical activity?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. In the past month, have you had chest pain when you were not doing physical activity?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Do you lose your balance because of dizziness or do you ever lose consciousness?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Do you have a bone or joint problem that could be made worse by a change in your physical activity?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. Do you know of any other reason why you should not do physical activity?</td>
</tr>
</tbody>
</table>

**YES to one or more questions**

Talk to your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want – as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

**NO to all questions**

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- Start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- Take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively.

**Delay becoming much more active:**

- If you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- If you are or may be pregnant – talk to your doctor before you start becoming more active.

Please note: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed use of the PAR-Q. Reprinted from ACSM’s Health/Fitness Facility Standards and Guidelines, 1997 by American College of Sports Medicine
Appendix B. Informed Consent

Informed Consent Form

Title of Research Project: Walk and work: case study series

Principal Investigator: Ronald H. Cox, PhD

Provided that you are over the age of 18, you are invited to participate in a research study that will investigate physical activity patterns of subjects during the workday and in leisure time. Subjects will be randomly assigned to a control group or an experimental group. The experimental group will use the active workstation which consists of a treadmill combined with a height adjustable standing desk. You will be asked screen questions (based on the exclusion criteria outlined below) by the researcher to ensure that it is safe for you to participate in the study. You may not participate in this study if you have any of the conditions noted on the list of exclusion criteria below:

<table>
<thead>
<tr>
<th>Exclusion Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anyone who is uncomfortable walking on a treadmill at speeds of 1-2 mph.</td>
</tr>
<tr>
<td>Anyone who requires assistive devices to walk or maintain balance.</td>
</tr>
<tr>
<td>Anyone whose physician has told him/her not to walk at all, or not to walk on a treadmill or perform vigorous exercise.</td>
</tr>
<tr>
<td>Weight&gt;350 pounds (d/t treadmill limit)</td>
</tr>
<tr>
<td>Anyone who knows or suspects they have a balance disorder</td>
</tr>
<tr>
<td>Those with Diabetes Mellitus may only participate with prior approval from their personal physician</td>
</tr>
</tbody>
</table>

If you choose to participate in this study, you will visit room 16 in Phillips Hall for testing on eight occasions over a 12 month period for approximately 1 hour on each occasion. You have two, one-hour sessions about every four months during the year. You will complete the following tests:

Metabolic Assessment and Exercise Readiness

1. Complete the Physical Activity Readiness Questionnaire. This is a brief (7 questions) questionnaire pertaining to your capability to perform physical activity.

2. Following universal precautions, a finger-stick blood sample (20 microliters) will be collected for the purpose of determining HDL cholesterol, LDL cholesterol, total cholesterol, triglycerides, and blood glucose. The blood sample will be analyzed using
the Cholestech desktop analyzer according to manufacturer’s recommended protocol. You will be required to fast for 12 hours before these tests. We will schedule this appointment at your convenience to minimize the need to fast beyond 12 hours.

3. Body composition will be determined using the BodPod (air plethysmography) and a bioelectrical impedance analyzer. For this test, you will stand barefoot on a scale. For the BodPod test, you will change into attire appropriate for the test. For women this is either a Lycra swimsuit or bike shorts and a jog bra that you provide. For men this will be a Speedo type swimsuit or bike shorts that you provide. The body composition lab has a private changing room so you will never be in a public area in your testing attire.

4. Body weight and height will be determined using a balance scale with a stadiometer.

5. Resting metabolism will be determined via indirect calorimetry. This is a non-invasive test that requires you rest quietly while breathing into a mouthpiece/face mask connected to a metabolic cart which measures and analyzes expired respiratory gases.

6. Estimated maximal oxygen uptake will be determined via a sub-maximal treadmill test. This test requires you to walk on a treadmill at speeds between 2.8 and 3.7 mph. The grade will be increased progressively from 0% (level) to a maximum of 15%. You will not exercise beyond 85% of your maximal heart rate (for example, a 40 year old subject would work at a heart rate no higher than 153 bpm vs. their predicted maximum of 180 bpm). The test takes approximately 20 minutes to complete. The maximum percent grade will vary by individual and will be determined by your heart rate during the test. This is usually accomplished within three levels. Heart rate is measured and monitored using a Polar Heart Rate Monitor, which consists of a chest strap worn by you and monitor affixed to the treadmill.

7. Blood pressure will be determined with an electronic blood pressure meter. In this procedure, familiar to all who have been to a physician’s office, a cuff will be placed around your arm and inflated to a pressure about 30mmHg higher than the anticipated blood pressure. As the pressure of the cuff is released the results of your systolic and diastolic blood pressure will appear.

8. Your waist will be measured using a tape measure.

**Questionnaires**

To assess the effects of participation in the Active Workstation program on study participants’ psychological health and well-being, a set of self-report questionnaires will be administered to each participant four times across a 12 month-period (once at baseline, and then again at four-month intervals).

All questionnaires will be administered in a packet form at baseline and again at four-month intervals until the conclusion of the study. You will be given a copy of the survey
packet by a research assistant (or a faculty co-investigator) along with a sealed envelope. You will complete the survey packet in a confidential manner (i.e., without anyone else seeing the form). Once the packet is completed, you will insert the completed survey in the envelope, seal it up, and write the last four digits of your Social Security Number across the seal. The research assistant (or faculty co-investigator) will return the sealed envelope to Dr. Horn (Dr. Horn does not have the key to codes/names). It is anticipated that you can complete the entire questionnaire packet in 15-20 minutes. All questionnaire data will be held in complete confidence, and completed surveys will be stored in a locked cabinet in a Miami University faculty member’s office. No one other than members of the research team will see the completed surveys.

Activity Assessment

We will also determine baseline activity levels by collecting/analyzing data from an accelerometer that you wear on your waistband for 2 weeks prior to beginning use of the Walkstation in the office. The accelerometer is similar to a pedometer, but is smaller (about 1 inch x 1 inch x 0.5 in). This device capture information about movement in three planes—vertical, horizontal, and lateral. If you are in the experimental groups, after 2 weeks, you will begin using the Walkstation and will continue to wear them accelerometer for an additional 2 weeks. It is important that you wear the accelerometer anytime you are not sleeping, bathing, or swimming.

You will be given a log to record the time you put the accelerometer on each day and the time you take the accelerometer off each day. You will also record any physical activity in which you participate (walking, gardening, etc.) and the time you start and stop the activity. Logs will be collected by a research assistant. To ensure compliance, email reminders will be sent to each participant by a research assistant each week.

Walkstation Implementation/Activity

Once baseline data are collected, you will begin using the Walkstation in your workspace if you are assigned to the experimental group. If you are in the control group, you may not use the Walkstation.

The Walkstation is an active workstation with a treadmill integrated into a height adjustable desk. You will use this active workstation to walk-and-work for a portion of your workday. For this case study, the Walkstation will be installed in your workspace at Miami University for 1 year. The Walkstation does not replace your usual desk and you will decide when to use the active desk, but we do ask that you accumulate a minimum of 2 hours per day of Walkstation use. However, if you are using the desk for less than 1 hour a day for one week, we will remove the Walkstation and make it available for another participant.

If you find the Walkstation to be unsuitable for your work, notify Ron Cox (coxhrh@muohio.edu or 529-4435) and the desk will be removed.
The investigator/research assistant will teach you how to adjust the Walkstation for proper ergonomic form while working. The Walkstation has an odometer that records the amount of time the treadmill is in use, as well as the distance walked. The research assistant(s) will come to your office each week to collect this information and reset the odometer.

If you are in the experimental group, the investigator/research assistant will teach you how to adjust the Walkstation for proper ergonomic form while working. You will record the time you spend using the Walkstation on a calendar provided by the investigator. The research assistant(s) will come to your office each week to collect this information and discuss any problems you are having with the Walkstation. There is a small possibility that you could stumble or fall while walking-and-working, just as this might happen while walking at any other time. You will be walking at speeds between 0.8-1.5 mph, which is rather slow compared to the walking we do every day. For comparison, walking at a speed of 2 mph is a leisurely pace and is considered low intensity physical activity. Walking at 3-4 mph is considered moderate intensity physical activity and would be considered sufficient to constitute exercise is done for a sufficient length of time. There is also a possibility that you will experience delayed onset muscle soreness from walking. Muscle soreness of this type does not require medical intervention and usually resolves within 4 days.

If you sustain a minor injury during testing or while using the Walkstation in your office, you should consult your personal physician. In the event you do not have a personal physician, we will provide you with the address and phone number of the urgent care clinic at McCullough-Hyde hospital.

McCullough-Hyde Hospital, 110 N. Poplar Street, Oxford, OH, 513-523-2111

In the event that a severe injury occurs in the lab, we will call 911 to obtain medical assistance for you. You are strongly encouraged to make the research staff aware of any discomfort or concerns you experience during the testing sessions or while you are using the Walkstation in your office. Be aware that should a physical injury result from the research procedures, financial compensation is not available and medical treatment is not provided free of charge.

We encourage your cooperation throughout the testing sessions and during the time the Walkstation is in your workspace. However, your participation is voluntary and you are free to refuse to participate and/or withdraw from the study at any time without being penalized or affecting your relations with Miami University in any way. Any information obtained in connection with this study that can be identified with you will remain confidential and will be disclosed only with your permission. In any written reports, publications or presentations, no participant will be identified by name.

If you are a participant in the experimental group or the control group, you will receive a $10 Kroger gift card for each testing session in the Phillips Hall laboratory. In addition, you will receive a $10 Kroger gift card for each week you wear the accelerometer.
By signing this document, I acknowledge the following:

- I, ________________________________, hereby agree to participate as a volunteer research subject in the scientific investigation described above, which is an authorized part of the education and research program of Miami University under the supervision of Ronald H. Cox, PhD.
- The investigation and my part in the investigation has been defined and fully explained to me and I understand the explanation. A copy of procedures of this investigation has been provided to me and has been discussed in detail with me.
- I am above the legally required 18 years of age necessary to participate in this study.
- I understand I can refuse to answer questions during the interview or refuse to participate in any interviews.
- I have been given the opportunity to ask questions and all such questions and inquiries have been answered to my satisfaction.
- I understand that in the event of physical injury resulting from the research procedure, financial compensation is not available and medical treatment is not provided free of charge.
- I further understand that I am free to stop my participation at any time during the study.
- I have reviewed the inclusion and exclusion criteria with the investigator and have no condition which precludes exercise.
- I have answered the PAR-Q items honestly.

If you have questions or concerns about the study, please contact Ron Cox at 513-529-4435 or coxrh@muohio.edu, Mandy Zylstra at zylstraj@muohio.edu. If you have general questions about your rights as a research participant, you may also contact Miami’s Office for the Advancement of Research and Scholarship at 513-529-3600 or humansubjects@muohio.edu.

______________________________
Date

______________________________
Participant’s Signature

______________________________
Participant’s Name Printed

I, the undersigned have defined and fully explained the investigation to the above participant.

______________________________
Date

______________________________
Investigator’s signature or that of official representative
### Weekly Accelerometer Log

**Directions:** Please indicate the time you put the accelerometer on and the time you took the accelerometer off for each day. In the comments section please indicate if you took the accelerometer off for any reason, the reason, and the time you put it back on. Also, if you do any physical activity please indicate the time you started and ended the activity and the type of activity (walking, gardening, etc.).

<table>
<thead>
<tr>
<th>Day</th>
<th>Date</th>
<th>Time On</th>
<th>Time Off</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuesday</td>
<td></td>
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<tr>
<td>Wednesday</td>
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<tr>
<td>Thursday</td>
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<tr>
<td>Friday</td>
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<tr>
<td>Saturday</td>
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<td></td>
</tr>
<tr>
<td>Sunday</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figures and Tables

Figure 1: 1988–2007 No Leisure-Time Physical Activity Trend

Data are reported from 36 participating states from 1988–2007. The proportion of the U.S. population that reported no leisure-time physical activity decreased from about 31% in 1989 to about 28% in 2000, and then decreased to about 24% in 2007.

Figure 2:

Percent of employed persons who did selected activities on workdays by hour of the day

NOTE: Data include individuals, age 15 and over, who were employed full-time on days they worked. Data are an average for 2003-06.

SOURCE: Bureau of Labor Statistics
Table 1: Total Steps/Day Classifications

<table>
<thead>
<tr>
<th>Classification</th>
<th>Steps/Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedentary</td>
<td>&lt;5,000 steps/day</td>
</tr>
<tr>
<td>Low Activity Level</td>
<td>5,000 - 7,499 steps/day</td>
</tr>
<tr>
<td>Somewhat Active</td>
<td>7,500 - 9,999 steps/day</td>
</tr>
<tr>
<td>Active</td>
<td>&gt; 10,000 steps/day</td>
</tr>
<tr>
<td>Highly Active</td>
<td>&gt;12,500 steps/day</td>
</tr>
</tbody>
</table>

Information obtained from Tudor - Locke et al (2004)

NOTE: Data include all persons age 15 and over. Data include all days of the week and are annual averages for 2006.

SOURCE: Bureau of Labor Statistics
Table 2: Percentages of Men and Women Inactive by Category

<table>
<thead>
<tr>
<th>Age</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 - 44</td>
<td>68%</td>
<td>73%</td>
</tr>
<tr>
<td>45 - 54</td>
<td>70%</td>
<td>75%</td>
</tr>
<tr>
<td>55 - 64</td>
<td>72%</td>
<td>71%</td>
</tr>
<tr>
<td>Work Category</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blue Collar</td>
<td>70%</td>
<td>78%</td>
</tr>
<tr>
<td>White Collar</td>
<td>58%</td>
<td>72%</td>
</tr>
<tr>
<td>Professionals</td>
<td>61%</td>
<td>66%</td>
</tr>
<tr>
<td>Work hours/week</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 - 29 Hours/week</td>
<td>61%</td>
<td>-</td>
</tr>
<tr>
<td>30 - 34 Hours/week</td>
<td>64%</td>
<td>-</td>
</tr>
<tr>
<td>35 - 49 Hours/week</td>
<td>65%</td>
<td>-</td>
</tr>
<tr>
<td>50 + Hours/week</td>
<td>67%</td>
<td>-</td>
</tr>
<tr>
<td>Other Factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependent children</td>
<td>71%</td>
<td>76%</td>
</tr>
<tr>
<td>Current Smoker</td>
<td>71%</td>
<td>76%</td>
</tr>
<tr>
<td>Former Smoker</td>
<td>66%</td>
<td>68%</td>
</tr>
<tr>
<td>Never Smoked</td>
<td>61%</td>
<td>71%</td>
</tr>
<tr>
<td>Obesity</td>
<td>Is a factor</td>
<td>Is a factor</td>
</tr>
</tbody>
</table>


Table 3: Demographic Data for Study Participants

<table>
<thead>
<tr>
<th></th>
<th>All Participants</th>
<th>Control Group</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (SD)</td>
<td>51.00 (5.87)</td>
<td>51.80 (4.55)</td>
<td>50.00 (7.87)</td>
</tr>
<tr>
<td>Height (SD) (cm)</td>
<td>161.97 (13.20)</td>
<td>157.96 (14.65)</td>
<td>166.98 (10.88)</td>
</tr>
<tr>
<td>Weight (SD) (kg)</td>
<td>77.81 (16.17)</td>
<td>76.92 (17.38)</td>
<td>78.93 (17.07)</td>
</tr>
<tr>
<td>BMI (SD)</td>
<td>29.88 (7.30)</td>
<td>31.24 (9.21)</td>
<td>28.18 (4.69)</td>
</tr>
</tbody>
</table>
Table 4: Comparison of Experimental and Control Groups' Levels of Physical Activity at Baseline

<table>
<thead>
<tr>
<th>Time Point</th>
<th>Means (SD) Exp. Group n = 4</th>
<th>Means (SD) Control Group n = 4</th>
<th>df</th>
<th>t-value</th>
<th>Sig (two tail)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire Day</td>
<td>192.68 (46.39)</td>
<td>197.87 (96.10)</td>
<td>6</td>
<td>-.10</td>
<td>0.93</td>
</tr>
<tr>
<td>Work Day</td>
<td>94.23 (25.27)</td>
<td>91.97 (15.09)</td>
<td>6</td>
<td>.15</td>
<td>0.88</td>
</tr>
<tr>
<td>Non-Work Day</td>
<td>286.89 (67.62)</td>
<td>286.68 (134.67)</td>
<td>6</td>
<td>.00</td>
<td>0.99</td>
</tr>
</tbody>
</table>

Means are in total counts/minute

<0.05

Table 5: Changes in Physical Activity from Baseline to Walkstation: Experimental Group (n = 4)

<table>
<thead>
<tr>
<th>Time Point</th>
<th>Means (SD) Baseline</th>
<th>Means (SD) Walkstation</th>
<th>t-value (df = 3)</th>
<th>Sig (two tail)</th>
<th>95% CI of Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire Day</td>
<td>192.68 (46.39)</td>
<td>246.05 (72.22)</td>
<td>-3.55</td>
<td>0.04</td>
<td>-101.20 to -5.52</td>
</tr>
<tr>
<td>Work Day</td>
<td>94.23 (25.27)</td>
<td>271.80 (99.30)</td>
<td>-4.13</td>
<td>0.03</td>
<td>-314.43 to -40.70</td>
</tr>
<tr>
<td>Non-Work Day</td>
<td>286.89 (67.62)</td>
<td>217.59 (77.26)</td>
<td>2.18</td>
<td>0.12</td>
<td>-31.83 to 170.42</td>
</tr>
</tbody>
</table>
Table 6: Comparison of Experimental and Control Group at Walkstation Time Point

<table>
<thead>
<tr>
<th>Time Point</th>
<th>Means (SD) Control Group n = 4</th>
<th>Means (SD) Exp Group n = 4</th>
<th>t-value (df = 5)</th>
<th>Sig (two tail)</th>
<th>95% CI of Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire Day</td>
<td>128.53 (33.06)</td>
<td>246.05 (72.22)</td>
<td>2.58</td>
<td>0.05</td>
<td>.26 to 234.76</td>
</tr>
<tr>
<td>Work Day</td>
<td>74.27 (18.90)</td>
<td>271.80 (99.30)</td>
<td>3.32</td>
<td>0.02</td>
<td>44.69 to 350.36</td>
</tr>
<tr>
<td>Non-Work Day</td>
<td>181.40 (53.01)</td>
<td>217.59 (77.26)</td>
<td>0.70</td>
<td>0.52</td>
<td>-98.48 to 170.86</td>
</tr>
</tbody>
</table>