THE USE OF STAND-CAPABLE WORKSTATIONS FOR REDUCING SEDENTARY TIME IN OFFICE EMPLOYEES

A Dissertation

by

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ABSTRACT

Stand-capable workstations offer office employees an alternative to sitting in their chairs all day, as they allow for work to be conducted while seated or standing. This can lead to substantial reductions in daily seated time, reducing risks associated with high levels of sedentary behavior such as mortality, obesity, diabetes, cardiovascular disease, and cancer. A limited number of studies have been conducted on standing habits at these workstations, with findings showing that reductions in seated time ranges from 0-2 hours.

Two types of stand-capable workstations exist: a sit-stand workstation that allows the user to adjust their desk surface between seated and standing height, and a stand-biased workstation that utilizes a desk set at standing height and a raised height chair, in addition to a footrest for increasing comfort while standing. The goal of this research was to determine standing habits of stand-capable workstation users in three different office settings, and to test the hypothesis that users of stand-biased workstations maintain their standing habits over time better than the sit-stand workstation users who may experience a decrease in standing habits after the novelty of their new workstation wears off.

Utilizing pre- and post- move surveys with employees at a pharmaceutical company that were moving into an open seating office plan with sit-stand workstations available, low rates of standing behavior were found. On the contrary, a study at Texas A&M University with employees that requested conversion to a stand-biased workstation found that employees averaged standing for approximately half of the time they spent at their desks. A study at Healthways allowed both subjective and objective measurement of employees that used each type of stand-capable workstation, and found that differences in standing habits observed initially between the two workstations declined over a six month follow-up period. This study also showed that those in sit-stand and stand-biased workstations sit approximately 1-2 hours less than their peers working in traditional seated workstations. Studies revealed comfort is a common

motivator for standing behavior, and no evidence was found to indicate decreases in standing habits over time in the A&M and Healthways study populations.

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TABLE OF CONTENTS

Page

Page

LIST OF FIGURES

Page

Page

LIST OF TABLES

Page

1 INTRODUCTION AND BACKGROUND

1.1 Problem of excessive sedentary behavior

With over one-third of U.S. adults considered obese, the problem of physical inactivity has received much attention (Ogden et al., 2012). It is currently recommended that adults get 30 minutes of moderate-intensity physical activity on at least five days of the week or 20 minutes of vigorous-intensity physical activity on at least three days of the week for a wide variety of health benefits (Haskell et al., 2007). However, more recent research has shown that acquiring recommended levels of physical activity may not be enough; the other end of the spectrum, sedentary behavior, such as sitting, needs to be considered as well. Sedentary behavior, classified as energy expenditure of 1.5 METs (metabolic equivalents) or less is distinct from lack of exercise or moderate to vigorous intensity physical activity (Tremblay et al., 2010, Owen et al., 2011). Just as two types of exercise, endurance training and resistance training, have different effects on the body, sedentary behavior has different consequences than the lack of moderate to vigorous physical activity (Hamilton et al., 2007).

1.1.1 Epidemiology of sedentary behavior and health outcomes

While there has been a recent influx of studies on sedentary behavior and health consequences, the connections have been documented for centuries. Bernardino Ramazzini, who is well known as the father of occupational medicine, described in the early 1600s the ill health effects he saw in workers that had jobs requiring prolonged sitting (Franco, 1999, Dunstan et al., 2012a).

Other early recorded observations on occupational sedentary behavior and negative impacts on health date back to 1864 when tailors described as having sedentary occupations were observed to have higher mortality levels than agricultural workers (MacAuley, 1994). In the 1950s, British researchers were able to find significant differences in rates and severity of cardiovascular events between London bus drivers that had light activity jobs and the conductors that moved around the double-decker buses (Morris et al., 1953). They built upon the bus driver findings and conducted more studies encompassing a wide range of job types, classifying them as heavy or light work. They found evidence further supporting their hypothesis that men in physically active jobs had a lower incidence and severity of heart disease than those in less physically active jobs (Morris et al., 1953).

The Morris bus driver studies are often cited as formative research that led to discoveries on the importance of daily physical activity. However, the more recent research into sedentary behavior also points back to these studies as they highlighted the detriments of sedentary behavior.

Over the past decade, an increasing number of epidemiologic studies have been conducted on the associations of sedentary behavior and health outcomes. Many have found associations with mortality from all causes, cardiovascular disease, diabetes, and cancer, all independent of leisure time physical activity (Katzmarzyk et al., 2009, Owen et al., 2011).

In a systematic review of 48 studies published between 1996 and 2011, Thorp et al. found that sedentary behavior is consistently associated with all-cause, cardiovascular disease (CVD) related, and all-other-cause mortality (Thorp et al., 2011). They also observed an increased risk for diabetes and a few site specific cancers, but the effect was attenuated after adjustment for BMI and moderate to vigorous physical activity. Mixed results were found examining the associations between sedentary behavior and measures of obesity.

A meta-analysis utilizing 10 cross-sectional studies found that people with the highest levels of sedentary behavior were 73% (O.R. 1.73, 95% C.I. 1.55-1.94, $p<.0001$) more likely to have metabolic syndrome than those that had the lowest levels of sedentary behavior (Edwardson et al., 2012). Even more alarming, another meta-analysis that utilized 16 prospective and two cross-sectional studies found that those with the highest levels of sedentary behavior compared to those with the lowest levels had a 112% increase in their relative risk for diabetes (R.R. 2.12, 95% CrI. 1.61-2.78), a 147% increase in their relative risk for cardiovascular events (R.R. 2.47,95% C.I. 1.44, 4.24), and a 49% increase in their risk of mortality (H.R. 1.49, 95% CrI, 1,14, 2.03) (Wilmot et al., 2012).

Several epidemiologic studies have linked sedentary behavior and colorectal, endometrial, ovarian, and prostate cancer occurrence, cancer mortality, and weight gain in colorectal cancer survivors, but not with breast cancer or renal cell carcinoma (Lynch, 2010, Lynch et al., 2013). The currently limited evidence does not allow for any strong conclusions about the associations between sedentary behavior and cancer or cancer survivorship (Lynch, 2010, Lynch et al., 2013). Many prospective and cross-sectional studies have been conducted to assess the relationship, with varying measures of sedentary behavior from reports on TV viewing time to classification based on occupation (Lynch, 2010).

A few studies have specifically examined occupational sitting as the exposure for adverse health outcomes. Van Uffelen et al. conducted a literature review that identified 43 papers examining the association between occupational sitting and a health risk. In general, the cross-sectional and case-control studies found associations between occupational sitting and health risks. Prospective studies only supported the relationship of sitting to diabetes and mortality, but not to BMI, cardiovascular disease or cancer (van Uffelen et al., 2010). A recent pooled analysis of several British population cohorts totaling 11,168 people followed for over 12 years also looked specifically at occupational sitting. Results showed an increased risk for all-cause mortality and cancer in only women with sedentary jobs, but no associations between sedentary jobs and cardiovascular disease (Stamatakis et al., 2013).

While the epidemiologic literature on sedentary behavior and adverse health outcomes is rapidly growing, there still has not been a consistent measure of sedentary behavior used, which may account for lack of consistency in results. Measures range from self-reported TV viewing time or occupation requirements to objective measurement from accelerometers. One study that examined both overall sitting and TV viewing found that television viewing had stronger associations with mortality than overall sitting time and that the most likely explanation was that the measurement properties varied significantly because questions assessing overall sitting can be much more challenging than those about TV viewing time (Matthews et al., 2012).

Reverse causality, or the possibility that the underlying disease is causing the sedentary behavior, has often been mentioned as a potential limitation in sedentary behavior epidemiologic studies. A large prospective study of 240,819 U.S. adults aged 50 -71 followed for 8.5 years addressed this issue (Matthews et al., 2012). The authors explain that reverse causality is an unlikely explanation because they found an association between sedentary behavior and mortality even among people reporting high levels of moderate to vigorous physical activity. They also conducted a sensitivity analysis excluding early deaths in study follow-up, which would likely be those with underlying disease at study enrollment, to further confirm results were unlikely to be from confounding and reverse causality.

A life table analysis that utilized data from a large prospective study conducted in Australia lead to an estimate that for every hour of TV watched by someone over 25 years old, their life expectancy decreased by 21.8 minutes (Veerman et al., 2012). Comparing this estimate to a previous estimate that every cigarette smoked leads to an 11 minute decrease in life expectancy in men (Shaw et al., 2000) shows sitting really may fulfill its reputation from recent press as ”the new smoking.”

1.1.2 Physiology of sedentary behavior

Large amounts of evidence exist in the field of exercise physiology showing a firm link between moderate to vigorous physical activity and health (Hamilton et al., 2007). On the other end of the spectrum, research on inactivity physiology is relatively limited because the impact of too much sitting has only become a focus within the past decade (Hamilton et al., 2007).

As epidemiological evidence about the detrimental effects of sedentary behavior mounts, biomedical researchers have been working to keep up by conducting studies that help explain how sedentary behavior affects the body. Undoubtedly, Marc Hamilton and colleagues at the Pennington Biomedical Research Laboratory have been leading this effort. In 2004, Hamilton and colleagues published a review describing how sedentary behavior affects lipoprotein lipase (LPL) in skeletal muscles. LPL, which is often thought of as a vacuum cleaner of fat, is a protein known to be important in controlling plasma triglyceride metabolism and HDL cholesterol. LPL has an established inverse relationship to coronary heart disease. LPL responds differently to the two opposite ends of the physical activity spectrum, physical inactivity (sedentary behavior) and vigorous physical activity (Hamilton et al., 2004). Changes in LPL activity from physical inactivity were not simply the inverse of changes from exercise, but LPL activity and concentrations actually decreased in greater magnitudes from physical inactivity than they increased from exercise (Hamilton et al., 2004). Other studies have shown that inactivity shuts off LPL and that this shut off occurs in the fatigue resistant muscles that are commonly engaged by light intensity physical activities (Bey and Hamilton, 2003, Zderic and Hamilton, 2006).

Hamilton has also demonstrated differences in muscle activation between sedentary and non-sedentary activities. Skeletal leg muscle recruitment was measured during sedentary and non-sedentary activity using an electromyogram (Hamilton et al., 2007). A silent signal was demonstrated only during sitting.

Results of epidemiological studies specifically linking sedentary behavior and diabetes may be further supported by biomedical studies of diabetes risk factors. Uninterrupted sedentary activity has been shown to be associated with increases in 2-hour post challenge plasma glucose levels, postprandial glucose levels and insulin spikes (Dunstan et al., 2012b, Healy et al., 2007). Both instances of hyperglycemia have been associated with effects on cardio metabolic health. It has been suggested that loss of muscle contractile activity from prolonged sitting slows the movement of GLUT-4 glucose transporters to the skeletal muscle cell surface (van Uffelen et al., 2010).

Uninterrupted sitting has long been established as a risk for deep venous thrombosis (DVT). DVT, a potentially fatal condition, occurs when blood clots form in the leg (Hamilton et al., 2007). Howard and colleagues conducted an investigation of uninterrupted and interrupted sitting and several parameters thought to be associated

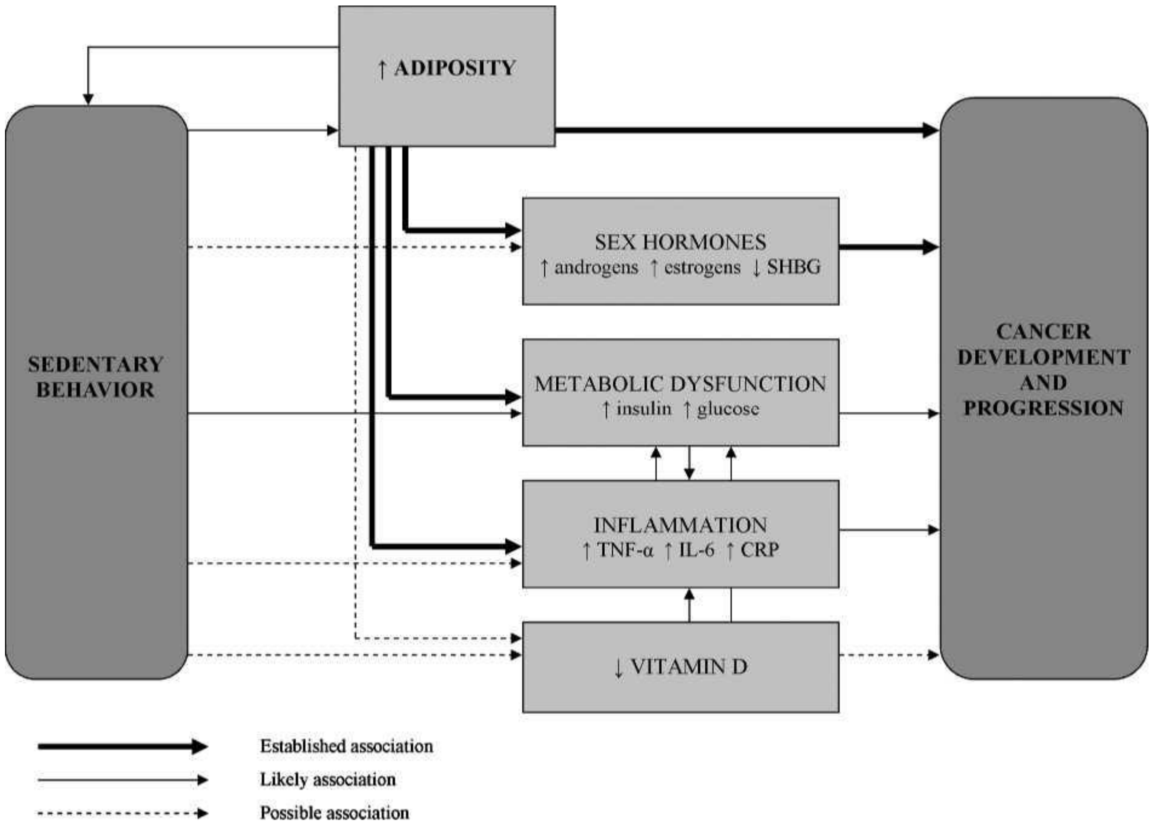

Figure 1.1 Hypothesized biologic pathway from sedentary behavior to cancer. (Lynch, 2010)

with thrombosis including fibrinogen, hematocrit, hemoglobin, red blood cell count, white blood cell count, mean platelet volume, platelet count, plasma volume. The authors found significant changes from prolonged sitting to measured levels of fibrinogen, hematocrit, hemoglobin, red blood cell count, and plasma volume that were attenuated by intermittent walking breaks (Howard et al., 2013).

While more epidemiologic evidence of associations between sedentary behavior and cancer is needed, biologic pathways for their associations have been hypothesized. In 2010, Brigid Lynch suggested possible, likely, and established associations between sedentary behavior and changes in sex hormone levels, metabolic dysfunction, inflammation, and vitamin D levels. All these changes have possible, likely and established associations with cancer as shown in Figure 1.1. Further, these connections may all act through the increase in adiposity that sedentary behavior is likely associated with (Lynch, 2010).

Bed rest studies have provided more evidence of the negative health consequences of sedentary behavior through metabolic effects. Periods of physical inactivity have been shown to be associated with unhealthy adipose tissue metabolism including glucose uptake, lipolysis, and lactate release, all possible linkages to the onset of type 2 diabetes (Hojbjerre et al., 2010). Severe whole body insulin-resistance was also found to be linked to sedentary behavior in a study that examined subjects before and after nine days of bed rest (Alibegovic et al., 2009).

1.1.3 Energy expenditure

Prolonged sitting can also have a substantial effect on daily energy expenditure levels. About one-third of daily energy expenditure is from activity which includes both exercise and non-exercise activity thermogenesis (NEAT) (Levine et al., 2006). NEAT is the energy expended by all physical activity other than that of intentional sporting-like exercise. It makes up for the majority of the variability in daily energy expenditure in most individuals because it can vary by as much as 2000 calories between people. As shown in Figure 1.2, moderate and vigorous intensity activity only account for a small percentage of typical daily activity and therefore can only impact a small percentage of daily energy expenditure. Replacing some time spent sedentary with light intensity physical activity is a promising way to increase NEAT levels throughout the day.

Occupation is a primary determinant of NEAT, and thus occupation is responsible for this wide variance (Levine et al., 2006, Levine, 2007). NEAT levels in a seated office environment can be increased through changes that lead to replacing some seated time with standing time (Benden, 2008). Even if caloric expenditure changes resulting from increasing NEAT levels are relatively small, they still may have a profound impact as it has been suggested that impacting energy balance through expenditure or consumption by as little as 100 calories a day may be sufficient to prevent weight gain in most U.S. adults (Hill et al., 2003).

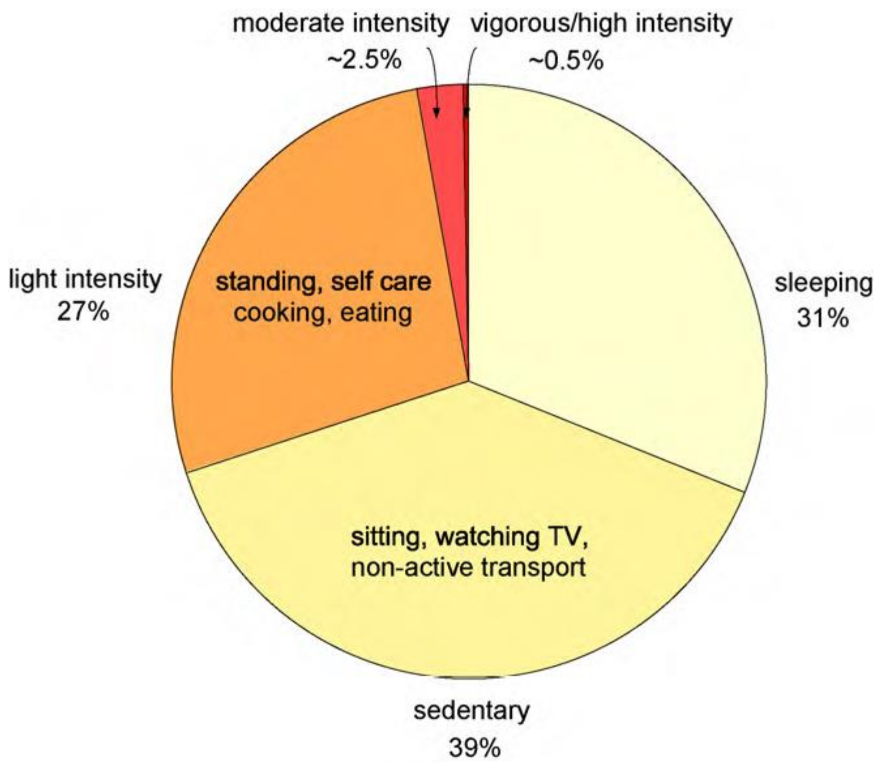

Figure 1.2 Typical adult pattern of daily activities, percentage of a 24 hour day (Norton et al, 2010)

1.1.4 Other effects of sedentary behavior

Effects of prolonged sitting stretch beyond those of chronic disease that have been widely studied, as previously described. Other consequences of prolonged sitting include lower back pain and body discomfort (Marshall and Gyi, 2010). In the U.S., lower back pain is highly prevalent and has a significant cost from medical expenses and lost productivity (Roffey et al., 2010). While a recent systematic literature review found no evidence to support a causal relationship between occupational sitting and lower back pain, Marshall and Gyi argue that static postures that result from seated work have a clearly established association with poor musculoskeletal health (Roffey et al., 2010, Marshall and Gyi, 2010).

Common ergonomic guidelines recommend variation in posture, but this may be difficult to do when sitting in a chair working on a computer. People in a lab-simulated office job that sat all day and did not vary their postures between sitting and standing reported a significantly higher number of musculoskeletal discomfort symptoms than those who varied their postures (Robertson et al., 2013). Variation of posture, or rotating between sitting and standing, has been shown to improve musculoskeletal discomfort without affecting work performance (Husemann et al., 2009).

While it is known that low levels of exercise are associated with depression, recent evidence suggests that those who have low levels of physical activity and high levels of sitting may have even higher odds of having depression than those who just sit less (van Uffelen et al., 2013). Other potential consequences of prolonged sitting may be breathing difficulty and chest pain (Peeters et al., 2013).

1.2 How much sitting do we do?

Many adults have found themselves in a daily routine that involves sitting while driving to work, sitting at a computer while at work, then sitting in the car to drive home, followed by more sitting in the evening while at home eating dinner and watching TV (Straker, 2012). Several studies have consistently shown that this equates to over half of our time awake being spent sedentary (Matthews et al., 2008, Healy et al., 2007, Vallance et al., 2011, Bankoski et al., 2011).

Studies that seek to measure the amount of time adults spend sedentary may utilize one of three techniques to quantify sedentary activities. Accelerometers have been used to measure amount of time spent sedentary based on low levels (<1.5 METS) of activity; inclinometers worn on the upper leg have been used to measure actual time seated; and self-reports have asked subjects to estimate the amount of time they are seated during a specific period or participating in a specific activity such as watching TV. In general, self-reported amounts of daily sitting in adults have been much lower than those found through objective measures, averaging around 4.7 to 5 hours a day (Bauman et al., 2011, Harrington et al., 2013).

Objectively measured average sedentary time measured with Actigraph^{TM} accelerometers in diabetic adults was 8.4 (s.d. 1.3) hours a day (Healy et al., 2007). Similar to the average of 8.5 (s.d. 2.2) hours per day sedentary found in a large cross-sectional study of 2,862 adults from the 2005-2006 National Health and Nutrition Examination Survey (NHANES) also using Actigraph^{TM} accelerometers (Vallance et al., 2011). Another study using NHANES data found that in a population of adults over 60, people spent an average of 9.5 hours a day sedentary (Bankoski et al., 2011). Even those who are meeting guidelines for 150 minutes per week of moderate-to-vigorous physical activity sit as much as those who do not meet physical activity guidelines (Craft et al., 2012). On the population level, differences in daily sedentary time have been seen for gender, race, and age (Healy et al., 2011a).

Americans are spending more time seated at their jobs than ever before, which is not surprising given the rise in technology. It is estimated that adults spend over half of their time at work in the seated position, and this may be closer to 90% for those who work in certain settings such as call centers (Straker et al., 2012). Fifty Australian office workers that wore Actical^{TM} accelerometers for seven days, were sedentary for 82% of their work day, with a total of 76% of workdays spent in sedentary time, compared to only 70% of non-work days that were spent sedentary (Parry and Straker, 2013). The study also found that workers had significantly fewer breaks in sedentary time during work hours than during non-work time.

As the proportion of manufacturing and agricultural jobs in the U.S. have declined, service jobs requiring less occupational energy expenditure have increased (Church et al., 2011). This has a profound impact on NEAT and daily energy expenditure. Figure 1.3 shows the steep decline in occupational related METs and energy expenditure since 1960. Church et al. concluded that over the past 50 years, mean daily occupational related energy expenditure has decreased by over 100 calories, which is enough to account for a large piece of the country's rising obesity epidemic that has occurred at the same time. This estimate of 100 calories is somewhat conservative as it does not account for advancements in technology that most likely allowed people in the same occupations to also expend less energy at work over time.

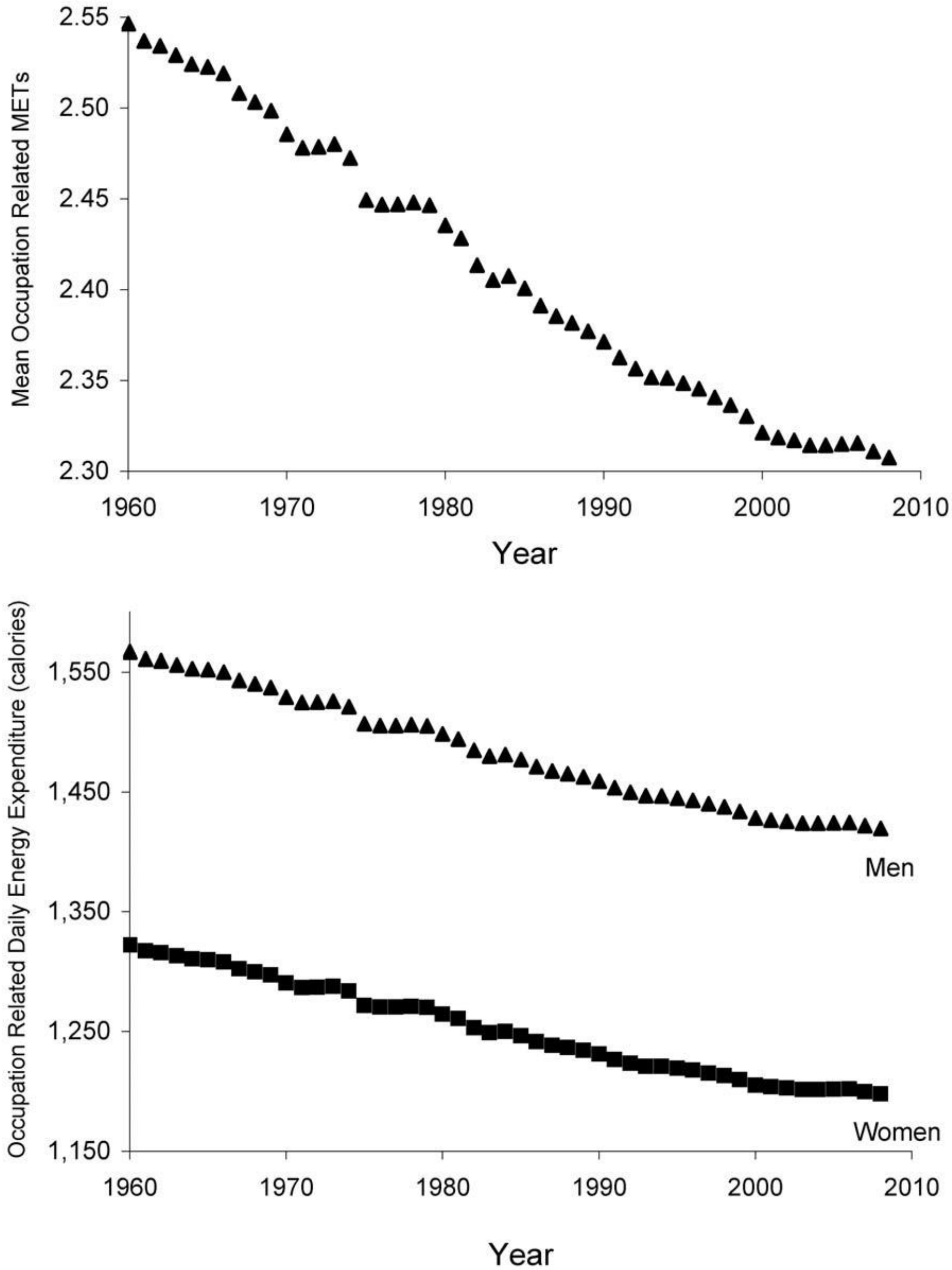

Figure 1.3 Occupational METs and energy expenditure since 1960 (Church et al., 2011)

1.3 Guidelines and recommendations

In spite of the recent evidence on the detriments of too much sitting, there are no clear guidelines for how much sitting time is healthy (Owen et al., 2009). The American College of Sports Medicine (ACSM) recognizes health benefits achieved through reducing time engaged in sedentary pursuits but makes no specific recommendations beyond generically recommending to reduce sedentary time and to break up sedentary activities with short bouts of physical activity or standing (Garber et al., 2011). Similarly, the American Cancer Society recommends limiting sedentary behavior such as sitting down, lying down, and watching TV (Kushi et al., 2012).

Having specific guidelines on the exact duration of daily sitting acceptable for optimal health would be ideal for public health messaging, but daily cumulative duration recommendations may never be the focus as breaks in sitting may be the true key. Recent laboratory based studies in overweight and obese adults have begun to shed more light on the importance of breaking up prolonged bouts of sitting. One study found that uninterrupted sitting increased fibrinogen, a protein with strong correlations to atherogenesis, thrombosis, and ischemia, but two minute bouts of light physical activity every 20 minutes attenuated these effects (Howard et al., 2013). Another study found that breaking up sitting with two minutes of light physical activity (walking) improved glucose metabolism compared to trials with no breaks in sitting (Dunstan et al., 2012b).

In her book titled *Sitting Kills, Moving Heals,* former director of NASA's Life Sciences Division, Janet Vernikos, writes that standing up often is what matters, not how long you stand (Vernikos, 2011). The act of standing up causes the body to initiate a shift in fluids, volume, and hormones, while muscle contractions occur and almost every nerve is stimulated. She has seen in her bed-rest studies in which she looked for ways to reduce gravity deprivation syndrome that bouts of standing were more effective at regulating blood pressure and restoring blood volume than bouts of slow walking. She postulates that this is because standing requires the body to pump blood up to the head without the help of contracting leg muscles. This recommendation for more breaks in sedentary time is supported by other studies that report an increasing number of interruptions to sedentary time were beneficial to metabolic risk markers such as measures of adiposity, blood glucose, C-reactive protein, triglycerides, HDL and blood pressure (Healy et al., 2008, Bankoski et al., 2011, Healy et al., 2011b).

1.4 Proposed intervention

While the evidence on the detriments of too much sitting is still growing, several researchers have pointed out that the science has mounted to the point that it is time to intervene and start testing how to best combat the problem of sitting too much (Owen et al., 2011, Gilson et al., 2012a). A 2011 theme issue on "too much sitting" of the American Journal of Preventive Medicine highlighted the growing evidence, both epidemiologic and physiologic, that sedentary behavior is an independent health risk factor of mortality. The issue contained an article by Owen and colleagues that explicitly stated the need for controlled intervention trials and "natural experiments" to acquire evidence on reductions in sedentary behaviors in adults (Owen et al., 2011). The authors used an ecological model to illustrate the need for interventions that target multilevel determinants of behavior and specific behaviors, settings such as the home or workplace, and population subgroups.

Dr. James Levine, known for his research on NEAT, has called for environmental changes particularly in the workplace, in order to increase NEAT levels (Levine, 2007). Since a large proportion of seated time occurs at work, workplace interventions offer an opportunity to significantly reduce someone's daily seated time. Also, since office based workers make up one of the largest employment groups (Dunstan et al., 2012a), approaches that focus on office settings have the potential to impact a large proportion of the employed population.

While the job of employers has traditionally been to protect workers from hazards they could encounter during work hours, many companies have demonstrated their willingness to expand beyond the role of health protection to health promotion. This has been demonstrated by anti-smoking and alcohol awareness programs that generally target activities outside of work (Straker and Mathiassen, 2009). Further, companies have sought ways to promote physical exercise in employees through incentive programs and onsite gyms. This is a direct result of companies recognizing that poor employee health leads to detriments in productivity and increases in healthcare costs. These current trends demonstrate that in light of recent evidence on the consequences of too much sitting, it would be reasonable for employers to intervene or offer alternatives to sitting while working.

Many approaches have been used to help people increase their physical activity, but only a few have been implemented to help people reduce their sedentary time. Office interventions that can replace employees' seated time with standing time have the potential to reduce mortality risks related to sedentary behavior, increase NEAT levels, and improve body comfort. Prior to 2009, a small number of workplace intervention studies existed that aimed to reduce sitting time, and the few that did had a primary focus of increasing physical activity (Chau et al., 2010). None of these studies were able to significantly reduce seated time compared to a control group.

One promising intervention is the use of stand-capable workstations as an alternative to traditional seated workstations. A stand-capable workstation allows someone to sit or stand at their workstation while they conduct their work. Several lab based studies have been conducted to assess the impact of standing on productivity, and so far no significant changes to productivity have been found (Husemann et al., 2009, Ebara et al., 2008). A recent review article examining sit-stand workstation effects on productivity and discomfort found that sit-stand workstations not only have no detrimental effects on productivity, but they also are likely to reduce perceived discomfort (Karakolis and Callaghan, 2014).

Several types of stand-capable workstations are on the market today. One type is a sit-stand workstation that allows the work surface to be adjusted from seated height to standing height. The adjustment typically can be made through the touch of a button connected to an electric or pneumatic lift device or by using a manual crank or lift.

Another type of stand-capable workstation is a stand-biased workstation. Stand-biased workstations are set at or can be adjusted to 40-42" high rather than the traditional

30”, and by design they encourage standing work for two to four hours per day rather than promoting the traditional eight hours of seated work (Gurr et al., 1998, Hjelm et al., 2000). A tall or bar-height chair (aka stool) is provided so that the user may sit at the workstation without adjusting the desk height. A stand-biased workstation should always include a footrest or foot-rail to allow variation in posture while both sitting and standing to improve comfort.

It is hypothesized that a stand-biased workstation will lead to greater utilization of the standing position than that of an adjustable sit-stand workstation. As more companies begin to implement stand-capable workstations, it has been acknowledged that many times sit-stand workstations are not fully utilized. One Swedish study that surveyed and interviewed employees at four different companies found that only about 20% of employees with a sit-stand desk utilized the stand function regularly (Wilks et al., 2006).

1.4.1 Energy expenditure of standing workstations

The most recent update to the compendium of physical activities reports that sitting for desk work requires 1.3 (Code 0904) to 1.5 (code 11580) METs and standing while on the computer is estimated to be 1.8 (code 09050) METs (Ainsworth et al., 2011). This can equate to a difference of about 40 calories an hour for a 175 pound person.

However, this estimate varies from that found in a lab study that used indirect calorimetry to assess the energy expenditure of subjects performing a typing task measured while seated in an office chair, seated on an exercise ball, and standing (Beers et al., 2008). Results of this study showed that working in the standing position caused a significant increase in energy expenditure of about 6%, or 4.1 kcal/hour, which in this population was a difference of approximately .06 METs between sitting and standing, much smaller of a difference than estimated using the compendium values.

The compendium values were further challenged in a 2011 pilot lab study in which no significant difference in energy expenditure was seen between sitting and standing office work (Speck and Schmitz, 2011). Study authors found working on a computer while sitting required an average of 1.038 (s.d. 0.08) METs and while standing required an average of 1.025 (s.d. 0.14) METs in the relatively small sample of only 13 adults measured for 7 minutes in each position with indirect calorimetry (Speck and Schmitz, 2011). Speck and Schmitz's MET value reported for sitting and working was similar to that reported for sitting in typing of 1.06 METs using a whole room calorimeter with 25 participants measured for 30 minute durations (Newton et al., 2013).

Another lab based study using indirect calorimetry with 20 healthy college-age students monitored for 45 minutes (with the first 15 minutes expunged) while preforming crosswords and word searches found that standing at an adjustable classroom desk utilized significantly more energy than sitting at a classroom desk (Reiff et al., 2012). Study authors found about a .34 kcal/min difference between sitting and standing in this study, a difference in METs of .28, very similar to the difference estimated from compendium values.

It is possible that the varying results of energy expenditure studies are due to differences in measurement times, calorimetry techniques, and formulas used to calculate energy expenditure. However, heterogeneity in energy cost of posture maintenance may also be a reason for differences seen across studies. After noticing reports of mean differences in sitting and standing energy expenditure ranging from none to over 20%, Miles-Chan and colleagues conducted a study utilizing 22 normal weight, European descent subjects measured with a ventilated-hood indirect calorimetry system that used minute by minute monitoring to detect changes in energy expenditure across the time-course (Miles-Chan et al., 2013). The authors found that eight out of 22 participants showed little or no change in energy expenditure standing compared to sitting, defined as a rise in energy expenditure change of less than 5%. Of the 14 participants that increased their energy expenditure while standing (7-21% over sitting), only 4 of them showed sustained increases in energy expenditure over sitting, and the other 10 decreased their energy expenditure values during the second 5 minutes of the standing period.

This study by Miles-Chan and colleagues has important implications for sedentary behavior research. The first is that there is a large variance in increase in energy expenditure gained from standing compared to sitting; as some people don not burn more calories standing and some burn 21% more. While the authors did find evidence that in general, standing increases energy expenditure over sitting, the evidence also indicates a possible difference in benefit gleaned from different usages of standing workstation interventions. Perhaps an even more important implication of this study is that energy expenditure of steady state standing will change over time in many people, and thus the pattern of standing may actually be more important than the total duration of standing, as proposed in other studies (Healy et al., 2008, Bankoski et al., 2011, Healy et al., 2011b, Dunstan et al., 2012b, Howard et al., 2013).While the study by Miles-Chan and colleagues was not able to measure the energy expenditure while transitioning from sitting to standing due to equipment used, it would be probable that the muscle movement required for the transition produced the highest increases in energy expenditure. If this is true and if energy expenditure increases dwindle after several minutes of standing, it may in fact be better to stress transitions rather than duration for those who use standing desks.

One noteworthy limitation of these energy expenditure studies besides the small sample sizes is that several have used young, healthy, normal weight subjects (Miles-Chan et al., 2013, Reiff et al., 2012). Other studies with a wider spread of ages have also included overweight (Beers et al., 2008) and obese (Speck and Schmitz, 2011) subjects but did not explore any differences for those who were older or heavier. With the high prevalence of overweight and obesity and aging workforce, it is important to understand the effects of age and weight status on differences in energy expenditure between seated and standing work.

While standing may not burn large amounts of energy more than sitting does, the physiologic research shows that standing may not have the same deleterious metabolic effects as sitting because of the way standing engages the large muscles of the lower body (Owen et al., 2011). It is possible that standing workstations allow for more transitions in addition to less seated time. Also, energy expenditure is not the only possible health benefit of standing workstations.

1.4.2 Other types of interventions

Another area that has been explored to decrease occupational sitting time is the use of software that prompts a computer user to take breaks at different times throughout the day. A recent study of 28 people in the United Kingdom found that this type of software significantly increased the number of breaks employees took from sitting but did not lead to significant impacts on total seated time (Evans et al., 2012). Negligible impacts on total seated time may always be a limitation with this single type of intervention in certain settings and job types as productivity may be hindered when employees are not seated at their workstations for long periods.

In the Netherlands, similar idea was developed by researchers who used accepted branding techniques to develop a term called "Stuff" that stands for Stand Up For Fun (Rutten et al., 2013). While the researchers have not formally tested "stuff" they assert that it can be used to help remind people to interrupt prolonged bouts of sitting with short breaks.

Treadmill workstations have been explored as a way to increase movement while working. Using a vertical treadmill workstation can lead to an additional 100 kilocalories being burned per hour, equating to an additional 400 kilocalories if an employee used the treadmill function for half of the day (Levine, 2007). Several barriers exist to the widespread use and implementation of treadmill desks. Treadmill desks are expensive, require more space than a traditional workstation, and add noise to the office environment (Benden, 2008). They have also been shown to cause a 6-11% decrease in keying and mousing capabilities (John et al., 2009, Straker et al., 2009). However, a year-long follow-up of 36 office employees with treadmill desks suggested that employees may suffer a minor deficit in work performance the first 3-5 months with a treadmill desk, but by the end of the 12 month follow-up work performance can surpass levels from seated work (Koepp et al., 2013). This study did find a significant decrease in sedentary time after implementation of the treadmill desks and modest amounts of weight loss. Further, the authors found obese people benefitted the most in terms of weight loss and suggested that providing a $3,000 treadmill desk to avoid the $10,000 a year cost of diabetes could be cost effective if specific individuals are targeted (Koepp et al., 2013).

Another alternative setup catching on in offices is the use of an exercise or therapy ball in place of a chair. The idea is that sitting on the exercise ball engages more muscles and burns more energy. Little research exists to support the use of exercise balls. One study on the use of exercise balls as chairs found that they produced no benefit but instead caused deficits to comfort (McGill et al., 2006).They offer no back support and are not adjustable, which often equates to poor ergonomics. Also, they do not pass American National Standards Institute (ANSI) office seating stability requirements (Maynard, 2013). Both the exercise ball and treadmill desk have been criticized for posing a risk for falling. Many corporate safety cultures would likely view this increase in risk as unacceptable.

1.4.3 Previous studies

To date, a limited number of research studies have been published on the use of stand-capable workstations and their impact on energy expenditure. No published studies have examined the use stand-biased workstations in adult populations. Lab studies have demonstrated that the use of a sit-stand workstation does not lead to deficits in keying or mousing capabilities (John et al., 2009).

Several studies have found that the use of a sit-stand workstation can significantly reduce seated time (Pronk et al., 2012, Alkhajah et al., 2012, Grunseit et al., 2013). Short term follow up of one month in one office intervention study found 66 minutes per day reductions in seated time while at work (Pronk et al., 2012). Two other studies that have followed up after a longer period with the sit-stand desks observed reductions in seated time of 137 minutes per day (Alkhajah et al., 2012) and 102 minutes per day (Grunseit et al., 2013). One recent study in Sweden did not introduce the sit-stand workstations; the authors just observed habits of call center workers that already had them (Straker et al., 2012). The study authors found a significant difference of about 19 minutes between amounts of seated time while at work between those who had sit-stand workstations versus traditional seated workstations. The latter study represents a population that had used the sit-stand workstations for more than just a short intervention period of 3 months or less, suggesting that as the novelty of the sit-stand workstation wears off, use of the standing position decreases. This may also be the reason that Wilks et al. 2006 only found one in five employees surveyed with a sit-stand desk actually used the stand function.

A recent Australian study by Healy and colleagues examined the short-term efficacy of a multi-component intervention that integrated individual, environmental, and organizational elements to reduce office sitting time. The authors found that those who received the intervention sat about two hours less per workday, made almost two additional sit to stand transitions per hour sitting, and had approximately one hour less of prolonged sitting compared to the controls after a four week intervention period (Healy et al., 2013). The study also examined anthropometric and cardio-metabolic health outcomes but found no statistically significant effects. This study was the first of its kind to examine a multi-component intervention that included installation of sit-stand workstations (environmental), management support, workshop on excessive sitting, weekly email standing tip (organizational), and face to face and phone support for participants via a health coach (individual).

The previously mentioned sit-stand desk studies all used measures of actual time seated either through some method of self-report (Pronk et al., 2012, Grunseit et al., 2013) or an inclinometer (Straker et al., 2012, Alkhajah et al., 2012, Healy et al., 2013). Only one published adult study in the literature used time sedentary measured via an accelerometer as the outcome of interest in a study of sit-stand workstation usage (Gilson et al., 2012b). While this study by Gilson and colleagues observed that participants were utilizing the standing desks, they did not find any significant difference in proportion of the workday spent in sedentary behavior compared to measurements taken prior to implementation of the stand-capable workstations (Gilson et al., 2012b). These results may not be surprising given that standing to work may not cause an increase in energy expenditure above the threshold of 1.5 METs for light physical activity.

1.5 Purpose of current study

The primary purpose of the current study is to determine if reductions in sedentary behavior may be achieved or better sustained by the use of a stand-biased workstation as compared to a sit-stand workstation. The secondary purpose of this study is to determine personal factors and perceptions related to the use of a stand-capable workstation. Reducing sedentary behavior has a positive impact on overall health, daily energy expenditure, and musculoskeletal comfort.

The following dissertation includes stand-capable desk studies in three different office environments. The first study was conducted at a large pharmaceutical company to determine factors associated with stand-capable workstation usage in an open seating office plan in which several sit-stand workstations are available. The second study utilized employee interviews to gather perceptions and standing habits with stand-biased desk users at The Texas A&M School of Rural Public Health. A six-month follow-up study of call center employees collected objective and subjective data to compare the use of a sit-stand, stand-biased and traditional seated workstations.

2 PRE AND POST MOVE SURVEYS WITH EMPLOYEES MOVING INTO AN OPEN OFFICE PLAN ENVIRONMENT WITH STAND-CAPABLE DESKS AVAILABLE

2.1 Overview

Americans are spending more time seated at their jobs than ever before. It is estimated that adults spend over half of their time at work in the seated position, and this estimate may be closer to 90% for those who work in certain settings such as call centers (Straker et al., 2012). Recent studies have shown that workplace sitting has a direct impact on overall daily sedentary time defined as energy expenditure less than 1.5 METs (Metabolic Equivalents) (Parry and Straker, 2013).

A growing body of evidence has shown the negative consequences of too much sitting throughout the day and prolonged sitting without breaks. High daily durations of sitting or sedentary time are associated with morbidity, cardiovascular disease, and diabetes (Wilmot et al., 2012). Research in the emerging field of inactivity physiology has further highlighted the metabolic consequences of uninterrupted sitting, but these negative effects can be attenuated through short bouts of walking (Healy et al., 2007, Dunstan et al., 2012b, Howard et al., 2013).

Sit-stand workstations that allow computer workstation users to work in either a seated or standing position offer a potential solution to the rampant problem of too much sitting. Initial lab-based studies have shown sit-stand workstations do not cause detriments to productivity and are able to improve user discomfort (Karakolis and Callaghan, 2014).

Several intervention studies assessing usage one to three months after sit-stand desk implementation have found reductions in daily seated time of approximately one to two hours (Pronk et al., 2012, Grunseit et al., 2013, Alkhajah et al., 2012, Healy et al., 2013). However, cross-sectional studies of work settings where sit-stand workstations have been present for 6 months up to many years reveal much smaller impacts to seated time and lower daily usage of the stand function indicating that usage may decline after novelty of the desk wears off (Straker et al., 2012,Wilks et al., 2006).

An open office seating plan that contains a mix of traditional seated workstations and sit-stand workstations offers a unique opportunity to study usage of sit-stand workstations because of the choice it provides employees on a daily basis. The purpose of this study was to gather information about perceptions and experiences with sit-stand workstations before and after employees had an opportunity to work at one.

One prior study has looked at the usage of stand-capable workstations in an open seating plan. This study by Gilson et al. (2010) did not find any significant changes in sedentary time in the employees they followed for one week immediately after stand-capable desks had been made available. The study highlights the need to examine factors associated with sit-stand workstation usage as participants exhibited a wide range of usage habits (one participant did not use the desk at all, while several employees used the desk at least once a day) (Gilson et al., 2012).

2.2 Methods

2.2.1 Setting

A large pharmaceutical company began implementing open office seating plans in several of its offices in 2012. An open office plan does not use assigned workspaces for employees; instead, employees can sit at any open desk when they arrive at work. This office plan is ultimately a cost saving plan as less office real estate is needed and people tend to interact and be more collaborative once they have become accustomed to the new setup. Within this environment in the Southeastern United States, several sit-stand workstations were made available. This offered a unique setting in which to study usage and factors associated with use of the stand-capable workstations because of the choice employees were given in selecting the type of workstation they used each day when they arrived at the office.

Prior to moving into the open office environment, a brief orientation described open office etiquette. During this time employees were also told that several sit-stand workstations would be available in the new location.

2.2.2 Recruitment

After study approvals from the Texas A&M Institutional Review Board and the pharmaceutical company's legal department were obtained, potential participants were contacted by email with an invitation to participate in a study on stand-capable workstations. The email was sent from within the company and had a link to the study survey. Reminder emails went out two times.

2.2.3 Participants

Employees in an office scheduled to move to an open office seating environment were invited to participate in the study. 154 people were in this group scheduled to move. Table 2.1 displays characteristics of the primarily female, middle-aged population. Job level is also presented in the table, with level one representing the highest grade.

Table 2.1 Pre-move participant characteristics (n=36)

Female	28 (77.8%)
Age range	
25-34	4 (11.1%)
35-44	11 (30.6%)
45-54	15 (41.7%)
55+	6 (16.7%)
Height range	
4’10” to 5’2”	4 (11.1%)
5’3” to 5’6”	14 (38.9%)
5’7” to 5’10”	10 (27.8%)
5’11” to 6’2”	6 (16.7%)
6’3” or taller	2 (5.6%)
Weight range (in pounds)	
125 or less	5 (13.9%)
126 to 155	10 (27.8%)
156 to 185	9 (25.0%)
186 to 215	7 (19.5%)
216 to 245	2 (5.6%)
246 or more	3 (8.4%)
Job Level (1 is highest)	
1	1 (3.0%)
4	3 (9.1%)
5	5 (15.2%)
6	11 (33.3%)
7	6 (18.2%)
8	5 (15.5%)
10	2 (6.1%)
Level of comfort	
Low	1 (3%)
Moderate	13 (39.4%)
Strong	12 (36.4%)
Very strong/extreme	7 (21.2%)

2.2.4 Study protocol

Study participants were asked to complete an online survey hosted in the company’s internal survey system. The survey was administered to participants approximately two weeks prior to the office move while they were in a traditional seated assigned office environment. The survey, found in Appendix A, included basic classification questions about participants (gender, height category, weight category, age category, and job level within the company). It also asked respondents to provide several estimates of time spent doing certain activities throughout the day (time at desk, time keying and mousing, and time on a computer at home). The survey then provided a description of a stand-capable workstation and asked a series of questions related to whether or not the participant thought they would use one if it were available, how much they would use it, and factors that made them want to or not want to use it. At the end of the survey, participants were asked if they were willing to complete a brief post move survey similar to the pre-move survey.

Three months after the move to an open seating plan office with stand-capable workstations available, participants were emailed a link to a post survey, found in Appendix B. The post survey asked the same basic classification questions about participants as the pre survey. It also asked about stand-capable workstation usage and estimated time spent standing. The survey collected information about what factors had made someone want to use or not want to use the standing position while working.

Data were downloaded from the company's internal survey system into a Microsoft™ Excel file and shared with Texas A&M. Data were then transferred into Stata version 13 (StataCorp LP, College Station, TX) for analysis.

2.2.5 Analysis

Descriptive statistics were calculated for the participant characteristics of both the pre and post survey. All data were collected as categorical variables, so all descriptive statistics for all questions are presented as proportions.

Fisher's exact test was used to determine if any perceived benefits or barriers to standing while working were associated with a participant's prediction of their likelihood of standing while working.

2.3 Results

2.3.1 Population characteristics

A total of 36 people initiated participation in this study as shown in Figure 2.1.

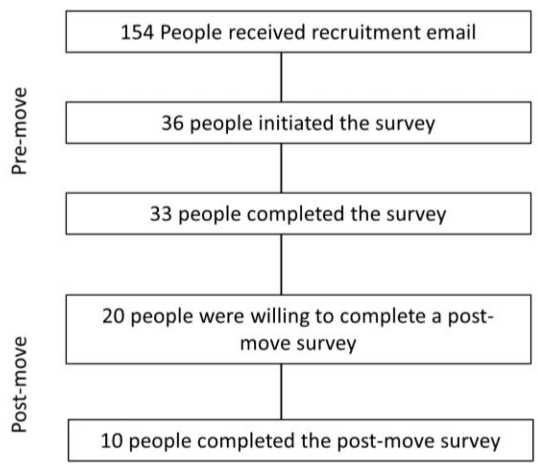

Figure 2.1 Survey response diagram

2.3.2 Reported habits

Pre-move habits are displayed in Table 2.2. Responses indicate that a majority of participants spent more than 6 hours a day seated and spent some time on the computer at home for both work and non-work activities.

Table 2.2 Pre-move habits (n=33)

Time spent seated	
>2-4 hours	3 (9.1%)
>4-6 hours	4 (12.1%)
>6-8 hours	22 (66.7%)
>8 hours	4 (12.1%)
Time spent standing	
0 hours (not at all)	23 (69.7%)
2 hours or less	10 (30.3%)
Time spent actively keying and mousing	
>2-4 hours	2 (6.1%)
>4-6 hours	10 (30.3%)
>6-8 hours	18 (54.6%)
>8 hours	3 (9.1%)
Time at home on computer for work-related activities	
none	7 (21.2%)
<2 hours	18 (54.6%)
2-4 hours	5 (15.2%)
>4 hours	1 (3.0%)
Preferred not to answer	2 (6.1%)
Time at home on computer for non-work related activities	
<2 hours	28 (84.9%)
2-4 hours	4 (12.1%)
Preferred not to answer	1 (3.0%)

2.3.2.1 Stand-capable workstation perceptions

Table 2.3 presents the responses to questions asked in the pre-move survey about predicted usage of a stand-capable workstation. Responses entered for other reasons that would make someone want to or not want to stand are included in Appendix C.

Table 2.3 Pre-move perceptions related to stand-capable workstations (n=33)

Likelihood of using a stand-capable workstation if one were available	
Very unlikely	4 (12.1%)
Unlikely	6 (18.2%)
Neither likely or unlikely	10 (30.3%)
Likely	6 (18.2%)
Very Likely	7 (21.2%)
How much of a typical workday participants thought they would stand	
No time at all	7 (21.2%)
1 hour or less a day	14 (42.4%)
>1-2 hours per day	7 (21.2%)
>2-6 hours per day	5 (15.2%)
Factors that would make participants consider trying a stand-capable workstation	
Increased body comfort	22 (66.7%)
Productivity	9 (27.3%)
To burn more calories/lose weight	14 (42.4%)
To stay alert	21 (63.6%)
Curiosity to try it out	15 (45.5%)
Other reason listed	5
Factors that would make participants not consider trying a stand-capable workstation	
Decreased body comfort	21 (63.6%)
Energy required	4 (12.1%)
Potential impacts to productivity	16 (48.5%)
Potential impacts to alertness	4 (12.1%)
Time it takes to adjust the furniture	5 (15.5%)
Other	5
If having a stand-capable workstation would make participants more likely to come into the office than work from home	
N/A-don't have ability to work from home	2 (6.1%)
Yes, it would make me more likely to come in	4 (12.1%)
No, it would not make me any more likely to come into the office	27 (81.8%)

2.3.2.2 Post-move survey

A total of 10 participants completed the post-move survey. Appendix C contains the age distribution of the two men and eight women that completed the survey. Table 2.4 displays the post-move habits reported by these respondents. When asked how often someone had tried to use a stand-capable workstation but one was not available, half of the respondents said it never occurred and half said that it occurred 25% of the time or less.

Reported stand-capable usage in the post move survey compared to pre move survey responses are in Table 2.5. Table 2.6 displays the perceptions of stand-biased workstations that post-survey respondents reported.

Table 2.4 Post-move habits (n=10)

Time spent seated	
2 hours or less	1 (10%)
>4-6 hours	3 (30%)
>6-8 hours	5 (50%)
>8 hours	1 (10%)
Time spent standing	
0 hours (not at all)	6 (60%)
2 hours or less	3 (30%)
>4-6 hours	1 (10%)
Time spent actively keying and mousing	
>2-4 hours	4 (40%)
>4-6 hours	3 (30%)
>6-8 hours	3 (30%)
Type of workstation currently used the most	
Adjustable sit-stand capable workstation	8 (80%)
Fixed height individual workstation	2 (20%)
Time at home on computer for work-related activities	
<2 hours	10 (100%)
Time at home on computer for non-work related activities	
none	1 (10%)
<2 hours	7 (70%)
>2 hours	2 (20%)

Table 2.5 Predicted and actual stand-capable desk usage

	Post survey stand-capable desk usage	
	Occasional use of standing position (n=5)	No occasional use of standing position (n=5)
Pre-survey prediction of stand-capable desk usage		
Unlikely	1*	2
Neither likely or unlikely	1	2
Likely	1	1*
Very likely	2	0
*2 people deviated from their predictions		

Table 2.6 Post-move perceptions related to stand-capable workstations (n=10)

Change in attitude towards using a stand-capable workstation?	
No change	7 (70%)
Positive	2 (20%)
Significantly more positive	1 (10%)
Have used the stand-capable workstation in the standing position at least occasionally	
Yes	5 (50%)
No	5 (50%)
Factors that make participants continue stand for short periods at a stand-capable workstation	
Increased body comfort	7 (70%)
Productivity	1 (10%)
To burn more calories/lose weight	5 (50%)
To stay alert	6 (60%)
Curiosity to try it out	5 (50%)
Locations of the workstations with the SMART working space	2 (20%)
Other reason listed	2 (20%)
Factors that make participants not continue stand for short periods at a stand-capable workstation	
Decreased body comfort	6 (60%)
Potential impacts to productivity	2 (20%)
Time it takes to adjust the furniture	1 (10%)
Undesirable locations of the workstations with the SMART working space	3 (30%)
Insufficient number of adjustable workstations in the SMART working space	2 (20%)
Other	2
If the stand-capable workstations make participants more likely to come into the office than work from home	
Yes, it has made me more likely to come in	1 (10%)
No, it has not influenced my attitude either way	9 (90%)

2.4 Discussion

Results of this study show that half or less of participants stood while working at a stand-capable workstation. 80% of post-survey respondents said they typically used a sit-stand workstation but only 50% said they actually stood at their workstation. This provides additional evidence that provision of a stand-capable workstation does not lead to usage of the stand function for everyone. In fact, usage may be very low after a long period with the workstations. Wilks et al. (2006) found that only about 20% of people with a stand-capable workstation used it for standing work.

Low utilization of the standing function may have been predictable before the move. In the pre-move survey, approximately 40% of participants expressed a likelihood of using a stand-capable workstation, 30% expressed that they would not use a stand-capable workstation, and 30% expressed that they were neither likely nor unlikely to use a stand-capable workstation. This brings up questions as to how stand-capable workstation interventions can best be deployed if less than half of people think they will actually use one. How someone perceives a stand-capable workstation before they have the chance to try one out may be an important barrier to use as many think they would not actually stand. It further brings up questions as to how to best inform those who are undecided about stand-capable workstation use. While the number of people completing the follow-up survey was small, it does provide some evidence of deviations from some people's original projections, as shown in Table 2.5. Only one of the three people who were "on the fence" about their projected stand-capable workstation usage reported using it. Opinions about a stand-capable workstation can be changed once someone is able to use one. Three (30%) of the post survey respondents had a more positive opinion about stand-capable workstations since moving to the new office.

This study provides evidence that comfort is a common reason for both standing and not standing while working. Approximately 60-70% of respondents of both the pre and post move surveys answered that body comfort was a factor for trying/using or not trying/continue using a stand-capable workstation in the standing position. The perception that stand-capable workstations could increase comfort was significantly associated with prediction that one would use a stand-capable workstation (see Appendix C). Perception of decreases in comfort was not significantly associated with prediction of using a stand-capable workstation. The variation of posture available from sit-stand workstations is widely accepted as a way to increase comfort. However, comfort may still be a barrier to use of the sit-stand workstations. Sit-stand workstations should be installed with appropriate accessories including anti-fatigue mats, footrests, and monitor arms in order to maximize comfort while standing, and help address comfort as a barrier for not standing.

Another commonly cited reason for wanting to use a stand-capable workstation was to stay alert. This reason was significantly associated with a prediction that one would stand at their workstation. No other perceived positive or negative aspects besides comfort were associated with prediction of standing habits. Only about a quarter of people thought that a stand-capable workstation would impact productivity in a positive way, while about half of people thought it would impact productivity in a negative way. This highlights the need for productivity to be explored in future research on stand-capable workstations as well as intervention messaging. Currently, studies of stand-capable workstation effects on productivity are limited to only lab settings (Karakolis and Callaghan, 2014, Robertson et al., 2013).

2.4.1 Limitations

Less than a quarter of employees that received the survey initiated it, and only a small number of participants completed the follow-up survey. The move to an open-plan office was met with some resistance by employees that were accustomed to traditional individual offices, and this may have impacted participation. The survey was administered through internal sources rather than from outside researchers. No data is available to determine any differences in people that did or did not complete the survey. In addition to a small sample size, response bias was also likely in this study, but could not be ascertained.

In order to limit the intrusiveness of the study, participants' height and weight were collected through categorical questions that provided ranges. Unfortunately, this placed limitations on how well the population could be classified and described. Data examining the conservative extreme of each category classify eight participants as obese, five participants as overweight or possibly obese, and several others that could be classified as overweight. Also, the study did not offer many opportunities for participants to provide open ended feedback about the stand-capable workstations. People who answered "other" and wrote specific reasons provided important information about influences on standing habits. For example, one person mentioned that seeing others standing influenced them towards standing, and one person mentioned a sense of less privacy influencing them not to stand. Both comments bring to light the importance of social and environmental influences that can easily be overlooked in intervention trials.

It is likely that self-reported time spent seated/standing is difficult for people to estimate. While the survey used a question similar to the Occupational Sitting and Physical Activity Questionnaire (OSPAQ), a tool with good reliability and moderate validity (Chau et al., 2012), it was not exactly the same.

2.4.2 Strengths

A major strength of this study is the environment that it was conducted in. An open plan office that allows a choice in desk type each day offers a unique perspective to study sit-stand workstation usage.

Another strength of this study is that employees were surveyed prior to their move into the new office that had sit-stand workstations available. This offered an opportunity to collect perspectives on sit-stand workstations before people had a chance to experience them. Participants had attended an open office orientation prior to completing the survey so they were familiar with the concept of a sit-stand workstation. While participation in the post-survey was low, it did offer insight into potential changes in perceptions after experiencing a stand-capable workstation.

2.5 Summary

Results of this study indicate that less than half of people in an office setting predicted they would stand to work when a sit-stand workstation became available to them. Once they had access to the stand-capable workstations, about half of the people utilized the stand-capable function, and 20% of people deviated from the standing habits they predicted. If people’s opinions of standing workstations change after using one, it became more positive. Comfort appears to be a major factor affecting stand-capable workstation usage.

3 INDIVIDUAL INTERVIEWS WITH STAND-BIASED WORKSTATION USERS

3.1 Overview

Americans are spending more time seated at their jobs than ever before. It is estimated that adults spend over half of their time at work in the seated position, and this estimate may be closer to 90% for those who work in certain settings such as call centers (Straker et al., 2012). Recent studies have shown that workplace sitting has a direct impact on overall daily sedentary time defined as energy expenditure less than 1.5 METs (Metabolic Equivalents) (Parry and Straker, 2013).

A growing body of evidence has shown the negative consequences of too much sitting throughout the day and prolonged sitting without breaks. High daily durations of sitting or sedentary time are associated with morbidity, cardiovascular disease, and diabetes (Wilmot et al., 2012). Research in the emerging field of inactivity physiology has further highlighted the metabolic consequences of uninterrupted sitting, but these negative effects can be attenuated through short bouts of walking (Healy et al., 2007, Dunstan et al., 2012b, Howard et al., 2013).

Sit-stand workstations that allow computer workstation users to work in either a seated or standing position offer a potential solution to the rampant problem of too much sitting. Initial lab-based studies have shown sit-stand workstations do not cause detriments to productivity and are able to improve user discomfort (Karakolis and Callaghan, 2014).

Several intervention studies assessing usage one to three months after sit-stand desk implementation have found reductions in daily seated time of approximately 1-2 hours (Pronk et al., 2012, Grunseit et al., 2013, Alkhajah et al., 2012, Healy et al., 2013). However, cross-sectional studies of work settings where sit-stand desks have been present for 6 months up to many years reveal much smaller impacts to seated time and lower daily usage of the stand function indicating that usage may decline after novelty of the desk wears off (Straker et al., 2012, Wilks et al., 2006). One potential way to encourage continued use of sit-stand desks after their novelty has worn off is to design them to bias the user towards standing (Benden, 2008). A stand-biased workstation is set at or can be adjusted to 40-42" high rather than the traditional 30", and by design it encourages standing work for two to four hours per day rather than promoting the traditional eight hours of seated work (Gurr et al., 1998, Hjelm et al., 2000). A tall or bar-height chair (aka stool) is provided so that the user may sit at the workstation without adjusting the desk height. A stand-biased workstation also includes a footrest in order to allow for varying of posture and improved comfort.

No one has yet published any studies on the use of stand-biased workstations in an office setting. The aim of this study was to assess the usage and perceptions related to stand-biased workstations in office workers employed in an academic research setting.

3.2 Methods

3.2.1 Setting

Interviews were conducted with employees currently using stand-biased workstations at the Texas A&M Health Science Center School of Rural Public Health (SRPH) in College Station, TX. The employees that were recruited into the study work in the SRPH administration building and have a stand-biased workstation set-up in a private office. Most stand-biased workstations were set up by retrofitting existing furniture to standing height for each individual, and converting to a stool height office chair. No standard office desk or chair was used for SRPH stand-biased conversions. All SRPH employees that converted to the stand-biased workstation had the Neutral Posture Inc. (Bryan, Texas) N·tune® footrest under the desk and and N·step™ footrest attached to their chair. Figure 3.1 shows a typical stand-biased workstation set-up used at SRPH.

Figure 3.1 Typical SRPH stand-biased workstation in seated and standing position

3.2.2 Recruitment

After approval from the Institutional Review Board was obtained, potential participants were contacted via email, see Appendix D and Appendix E, to schedule a face to face or phone interview time. Follow-up emails were sent to those who did not respond within a few days.

3.2.3 Participants

SRPH employees that were contacted for the interviews were full time employees, working in administrative, research, or teaching positions. All potential subjects had worked at SRPH for longer than 3 months. Two of the participants were adjunct faculty at SRPH that no longer had offices at SRPH but had offices at other academic institutions where they kept their stand-biased setups. All SRPH employees that converted to a stand-biased workstation did so by request to the administration, who later provided a list of potential participants to the researcher.

3.2.3.1 Population characteristics

A total of 25 of 27 people contacted for the study agreed to participate, for a recruitment rate of 92.6%. Characteristics of the study population and its desk set-ups are provided in Table 3.1.

Table 3.1 Participant Characteristics (n=25)

Mean (SD) age (years)	42.8 (12.4)
% Female	72.0
BMI Categories	
% Normal Weight	56.5
% Overweight	26.1
% Obese	17.4
Physical Activity Level	
% Low	12.0
% Moderate	44.0
% High	44.0
Race	
% Non-Hispanic white	76.0
% Asian	12.0
% Hispanic white	4.0
% Black or African American	4.0
% Multiracial	4.0
Office Accessories	
% with footrest	100.0
% with monitor arm	84.0
% with keyboard tray	36.0
% with anti-fatigue mat	12.0
Mean (SD) months with stand-biased workstation	18.8 (15.5)

24 out of 25 participants provided their age, and 23 out of 25 participants provided their weight to calculate BMI.

3.2.4 Study protocol

Once an interview was set up, the researcher called or met with participants in their offices at SRPH. An approximately 15 minute long interview took place with each individual using the script in Appendix F. The interview covered the participant's history of using a stand-biased workstation, their current habits, and their experiences with the workstation. Participants were asked to estimate the amounts of time they spent seated and standing at their workstation. No specific instrument was utilized for these questions. However, questions were similar to questions used in the Modified Occupational Sitting and Physical Activity Questionnaire (OSPAQ), a tool with reported excellent test-retest reliability and moderate validity (Chau et al., 2012). The OSPAQ asks, "On a typical workday in the past seven days, how much of your working time did you spend sitting (Pereira et al., 1997) ?"The questionnaire used in this study asked participants to "estimate the total number of hours you spend seated at your primary workstation throughout a typical 8-hour workday." Another study that has assessed time spent seated and standing through self-report and objective monitoring have noted that the two measures correspond well (Toomingas et al., 2012).

Physical activity was assessed using questions from the International Physical Activity Questionnaire (IPAQ) which has been validated for measuring physical activity levels in 18 to 65 year olds through self-report (Craig et al., 2003). Survey responses to this set of questions allowed for classification of participants' physical activity levels into 3 categories: low, medium, or high. The interview also collected information about basic demographics.

3.2.5 Analysis

Analysis of the data included basic descriptive statistics in order to describe typical usage of stand-biased workstations. The primary purpose of the interviews was to examine self-reported seated and standing habits of stand-biased workstation users and to collect subjective information about each user's experience with the workstation.

All data were transferred from Excel into STATA/IC version 13 (STATA Software, version 13.0, StataCorp LP, College Station, TX) for analysis. Descriptive statistics (means, standard deviations, and frequencies) were calculated for each variable in the dataset. Distributions of variables were examined graphically with boxplots and histograms. A two-sample t-test was used to compare any differences in reported standing time between those who had a stand-biased workstation for less than one year and those who had a stand-biased workstation for a year or more.

3.3 Results

The average time a participant had a stand-biased workstation was 18 months and ranged from 1.5 months up to five years. Figure 3.2 shows the distributions of participants' time with a stand-biased workstation.

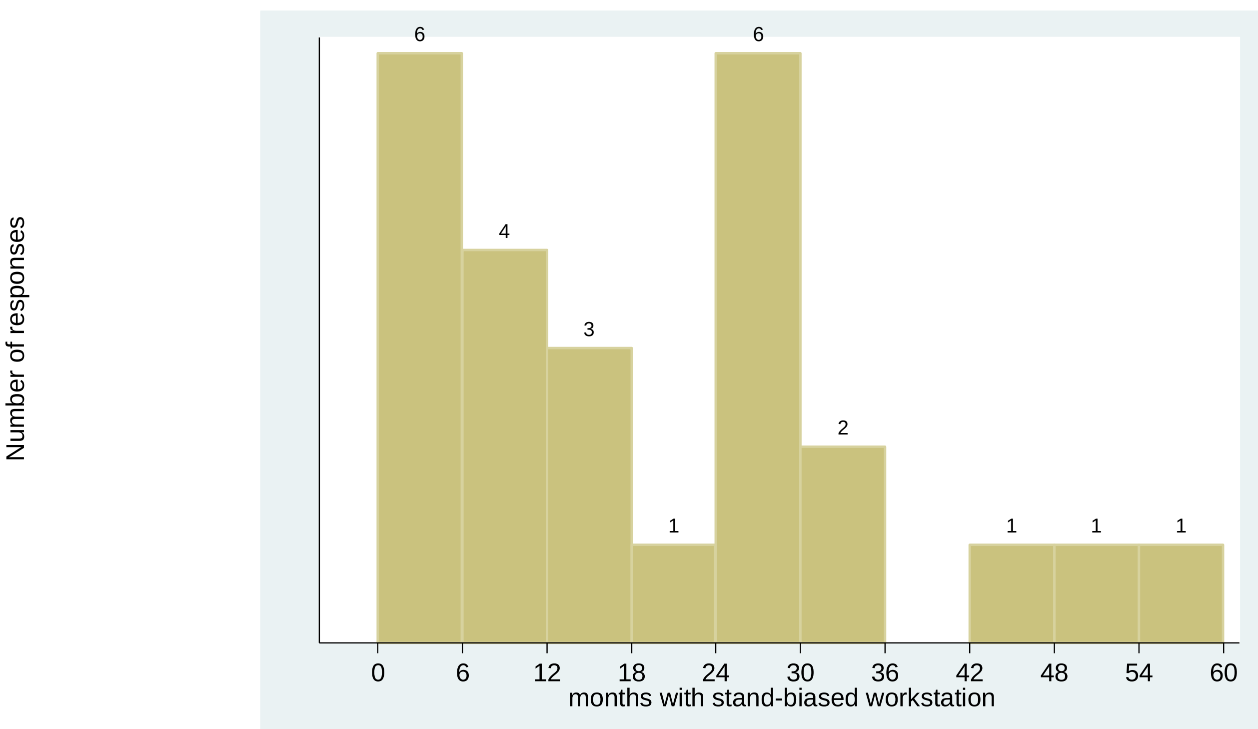

Figure 3.2 Histogram of participants' time with a stand-biased workstation

3.3.1 Reported workstation usage

Participants reported the average amount of time they spent at their workstation on a typical workday to range between two and eight hours, with a population average of 6.4 hours and standard deviation of 1.7. They reported an average of 3 hours, or 49% of their time, at the workstation spent seated and an average of 3.4 hours, or 51% of their time, at the workstation spent standing. In great contrast, they reported an average of 99% of the time spent seated prior to converting to a stand-biased workstation. Prior to conversion 23 participants reported no time standing, and two people reported one hour or less. Data are displayed in Table 3.2.

Table 3.2 Reported standing and sitting habits before and after conversion

	Prior to switching to stand-biased workstation (n=25)	After switching to a stand-biased workstation (n=24)
Percent of time seated	99%	49%
Percent of time standing	1%	51%
Paired t-test for time sitting/standing before and after switching p value=.000		

Comparisons of standing habits were made between those who had a stand-biased workstation for less than a year and those who had the workstation for a year or longer as shown in Table 3.3. No significant differences were found. Figure 3.3 shows a scatterplot used to check for any trend in standing habits by time with workstation. The scatterplot revealed no trend in standing habits by time with workstation, suggesting that a decline in workstation usage over duration of use did not occur with study participants.

Table 3.3 Reported standing and sitting habits by time with workstation

	Stand-biased workstation less than one year (n=10)	Stand-biased workstation one year or more (n=14)	p value
Time standing in hours	3.5	3.3	.7996
Percent of time standing	58%	46%	.3081
p-value from two sample t-test			

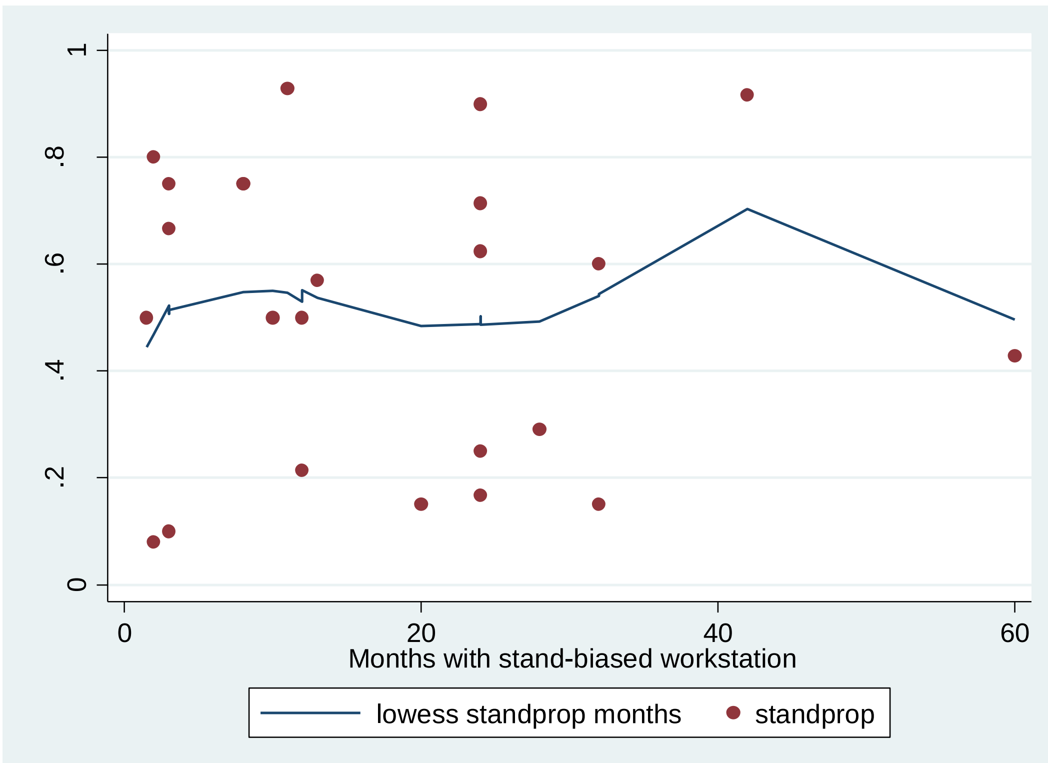

Figure 3.3 Scatterplot of time with workstation and proportion of time at workstation spent standing (standprop)

Table 3.4 presents the reported changes to participants' standing habits since they received their workstations. A majority of participants did not report any changes in standing habits; only a fifth of participants reported standing more initially.

Table 3.4 Reported changes in standing habits overtime

	Stand-biased workstation less than one year (n=10)	Stand-biased workstation one year or more (n=15)	Total
Has been the same overtime	8 (80%)	3 (20%)	11 (44%)
Stood less initially	2 (20%)	1 (6.7%)	3 (12%)
Stood more initially	0	5 (33.3%)	5 (20%)
Varies with task/workload	0	3 (20%)	3 (12%)
Changed with health	0	1 (6.7%)	1 (4%)
Fluctuated overtime	0	2 (13.3%)	2 (8%)

Column percentages reported

Participants were asked to estimate the number of times they transition from the seated to the standing position throughout the day, and responses ranged from one to fifty times with an average of 9.7 transitions. Eight percent reported 12 or less transitions. Reported duration for standing bouts ranged from 2 minutes to 4 hours. 43.5% reported bouts of standing to be 30 minutes or less, and 30.4% reported bouts between 30 minutes and 1 hour.

Over the course of the interviews, ten people mentioned a specific pattern of standing that included standing for extended periods in the morning or standing until they went to lunch. One person elaborated on this fact by mentioning, "I walk in my office, set my things down and am ready to work, and before I know it, three hours have passed."

When asked if they felt they had transitioned and become acclimated to the new workstation, 84% (21 people) felt like they had transitioned. Estimated time that it took to transition ranged from no time at all (6 people) up to 6 months (3 people), as displayed in Table 3.5.

Table 3.5 Times reported to fully transition into stand-biased workstation

Response	Number responding (% of those who had transitioned)
No time	6 (28.6%)
Up to a week	4 (19%)
Between one week and one month	4 (19%)
1-2 months	2 (9.5%)
3-6 months	5 (23.8%)

All participants reported having a footrest, and most (20 people) reported using it sometimes or frequently as shown in Figure 3.4. 80% of people reported maintaining their weight since switching to a stand-biased workstation, as shown in Appendix G.

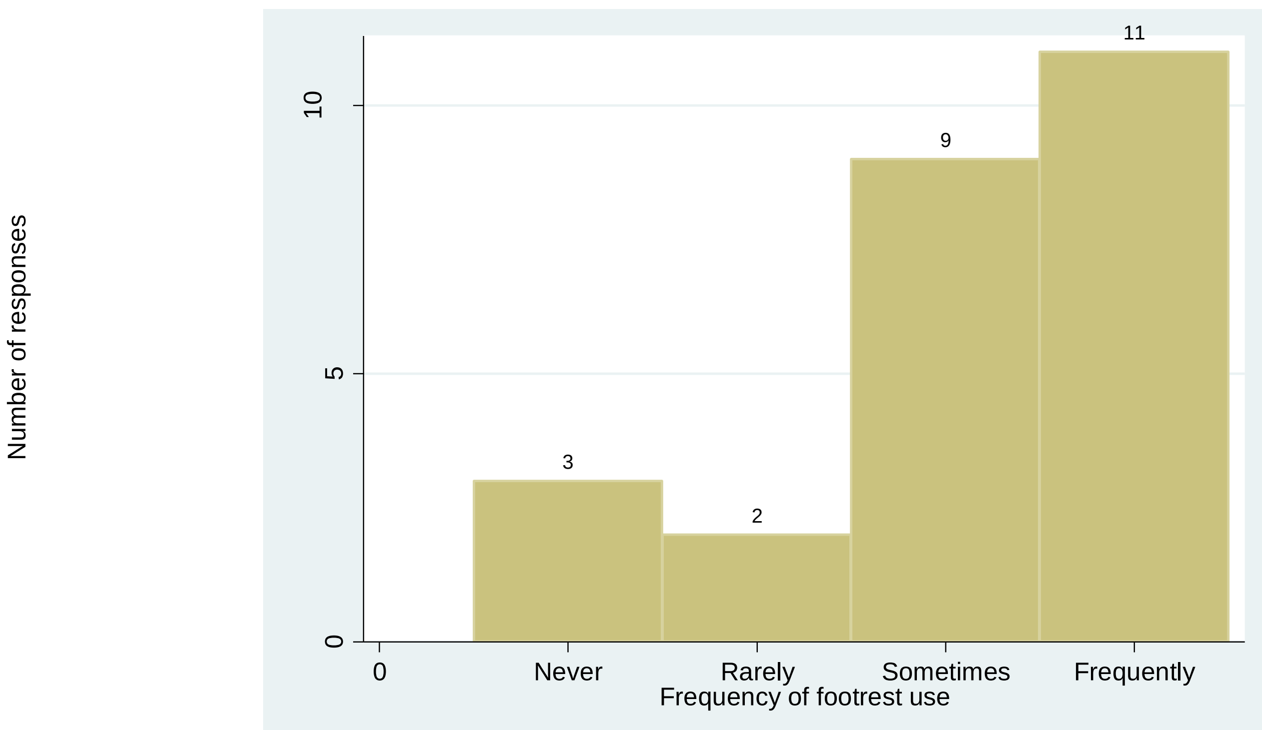

Figure 3.4 Histogram of footrest usage

3.3.2 Workstation perceptions

When asked why they requested a stand-capable workstation in the first place, responses ranged from just liking the idea, to comfort, to productivity, to helping with pain. Thirty three unique responses were provided, as shown in Table 3.6.

Table 3.6 Reasons for requesting a stand-biased workstation

Outside Influences	Specific Perceived Benefits	Personal/Work Factors	Misc.
• Saw others (6) • Knowledge of the research (5) • Experts in building (4) • Knowledge of benefits (3)	• Burn more calories (6) • Increased energy (3) • Move more (2) • Improved alertness (2) • Comfort • Increased productivity • Improved posture • Improved concentration • Able to stretch • Better respiration • Better reaction • Get rid of lactic acid	• Was in pain (7) • Stand-biased workstation was available (5) • Work long hours (4) • Uncomfortable sitting (2) • Too comfortable sitting • Get ancy sitting • Felt bad • Long commute • Wanted to be eye level with office visitors • Poor posture • Involved in standing desk research	• Just liked the idea (2) • Sitting too much (2) • Wanted to stand • Curiosity • Wanted to break up the sitting • It was a new idea

Parenthesis indicate how many people mentioned a reason if it was more than one person

Overall, participants provided overwhelmingly positive feedback regarding the stand-biased workstations, and all but one person said they would make the switch to a stand-biased workstation again. The one person who said they would not make the switch again said this because of the strong paint smell from the retrofitted furniture. Table 3.7 includes a sample of pros and cons participants mentioned about their workstations. Appendix G includes lists of habits mentioned around standing workstations and a sample of other comments heard in the interviews.

Table 3.7 Pros and Cons of workstation

Positive aspects of the workstation	Negative aspects of the workstation
• Feel more productive (4) • Have a high energy level (2) • Office looks better (2) • Has changed workstyle, can now use both monitors more effectively, and read from monitor instead of paper • Can stretch and move more • Easier to get in and out of tall chair • Eye to eye with visitors when they walk in • Couldn't go back to a seated desk • Helped posture • Back doesn't hurt anymore • Feel more efficient • Helped with hip problems	• Chair gets in the way in a tight office space (5) • Too tall for workstation when heals are worn • Bar height stools are weird for visitors to sit and talk • Can't use anti-fatigue mat with the wheels on the chair • Monitor too low because don't have monitor arm • Platform of desk has a strong paint smell
Parenthesis indicate how many people made a comment if it was more than one person	

3.4 Discussion

This study demonstrates high acceptance and sustained usage of stand-biased workstations over time. Participants reported standing at their workstations for an average of 3.4 hours, or 51% of their time, at their workstation each day. This finding of 3.4 hours of standing is much higher than previous studies that found reductions in sitting time of approximately 1-2 hours in people who had used sit-stand adjustable workstations for only three months or less (Pronk et al., 2012, Grunseit et al., 2013, Alkhajah et al., 2012, Healy et al., 2013).

No significant difference in standing habits was observed for those who had their stand-biased workstation for less than one year compared to those who had it for a year or longer. Five people, or 20% of participants, reported standing at their desk initially more than they did currently. All 5 of these people had a stand-biased workstation for a year or more and still averaged 2.9 hours of standing a day (range of 1-5.5 hours). It is likely that some of these people were standing too much and standing less now is actually movement in the right direction. Eighty percent of participants with a stand-biased workstation for a year or more reported some change in their standing habits, while only 20% of participants with a stand-biased workstation for less than one year reported some change in their standing habits. This is not surprising given that the longer amount of time would allow for more changes but is particularly important for short-term follow-up studies of stand-capable desk usage. Implications may even be that there is no true steady state of an office employee's typical standing habits. Changes in habits were likely not all related to factors with the workstation itself as some participants noted changes with workload, life, or health.

While there is yet to be any clear evidence on the amount of sitting or standing time that is ideal, recent evidence suggests the pattern of sitting may actually be just as important as the total amount of sitting (Howard et al., 2013, Dunstan et al., 2012b, Vernikos, 2011). Results of this study found that stand-biased desk users transition from sitting to standing an average of 9.7 times per day (range of 1-50). It is not known how many transitions are necessary for optimal benefit as studies have looked at interrupting sitting or lying down from every 20 minutes (Howard et al., 2013, Dunstan et al., 2012b) to every hour or two hours (Vernikos, 2011). This study likely contained a mix of people who were and were not transitioning enough; unfortunately, there is not enough current evidence to determine who belongs in which category.

Qualitative information gathered through these interviews provides insight into reasons for requesting a stand-biased workstation in the first place. Several people (7) mentioned they requested the workstation because they were experiencing pain or discomfort. Others did so because they saw others with a stand-biased workstation or because they wanted to burn more calories by standing. Several people mentioned multiple factors that made them want the workstation. Employers implementing stand-capable desk interventions likely need to promote their usage for a variety of reasons and not just focus on one of their benefits (i.e. only promoting their use for increased calorie burn).

Open ended questions were used to gather information about positive and negative aspects of stand-biased workstations. Several participants mentioned positive factors related to increases in productivity and energy from using a stand-biased desk. The most common negative aspect mentioned was that the chair gets in the way in a tight office space. Space is an important consideration to make when implementing stand-capable changes, particularly for those with a U-shaped desk configuration.

3.4.1 Limitations

Like other studies on stand-capable workstation usage (Pronk et al., 2012, Alkhajah et al., 2012), participants in this study worked in a health-focused setting. Population characteristics show that 56.5% of participants had a normal weight BMI and 88% had moderate or high levels of physical activity, indicating a sample that is leaner and more active than a typical office population. This may reflect a population that is more motivated than other populations to use and continue using a stand-capable workstation. This study was not powered beforehand, and likely had a sample size that was too small to detect any differences in standing usage for those who had their workstations for less than or more than one year.

It is also important to note that this was a motivated population to begin with as each person requested a stand-biased workstation. Findings of this study may not be directly generalizable for a workplace setting where stand-biased workstations are distributed to all employees regardless of their desire for one. Further, this population may have been even more motivated because of well-known research conducted by colleagues in the building on stand-capable workstations in both school and office settings. These two factors that are unlikely to be present in most office situations, particularly the influence of colleagues researching sedentary behavior likely caused people at SRPH to stand more or maintain their standing habits at their stand-biased workstations.

It is likely that self-reported time spent seated/standing, transitions from sitting to standing, and average bouts of standing are difficult for people to estimate. While this study used a question similar to the OSPAQ, a tool with good reliability and moderate validity (Chau et al., 2012), it was not exactly the same. Also, there is no research on questions having participants estimate number of sitting to standing transitions or duration of standing bouts. Participants seemed to have the most difficulty providing those two estimates because in reality they may vary from day to day.

3.4.2 Strengths

A major strength of this study is that it includes a population of stand-biased workstation users that had varying amounts of time with their workstations. This allowed for examination of changing patterns in usage across time.

The study also collected qualitative information about motivation for stand-biased desk use and about experiences with the workstation. There are no known studies on the use of stand-biased workstations in adult populations. There are also no known studies reporting on factors motivating people to use stand-biased workstations. However, the study by Wilks and colleagues, 2006, provided reasons as to why people did not stand at their desks, which was primarily just not bothering to use it.

3.5 Summary

Participants in this study reported an average of 3.4 hours standing at their stand-biased workstation each day. Results do not indicate a significant decrease in standing over time, nor as the initial novelty of the desk wears off. The motivated participants in this study provided overwhelmingly positive feedback about the workstations.

4 SIX MONTH FOLLOW-UP OF STAND-CAPABLE DESK USERS IN A CALL CENTER

4.1 Overview

Americans are spending more time seated at their jobs than ever before. It is estimated that adults spend over half of their time at work in the seated position, and this estimate may be closer to 90% for those who work in certain settings such as call centers (Straker et al., 2012). Recent studies have shown that workplace sitting has a direct impact on overall daily sedentary time, defined as energy expenditure less than 1.5 METs (Metabolic Equivalents) (Parry and Straker, 2013).

A growing body of evidence has shown the negative consequences of too much sitting throughout the day and of prolonged sitting without breaks. High daily durations of sitting or sedentary time are associated with morbidity, cardiovascular disease, and diabetes (Wilmot et al., 2012). Research in the emerging field of inactivity physiology has further highlighted the metabolic consequences of uninterrupted sitting, and that these negative effects can be attenuated through short bouts of walking (Healy et al., 2007, Dunstan et al., 2012b, Howard et al., 2013).

Sit-stand workstations that allow computer workstation users to work in either a seated or standing position offer a potential solution to the rampant problem of too much sitting. Initial lab-based studies have shown sit-stand workstations do not cause detriments to productivity and are able to improve user discomfort (Karakolis and Callaghan, 2014).

Several intervention studies assessing usage 1-3 months after sit-stand workstation implementation have found reductions in daily seated time of approximately 1-2 hours (Pronk et al., 2012, Grunseit et al., 2013, Alkhajah et al., 2012, Healy et al., 2013). However, cross-sectional studies of work settings where sit-stand desks have been present for six months up to many years reveal much smaller impacts to seated time and lower daily usage of the stand function indicating that usage may decline after novelty of the desk wears off (Straker et al., 2012, Wilks et al., 2006). One potential way to encourage continued use of sit-stand workstations is to design them to bias the user towards standing (Benden, 2008). A stand-biased workstation is set at or can be adjusted to 40-42 inches high rather than the traditional 30 inches, and by design it encourages standing work for two to four hours per day rather than promoting the traditional eight hours of seated work (Gurr et al., 1998, Hjelm et al., 2000). A tall or bar-height chair (aka stool) is provided so that the user may sit at the workstation without adjusting the desk height, and a footrest is used to improve comfort.

The aim of this study was to assess the standing usage of sit-to-stand and stand-biased workstations in a call center over six months. Call center work often involves repetitive tasks that require prolonged sitting (Norman et al., 2008). Traditional office work often involves several productive opportunities to get up from one's desk throughout the day to attend meetings, speak with colleagues, make copies, etc. In call center work there exist few productive opportunities away from one's computer, making stand-capable workstations one of the best options for variation in posture (Toomingas et al., 2012). The consistency in job tasks both across employees and across time makes a call center an appealing setting for a longitudinal trial of stand-capable workstations.

4.2 Methods

4.2.1 Setting

Healthways Inc., a well-being improvement company with headquarters in Franklin, Tennessee, has multiple call centers in which their Health Coaches, Clinicians (Nurses and Dieticians), and Customer Service Representatives work. As a health and well-being focused company, Healthways strives to provide its own employees with an environment conducive to wellness. This includes games throughout the building such as table tennis and four-square, an onsite cafeteria with healthy food options, policies that encourage employees to wear work-out clothes to work two days a week, and onsite fitness classes. As part of Healthways' continued efforts to create an environment conducive to healthful living, a new call center for over 100 employees was opened in early 2013 at the Franklin office with both sit-stand and stand-biased workstations.

Both the sit-stand and stand-biased workstations use a SteelCase™ (Grand Rapids, Michigan) Series 5 Desk ($750) that has an electric motor allowing it to adjust anywhere from 25.5 to 51 inches tall. This allows the user to press an up or down button to adjust the desk surface to proper height for sitting (27-31 inches) and proper height for standing (37-46 inches). As shown in Figure 4.1, the sit-stand workstations have a standard height task chair, The SteelCase™ Think Chair Model 6205 ($550), that has a seat height that can be adjusted between 16 inches and 21 inches. As shown in Figure 4.2, the stand biased workstations have a raised height or bar height task chair, The Neutral Posture Inc. (Bryan, Texas) U4IA4692 Mesh Back Stool ($600) with attached foot platform at 6 and 10 inches that has a seat height that can be adjusted between 25.5 and 36 inches. Footrests ($50) that allow a user to prop one foot up at 8 or 12 inches were purchased for stand-biased desk users. Anti-fatigue mats ($40) were purchased for sit-to-stand users. Monitor arms ($300) for the dual monitor set-up were purchased and installed at each workstation

Healthways purchased two types of each chair in order to determine what workstation they should choose for other call centers. The two types of workstations were mixed throughout the call center so that each type of workstation had a mix of all types of call center employees (Health Coaches, Clinicians, Customer Service Representatives, and Managers). Assignment to the workstation type was dependent on Healthways, and it made assignments as random as possible. However, because the call center consists of groups of four or eight workstations, efforts were made to keep the type of workstation the same within each group. The different types of employees (nurse, health coach, etc.) generally sit in a group of four or eight workstations.

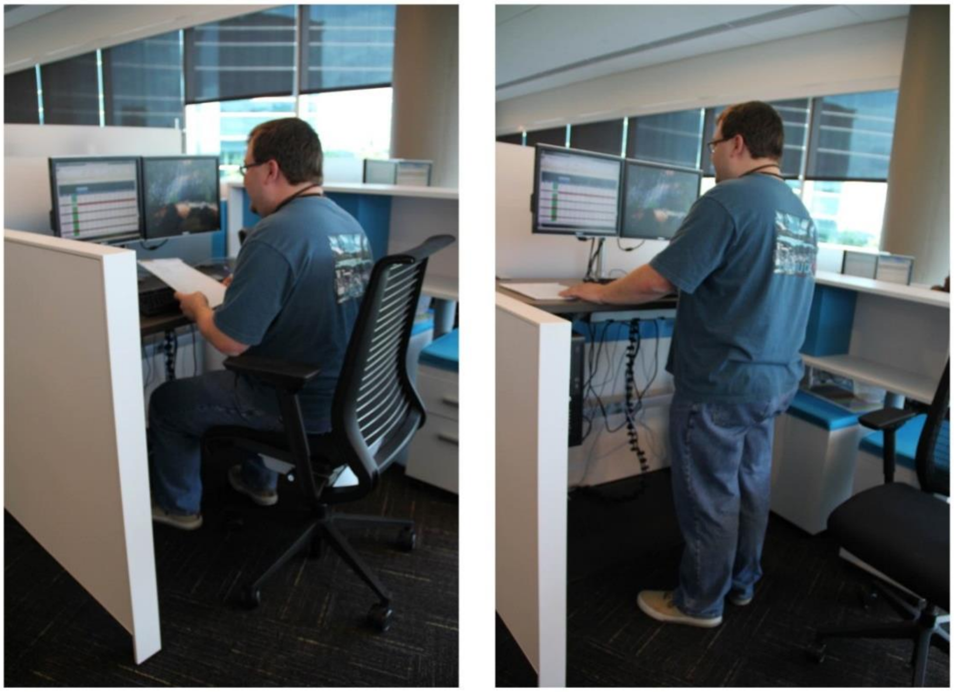

Figure 4.1 Sit-to-stand desk in the seated and standing positions

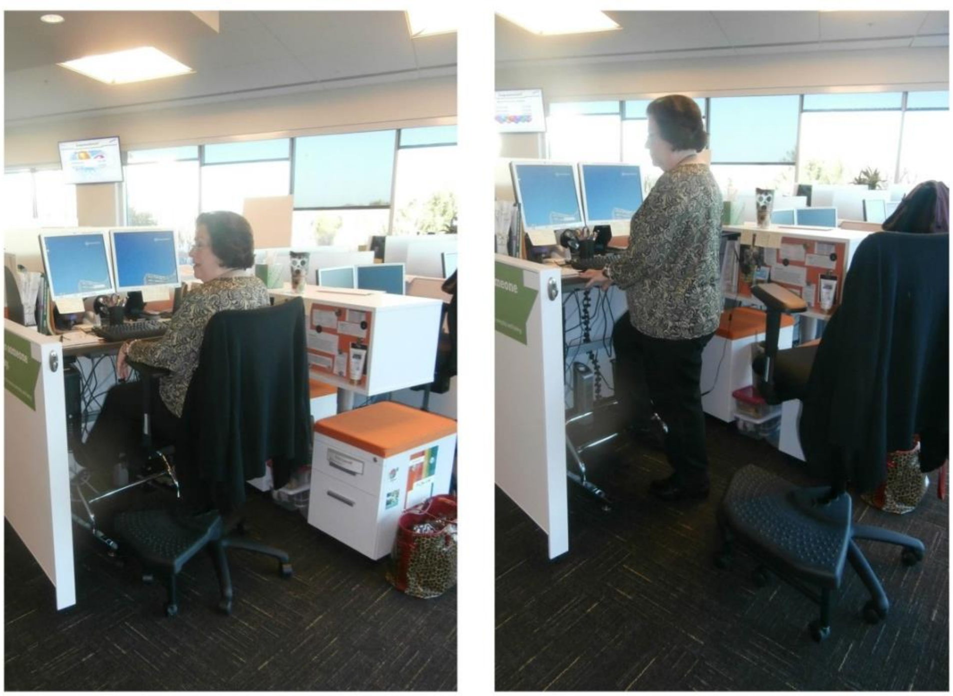

Figure 4.2 Stand-biased desk in the seated and standing positions

4.2.2 Participants

Any person working in the new Healthways call center with a sit-stand workstation or a stand-biased workstation was eligible for participation in the study. These were all full-time employees on permanent or temporary status. Some temporary employees became full-time employees after an initial employment period. Given that the study call center was a new area at Healthways, most employees (besides managers) that worked in the call center had worked at Healthways for approximately three months or less. Many employees started in the call center immediately after completing their initial 4-8 week orientation and training.

Employees in the call center include health coaches, clinicians, customer service representatives, and managers. Health coaches are generally people with a bachelors or masters in a health or exercise related subject. Their job is to provide necessary coaching over the phone for program participants to reduce or eliminate high risk behaviors. Nurses working within the call center are registered nurses with at least one year of experience as a direct patient care nurse. Their job is to apply the nursing process over the phone with program participants in order to guide the development and implementation of participant action plans to reduce clinical risk factors. Customer Service Representatives have a high school education or higher and are responsible for handling customer service inquiries and problems from members. Managers provide guidance and supervision to a team of 16-20 employees to ensure that quality and operational goals are being met.

All employees in the call center received a brief training on the new workstations prior to moving in. The training covered how to adjust the workstation to proper ergonomic fit. Employees were also told not to switch chairs.

4.2.3 Recruitment

After approval from the Texas A&M Institutional Review Board and the Healthways legal department were obtained, employees working in the new call center area were contacted about the study. The study consent form, found in Appendix H, and a message describing the study was sent to the eligible employees from The Healthways Human Resources Department. Managers also mentioned the opportunity to participate in the study during their team meetings.

A total of 48 people in sit-to-stand workstations and 50 people in stand-biased workstations were contacted about the study. A participation rate of 94% was achieved in the sit-to-stand group and 92% in the stand-biased group (see Figure 4.3).

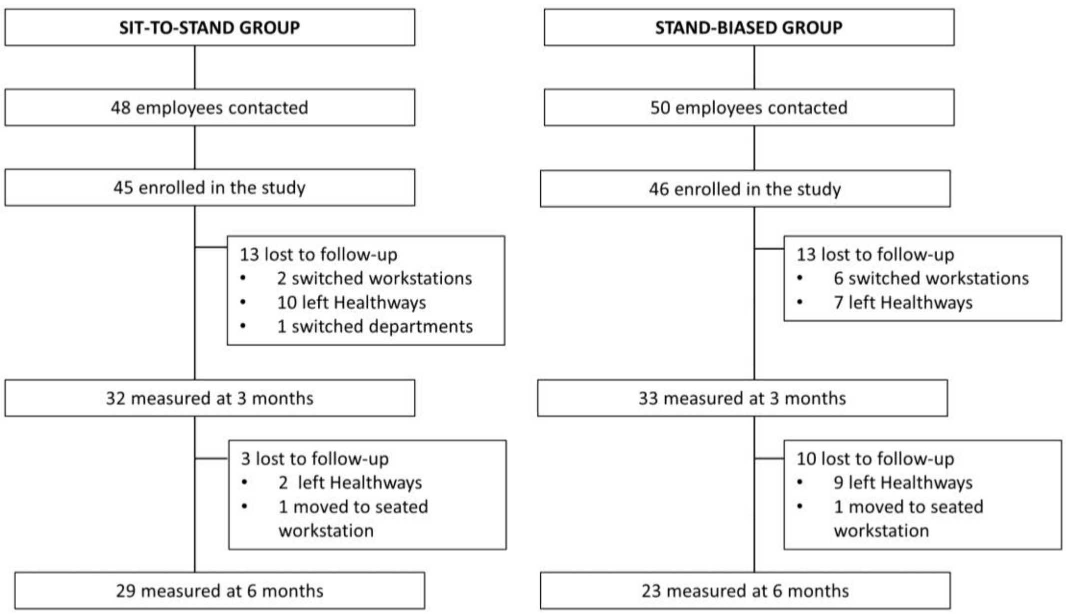

Figure 4.3 Flow-diagram of participation and follow-up

4.2.4 Study protocol

Upon completion of the informed consent document, the researcher helped subjects determine whether they had a sit-stand workstation or a stand-biased workstation and marked it on the informed consent document. The researcher then asked participants to fill in an information sheet, found in Appendix I, that collected information necessary to calibrate the Sensewear® armbands to each individual. The researcher calibrated the Sensewear® monitor with each participant's data, and marked the armband with the participant's assigned study ID number. At the beginning of the participant's next shift, they were provided with the calibrated armband and instructed to wear it for a period of two working days. An information sheet on the Sensewear® monitor, found in Appendix J, was provided with each monitor. Participants were emailed a link to the study survey which was hosted via SurveyMonkey.com. Reminder emails were sent, and managers were asked to help ask participants to complete the survey.

Measurement took place at three time points over the course of six months, as shown in Table 4.1. Baseline measurement occurred approximately zero to three weeks after employees moved into the new workstations (February-March 2013). Follow-up then took place three months and six months later. Study timing did not allow for baseline measurement to be taken prior to moving into the stand-capable workstations. This was due to the fact that many employees in the new call center had training up until the time they moved into the stand-capable workstations, and the fact that this study was initiated after installation of the new furniture.

Table 4.1 Dates of measurement

Dates	Measurement Phase
February 19-22	Initial recruitment and measurement (employees moving into new call center January 28)
March 18-21	Initial recruitment and measurement (employees moving into new call center February 25 and March 20)
June 4-7	3 month follow-up
August 19-22	6 month follow-up

4.2.4.1 Objective measurement

The armband accelerometer (SenseWear® model MF-SW by Body Media, Pittsburgh, PA) was used to collect activity data on participants over the course of two workdays at each point of measurement (baseline, three months and six months). Based on the researcher's previous experience with the SenseWear® devices (Benden, 2006, Benden et al., 2011)and the repetitive nature of call center work, two days provided data sufficient to represent a typical workday. Participants were asked to wear the armband from the time they arrived at work until just before they left.

The Sensewear® armband gathers data every minute of use on movement, heat flux, skin temperature, and galvanic skin response (Malavolti et al., 2007). It uses this information and user characteristics (age, height, weight, handedness, sex, and smoking status) to calculate caloric expenditure and number of steps taken during each one minute interval of use. A full list of data collected by the Sensewear® armband is in Appendix K.

Studies have reported that the armband provides valid measurements of physical activity in free-living conditions (Welk et al., 2007, Wadsworth et al., 2005) both at rest (Malavolti et al., 2007) and during physical activity (St-Onge et al., 2007, Welk et al., 2007). Numerous research studies have employed the use of this device for collecting energy expenditure data including a recent stand-capable workstation study with 11 Australian employees (Gilson et al., 2012).

While the Sensewear® device does not collect information on body position (sitting or standing), the measure of energy expenditure was used in examining effects from the stand-capable workstation. Sensewear® data were analyzed for proportion of time in each of the physical activity intensity categories as displayed in Table 4.2. Published energy expenditure levels in METs (Metabolic Equivalent of Task, defined as the ratio of the metabolic rate to the resting metabolic rate) classify sitting work at around 1.3-1.5 METs (sedentary range) and standing work at 1.8 METs (light activity range) (Ainsworth et al., 2011, Owen et al., 2010). However, studies have found that levels of energy expenditure sitting or standing may not differ significantly and vary greatly due to other activities such as fidgeting (Speck and Schmitz, 2011, Marshall and Merchant, 2013). Therefore, sedentary and light activity levels were compared but could not be interpreted as sitting or standing behavior.

Table 4.2 Categories of exercise intensity used for analysis of Sensewear® data

Intensity Category	**Energy Expenditure**	**Descriptive Measures (Norton et al., 2010)**
Sedentary	<1.5 METs	Activities that involve sitting or lying with little additional movement
Light	1.6 < 3.0 METs	An aerobic activity that does not cause a noticeable change in breathing rate and can be sustained for at least one hour
Moderate	3.0 < 6.0 METs	An aerobic activity that is able to be maintained while carrying on a conversation, may last 30-60 minutes
Vigorous & High	≥ 6.0 METs	An aerobic activity that generally cannot be maintained uninterrupted, may last about 30 minutes (vigorous), or an intensity that generally cannot be sustained for longer than 10 minutes (high)

Each Sensewear® armband was calibrated using the Sensewear® Professional 7.0 Software for each study participant prior to their two day measurement period. Data from each participant were downloaded using the Sensewear® Professional 7.0 Software at the end of each participant's two day measurement period and exported by the Sensewear® software into a Microsoft™ Excel file that includes the information in Appendix K.

4.2.4.2 Subjective measurement

An online survey, found in Appendix L, was used to collect information on demographics, seated and standing habits, perceptions of stand-capable workstations, musculoskeletal symptoms, and physical activity.

Musculoskeletal Symptoms were assessed through the survey using questions from the Standardized Nordic Musculoskeletal Questionnaire (NMQ) (Kuorinka et al., 1987, Dickinson et al., 1992). The NMQ consists of assessment of trouble (ache, pain, or discomfort) in nine body parts. It has been shown to be a reliable, repeatable, sensitive, and useful tool for screening and surveillance of musculoskeletal symptoms (Palmer et al., 2003, Kuorinka et al., 1987, Ohlsson et al., 1994, Dickinson et al., 1992).

Physical activity was assessed through the survey using questions from the International Physical Activity Questionnaire (IPAQ) which has been validated for measuring physical activity levels in 18 to 65 year olds through self-report (Craig et al., 2003). Survey responses to this set of questions allowed for classification of participants' physical activity levels into three categories: low, medium, and high.

Participants were asked to estimate the amount of time they spent seated and standing at their workstation. No specific instrument was utilized for these questions. However, questions were similar to questions used in the Modified Occupational Sitting and Physical Activity Questionnaire (OSPAQ), a tool with reported excellent test-retest reliability and moderate validity (Chau et al., 2012). The OSPAQ asks, "On a typical workday in the past seven days, how much of your working time did you spend sitting?" (Pereira et al., 1997) and the questionnaire used in this study asked participants to "Estimate the total number of hours you spend seated at your primary workstation throughout a typical 8-hour workday." Another study that assessed time spent seated and standing through both self-report and objective monitoring noted that the two measures corresponded well (Toomingas et al., 2012).

4.2.4.3 Control group

The main purpose of this study was to compare the reductions in seated time between those using a sit-stand workstation and those using a stand-biased workstation. However, as time and resources allowed, a seated control group was also recruited into the study. The seated control group is from a previously existing section of the Healthways call center. Employees in this part of the call center conduct the same work as those in the new side (stand-capable side) of the call center with different customers. Controls were asked to wear the Sensewear® monitor for two workdays and to complete a study survey, found in Appendix M. The survey is similar to the one given to the intervention groups, but it is adjusted for not having access to a stand-capable workstation. Controls were not followed over time; they only wore the Sensewear® monitor and completed the survey upon enrollment into the study since it was expected that their sedentary patterns would be in a steady state.

4.2.5 Analysis

All data were transferred from Excel into STATA/IC version 13 (STATA Software, version 13.0, StataCorp LP, College Station, TX) for analysis. Descriptive statistics (means, standard deviations, and frequencies) were calculated for each variable in the dataset, stratified by type of workstation. Distributions of variables were examined graphically with boxplots and histograms.

Equality of variable means between the three groups was assessed with the ANOVA test. The two treatment groups (sit-to-stand and stand-biased) were also compared on their own using a two sample t-test.

Pearson's Chi-square was used to test for equality of distributions of categorical variables. Fisher's exact test was used to test for equality of distributions of categorical variables with distributions that had cell counts less than five.

A generalized linear mixed model estimating proportion of time sedentary by desk type, controlling for sex, age, race, and body mass index (BMI) was built in SAS® Version 13, (SAS®, Cary, North Carolina).

Table 4.3 Population characteristics at baseline

	Sit-to-stand group (n=45)	Stand-biased group (n=46)	Seated control group (n=47)	p-value
Mean (SD) age (years)	34.8 (11.5)	28.9 (6.8)	35.0 (13.2)	.0106*
% Female	71.1	58.7	70.2	.371
% Smokers	2.2	6.5	4.3	.783[A]
Handedness				
% Right	84.4	78.3	83.0	.584[A]
% Left	15.6	15.2	12.8	
% Ambidextrous	0	6.5	4.3	
Mean (SD) Body weight (pounds)	179.1 (57.1)	170.5 (39.5)	178.2 (43.2)	.3297
Mean (SD) Height (inches)	65.9 (4.1)	66.7 (3.6)	67.0 (3.6)	.3953
Mean (SD) BMI (kg/m^2)	29.0 (9.13)	26.8 (5.5)	27.8 (5.7)	.6263
BMI Categories				
% Normal weight or under weight	46.7	43.48	40.4	.946
% Overweight	20.0	26.1	25.5	
% Obese	33.3	30.4	34.0	
Physical Activity Levels				
% Low	43.9	40.0	39.5	.891
% Moderate	29.3	27.5	23.3	
% High	26.8	23.3	37.2	
Job types				
% Health Coach	41.5	57.5	60.5	.000[A]*
% Customer Service	31.7	22.5	0	
% Clinician	17.1	10.0	34.9	
% Other	9.8	10.0	4.6	
Race				
% African American	24.4	25.0	16.3	.872[A]
% Non-Hispanic white	68.3	67.5	74.4	
% other	7.3	7.5	9.3	

p-value is from using One-way ANOVA for means and Pearson chi-squared for percentages reported, or Fisher's exact test [A] if distributions had cell counts of 5 or less
*significant at the 0.05 level

4.3 Results

4.3.1 Population characteristics

As shown in Table 4.3, baseline population characteristics of the two treatment groups and the control group did not differ significantly for gender, smoking status, handedness, height, weight, BMI, physical activity, race, or musculoskeletal discomfort. The only statistically significant differences observed between the groups were for age and job type. The stand-biased group was younger than the sit-to-stand and control groups with a mean age of 28.9 years compared to a mean age of 34.8 years and 35.0 years respectively, a difference that unlikely has clinical relevance. Since most customer service representatives worked in the stand-capable part of the call center, none were in the seated control group.

4.3.2 Activity measures

Table 4.4 displays the activity data for the seated controls alongside that of the stand-capable groups at baseline. Data show a significant difference for amount of time reported seated and standing in the controls compared to the stand-capable groups but similar amounts of time monitored with the Sensewear® armband.

Table 4.4 Mean (SD) activity habits recorded by Sensewear® and reported in the survey at baseline with controls

	Sit-to-stand group (n=45)	Stand-biased group (n=46)	Seated control group (n=47)	p-value
Hours of armband use	15.8 (4.9)	17.1 (3.6)	15.4 (4.8)	.2552
Proportion of Monitored time in each activity level				
Sedentary	.79 (.14)	.72 (.17)	.78 (.13)	.0853
Light Activity	.14 (.10)	.19 (.13)	.17 (.10)	.1418
Moderate Activity	.06 (.07)	.09 (.08)	.05 (.05)	.0318*
Vigorous Activity	.001 (.002)	.002 (.003)	.002 (.007)	.5244
Steps per minute	3.7 (2.05)	5.0 (2.5)	4.7 (2.6)	.0382*
Calories per minute	1.8 (.41)	1.9 (.41)	1.8 (.41)	.2474
METs per minute	1.4 (.40)	1.6 (.37)	1.4 (.32)	.0626
Reported time at workstation on a typical day	7.4 (.83)	6.8 (1.24)	7.1 (.75)	.0352*
Proportion of time reported sitting	.75 (.17)	.65 (.19)	.91 (.10)	.0000*

p-value calculated using One-way ANOVA
*significant at the 0.05 level

Table 4.5 displays the activity data collected for the study participants at baseline. Average armband wear-time for the two groups and average energy expenditure in calories or METs did not differ significantly. However, a few baseline measures show the stand-biased group to be slightly more active; the stand-biased group spent on average 7% less time sedentary than those in the sit-to-stand group. The stand-biased group also averaged significantly more steps per minute than the sit-stand group. The stand-biased group reported sitting 10% of the workday less than the sit-stand group.

Table 4.5 Mean (SD) activity habits recorded by Sensewear® and reported in the survey at baseline

	Sit-to-stand group (n=45)	Stand-biased group (n=46)	p-value
Hours of armband use	15.8 (4.9)	17.1 (3.6)	.2049
Proportion of Monitored time in each activity level			
Sedentary	.79 (.14)	.72 (.17)	.0453*
Light Activity	.14 (.10)	.19 (.13)	.0678
Moderate Activity	.06 (.07)	.09 (.08)	.1181
Vigorous Activity	.001 (.002)	.002 (.003)	.2929
Steps per minute	3.7 (2.05)	5.0 (2.5)	.0138*
Calories per minute	1.8 (.41)	1.9 (.41)	.1009
METs per minute	1.4 (.40)	1.6 (.37)	.0565
Reported time at workstation on a typical day	7.4 (.83)	6.8 (1.24)	.0704
Proportion of time reported sitting	.75 (.17)	.65 (.19)	.0179*

p-values reported are from two sample t-tests
*significant at the 0.05 level

Tables 4.6 and 4.7 show the activity measures collected at three and six months, respectively. The tables show that by three months, proportion of sedentary time for both groups converge around approximately 75% of the time monitored. No other statistically significant differences for activity were seen at three or six months. Average self-reported proportion of workday spent seated remained fairly constant for the two groups over the course of the study. However, the difference was no longer statistically significant at three and six months, likely due to the dwindling sample size from loss to follow-up. At three and six months, participants were asked to estimate the amount of transitions they made per day from the seated to the standing position and average duration of standing bout. No significant differences were observed between these variables.

Table 4.6 Mean (SD) activity habits recorded by Sensewear® and reported in the survey at 3 months

	Sit-to-stand group (n=32)	**Stand-biased group (n=33)**	**p-value**
Hours of armband use	16.0 (2.9)	15.6 (4.4)	.6301
Proportion of Monitored time in each activity level			
Sedentary	.75 (.18)	.76 (.15)	.8313
Light Activity	.16 (.10)	.16 (.09)	.8583
Moderate Activity	.09 (.09)	.08 (.08)	.7164
Vigorous Activity	.00 (.00)	.00 (.01)	.8785
Steps per minute	4.9 (2.6)	5.2 (3.0)	.6202
Calories per minute	1.8 (.50)	1.9 (.45)	.7889
METs per minute	1.5 (.51)	1.5 (.37)	.8693
Reported time at workstation on a typical day	7.3 (1.5)	6.3 (2.1)	.0074*
Proportion of time reported sitting	.75 (.18)	.69 (.22)	.2857
Transitions reported per day	2.8 (2.2)	3.3 (1.8)	.3340
Duration of standing reported per bout	31.9 (35.6)	35.5 (54.2)	.7509

p-values reported are from two sample t-tests
*significant at the 0.05 level

Table 4.7 Mean (SD) activity habits recorded by Sensewear® and reported in the survey at 6 months

	Sit-to-stand group (n=29*)	Stand-biased group (n=23)	p-value
Hours of armband use	16.4 (4.42)	14.2 (4.88)	.0932
Proportion of Monitored time in each activity level			
Sedentary	.76 (.16)	.75 (.16)	.7618
Light Activity	.16 (.08)	.16 (.16)	.9876
Moderate Activity	.08 (.08)	.09 (.10)	.5968
Vigorous Activity	.00 (.00)	.00 (.00)	.1949
Steps per minute	4.2 (1.9)	5.2 (2.8)	.1683
METs per min	1.47 (.47)	1.52 (.40)	.6708
Calories per minute	1.80 (.46)	1.94 (.49)	.5594
Reported time at workstation on a typical day	7.33 (.88)	6.8 (1.4)	.8664
Proportion of time reported sitting	.78 (.20)	.67 (.29)	.1401
Transitions reported per day	3.3 (2.8)	2.7 (1.4)	.3754
Duration of standing reported per bout	43.8 (77.2)	37.17 (51.7)	.7228

p-values reported are from two sample t-tests
*29 people in sit to stand desks completed full measurement and one additional person completed the survey

A total of 29 sit-to-stand and 23 stand-biased participants completed the study. Loss to follow-up occurred because of three different reasons: an employee was no longer working with Healthways, had taken an assignment in a new department in Healthways, or had switched workstation type over the course of the study.

Table 4.8 displays the generalized linear mixed model (GLMM) for proportion of monitored time spent sedentary. The model shows no significant effects for desk type on change in sedentary behavior when controlling for sex, age, race, time and BMI. Table 4.9 displays the generalized linear mixed model for proportion of self-reported time at workstation spent seated. The model shows significant effects for workstation and obesity when controlling for sex, age, race, and time.

Table 4.8 Generalized linear mixed model for proportion of monitored time sedentary

Covariate		**Estimate**	**Standard Error**	**p value**
Intercept		0.6591	0.0220	<.0001*
Workstation	seated	Reference		
	sit-to-stand	0.0171	0.0245	0.4869
	stand-biased	0.0162	0.0274	0.5561
Gender	Female	Reference		
	male	-0.0083	0.0276	0.7643
Age	≤30 years	Reference		
	31-40 years	0.0627	0.0301	0.0398*
	41-50 years	0.0835	0.0277	0.0033*
	≥51 years	0.1226	0.0324	0.0003*
Race	white	Reference		
	African American	0.0529	0.0220	0.0183*
	Other	0.0471	0.0319	0.1435
BMI	<25 kg/m^2	Reference		
	25-29.9 kg/m^2	0.0787	0.0254	0.0026*
	≥30 kg/m^2	0.1174	0.0272	<.0001*
Time	baseline	Reference		
	3 months	-0.0154	0.0150	0.3074
	6 months	-0.0060	0.0152	0.6940
Random Effects				
	Subject	**Residual**		
	0.0109	0.0050		

*significant at the 0.05 level

Table 4.9 Generalized linear mixed model for proportion of self-reported time seated

Covariate		**Estimate**	**Standard Error**	**p value**
Intercept		0.7717	0.02153	<.0001*
Workstation	seated	Reference		
	sit-to-stand	-0.1488	0.0263	<.0001*
	stand-biased	-0.2227	0.0313	<.0001*
Gender	Female	Reference		
	male	-0.0296	0.0285	0.3023
Age	≤30 years	Reference		
	31-40 years	0.0065	0.0390	0.8674
	41-50 years	0.0207	0.0308	0.5032
	≥51 years	0.0368	0.0358	0.3072
Race	white	Reference		
	African American	0.0322	0.0274	0.2417
	Other	-0.1095	0.0750	0.1473
BMI	<25 kg/m^2	Reference		
	25-29.9 kg/m^2	0.0404	0.0272	0.1411
	≥30 kg/m^2	0.0541	0.0260	0.0406*
Time	baseline	Reference		
	3 months	0.0327	0.0171	0.0593
	6 months	0.0351	0.0222	0.1173
Random Effects				
	Subject	**Residual**		
	0.0161	0.0087		

*significant at the 0.05 level

Figures 4.4-4.6 show the pattern of proportion of time in each activity level for the stand-capable groups, both individually and combined, with the level of controls denoted (inferred as constant over the course of the study). Likewise, Figure 4.7 shows the pattern of proportion of time reported seated for the stand-capable groups, both individually and combined, with the level of controls denoted. Figures 4.8 and 4.9 display the distribution of this data over time through boxplots.

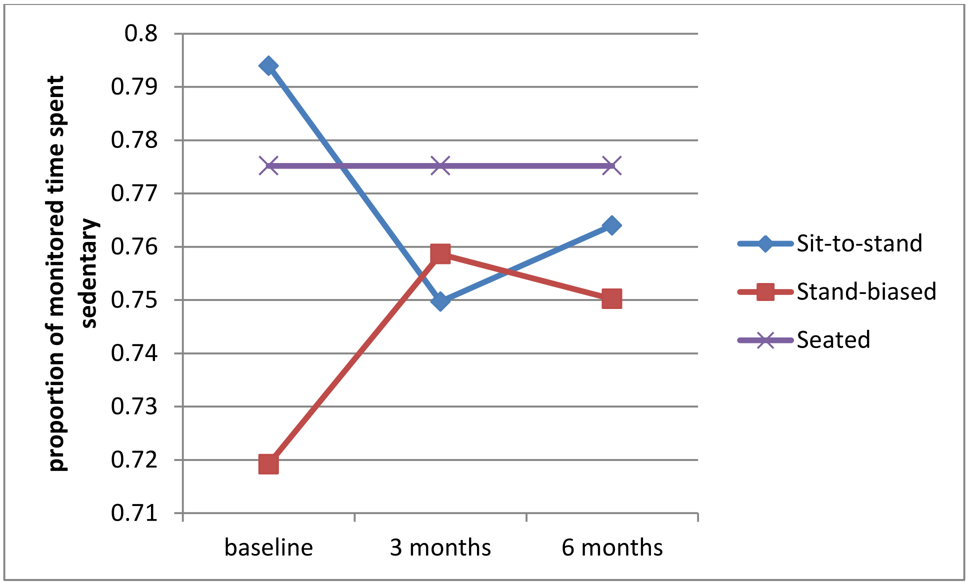

Figure 4.4 Graph of sedentary time by workstation for three time-points with line for seated controls shown

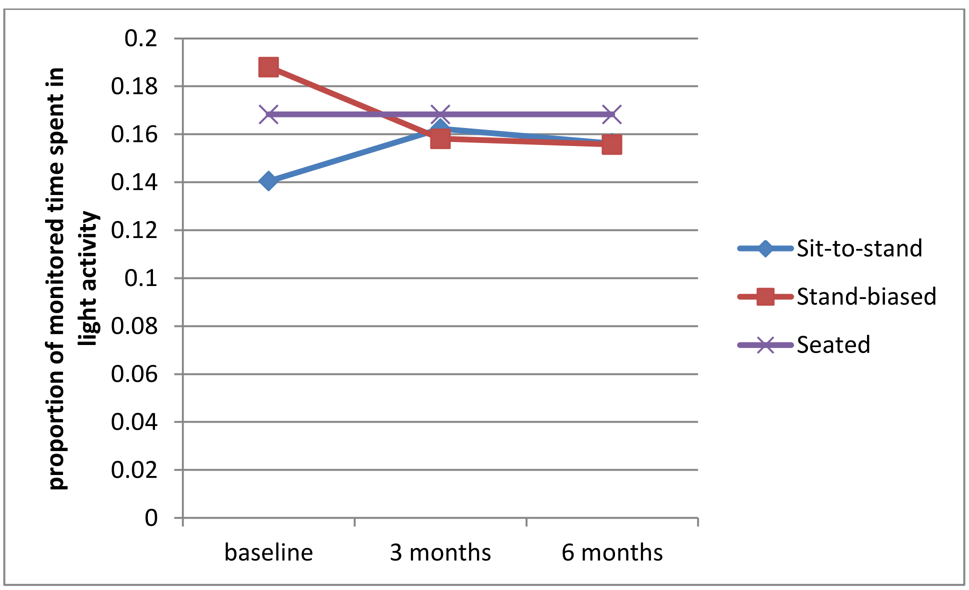

Figure 4.5 Graph of light activity time by workstation for three time-points with line for seated controls shown

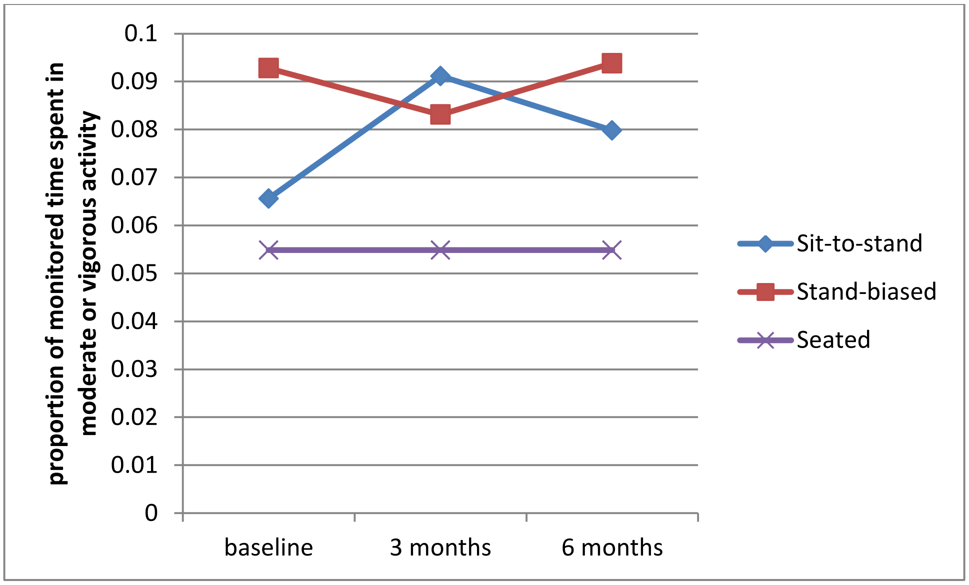

Figure 4.6 Graph of moderate and vigorous activity time by workstation for three time-points with line for seated controls shown

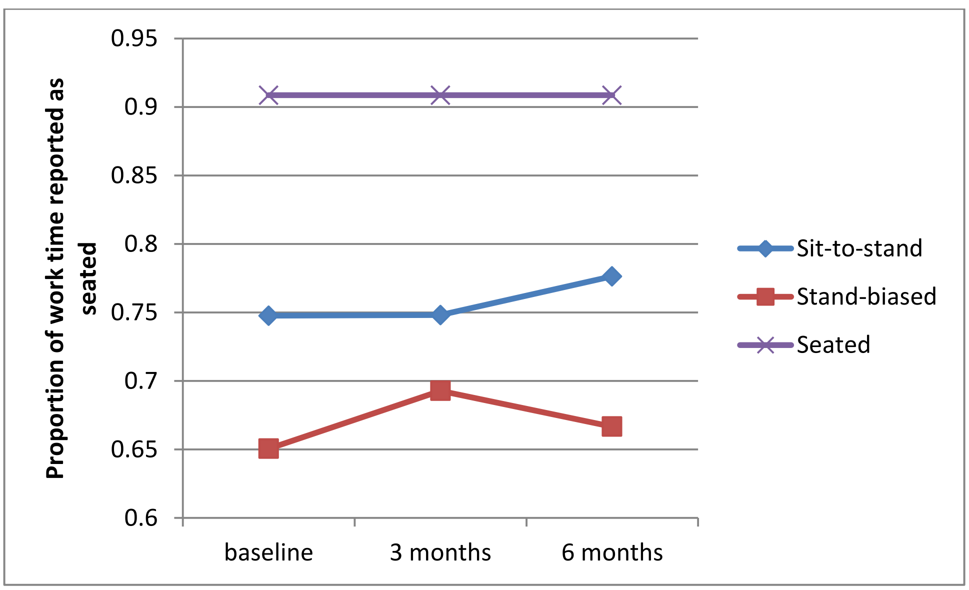

Figure 4.7 Graph of seated time by workstation for three time-points with line for seated controls shown

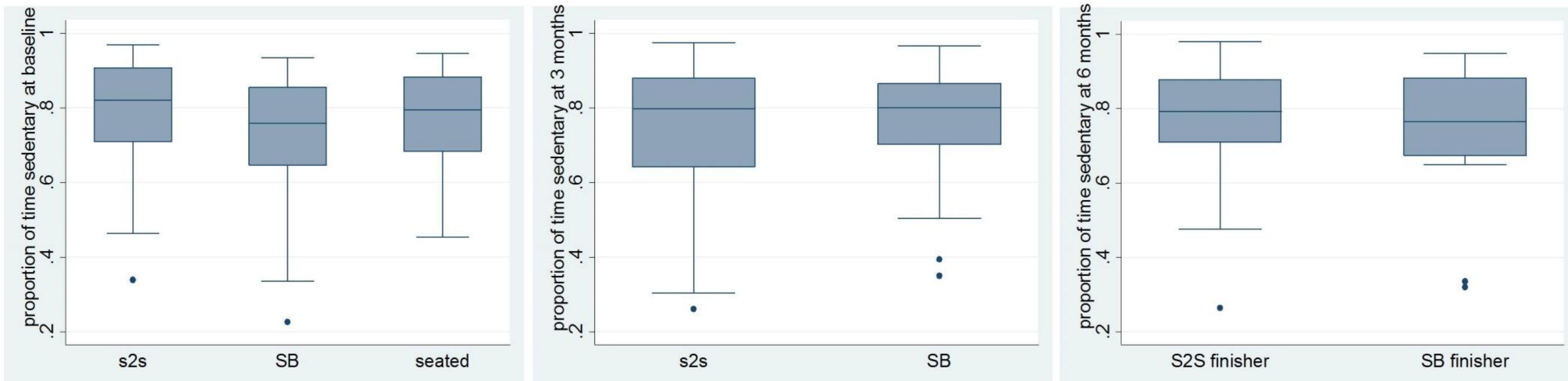

Figure 4.8 Boxplots of proportion of monitored time spent sedentary at baseline, 3 months, and 6 months

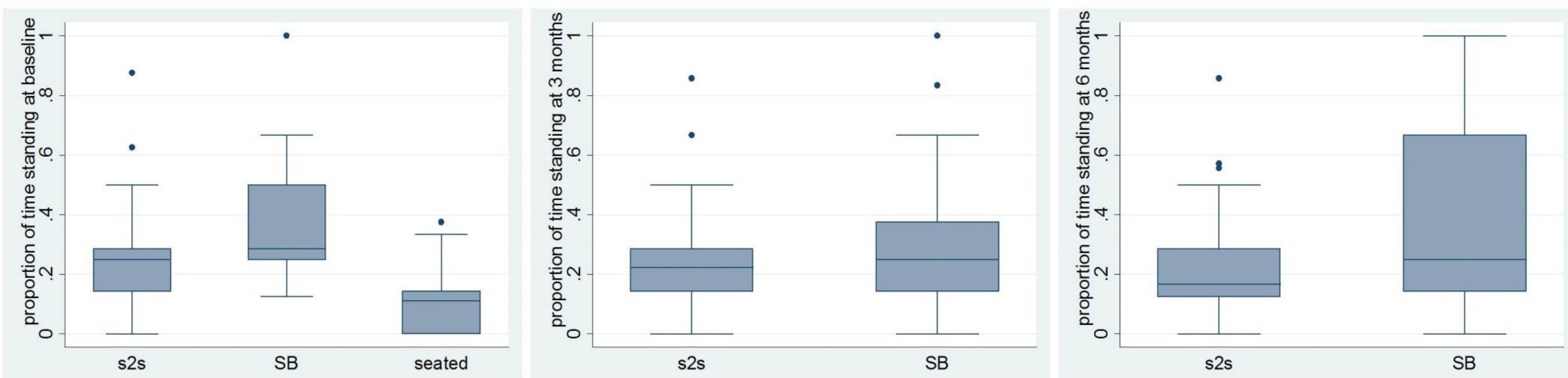

Figure 4.9 Boxplots of self-reported proportion of workday spent standing at baseline, 3 months, and 6 months

4.3.3 Survey responses

Table 4.10 shows the musculoskeletal discomfort/pain reported by the study group at baseline alongside the controls. The control group showed significantly higher prevalence of pain in all body regions except the elbow and low back. Low back pain prevalence was also highest in the control group, with 72% reporting discomfort in the past 12 months.

Table 4.10 Population musculoskeletal symptoms at baseline

	Sit-to-stand group (n=45)	**Stand-biased group (n=46)**	**Seated control group (n=47)**	**p-value**
Musculoskeletal pain in past 12 months, pain in each region				
% Neck	33.3	39.0	65.1	.007*
% Shoulder	31.7	30.0	60.5	.006*
% Upper Back	12.2	20.0	60.5	.000[A]*
% Elbow	7.3	5.0	9.3	.908[A]
% Low Back	53.7	60	72.1	.208
% Wrist	17.1	22.5	51.2	.001*
% Hip	22.0	12.5	58.1	.000[A]*
% Knee	12.2	17.5	39.5	.009[A]*
% Feet	4.9	7.5	30.2	.002[A]*

p-value is from Pearson chi-squared or Fisher's exact test [A] if distributions had cell counts of 5 or less.
*significant at the 0.05 level

Survey responses for musculoskeletal pain in the two treatment groups over the course of the study are shown in Table 4.11. The only statistically significant difference in prevalence of pain observed between the two workstations was at six months with those in stand-biased workstations showing more people reporting neck pain.

Table 4.11 Prevalence of musculoskeletal symptoms in each region

	Sit-to-stand group	**Stand-biased group**	**p-value**
BASELINE	n=41	n=40	
% Neck	33.3	39.0	.589
% Shoulder	31.7	30.0	.868
% Upper Back	12.2	20.0	.339 [A]
% Elbow	7.3	5.0	1.0 [A]
% Low Back	53.7	60	.565
% Wrist	17.1	22.5	.540
% Hip	22.0	12.5	.261 [A]
% Knee	12.2	17.5	.502 [A]
% Feet	4.9	7.5	.675 [A]
3 MONTHS	n=32	n=33	
% Neck	21.9	30.3	.440
% Shoulder	15.6	30.3	.160 [A]
% Upper Back	9.4	18.2	.475 [A]
% Elbow	9.4	3.0	.355 [A]
% Low Back	50.0	27.3	.060
% Wrist	21.9	21.2	.948
% Hip	12.5	12.1	1.00 [A]
% Knee	12.5	15.2	1.00 [A]
% Feet	3.1	18.2	.105 [A]
6 MONTHS	n=30	n=23	
% Neck	23.3	56.5	.013*
% Shoulder	30.0	26.1	.754
% Upper Back	13.3	26.1	.300 [A]
% Elbow	13.3	0.0	.124 [A]
% Low Back	50.0	30.4	.152
% Wrist	26.7	17.4	.519 [A]
% Hip	16.7	26.0	.501 [A]
% Knee	16.7	17.4	1.00 [A]
% Feet	6.7	8.7	1.00 [A]

p-values are from the Pearson chi-squared test, or Fisher's exact test[A] if cell counts are less than 5
*significant at the 0.05 level

Table 4.12 details survey responses of pros and cons for standing at the workstations. The most common reason answered for standing by both groups was increased body comfort. Approximately half of all participants replied that they had no reasons not to stand. The most common reason answered by both groups for not standing was decreased body comfort.

Table 4.12 Number of participants (% of respondents) reporting factors in the survey (via multiple choice) that influenced them towards working in the standing position at baseline.

	Sit-to-stand group (n=43)	**Stand-biased group (n=42)**	**p-value**
Reasons to stand			
Increased body comfort	31 (72%)	32 (76%)	.666
Productivity	15 (35%)	23 (55%)	.065
To burn more calories	19 (44%)	26 (62%)	.102
To stay alert	25 (58%)	29 (69%)	.296
Curiosity to try it out	19 (44%)	17 (40%)	.729
Seeing others standing while using	16 (37%)	11 (26%)	.275
Direct encouragement by others	4 (9%)	6 (14%)	.520[A]
None	1 (2%)	1 (2%)	1.000[A]
Reasons not to stand			
Decreased body comfort	14 (33%)	8 (19%)	.155
Energy required	3 (7%)	5 (12%)	.483 [A]
Impacts to productivity	4 (9%)	3 (7%)	1.00 [A]
Impacts to alertness	3 (7%)	4 (10%)	.713 [A]
Time to adjust furniture	0	3 (7%)	.116 [A]
None	20 (47%)	22 (52%)	.588

p-values are from the Pearson chi-squared test, or Fisher's exact test[A] if cell counts are less than 5

At baseline, close to half of all participants reported they had experienced increased focus and alertness since switching to a standing workstation as shown in Table 4.13. A high acceptance was reported at baseline for both the sit-to-stand and stand-biased groups with 91% and 82% stating they would make the switch to a stand-capable workstation again, respectively. At six months, these distributions changed slightly, as 80% of sit-to-stand users and 83% of stand-biased users reported they would make the switch again.

At six months, 79% of participants reported that they had transitioned and become comfortable with the new workstation. Of those who reported transitioning to the new workstation, 93% reported the time to transition took four weeks or less. Table 4.14 displays the experiences of the two groups reported at six months.

Table 4.13 Number of participants (% of respondents) reporting in the survey (via multiple choice) about their experience with the new workstation at baseline (82 respondents)

	Sit-to-stand group (n=42)	**Stand-biased group (n=40)**	**p-value**
Increased pain and discomfort at work	2 (5%)	2 (5%)	1.00 [A]
Decreased pain and discomfort at work	12 (29%)	10 (25%)	.715
Increased focus and alertness	18 (43%)	22 (55%)	.272
Decreased focus and alertness	1 (2%)	3 (8%)	.353 [A]
Increased Productivity	9 (21%)	15 (38%)	.110
Decreased Productivity	2 (5%)	0	.494 [A]
Increased levels of energy	17 (40%)	16 (40%)	.965
Decreased levels of energy	0	0	
None	11 (26%)	9 (23%)	.697
If participants would make the switch again (87 responses)			
Yes	39 (91%)	36 (82%)	.052
No	2 (5%)	8 (18%)	
Undecided	2 (5%)	0	

p-values are from the Pearson chi-squared test, or Fisher's exact test[A] if cell counts <5

Table 4.14 Number of participants (% of respondents) reporting in the survey (via multiple choice) about their experience with the new workstation at 6 months (53 respondents)

	Sit-to-stand group (n=30)	Stand-biased group (n=23)	Chi-Square test Statistic
Increased pain and discomfort at work	2 (7%)	1 (4%)	1.00 [A]
Decreased pain and discomfort at work	4 (13%)	8 (35%)	.098 [A]
Increased focus and alertness	12 (40%)	8 (35%)	.698
Decreased focus and alertness	0	1 (4%)	.434 [A]
Increased Productivity	6 (20%)	12 (52%)	.014*
Decreased Productivity	0	1 (4%)	.434 [A]
Increased levels of energy	10 (33%)	7 (31%)	.823
Decreased levels of energy	0	1 (4%)	.434 [A]
None	12 (40%)	6 (26%)	.289

p-values are from the Pearson chi-squared test, or Fisher's exact test[A] if cell counts are less than 5
*significant at the 0.05 level

4.4 Discussion

Data from this study failed to uncover any significant differences over six months in energy expenditure between those with a sit-stand and a stand-biased workstation. However, this study did reveal that desk type was a statistically significant predictor of self-reported seated behavior, and users of sit-to-stand and stand-biased workstations reported sitting less than the control group. Baseline differences in proportion of time spent sedentary, average steps per minute, average METs per minute, and proportion of time seated showed advantages for a stand-biased workstation compared to a sit-stand workstation. However, these differences faded over the course of the study, and type of workstation (sit-stand or stand-biased) had no significant effect on changes in proportion of monitored time spent sedentary over the course of the study. While not statistically significant, stand-biased users consistently had a slightly higher METs per minute average, and calories per minute were 0.1 calories higher than the sit-to-stand group. Over the course of a workday, this difference could equate to about 50 calories, nearly half of the 100 calories estimated as required to prevent weight gain in most U.S. adults (Hill et al., 2003).

Graphical examination of data by BMI category, shown in Figures 4.10 and 4.11, reveals that there may be different intervention effects for people in different weight categories. This was also shown in the GLMM for proportion of self-reported time seated, as obesity had a significant effect, as obese participants reported a higher proportion of time seated than normal weight participants. Patterns of sedentary behavior (Figure 4.10) do not reveal much variation by workstation within BMI categories. However, self-reported time spent standing shows that within the stand-biased workstation users, those who are overweight stand just as much as the normal weight participants. This pattern was not seen within the users of sit-stand workstations. Also, patterns by BMI category did not remain stable across the course of the study. As research into the use of stand-biased workstation advances, it will be important to determine how usage may vary by different types of people.

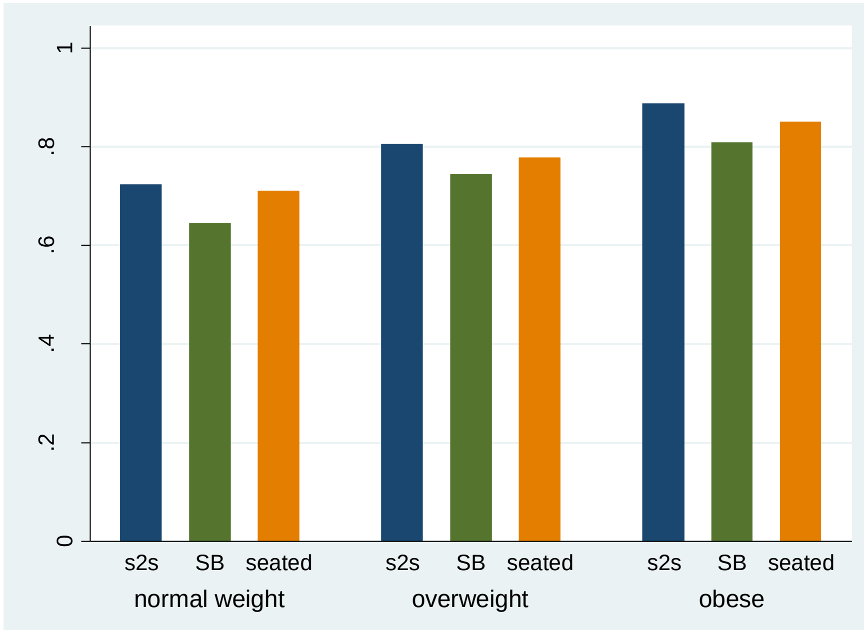

Figure 4.10 Histogram of reported proportion of monitored time spent sedentary by workstation type and BMI category

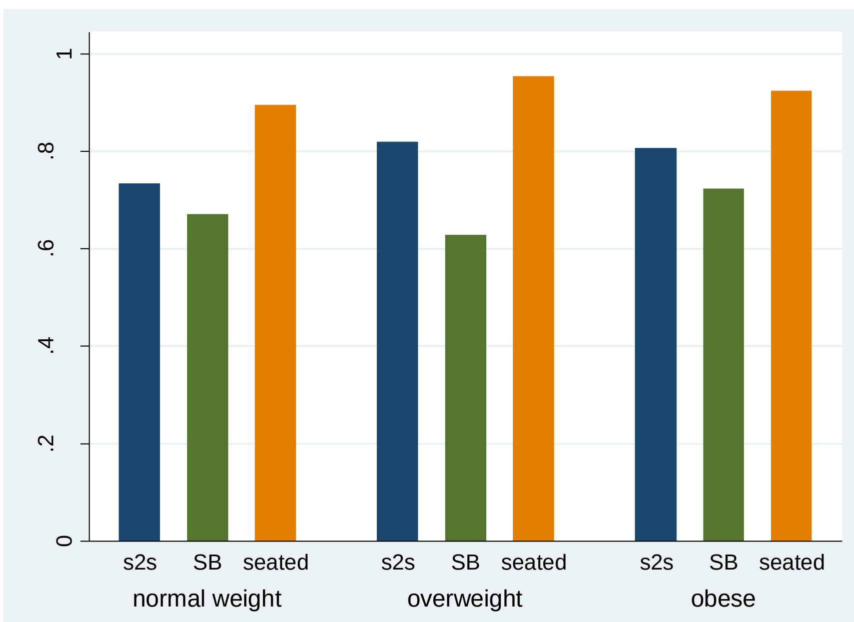

Figure 4.11 Histogram of reported proportion of workday spent seated by workstation type and BMI category

Self-reported time spent seated showed that those on the stand-capable side of the call center were seated for an average of 72-73% of their day compared to those on the seated control side that spent 91% of their day seated. At baseline, those in sit-stand workstations reported standing 16% of their workday more than the controls, and stand-biased users reported standing 26% more of their workday than the controls. This equates to a reduction in seated time of about 1 hour 17 minutes and 2 hours 5 minutes for sit-stand and stand-biased users respectively over an eight hour workday. These reductions in seated time are similar to that of previous studies (Pronk et al., 2012, Grunseit et al., 2013, Alkhajah et al., 2012, Healy et al., 2013). Six month data showed that there was a slight decrease in standing time, but the amount of standing time compared to the controls was still 1 hour 2 minutes and 1 hour 55 minutes for sit-to-stand and stand-biased users respectively over an eight hour workday. Results of the GLMM for proportion of self-reported time spent seated did not show time (baseline, 3 months or 6 months) to be a statistically significant predictor of reported sitting. This is the first study to show sustained reported usage of stand-capable workstations over six months.

Despite findings of reductions in slf-reported sitting time, there was no significant difference in the proportion of monitored time spent sedentary between the stand-capable and seated control groups. This finding is similar to the findings of a recent study in Australia that found that while people did use standing desks, there were no significant changes in their overall sedentary work time monitored by Sensewear® armbands (Gilson et al., 2012). Like Gilson and colleagues, it is postulated that the lack of impact on sedentary behavior in this study is due to either a lack in sensitivity by the Sensewear® armband at sedentary and light levels of physical activity, or that standing and working is also a sedentary activity for many. While compendium of physical activity estimates classify sitting work in the sedentary range (<1.5 METs) and standing work in the light activity range (1.5-3.0 METs) (Ainsworth et al., 2011), recent studies have challenged this idea (Beers et al., 2008, Speck and Schmitz, 2011). Another recent study comparing energy expenditure (EE) of seated and standing work found that among its young, healthy, and fairly homogenous population, some experience a 20% increase in EE for standing compared to sitting and some have no increase in EE (Miles-Chan et al., 2013). Further, the authors found that for those who increased their EE standing, distinct patterns of energy change occurred (i.e EE remains elevated after 10 minutes standing, or EE decreases back to sitting levels over the 10 minutes of standing work). These data suggest that in the present study, some people may exhibit no effect in sedentary behavior from standing work, and that the pattern of standing may greatly affect some of those that do experience an increase in EE from standing work.

It is likely that self-reported time spent seated/standing, transitions from sitting to standing, and average bouts of standing are difficult for people to estimate. Results from these estimates are somewhat conflicting as consideration of transitions reported and average time spent standing do not mirror patterns seen with cumulative time spent seated and standing. Regardless, the number of transitions reported a day, with an average centered around approximately three times, is probably lower than needed for substantial health benefit in light of recent evidence showing breaks in sedentary time can bring substantial metabolic benefit (Howard et al., 2013).

One of the major benefits of stand-capable workstations confirmed in this study is the impacts on comfort. At baseline, nearly three-fourths of participants reported increased body comfort as a factor influencing them to stand. Interestingly, only about a quarter of baseline participants reported that they had actually experienced decreased pain and discomfort. Perhaps this points to avoidance of pain and discomfort rather than relief. Comparisons with seated controls show dramatic differences in prevalence of discomfort with those who have stand-capable workstations. It is possible that since many employees started working at Healthways in the new call center or spent only a few months in the seated side of the call center prior to moving to a stand-capable workstation, there was limited time for musculoskeletal symptoms to develop from prolonged seated work. Regardless of whether stand-capable workstations avoided or assuaged musculoskeletal symptoms in this population, this study provides clear evidence to their benefits on comfort.

Discomfort data from the NMQ revealed a dramatic decrease in the proportion of respondents in stand-biased workstations reporting low back symptoms. Reported prevalence dropped from 60% at baseline to around 30% at three and six months follow-up. This was not a result of attrition, as analysis of only those who completed the study showed similar prevalence to the full study group of low-back symptoms at baseline. Neck pain exhibited an opposite trend than the low-back symptoms, as it had a prevalence of 39% at baseline and 56.5% at six months in the stand-biased group. This was likely partially a result of attrition, as analysis of only those who completed the study showed a higher prevalence (47.8%) than the full study group (39%) of neck symptoms at baseline. Neck pain also likely increased from poor ergonomics with monitors adjusted too low.

Participants provided subjective feedback about their experiences with the stand-capable workstations throughout each survey; a complete summary and list of open-ended responses is in Appendix N. Common themes found in these responses further highlight usability of these workstations. Responses show that users had an understanding of the health benefits possible through standing rather than sitting. For example, participants commented that it helps with osteoporosis prevention, allows them to stretch, allows them to be conscious of posture, and allows for calf raises.

Several people repeatedly mentioned that privacy was an issue with the raised chairs or while standing. They reported they did not like others to hear them while they were on their calls. When the new call center opened, management realized this issue, and the white noise level was turned up to a higher level; however, comments about privacy persisted throughout the six month study. This highlights not only environmental and social influences on workstation usage and acceptability but the possible lack of generalizability of study results between open plan office and private office settings.

4.4.1 Limitations

Like several other studies on standing workstation use (Pronk et al., 2012, Alkhajah et al., 2012), this study population was health-focused by the nature of their work, which may limit the generalizability of these results to other workplace settings.

Another potential limitation of this study was the contamination between the two types of stand-capable workstations. Initially, those with the same desk type were grouped together in pods of four or eight people. However, movement within the call center was common, and by six months, several sit-to-stand and stand-biased users had intermingled in the pods of four or eight. This movement likely did not have much effect since pods of four or eight of each type of desk were intermingled throughout the open design call center. Figure 4.12 provides a layout of part of the call center, demonstrating the open design in which the pods of sit-to-stand and stand-biased workstations were mixed.

Figure 4.12 Call center floor plan

Like many longitudinal studies in real-world settings, loss to follow-up occurred in this population. While call-centers may be an ideal study setting for the lack in variation of work tasks across people with the same job title and across time, turnover is high. Several employees that were on temporary status were enrolled into the study in an effort to increase sample size. Baseline and three month data analysis of those who were lost to follow-up and those who completed the study did not reveal any major differences between the groups (Appendix O). Small numbers by the end of this observational study likely impacted the power to detect statistical differences between the two groups.

Unfortunately, the definition of stand-biased used for classification in this study was based solely on chair-type (bar height versus traditional height). Another major component of stand-biased workstations is the footrest. Participants were just getting footrests at the time of baseline measurement. Healthways management made efforts to distribute footrests to those with stand-biased workstations and anti-fatigue mats to those with sit-to-stand workstations. For a number of reasons, not all stand-biased users reported having a footrest, and likewise, some sit-stand users reported having a footrest. Table 4.15 displays the percent of participants reporting having a footrest at the six month follow up. Analysis of another question regarding footrest usage reveals inconsistency in responses, and having a footrest was likely mis-reported.

Table 4.15 Percent of participants with footrests at study completion

Sit-to-stand	**Stand-biased group**
31%	83%

Being that the study was opportunistic and took place in a setting where furniture was already set-up, there are several limitations to this study and the design. The first, as mentioned above is the contamination of workstation types, particularly with footrests. Had the study been completely funded and controlled by external resources, all workstation equipment would have been fully set-up prior to the study beginning. Also, workstation groups may have been allocated differently within the entire call center if the researcher had the ability to do so. Stand-capable workstation users were new-hires, while controls had much longer tenure at Healthways, many with over five years of experience. It is possible that those who had been at Healthways for a longer period of time were less inclined to take advantage of fitness opportunities offered during work hours because it was no longer a novelty. Designing the study so that participants would serve as their own control may have been the most ideal option. However, this was not realistic as it would have required enough traditional seated workstations for every employee to work at for a baseline measurement. This could have been possible if Healthways was replacing existing furniture with stand-capable furniture, but they were not; a completely new area of the building was opened with the new stand-capable furniture.

4.4.2 Strengths

Several strengths of this study also deserve mentioning. While both types of measures used are not without their limitations, collecting both objective and subjective data from study subjects provided a broader picture of workstation use in this population.

As mentioned previously, several have noted that as the novelty of a stand-capable workstation wears off, the usage declines. Because participants were followed for six months, it was likely a long enough time with the stand-capable workstations for the novelty to wear off, and that habits and usage determined in this study were believed to be at steady-state.

This study was also unique because it defined two different types of stand-capable workstations in order to explore differences in usage over time. While there were no significant sustained differences between sedentary behavior or time reported sitting over the course of six months, data provide evidence that initially, stand-biased workstations were more fully utilized than sit-to-stand workstations.

4.5 Summary

This study found sustained reductions over six months in seated time for users of stand-capable workstations. Initial measurements revealed significant differences in proportion of time sedentary and self-reported sitting time between sit-stand workstation users and stand-biased workstation users, but there were no significant differences in these measures by six months follow-up. A generalized linear mixed model provided no evidence that sedentary behavior was related to stand-capable workstation type. However, a generalized linear mixed model for self-reported proportion of time spent seated showed that stand-capable workstation users sat for less time than the seated control group, and the effect was significant.

In this call-center study, those who used a sit-stand workstation sat approximately 1 hour and 2 minutes less and those who used a stand-biased workstation sat 1 hour 55 minutes less over an eight hour workday when compared to those who used a traditional seated workstation. Reductions in seated time did not have an impact on the amount of work time spent sedentary, classified as less than 1.5 METs. Overall, stand-capable workstation users exhibited less musculoskeletal discomfort than the traditional seated desk users. Stand-capable desks had a high level of acceptability.

5 CONCLUSIONS

5.1 Findings from dissertation studies

Results of these three studies represent stand-capable workstation use in a variety of workplace settings with different deployment strategies. All three organizations were health related; one is a pharmaceutical company, SRPH is a school of public health doing both education and research, and Healthways is a health and well-being improvement company. When looking across the results of the three studies it is important to keep in mind the different stand-capable deployment strategy used in each environment. The pharmaceutical company employees gained access to stand-capable workstations by moving into an open-seating office plan. The move was met with resistance. SRPH employees each requested a stand-biased workstation. They were perhaps the most informed population on the benefits of stand-capable workstations as many participants conducted research on stand-capable desks or worked alongside those who did. All employees working in Healthways' new call center received a stand-capable workstation.

Table 5.1 presents the standing habits reported in each of the studies. The pharmaceutical company participants provided only categorical feedback (selecting a range of time standing) for amount of time spent standing, so an average was not calculated for this group. They also were not asked to report the number of transitions they made from sitting to standing. While time with workstations in our studies varied from three months to five years, it shows much higher population usage than observed in a previous observational study where stand-capable workstations had been present for a while (Wilks et al., 2006). Overall, the SRPH participants had the most usage of their stand-capable workstations. The SRPH average time standing of 3.4 hours is much higher than previous studies that found reductions in sitting time of 1-2 hours in people who had used sit-stand adjustable workstations for only three months or less, findings that are similar to Healthways participants at six months (Pronk et al., 2012, Grunseit et al., 2013, Alkhajah et al., 2012, Healy et al., 2013).

Table 5.1 Standing habits in three dissertation studies

	Pharmaceutical company follow-up (n=10)	**SRPH interviews (n=25)**	**Healthways 6-month follow-up* (n=52)**
Percent of Population that reported standing at all	50%	100%	88%
Average percent of workday reported standing	-	51% (range 8-93%)	29% (range 0-100%)
Average transitions reported from seated to standing per day	-	9.7 (range 1-50)	3.1 (range 1-10)

* Combined sit-stand and stand-biased participants

The role of choice is likely a very important determinant of stand-capable desk usage. In the pharmaceutical company pre-move study, only 40% of participants said they were likely to use a stand-capable desk if one were available. This likely contributed to a low rate of stand-capable desk usage in this population. However, all SRPH employees specifically requested a stand-biased workstation (many were presented with the opportunity and said yes). In a way, this meant each person predicted they would use the workstation in the standing position. This 100% prediction of usage did lead to 100% of participants who utilized the standing position. Interviews with those at SRPH that have not requested a stand-capable workstation could help explain barriers to use. As a direct result of the SRPH study, a new policy was created with that would allow any SRPH employee that wanted a stand-biased workstation the funding to convert to one.

Neither the SRPH nor Healthways study uncovered any dramatic declines in standing habits over time. This is likely due to a number of factors including the ability to bias users with the workstation design, the motivated populations, and the positive attitudes towards the workstations. Knowing that people can sustain their standing habits over time and after the initial novelty of a new workstation wears off has tremendous implications for employers looking to invest in the health and well-being of their employees. While the Healthways study failed to find any sustained difference in sedentary behavior between the stand-biased and sit-stand workstations over six months, it did reveal that both types of stand-capable workstation users had sustained standing habits that were significantly different than the control group. Differences in usage by the end of the study may have been difficult to determine because of a lack in consistency in equipment used at each type of workstation or the small sample size available at six months. More comparative research on sit-stand and stand-biased workstations in different types of office environments (open plan versus private offices) is needed.

The importance of comfort from being able to stand while working was highlighted in each of the three studies. Not only do people perceive stand-capable workstations as able to impact comfort, the workstations were shown to positively impact comfort in the Healthways study. The pharmaceutical company pre-move survey answers showed that comfort was a determinant for standing or not standing for a majority of participants. Twenty eight percent of SRPH participants said they requested their workstation because they were experiencing pain or discomfort, and many said that the workstation had helped them. The Healthways study showed that the stand-capable workstation users experienced significantly less discomfort in most body regions than those in traditional seated workstations. This shows that in addition to metabolic benefits gained from stand-capable workstations, companies should also weigh their impacts on worker comfort when making purchasing decisions.

5.2 Future research

Currently, studies of stand-capable workstation effects on productivity are limited to only lab settings (Karakolis and Callaghan, 2014, Robertson et al., 2013). All productivity data collected in these studies were limited to subjective responses. About half of Healthways participants felt that the stand-capable workstations had a positive impact on productivity, and less than 10% felt the workstations had a negative impact on productivity. This is the opposite trend that was found in the pharmaceutical company pre-move survey as only about a quarter of participants thought that impacts to productivity would be positive and about half thought they would be negative. Several SRPH interviewees mentioned the increases in productivity they had experienced since switching to a stand-biased workstation. This anecdotal information needs to be studied with reliable productivity measures that would inform future stand-capable desk purchasers and enable them to factor in productivity to calculate a return on investment. Perhaps even more difficult to study, but potentially an important factor for employers making the purchasing decisions, would be how the ability to stand affects creativity.

Measurement in future studies is important. Nearly all of this research was limited to subjective responses, and objective measurement obtained through the Sensewear® Armbands may have lacked the sensitivity needed to discern any intervention effects. Future research on stand-capable workstations should utilize new technology such as the activPAL3™ that can provide reliable information on seated and standing time as well as transitions from sitting to standing. It is likely that participants in these dissertation studies had a difficult time estimating sit-to-stand transitions as the number of times reported for a whole workday were similar to the number recorded per hour in a recent study using the activPAL3™ (Healy et al., 2013). In a 2011 review, Healy et al. recommended using both self-reported and device based measures to study sedentary time. As measurement of seated and standing times becomes more reliable, researchers can better explore associations with stand-capable desk use and clinical outcomes such as cholesterol and glucose levels.

While not a main component of any of these studies, research on how to best educate new users on stand-capable workstations will help maximize their benefit. A recent lab-based study found that people who received ergonomics training stood at their stand-capable workstations, while those who received minimal training did not stand at all (Robertson et al., 2013). It was apparent in these studies that switching positions often was not given high importance by the participants who would primarily be considered minimally trained.

However, as there are currently no clear guidelines or recommendations for standing office work, it may be difficult to create education materials. Physical activity guidelines prescribe a precise dose of activity Americans should aim to acquire each week (Haskell et al., 2007). Current sitting guidelines are vague and do not provide any recommended dosages or patterns for optimal health and comfort (Owen et al., 2009, Garber et al., 2011, Kushi et al., 2012). People need to understand that stand-capable desks are not “can only stand desks” that lead people to stand too much and thus replace the problems of too much sitting with too much standing. Just as sitting too much has shown to have negative health consequences, standing too much can also be detrimental. Studies have shown too much standing to be associated with chronic venous insufficiency, musculoskeletal pain in the feet and lower back, preterm birth, and spontaneous abortions (McCulloch, 2002). There is not a known threshold for too much standing, but there quite possibly were several people in the SRPH and Healthways studies that stood for longer than necessary.

5.3 Study implications

Public health research in this field is rapidly advancing. At the same time the research is unfolding, thousands of stand-capable desks are being purchased for offices across the country. This dissertation adds to the growing research by showing standing behavior can be sustained for six months and even longer as observed in the SRPH study. This research also brought to light important factors that motivated people to stand or not stand at a stand-capable workstation. While more research comparing stand-biased and stand-capable workstations in different environments is needed, this dissertation does offer evidence of the advantages of stand-biased workstations.

5.4 Other comments

As research with children using stand-capable desks in classrooms advances, it is imperative that the adult research keeps pace. Promising research in classrooms has shown stand-capable desks may be able to change behavior enough to help combat the childhood obesity epidemic (Benden, 2008, Hinckson et al., 2013). If this research transforms the classroom of the future away from traditional seated desks, it will be necessary to transform the office of the future as well. If a child grows up using a stand-capable desk throughout their education, they can't suddenly be sentenced to a life of sitting when they first enter the workforce as a young adult.

While stand-capable workstations currently seem to be the best solution for our problem of too much sitting, there may be other alternatives down the road. While it may be difficult to grasp in this economic climate, some have suggested other possibilities to combat the problem of too much sitting through breaks, changes regarding work requirements, or even a reduction of working time (Husemann et al., 2009).

Other ideas rely on advances in technology. While our improvements in technology are largely to blame for the current sitting problem, it is possible that further advances in technology may actually be what can ultimately free us from our chairs. Wearable computers that utilize glasses and portable input devices that allow a user to walk or stand while working have been proposed (Fukumoto et al., 1999). While this possibility may come with its own set of hazards, it illustrates one possible way for people to work in a non-traditional workspace. However, this type of solution may be decades away as the technology still needs to be perfected.

5.5 Final conclusions

Stand-capable workstations offer a promising solution to the negative health consequences from too much sitting by America's workforce. This dissertation was able to show sustained usage of stand-capable workstations for six months and longer. This study also provides evidence that environment and introduction methods to employees may have an impact on their adoption. Stand-biased workstations were shown to have better rates of use than sit-stand workstations initially, but differences in usage over time faded. More investigation is needed to determine the best type of stand-capable workstation for different settings. In addition to reducing seated time, these studies found that stand-capable workstations were able to improve comfort, a factor that made people want to stand while working.

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APPENDIX A

PHARMACEUTICAL COMPANY STAND-CAPABLE WORKSTATION

PRE-SURVEY

Our company has partnered with researchers at Texas A&M University to study attitudes, beliefs and behaviors associated with standing computer workstations. Using both pre- and post-move surveys, we aim to specifically improve our understanding of current and anticipated work habits based upon the opportunity to work with computers while standing. This pre-move survey, consisting of 17 questions in total, is expected to take you no more than 5-7 minutes to complete. Your responses will be kept confidential. Thank you in advance for your valuable time.

This first set of questions is for classification purposes only. They will only be used to group your answers with others like yourself.

Question 1

Please indicate your gender.

- ❍ Male
- ❍ Female

Question 2

Please select the category that includes your age.

- ❍ 18-24
- ❍ 25-34
- ❍ 35-44
- ❍ 45-54
- ❍ 55-64
- ❍ 65 or older

Question 3

Please select the category that includes your height in feet and inches (round to the closest inch).

- ❍ 4’10” or shorter
- ❍ 4’10” to 5’2”
- ❍ 5’3” to 5’6”
- ❍ 5’7” to 5’10”
- ❍ 5’11” to 6’2”
- ❍ 6’3” or taller

Question 4

Please select the category that includes your weight in pounds.

- ❍ 110 or less
- ❍ 111 to 125
- ❍ 126 to 140
- ❍ 141 to 155
- ❍ 156 to 170

- ❍ 171 to 185
- ❍ 186 to 200
- ❍ 201 to 215
- ❍ 216 to 230
- ❍ 231 to 245
- ❍ 246 to 260
- ❍ 261 or more

Question 5

What is your grade level?

- ❍ 1
- ❍ 2
- ❍ 3
- ❍ 4
- ❍ 5
- ❍ 6
- ❍ 7
- ❍ 8
- ❍ 9
- ❍ 10
- ❍ L
- ❍ P

Question 6

Estimate the total number of hours you currently spend at your workstation or desk across a typical work day.

	0 hours (not at all)	2 hours or less	greater than 2 to 4 hours	greater than 4 to 6 hours
Seated	❍	❍	❍	❍
Standing	❍	❍	❍	❍

Question 7

Estimate the total number of hours you currently spend actively keying and mousing (do your best to exclude pauses in your estimation) throughout a typical workday.

- ❍ 2 hours or less
- ❍ Greater than 2 to 4 hours
- ❍ Greater than 4 to 6 hours
- ❍ Greater than 6 to 8 hours
- ❍ Greater than 8 hours or more

Question 8

What level of training and assistance have you been given regarding the setup of the computing equipment and office furniture provided to you?

- ❍ None
- ❍ Electronic material with oral instructions
- ❍ Electronic material with oral instructions and individual evaluation and recommendations

- ❍ Electronic material with electronic self-assessment
- ❍ Other, please specify________________________________

Question 9

The workstation I currently use can best be described as:

- ❍ A traditional seated workstation with adjustable height chair
- ❍ A sit/stand capable workstation (electric or manual) with an adjustable height chair.
- ❍ A standing desk with footrest and adjustable height stool.

Question 10

How much time do you spend on a computer at home per week?

	None	Less than 2 hours per day	2-4 hours per day
For non-work related activities	❍	❍	❍
For work-related activities	❍	❍	❍

Please answer the following questions associated with perceptions and attitudes towards stand-capable workstations. A standing workstation, or a stand capable workstation, is a desk that can be raised to the height of your elbows while you are standing. This allows you to spend part of your workday standing while using the computer or performing other related work tasks.

Question 11

How likely would you be to use a stand-capable workstation if one were made available to you?

- ❍ Very unlikely
- ❍ Unlikely
- ❍ Neither likely or unlikely
- ❍ Likely
- ❍ Very likely

Question 12

How much of a typical workday do you think you would spend standing if a stand-capable workstation were available to you?

- ❍ No time at all
- ❍ 1 hour or less a day
- ❍ Greater than 1 to 2 hours a day
- ❍ Greater than 2 to 4 hours a day
- ❍ Greater than 4 to 6 hours a day
- ❍ Greater than 6 to 8 hours a day
- ❍ Greater than 8 hours a day

Question 13

What factors (check all that apply) would make you consider trying a stand-capable workstation?

- ❑ Increased body comfort

- ❑ Productivity
- ❑ To burn more calories/ to lose weight
- ❑ To stay alert
- ❑ Curiosity to try it out
- ❑ Other, please specify:____

Question 14

What factors (check all that apply) would make you not consider trying a stand-capable workstation? *Please do not provide any sensitive personally identifiable information such as individual medical status or specific medical condition*.

- ❑ Decreased body comfort
- ❑ Energy required
- ❑ Potential impacts to my productivity
- ❑ Potential impacts to my alertness
- ❑ Other, please specify:____

Question 15

If you have the ability to work remotely from home, would knowing a sit to stand-capable workstation is available to you make it more likely for you to come into the office?

- ❍ Not applicable, I do not have the ability to work remotely from home
- ❍ Yes, it would make me more likely to come into the office
- ❍ No, it would not make me any more likely to come into the office

Question 16

What category best describes your level of comfort with your current individual workstation or desk setup when computing?

- ❍ Very low comfort
- ❍ Low comfort
- ❍ Moderate comfort
- ❍ Strong comfort
- ❍ Very strong comfort
- ❍ Extreme comfort

Question 17

Would you be opposed to completing a short post-move survey via Select Survey on this same topic?

- ❍ I will participate, my email is:____
- ❍ I choose not to participate..

APPENDIX B

PHARMACEUTICAL COMPANY STAND-CAPABLE WORKSTATION POST-SURVEY

Page 1 - Heading

The questions included in this brief survey are designed to improve our understanding of current and anticipated working habits based upon computer workstation setups. This survey, consisting of 18 questions in total, is expected to take you no more than 5-7 minutes to complete. Your responses will be kept confidential.

Description

Page 1 - Heading

The next questions are for classification purposes only. They will only be used to group your answers with others like yourself.

Page 1 - Question 1 - Choice - One Answer (Bullets)

Please indicate your gender.

- ❍ Male
- ❍ Female

Page 1 - Question 2 - Choice - One Answer (Drop Down)

Please select the category that includes your age.

- ❍ 18-24
- ❍ 25-34
- ❍ 35-44
- ❍ 45-54
- ❍ 55-64
- ❍ 65 or older

Page 1 - Question 3 - Open Ended - Comments Box

Please select the category that includes your height in inches (round to the closest inch).

- ❍ 58 or shorter
- ❍ 59 to 62
- ❍ 66 to 63
- ❍ 70 to 67

- 74 to 71
- 75 or taller

Page 1 - Question 4 - Open Ended - Comments Box

Please select the category that includes your weight in pounds.

- 110 or less
- 125 to 111
- 140 to 126
- 155 to 141
- 170 to 156
- 185 to 171
- 200 to 186
- 215 to 201
- 230 to 216
- 245 to 231
- 260 to 246
- 261 or more

Page 1 - Question 5 - Choice - One Answer (Drop Down)

What is your grade level?

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- L
- P

Page 1 - Question 6 - Choice - One Answer (Bullets)

Since your move, estimate the total number of hours you spend seated at an individual workstation or desk throughout a typical workday.

- 0 hours (I do not stand at all)
- 2 hours or less
- greater than 2 to 4 hours
- greater than 4 to 6 hours
- greater than 6 to 8 hours
- greater than 8 hours or more

Page 1 - Question 7 - Choice - One Answer (Bullets)

Since your move, estimate the total number of hours you spend standing at an individual workstation or desk throughout a typical workday.

- ❍ 0 hours (I do not stand at all)
- ❍ 2 hours or less
- ❍ greater than 2 to 4 hours
- ❍ greater than 4 to 6 hours
- ❍ greater than 6 to 8 hours
- ❍ greater than 8 hours or more

Page 1 - Question 8 - Choice - One Answer (Bullets)

Since your move, estimate the total number of hours you spend actively keying and mousing (exclude pauses in your consideration) throughout a typical workday.

- ❍ 2 hours or less
- ❍ greater than 2 to 4 hours
- ❍ greater than 4 to 6 hours
- ❍ greater than 6 to 8 hours
- ❍ greater than 8 hours or more

Page 1 - Question 9 - Choice - One Answer (Bullets)

What level training have you been given regarding the setup of the computing equipment and office furniture provided to you?

- ❍ None
- ❍ electronic material with oral instructions
- ❍ electronic material with oral instructions and individual evaluation and recommendations
- ❍ electronic material with electronic self-assessment
- ❍ Other, please specify

Page 1 - Question 10 - Choice - One Answer (Bullets)

The workstation I typically choose to use in my new location can best be described as:

- ❍ A traditional fixed-height seated workstation with an adjustable height chair.
- ❍ A sit/ stand-capable workstation (electric or manual) with an adjustable height chair.
- ❍ A standing desk with footrest and adjustable height stool.
- ❍ Sometimes a traditional fixed-height seated workstation and sometimes a sit/ stand-capable workstation (electric or manual) with an adjustable height chair.

Page 1 - Question 11 - Choice - One Answer (Bullets)

Since your move, how much time do you spend on a computer at home for non work-related activities?

- ❍ None
- ❍ Less than 1 hour per day

- ❍ 2-3 hours per day
- ❍ More than 4 hours per day
- ❍ I prefer not to answer

Page 1 - Question 12 - Choice - One Answer (Bullets)

Since your move, how much time do you spend on a computer at home for work-related activities?

- ❍ None
- ❍ Less than 1 hour per day
- ❍ 2-3 hours per day
- ❍ More than 4 hours per day

Page 2 - Heading

Please answer the following questions associated with the stand-capable computing workstations available to you.

Description

Page 2 - Question 13 - Choice - One Answer (Bullets)

Since your move, are you aware that there are adjustable workstations available that enable you to stand at your computer and work?

- ❍ Yes
- ❍ No

Page 2 - Question 14 - Choice - One Answer (Bullets)

Since your move, how likely are you to work while standing for short periods if a stand-capable workstation is unoccupied and available for your use?

- ❍ Very unlikely
- ❍ Unlikely
- ❍ Neither likely or unlikely
- ❍ Likely
- ❍ Very likely

Page 2 - Question 15 - Choice - Multiple Answers (Bullets)

Since your move, what factors (check all that apply) make you want to continue working while standing for short periods across the workday? Please do not provide any sensitive personally identifiable information such as individual medical status or specific medical condition

- ❑ I have not yet tried standing while working at my computer
- ❑ I have tried standing for short periods while working at my computer and found it was not to my liking
- ❑ increased body comfort
- ❑ increased productivity

- ❑ to burn more calories/ to lose weight
- ❑ to stay alert
- ❑ continued curiosity to try it out
- ❑ the physical locations of the stand-capable workstations in the office are to my liking
- ❑ other, please specify

Page 2 - Question 16 - Choice - Multiple Answers (Bullets)

What factors (check all that apply) now make you not want to work while standing for periods across the day?

- ❑ I plan to take full advantage of stand-capable workstations for the foreseeable future
- ❑ decreased body comfort
- ❑ energy required
- ❑ impacts on my productivity
- ❑ impacts on my alertness
- ❑ the physical locations of the stand-capable workstation in the office are not to my liking
- ❑ other, please specify

Page 2 - Question 17 - Choice - One Answer (Bullets)

Since your move, if you have the ability to work remotely from home, does knowing a stand-capable workstation is available to you make it more likely for you to come into the office?

- ❍ Not applicable, I do not have the ability to work remotely from home
- ❍ Yes, it would make me more likely to come into the office
- ❍ No, it would not make me any more likely to come into the office

Page 3 - Question 18 - Rating Scale - Matrix

Since your move if you have worked while standing on more than a "try-out" basis, please indicate the changes in job related comfort you have for the body regions below (leave scoring blank if you have not had the opportunity or have not yet used a stand-capable workstation).

	more comfort	**No change in comfort**	**less comfort**
eyes	❍	❍	❍
neck/ shoulders	❍	❍	❍
back	❍	❍	❍
arms	❍	❍	❍
wrists/ hands	❍	❍	❍
buttocks/hips/ thighs	❍	❍	❍
knees	❍	❍	❍
lower legs	❍	❍	❍
ankles/ feet	❍	❍	❍

APPENDIX C

PHARMACEUTICAL COMPANY RESULTS NOT INCLUDED IN TEXT

Table C.1 Training provided to survey participants (pre & post survey)

	Responses
Pre-move survey responses (n=33)	
Electronic material with oral instructions	7 (21.2%)
Electronic material with oral instructions and individual evaluation and recommendations	11 (33.3%)
Electronic material with electronic self assessment	6 (18.2%)
None	3 (9.1%)
Other	6 (18.2%)
Post-move survey responses (n=10)	
Electronic material with oral instructions	2 (20%)
Electronic material with oral instructions and individual evaluation and recommendations	1 (10%)
Face-to-face presentation	6 (60%)
Other (group presentation)	1 (10%)

Table C.2 Participant responses to "other" questions

Other reasons listed for considering trying a stand-capable workstation:

-health benefits as recent media information indicates long periods of sitting can raise risk of heart attacks

-As a male, I would like to stand more for comfort. Sitting all day as a male gets uncomfortable some days.

-I'm not able to stand at all - in a wheelchair.

-fine as is on all the above

Other reasons listed for not considering trying a stand-capable workstation:

-Medical reasons, sense of less privacy

-I'm not able to stand at all

-in a wheelchair

Other reasons for using stand-capable workstation

-Seeing others standing while using

-adjusts low enough

Table C.2 (continued)

Other reasons for not using a stand-capable workstation
-Medical reasons, sense of less privacy
-I'm not able to stand at all - in a wheelchair.

Table C.3 Post-move Participant Characteristics (n=10)

Female	8 (80%)
Age range	
25-34	2 (20%)
35-44	3 (30%)
45-54	4 (40%)
55-64	1 (10%)
65+	0
Height range	
4’10” to 5’2”	4 (11.1%)
5’3” to 5’6”	14 (38.9%)
5’7” to 5’10”	10 (27.8%)
5’11” to 6’2”	6 (16.7%)
6’3” or taller	2 (5.6%)
Weight range (in pounds)	
110 or less	0
111 to 125	0
126 to 140	2 (20%)
141 to 155	1 (10%)
156 to 170	0
171 to 185	1 (10%)
186 to 200	2 (20%)
201 to 215	1 (10%)
216 to 230	1 (10%)
231 to 245	1 (10%)
246 to 260	1 (10%)
261 or more	0
Grade Level	
5	2 (20%)
6	5 (50%)
7	1 (10%)
8	2 (20%)

Table C.4 Number of people reporting reasons to try or not try a standing workstation by their estimated likelihood of using the workstation

	Likely to stand (n=13)	Neither likely or likely to stand (n=10)	Unlikely to stand (n=10)	Fisher's exact Test p-value
Reasons that would make someone consider trying a stand-capable workstation				
Increased comfort	13	7	2	.000
Productivity	6	3	0	.053
To burn calories	9	3	2	.061
To stay alert	13	6	2	.000
Curiosity to try it out	4	7	4	.209
Reasons that would make someone not consider trying a stand-capable workstation				
Decreased comfort	6	9	6	.109
Energy required	1	3	0	.163
Impacts to productivity	5	5	6	.621
Impacts to alertness	0	3	1	.086
Time to adjust the furniture	3	1	1	.704

APPENDIX D

SRPH RECRUITMENT EMAIL TEXT

Hi {insert name},

I am currently working on my dissertation topic around stand-capable desks, and have decided to conduct in house interviews with those at SRPH that have a standing desk. I was wondering if I could either meet with you in person on {insert days at SRPH}, or set-up to call you at a specific time to conduct the approximately 15 minute interview about your workstation? Please respond to this email with your availability if you are interested in participating.

Please take a few minutes to review the attached study information sheet and let me know if you have any questions. This interview has been reviewed and approved by the Texas A&M Institutional Review Board.

Thank you in advance for your time!

Meghan (Wernicke) Kress
DrPH Student
Department of Environmental & Occupational Health
Texas A&M School of Rural Public Health

APPENDIX E

SRPH STAND BIASED WORKSTATION INTERVIEW INFORMATION SHEET

Introduction

The purpose of this document is to provide you information that may affect your decision as to whether or not you want to participate in this research study. If you agree, you will be asked to participate in a research study examining factors associated with the use of stand biased desks and reductions in sitting time. The purpose of this study is to examine the use and benefits of a stand-biased desk. You have been selected to be a possible participant because you have a stand biased desk in your office.

What will I be asked to do?

If you decide to participate in this study, you will be asked to set up a time that works for your schedule to answer a series of questions about your experience with your stand biased workstation. The interview will also ask a few basic questions about your physical activity habits and demographics. No identifiable information about you related to this study will be shared.

What are the risks involved in this study?

The risks associated with this study are minimal, and are not greater than risks you ordinarily encounter in daily life. However, keep in mind that participation in this research study is not a substitute for consultation with a physician for any medical or health-related condition you may have.

What are the possible benefits of this study?

You will receive no direct benefit from participating in this study; however, information from this study will help with understanding standing office changes to reduce sedentary time and improve health.

Do I have to participate?

No, you do not have to be in this research study. There is no penalty for choosing not to participate, and you can withdraw from the research study without any penalty if you change your mind later.

Who will know about my participation in this research study?

This study is confidential and the records of this study will be kept private. No identifiers linking you to this study will be included in any sort of report that might be published. Research records will be stored securely and only Texas A&M Researchers Meghan Kress and Dr. Mark Benden will have access to the records.

Whom do I contact with questions about the research?

If you have questions regarding this study, you may contact Meghan Kress at (xxx) xxx-xxxx or xxxx@xxxx.edu or Dr. Mark Benden (xxx) xxx-xxxx or xxxx@xxxx.edu.

Whom do I contact about my rights as a research participant?
This research study has been reviewed by the Human Subjects' Protection Program and/or the Institutional Review Board at Texas A&M University. For research-related problems or questions regarding your rights as a research participant, you can contact these offices at (xxx) xxx-xxxx or xxx@xxxx.edu.

Consent
Please be sure you have read the above information, asked questions and received answers to your satisfaction. By setting up an interview time, you consent to participate in this study.

APPENDIX F

SRPH STAND BIASED WORKSTATION INTERVIEW SCRIPT

1. **Do you possess any of the following at your workstation?**

- ☐ Footrest (under the desk)
- ☐ Monitor arm
- ☐ Adjustable keyboard tray
- ☐ Standing pad/fatigue mat
- ☐ None of the above
- ☐ Other (please specify)

2. **When did you first get the stand-capable workstation?**

3. **Can you please tell me a little bit about the reason or reasons that you requested a stand-capable workstation?**

   {if they need examples: you saw others with one, wanted to lose weight, wanted to stay active and alert, had the opportunity, had back pain, etc.}

4. **How many hours do you estimate that you spend at your primary workstation throughout a typical 8-hour work day.**

hours:

5. **Of those hours, how many do you think you spend seated and how many do you think you spend standing?**

seated hours:

standing hours:

6. **{If they answered at least some time spent standing} How many times do you estimate that you transition from the sitting to the standing position throughout the day?**

number of times: [ ]

7. **{If they answered at least some time spent standing} When you stand, about how long do you typically stand before you transition back to sitting?**

minutes: [ ]

8. **Would you say that the amount you stand at your workstation has been pretty consistent since you first got the workstation?**

   If not, could you tell me about standing at your workstation since you got it? (for example: did you stand a whole lot when you first got it, and now that the novelty has worn off you don't stand as much?) (what do you think influenced your changes in use?)

9.

10. **Prior to converting to a standing workstation, how many hours do you think you spent seated and standing at your old desk?**

seated hours: [ ]

standing hours: [ ]

11. **{If they have a footrest} When standing at your workstation, how often do you use a footrest?**

- ○ N/A – do not have a footrest
- ○ Never
- ○ Sometimes
- ○ Frequently

12. At this point, do you feel that you have fully transitioned or become comfortable with your standing workstation, so that you are able to stand for periods of time while working?

- Yes
- No
- Unsure

13. Approximately how long did it take for you to fully transition (become comfortable with) your office workstation enabling you to stand while working?

14. Since switching to a standing workstation have you experienced any changes in weight?

- Experienced weight loss
- Experienced weight gain
- Maintained weight
- I don't know

15. Would you make the switch again from a seated to a standing workstation given your experience to this point?

- Yes
- No
- Undecided

The next questions are to provide information about your current physical activity and habits outside of work.

16. In a typical week, on how many days do you vigorous-intensity sports, fitness, or recreational (leisure) activities that cause large increases in breathing or heart rate and may include football, aerobics, or running?

days:

17. How much time do you spend doing vigorous-intensity sports, fitness, or recreational (leisure) activities on a typical day?

minutes: [ ]

18. In a typical week, on how many days do you moderate-intensity sports, fitness, or recreational (leisure) activities that cause a small increase in breathing or heart rate such as brisk walking, cycling, swimming, or volleyball?

days: [ ]

19. How much time do you spend doing moderate-intensity sports, fitness, or recreational (leisure) activities on a typical day?

minutes: [ ]

19. In a typical week, how many days do you walk for at least 10 minutes at a time? This includes at work and at home, walking for travel from place to place, and any other walking you do solely for recreation or leisure.

days: [ ]

20. How much time do you spend walking or bicycling for travel on a typical day?

minutes: [ ]

The following question is about sitting or reclining at work, at home, getting to and from places, or with friends including time spent sitting at a desk, sitting with friends, traveling in car, bus, or train, reading, playing cards or watching television, but do not include time spent sleeping.

21. How much time do you typically spend sitting or reclining on a typical day?

hours: [ ]

22. Do you identify yourself as hispanic or latino?

- ○ Yes
- ○ No

23. What is your race?

- American Indian or Alaskan Native
- Asian
- Black or African American
- Native Hawaiian or Pacific Islander
- White or Caucasian
- Multiracial or more than one race

24. How tall are you, and how much do you weigh?

25. How old are you?

APPENDIX G

SRPH STAND BIASED WORKSTATION INTERVIEW RESULTS NOT INCLUDED IN TEXT

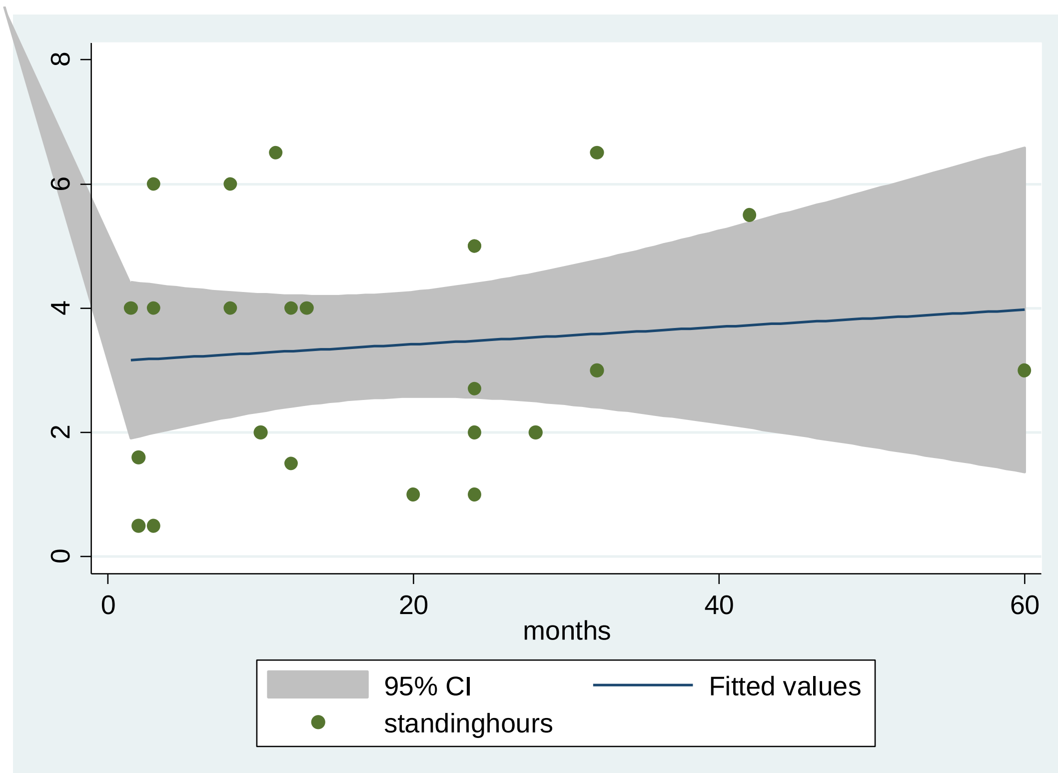


Figure G.1 Scatterplot of time with workstation and daily time at workstation spent standing

Table G.1 Weight change since getting workstation

Experienced weight loss	4 (16%)
Maintained weight	20 (80%)
Don't know	1 (4%)

Table G.2 Habits mentioned related to workstation usage

- Used to have to walk out of office when tired but not anymore
- Usually sit while reading documents or when on the phone
- I am more conscious of my posture and switching postures
- Don't stand as much in heels
- Can still get lazy and sit
- Foot injury makes it hard to stand
- Likes to stand when people are in the office or when on the phone
- Standing while recording lectures is better as it mimics the classroom
- Amount of standing at workstation varies with meetings, whether sitting in one straight for two hours, or having to run from meeting to meeting
- Walk and pace on the phone
- Walk in, set stuff down, and am ready to work
- Can stand for the afternoon lull

Table G.3 Miscellaneous Comments

- The more you can make the office fit you the better
- Wish workstation wasn't just about status, but for people with problems
- Cost is still a consideration
- Have to seek out advice on the details
- Know that standing is good for health, but not beneficial for all people, such as those with muscle or joint problems
- Can use to lose weight, but not a cure

APPENDIX H

HEALTHWAYS WORKSTATION STUDY CONSENT FORM

Introduction

The purpose of this form is to provide you information that may affect your decision as to whether or not to participate in this research study. Also, if you decide to be involved in this study, this form will be used to record your consent.

If you agree, you will be asked to participate in a research study examining factors associated with the use of different types of desks and sitting time. The purpose of this study is to examine the use and benefits of a sit to stand desk that can be easily changed between sitting and standing height, a stand-biased desk that is set at standing height and utilizes a raised chair for sitting, and a seated workstation control group. You have been selected to be a possible participant because you work in a Healthways call center. This study is being sponsored/funded by Healthways and Texas A&M University.

Definitions:

Sit to stand workstation: regular height chair with desk that can be adjusted between seated or standing height

Stand-biased workstation: raised height chair and raised desk that allows both sitting and standing without adjusting desk height.

Seated workstation: Traditional chair and desk. Desk height is not easily adjusted.

What will I be asked to do?

If you decide to participate in this study, you will be asked to complete an online survey. The survey should take approximately 10 minutes to complete. You will also be asked to wear a Sensewear monitoron your upper arm for two work days. The monitor will allow researchers at Texas A&M to upload information about energy expenditure, and number of steps taken. The monitor only provides information when it is connected to a computer with Sensewear software that Texas A&M owns. Information collected from your monitor will be shared with you upon request. The monitor will collect information about times of use, number of steps taken, metabolic equivalents (METs) and energy expenditure in calories.

No identifiable information about you related to this study will be shared with Healthways and nothing from this study will be used in making any decisions related to your employment with Healthways.

What are the risks involved in this study?

The risks associated with this study are minimal, and are not greater than risks you ordinarily encounter in daily life. However, keep in mind that participation in this research study is not a substitute for consultation with a physician for any medical or health-related condition you may have.

What are the possible benefits of this study?
You will receive no direct benefit from participating in this study; however, information from this study will help with standing office changes to help reduce sedentary time and improve health.

Do I have to participate?
No, you do not have to be in this research study. Participation is voluntary and is not a condition of your employment with Healthways. There is no penalty for choosing not to participate, and you can withdraw from the research study without any penalty if you change your mind later.

Who will know about my participation in this research study?
This study is confidential and the records of this study will be kept private. No identifiers linking you to this study will be included in any sort of report that might be published. Research records will be stored securely and only Texas A&M Researchers Meghan Kress and Dr. Mark Benden will have access to the records.

Whom do I contact with questions about the research?
If you have questions regarding this study, you may contact Meghan Kress at (xxx) xxx-xxxx or xxx@xxxx.edu.

Whom do I contact about my rights as a research participant?
This research study has been reviewed by the Human Subjects' Protection Program and/or the Institutional Review Board at Texas A&M University. For research-related problems or questions regarding your rights as a research participant, you can contact these offices at (xxx) xxx-xxxx or xxx@xxx.edu.

Signature
Please be sure you have read the above information, asked questions and received answers to your satisfaction. You will be given a copy of the consent form for your records. By signing this document, you consent to participate in this study by completing surveys and wearing a Sensewear monitor periodically. As your participation is voluntary, you are releasing Healthways and Texas A&M University, their employees, agents, and representatives from any and all claims, losses, and liability of any kind or damages, including, but not limited to illness or personal injury in any way arising from your participation in this research study.

Signature: ____ **Date:** _____________

Printed Name: ____

Signature of Person Obtaining Permission: ________________________ **Date:** ________

Printed Name of Person: ____

APPENDIX I

DATA COLLECTION FORM FOR THE SENSEWEAR ARMBANDS

The following information is used in order to calibrate your armband so that it may collect accurate information regarding your activity. This information will be used only by Texas A&M, and will be kept confidential.

Name: ______________________________________

Date of birth: __________________ (month/day/year)

Height: ______feet _____inches

Weight: ______pounds

Sex: □Male □Female

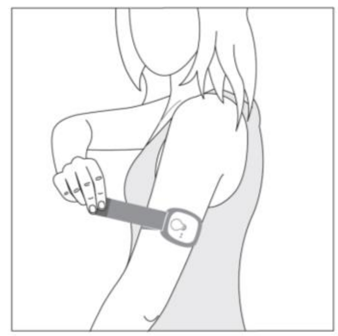
Handedness: □Right □ Left □ Ambidextrous

Do you smoke? □ Yes □No

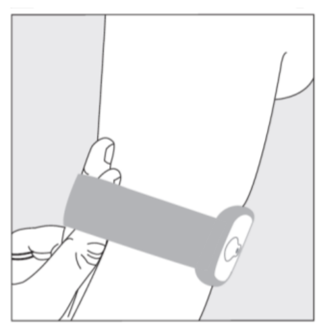
APPENDIX J

INFORMATION ABOUT THE SENSEWEAR ARMBANDS

- Instructions for the armbands:
  - At the beginning of each morning you are to wear the sensor, please put on your assigned armband as soon as you get to your workstation
  - Place the Armband device on your upper left arm (the tricep), with the Armband logo facing outwards and the silver sensors touching the skin



  - If you are wearing long sleeves or a jacket, please remove the jacket or push up the sleeve to the proper height to attach the armband on the left tricep (the device will only activate if it has *direct* contact with the skin). You can pull down your sleeves or put your jacket back on over the armband once it is adjusted
  - Adjust the strap to a point that Is snug, but comfortable
    - You should be able to place two fingers beneath the strap
    - Once the strap is adjusted to a comfortable fit, you can just slide it on and off instead of readjusting it the next morning



  - The armband will turn itself on and begin collecting data once it has contact with your skin. This will occur within 10 minutes of contact, and will indicate that it is activated by a short series of audio tones

- There is no power button for the armband
  - However, there is a "status" button (the big button in the middle)
    - This tells you how much memory and battery life the device holds via a series of lights:
      - Green indicates more than 24 hours of battery life remain
      - Flashing amber/red indicated that the battery needs to be recharged (this should hopefully not be a problem for you, as the armbands retain enough energy to go several days without charging). If for some reason you notice the red/amber light on your armband, please contact Meghan.
- The device is not waterproof
- <u>Please do not switch armbands with other participants. Your armband is calibrated specifically to you, which impacts how the device collects data.</u>
- At the end of the workday, remember to take the devices off and leave it on your keyboard before you go home
  - The devices will turn themselves off within ten minutes once they are no longer in direct contact with the skin. They will also indicate this via a chime.
- At the end of your second day wearing the armband, please return the device to Meghan.

Feel free to contact Meghan with any questions or concerns!

Pictures from: Sensewear Quickstart Guide. http://sensewear.bodymedia.com/

APPENDIX K

DATA INCLUDED IN THE SENSEWEAR DATA FILES

Collected for each minute of use:

1. Time
2. Transverse accel-peaks
3. Forward accel-peaks
4. Longitudinal accel-peaks
5. Skin temp-average
6. GSR-average
7. Transverse accel-average
8. Longitudinal accel-average
9. Near-body temp-average
10. Transverse accel-MAD
11. Longitudinal accel-MAD
12. Step Counter
13. Forward accel-average
14. Forward accel-MAD
15. Lying down
16. Sleep
17. Physical Activity
18. Energy Expenditure
19. Sedentary
20. Light
21. Moderate
22. Vigorous
23. METs

Collected for each period of use:

24. Timestamp
25. Subject Info
26. Hours of armband data
27. Hours off body
28. Percent Onbody
29. Total EE
30. Measured EE
31. Offbody EE
32. Average METs
33. Total Sedentary Activity
34. Total Light Activity
35. Total Moderate Activity
36. Total Vigorous Activity

APPENDIX L

HEALTHWAY STAND-CAPABLE WORKSTATION USERS SURVEY

The questions included in this survey are designed to improve our understanding of the office workstation impacts on employee health. We greatly appreciate you taking the time to fill it out.

Q1. Please enter your first and last name.
Your name will be used only for keeping track of your responses over the course of the study. Your personal responses will be kept confidential.

Q2. The workstation I currently use can best be described as:

- A traditional seated workstation
- A sit to stand capable workstation (regular height chair with desk that can be adjusted between seated or standing height)
- A stand-biased workstation (raised height chair and raised desk that allows both sitting and standing without adjusting desk height.)
- Other (please specify)

Q3. Please check all that apply. Which of the following do you possess at your workstation?

- Footrest (under the desk)
- Monitor arm
- Adjustable keyboard tray
- Standing pad/fatigue mat
- None of the above
- Other (please specify)

Q4. What level training have you been given regarding the workstation equipment provided to you?

- None or written material
- Oral instructions
- Written material with oral instructions
- Written material with oral instructions and individual evaluation and recommendations
- Other (please specify)

Q5. Estimate the total number of hours you spend at your primary workstation throughout a typical 8-hour work day.

hours: [ ]

Q6. Estimate the total number of hours you spend seated at your primary workstation throughout a typical 8-hour work day.

hours: [ ]

Q7. Prior to converting to a workstation that allows you to stand, estimate the amount of time you spent standing at your primary workstation throughout a typical day

- 0 hours
- ~1 hour
- ~2 hours
- ~3 hours
- ~4 hours
- ~5 hours
- ~6 hours
- ~7 hours
- ~8 hours

Q8. After moving to a workstation that allows you to stand, and using it for a little while, estimate the amount of time you now spend standing at your primary workstation throughout a typical day.

- 0 hours
- ~1 hour
- ~2 hours
- ~3 hours
- ~4 hours
- ~5 hours
- ~6 hours
- ~7 hours
- ~8 hours

Q9. When standing at your workstation, how often do you use a footrest?

- N/A – do not have a footrest
- Never
- Sometimes
- Frequently

Q10. Which of the following factors (check all that apply) influenced you toward trying or continuing to work in the standing position?

- Increased body comfort
- Productivity
- To burn more calories/to lose weight
- To stay alert
- Curiosity to try it out
- Seeing others standing while using
- Direct encouragement by others
- None of the above
- Other (please specify)

Q11. What factors (check all that apply) make you not want to work in the standing position?

- Decreased body comfort
- Energy required
- Impacts to my productivity
- Impacts to my alertness
- The time it takes to adjust the furniture
- None of the above
- Other (please specify)

Q12. At this point, do you feel that you have fully transitioned or become comfortable with your new workstation, so that you are able to stand for periods of time while working?

- Yes
- No
- Unsure

Time to transition

Q13. Approximately how long did it take for you to fully transition (become comfortable with) your office workstation enabling you to stand while working?

- ◯ Less than 1 week
- ◯ 1-2 weeks
- ◯ 2-4 weeks

Q14. Please check all that apply. While you were transitioning to your standing workstation, did you experience any of the following symptoms that you attribute to the transition?

- ☐ Soreness
- ☐ Fatigue
- ☐ Pain & Discomfort
- ☐ None of the above
- ☐ Other (please specify)

Q15. Since switching to a standing workstation I have:

- ◯ Experienced weight loss
- ◯ Experienced weight gain
- ◯ Maintained weight
- ◯ I don't know

Q16. Please check all that apply. Since switching to a standing workstation, I have experienced:

- ☐ Increased pain and discomfort at work
- ☐ Decreased pain and discomfort at work
- ☐ Increased focus and alertness
- ☐ Decreased focus and alertness
- ☐ Increased productivity
- ☐ Decreased productivity
- ☐ Increased levels of energy
- ☐ Decreased levels of energy
- ☐ None of the above

Q17. Please describe any other pros and cons you have noticed with your current workstation.

Q18. Would you make the switch again from a seated to a standing workstation given your experience to this point?

- Yes
- No
- Undecided

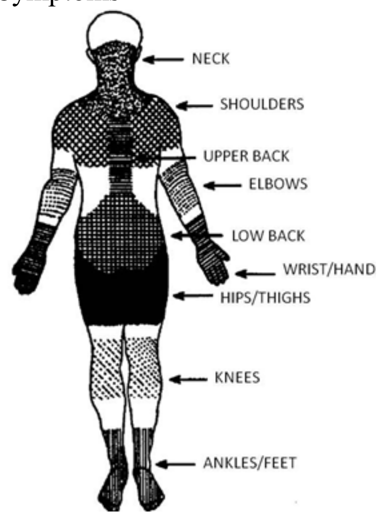
<u>Musculoskeletal Symptoms</u>

The next set of questions are for the analysis of Musculoskeletal Symptoms

Instructions for this set of questions:

Please answer each question. You may be in doubt as to how to answer, but please do your best anyway. Please answer every question, even if you have never had trouble with any part of your body.

In this picture you can see the approximate positions of the parts of the body referred to in these questions. Limits are not sharply defined, and certain parts overlap. You should decide for yourself in which part you have or have had trouble (if any).



Q19. Have you at any time during the last 12 months had trouble (such as ache, pain, discomfort, numbness) in your neck?

- No
- Yes

Q20. Have you had trouble (such as ache, pain, discomfort, numbness) in your neck at any time during the last 7 days?

- No
- Yes

Q21. During the last 12 months have you been prevented from carrying out normal activities (eg. job, housework, hobbies) because of the trouble in your neck?

- No
- Yes

Q22. Have you at any time during the last 12 months had trouble (such as ache, pain, discomfort, numbness) in your shoulders?

- No
- Yes, in the right shoulder
- Yes, in the left shoulder
- Yes, in both shoulders

Q23. Have you had trouble (such as ache, pain, discomfort, numbness) in your shoulders at any time during the last 7 days?

- No
- Yes

Q24. During the last 12 months have you been prevented from carrying out normal activities (eg. job, housework, hobbies) because of the trouble in your shoulders?

- No
- Yes

Q25. Have you at any time during the last 12 months had trouble (such as ache, pain, discomfort, numbness) in your upper back?

- No
- Yes

Q26. Have you had trouble (such as ache, pain, discomfort, numbness) in your upper back at any time during the last 7 days?

- No
- Yes

Q27. During the last 12 months have you been prevented from carrying out normal activities (eg. job, housework, hobbies) because of the trouble in your upper back?

- No
- Yes

Q28. Have you at any time during the last 12 months had trouble (such as ache, pain, discomfort, numbness) in your elbows?

- No
- Yes, in the right elbow
- Yes, in the left elbow
- Yes, in both elbows

Q29. Have you had trouble (such as ache, pain, discomfort, numbness) in your elbows at any time during the last 7 days?

- No
- Yes

Q30. During the last 12 months have you been prevented from carrying out normal activities (eg. job, housework, hobbies) because of the trouble in your elbows?

- No
- Yes

Q31. Have you at any time during the last 12 months had trouble (such as ache, pain, discomfort, numbness) in your low back (small of the back)?

- No
- Yes

Q32. Have you had trouble (such as ache, pain, discomfort, numbness) in your low back at any time during the last 7 days?

- No
- Yes

Q33. During the last 12 months have you been prevented from carrying out normal activities (eg. job, housework, hobbies) because of the trouble in your low back?

- No
- Yes

Q34. Have you at any time during the last 12 months had trouble (such as ache, pain, discomfort, numbness) in your wrist/hands?

- No
- Yes, in the right wrist/hand
- Yes, in the left wrist/hand
- Yes, in both wrists/hands

Q35. Have you had trouble (such as ache, pain, discomfort, numbness) in your wrist/hands at any time during the last 7 days?

- No
- Yes

Q36. During the last 12 months have you been prevented from carrying out normal activities (eg. job, housework, hobbies) because of the trouble in your wrist/hands?

- No
- Yes

Q37. Have you at any time during the last 12 months had trouble (such as ache, pain, discomfort, numbness) in one or both hips/thighs?

- No
- Yes

Q38. Have you had trouble (such as ache, pain, discomfort, numbness) in your hips/thighs at any time during the last 7 days?

- No
- Yes

Q39. During the last 12 months have you been prevented from carrying out normal activities (eg. job, housework, hobbies) because of the trouble in your hips/thighs?

- No
- Yes

Q40. Have you at any time during the last 12 months had trouble (such as ache, pain, discomfort, numbness) in one or both knees?

- No
- Yes

Q41. Have you had trouble (such as ache, pain, discomfort, numbness) in your knees at any time during the last 7 days?

- No
- Yes

Q42. During the last 12 months have you been prevented from carrying out normal activities (eg. job, housework, hobbies) because of the trouble in your knees?

- No
- Yes

Q43. Have you at any time during the last 12 months had trouble (such as ache, pain, discomfort, numbness) in one or both ankles/feet?

- No
- Yes

Q44. Have you had trouble (such as ache, pain, discomfort, numbness) in your ankles/feet at any time during the last 7 days?

- ◯ No
- ◯ Yes

Q45. During the last 12 months have you been prevented from carrying out normal activities (eg. job, housework, hobbies) because of the trouble in your ankles/feet?

- ◯ No
- ◯ Yes

The next questions are to provide information about your current physical activity outside of work.

Q46. In a typical week, on how many days do you vigorous-intensity sports, fitness, or recreational (leisure) activities that cause large increases in breathing or heart rate and may include football, aerobics, or running?

days: [ ]

Q47. How much time do you spend doing vigorous-intensity sports, fitness, or recreational (leisure) activities on a typical day?

minutes: [ ]

Q48. In a typical week, on how many days do you moderate-intensity sports, fitness, or recreational (leisure) activities that cause a small increase in breathing or heart rate such as brisk walking, cycling, swimming, or volleyball?

days: [ ]

Q49. How much time do you spend doing moderate-intensity sports, fitness, or recreational (leisure) activities on a typical day?

minutes: [ ]

Q50. The following question is about sitting or reclining at work, at home, getting to and from places, or with friends including time spent sitting at a desk, sitting with friends, traveling in car, bus, or train, reading, playing cards or watching television, but do not include time spent sleeping.

How much time do you typically spend sitting or reclining on a typical day?

hours: [ ]

Q51. How much time do you spend on a computer at home?

- None
- Less than 1 hour per day
- 2-3 hours per day
- More than 4 hours per day
- Other (please specify)

The next questions are for classification purposes only, used to group your answers with others like yourself.

Q52. What is your role at Healthways?

- Health Coach
- Customer Service Representative
- RD/RT
- Clinician
- Leader
- Other (please specify)

Q53. Do you identify yourself as Hispanic or Latino?

- Yes
- No

Q54. What is your race?

- American Indian or Alaskan Native
- Asian
- Black or African American
- Native Hawaiian or Pacific Islander
- White or Caucasian
- Multiracial or More than one race

Thank you again for taking the time to answer the questions and to participate in this study!

APPENDIX M

HEALTHWAY SEATED WORKSTATION USERS SURVEY

The questions included in this survey are designed to improve our understanding of the office workstation impacts on employee health. We greatly appreciate you taking the time to fill it out.

Q1. Please enter your first and last name.
Your personal responses will be kept confidential.

For this first set of questions, please answer the following questions associated with your workstation.

Q2. The workstation I currently use can best be described as:

- ○ A traditional seated workstation
- ○ A sit to stand capable workstation (regular height chair with desk that can be adjusted between seated or standing height)
- ○ A stand-biased workstation (raised height chair and raised desk that allows both sitting and standing without adjusting desk height.)
- ○ Other (please specify)

Q3. Please check all that apply. Which of the following do you possess at your workstation?

- ☐ Footrest (under the desk)
- ☐ Monitor arm
- ☐ Adjustable keyboard tray
- ☐ Standing pad/fatigue mat
- ☐ None of the above
- ☐ Other (please specify)

Q4. What level training have you been given regarding the workstation equipment provided to you?

- ○ None or written material
- ○ Oral instructions
- ○ Written material with oral instructions
- ○ Written material with oral instructions and individual evaluation and recommendations
- ○ Other (please specify)

Q5. Estimate the total number of hours you spend at your primary workstation throughout a typical 8-hour work day.

hours: [ ]

Q6. Estimate the total number of hours you spend seated at your primary workstation throughout a typical 8-hour work day.

hours: [ ]

Q7. Please estimate the amount of time you spend standing at your primary workstation throughout a typical day

- ○ 0 hours
- ○ ~1 hour
- ○ ~2 hours
- ○ ~3 hours
- ○ ~4 hours
- ○ ~5 hours
- ○ ~6 hours
- ○ ~7 hours
- ○ ~8 hours

Q8. Which of the following factors (check all that apply) would influence you toward trying a stand-capable workstation that would allow you to work some in the standing position?

- ☐ Increased body comfort
- ☐ Productivity
- ☐ To burn more calories/to lose weight
- ☐ To stay alert
- ☐ Curiosity to try it out
- ☐ Seeing others standing while using
- ☐ Direct encouragement by others
- ☐ None of the above
- ☐ Other (please specify)

[ ]

Q9. What factors (check all that apply) would make you not want to try a stand-capable workstation that would allow you to work some in the standing position?

☐ Decreased body comfort

☐ Energy required

☐ Impacts to my productivity

☐ Impacts to my alertness

☐ The time it takes to adjust the furniture

☐ None of the above

☐ Other (please specify)

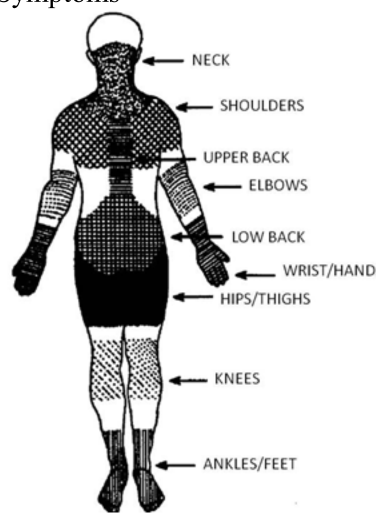
Musculoskeletal Symptoms

The next set of questions are for the analysis of Musculoskeletal Symptoms

Instructions for this set of questions:

Please answer each question. You may be in doubt as to how to answer, but please do your best anyway. Please answer every question, even if you have never had trouble with any part of your body.

In this picture you can see the approximate positions of the parts of the body referred to in these questions. Limits are not sharply defined, and certain parts overlap. You should decide for yourself in which part you have or have had trouble (if any).



Q10. Have you at any time during the last 12 months had trouble (such as ache, pain, discomfort, numbness) in your neck?

○ No

○ Yes

Q11. Have you had trouble (such as ache, pain, discomfort, numbness) in your neck at any time during the last 7 days?

○ No

○ Yes

Q12. During the last 12 months have you been prevented from carrying out normal activities (eg. job, housework, hobbies) because of the trouble in your neck?

- No
- Yes

Q13. Have you at any time during the last 12 months had trouble (such as ache, pain, discomfort, numbness) in your shoulders?

- No
- Yes, in the right shoulder
- Yes, in the left shoulder
- Yes, in both shoulders

Q14. Have you had trouble (such as ache, pain, discomfort, numbness) in your shoulders at any time during the last 7 days?

- No
- Yes

Q15. During the last 12 months have you been prevented from carrying out normal activities (eg. job, housework, hobbies) because of the trouble in your shoulders?

- No
- Yes

Q16. Have you at any time during the last 12 months had trouble (such as ache, pain, discomfort, numbness) in your upper back?

- No
- Yes

Q17. Have you had trouble (such as ache, pain, discomfort, numbness) in your upper back at any time during the last 7 days?

- No
- Yes

Q18. During the last 12 months have you been prevented from carrying out normal activities (eg. job, housework, hobbies) because of the trouble in your upper back?

- No
- Yes

Q19. Have you at any time during the last 12 months had trouble (such as ache, pain, discomfort, numbness) in your elbows?

- No
- Yes, in the right elbow
- Yes, in the left elbow
- Yes, in both elbows

Q20. Have you had trouble (such as ache, pain, discomfort, numbness) in your elbows at any time during the last 7 days?

- No
- Yes

Q21. During the last 12 months have you been prevented from carrying out normal activities (eg. job, housework, hobbies) because of the trouble in your elbows?

- No
- Yes

Q22. Have you at any time during the last 12 months had trouble (such as ache, pain, discomfort, numbness) in your low back (small of the back)?

- No
- Yes

Q23. Have you had trouble (such as ache, pain, discomfort, numbness) in your low back at any time during the last 7 days?

- No
- Yes

Q24. During the last 12 months have you been prevented from carrying out normal activities (eg. job, housework, hobbies) because of the trouble in your low back?

- No
- Yes

Q25. Have you at any time during the last 12 months had trouble (such as ache, pain, discomfort, numbness) in your wrist/hands?

- No
- Yes, in the right wrist/hand
- Yes, in the left wrist/hand
- Yes, in both wrists/hands

Q26. Have you had trouble (such as ache, pain, discomfort, numbness) in your wrist/hands at any time during the last 7 days?

- No
- Yes

Q27. During the last 12 months have you been prevented from carrying out normal activities (eg. job, housework, hobbies) because of the trouble in your wrist/hands?

- No
- Yes

Q28. Have you at any time during the last 12 months had trouble (such as ache, pain, discomfort, numbness) in one or both hips/thighs?

- No
- Yes

Q29. Have you had trouble (such as ache, pain, discomfort, numbness) in your hips/thighs at any time during the last 7 days?

- No
- Yes

Q30. During the last 12 months have you been prevented from carrying out normal activities (eg. job, housework, hobbies) because of the trouble in your hips/thighs?

- No
- Yes

Q31. Have you at any time during the last 12 months had trouble (such as ache, pain, discomfort, numbness) in one or both knees?

- No
- Yes

Q32. Have you had trouble (such as ache, pain, discomfort, numbness) in your knees at any time during the last 7 days?

- No
- Yes

Q33. During the last 12 months have you been prevented from carrying out normal activities (eg. job, housework, hobbies) because of the trouble in your knees?

- No
- Yes

Q34. Have you at any time during the last 12 months had trouble (such as ache, pain, discomfort, numbness) in one or both ankles/feet?

- No
- Yes

Q35. Have you had trouble (such as ache, pain, discomfort, numbness) in your ankles/feet at any time during the last 7 days?

- No
- Yes

Q36. During the last 12 months have you been prevented from carrying out normal activities (eg. job, housework, hobbies) because of the trouble in your ankles/feet?

- No
- Yes

The next questions are to provide information about your current physical activity outside of work.

Q37. In a typical week, on how many days do you vigorous-intensity sports, fitness, or recreational (leisure) activities that cause large increases in breathing or heart rate and may include football, aerobics, or running?

days: [ ]

Q38. How much time do you spend doing vigorous-intensity sports, fitness, or recreational (leisure) activities on a typical day?

minutes: [ ]

Q39. In a typical week, on how many days do you moderate-intensity sports, fitness, or recreational (leisure) activities that cause a small increase in breathing or heart rate such as brisk walking, cycling, swimming, or volleyball?

days: [ ]

Q40. How much time do you spend doing moderate-intensity sports, fitness, or recreational (leisure) activities on a typical day?

minutes: [ ]

Q41. The following question is about sitting or reclining at work, at home, getting to and from places, or with friends including time spent sitting at a desk, sitting with friends, traveling in car, bus, or train, reading, playing cards or watching television, but do not include time spent sleeping.

How much time do you typically spend sitting or reclining on a typical day?

hours: [ ]

Q42. How much time do you spend on a computer at home?

- ○ None
- ○ Less than 1 hour per day
- ○ 2-3 hours per day
- ○ More than 4 hours per day
- ○ Other (please specify)

[ ]

The next questions are for classification purposes only, used to group your answers with others like yourself.

Q43. What is your role at Healthways?

- Health Coach
- Customer Service Representative
- RD/RT
- Clinician
- Leader
- Other (please specify)

Q44. Do you identify yourself as Hispanic or Latino?

- Yes
- No

Q45. What is your race?

- American Indian or Alaskan Native
- Asian
- Black or African American
- Native Hawaiian or Pacific Islander
- White or Caucasian
- Multiracial or More than one race

-

Thank you again for taking the time to answer the questions and to participate in this study!

APPENDIX N

HEALTHWAYS STUDY RESULTS NOT INCLUDED IN THE TEXT

Table N.1 Number of participants (% of respondents) reporting factors in the survey (via multiple choice) that influenced them towards working in the standing position at baseline.

	Sit-to-stand group (n=43)	Stand-biased group (n=42)	Chi-Square test Statistic
Reasons to stand			
Increased body comfort	31 (72%)	32 (76%)	.666
Productivity	15 (35%)	23 (55%)	.065
To burn more calories	19 (44%)	26 (62%)	.102
To stay alert	25 (58%)	29 (69%)	.296
Curiosity to try it out	19 (44%)	17 (40%)	.729
Seeing others standing while using	16 (37%)	11 (26%)	.275
Direct encouragement by others	4 (9%)	6 (14%)	.520[A]
None	1 (2%)	1 (2%)	1.000[A]
Reasons not to stand			
Decreased body comfort	14 (33%)	8 (19%)	.155
Energy required	3 (7%)	5 (12%)	.483 [A]
Impacts to productivity	4 (9%)	3 (7%)	1.00 [A]
Impacts to alertness	3 (7%)	4 (10%)	.713 [A]
Time to adjust furniture	0	3 (7%)	.116 [A]
None	20 (47%)	22 (52%)	.588

[A]had distribution with cell count less than 5, p-value is from Fisher's exact test.

Other factors listed for using workstation in standing position:

-Convenience. I don't have to go through the sit/stand/sit routine every time I need to go somewhere.

-weight-bearing for osteo prevention.

-prevent my hip flexors from tightening up

-stretch my legs

-not necessarily to burn calories, but to make it easier for me to fidget! tap feet, bounce up and down, etc.

-cannot sit still for long periods of time

-Assigned workstation by Sup

Other factors listed for not using workstation in standing position:
- It is distracting because there are no barriers between my neighbors and it's hard to hear and concentrate on my call.
- Pressure on joints. Lack of privacy.
- my feet/knees start to hurt after a while
- Others hearing my calls - Don't want to interupt my co-workers
- Others can hear me on my calls more when I'm standing
- i just get lazy sitting and dont even think about doing it.
- it is not as private as sitting down lower at my workstation
- Tough on the knees after a while
- after about 30 mins my feet hurt, so I go back to sitting
- sciatica in my back most comfortable when adjust or stand for 5-10 minute intervals walk in place abt once an hour
- The lack of space to set-up a proper workstation.

Table N.2 Number of participants (% of respondents) reporting in the survey (via multiple choice) about their transition to the new workstation at baseline

	Sit-to-stand group (n=43)	**Stand-biased group (n=42)**	**Chi-Square test Statistic**
Feel that they have transitioned or become comfortable with new workstation			
Yes	36 (84%)	35 (83%)	.855
No	5 (12%)	4 (10%)	
Unsure	2 (4%)	3 (7%)	
Time to transition for those who have become comfortable			
Less than 1 week	28 (78%)	25 (71%)	.786 [A]
1-2 weeks	7 (19%)	9 (26%)	
2-4 weeks	1 (3%)	1 (3%)	
Symptoms attributed to the transition (40 & 41 respondents in respective groups)			
Soreness	2 (5%)	6 (14%)	.264
Fatigue	2 (5%)	4 (10%)	.675
Pain & Discomfort	5 (13%)	3 (7%)	.482
None of above	32 (80%)	33 (80%)	.956

[A]had distribution with cell count less than 5, p-value is from Fisher's exact test.

Other symptoms reported:

-Swelling in feet

-not being able to concentrate

-my back hurts

Table N.3 Number of participants (% of respondents) reporting in the survey (via multiple choice) about their experience with the new workstation at baseline (82 respondents)

	Sit-to-stand group (n=42)	**Stand-biased group (n=40)**	**Chi-Square test Statistic**
Increased pain and discomfort at work	2 (5%)	2 (5%)	1.00 [A]
Decreased pain and discomfort at work	12 (29%)	10 (25%)	.715
Increased focus and alertness	18 (43%)	22 (55%)	.272
Decreased focus and alertness	1 (2%)	3 (8%)	.353 [A]
Increased Productivity	9 (21%)	15 (38%)	.110
Decreased Productivity	2 (5%)	0	.494 [A]
Increased levels of energy	17 (40%)	16 (40%)	.965
Decreased levels of energy	0	0	
None	11 (26%)	9 (23%)	.697
If participants would make the switch again (87 responses)			
Yes	39 (91%)	36 (82%)	.052
No	2 (5%)	8 (18%)	
Undecided	2 (5%)	0	

[A] had distribution with cell count less than 5, p-value is from Fisher's exact test.

Other pros or cons about the workstations

Pros:

- I am able to do traditional sets of calf raises; Increasing strength, size and mobilty.
- Standing at the work desk allows me to be more concious of my posture.
- Having the option to stand makes me want to stand. When the only option is sitting, I am less likely to stand. It will be difficult for me to ever go back to a sit-only work station.
- I enjoy having the option to stand and move around while making calls.
- helps my back lumbar pain - none now. Helps decrease edema in legs to stand and I do steps and bends. Easier to see co-workers to flag them if you need assistance for something and you are standing up.
- everything is good
- I can choose whether to sit or stand when I please.

(Pro's continued)

- pro's-it is nice to have the option to stand No con's
- When I'm tired of sitting I'll stand and when tired of standing I'll sit. It is very nice to get to choose!
- I love being able to stand at my desk. Sitting causes low back pain for me.
- i liike the fact that it is adjustable with a high chair if you have a standard chair you are more than like to treat it like it a normal work station.
- flexiblility at desk station , adjusting the height of the desk, also the arm rest is level with body.
- Pros You can stand when and complete your work when you need to stretch.
- I like being able to switch between sitting and standing. Sitting eventually makes my lower back hurt, so I stand, then standing eventually makes my feet hurt so I sit. Also, being able to stand and stretch and fidget helps me stay more alert and productive.
- adaptability to stand when needed & not make awkward or uncomfortable
- ability to stretch is a plus
- Having two options is great!!
- like having the ability to stretch my legs and get my blood flowing while i continue to work

Cons:

- Chair is a little too tall for when you are sitting down
- Monitors are too low and causes shoulder pain.
- very clumsy at first for a few days. I was afraid i would fall off in the floor while trying to get into the chair. that changed after i figured out how to operate it.
- The lack of privacy can make it difficult to work. A lower seat makes it feel like I have greater privacy.
- I get distracted much easier while standing, and I feel I am much more efficiant at work while sitting.
- Nothing that wasn't already addressed. It did take a few days to adjust the levels to avoid neck and back soreness, but I seem to be getting used to it.
- my feet start to hurt after a while of standing, usually 20-30min after standing. this does stop me from standing but i want a fatigue mat.
- hand to keyboard issues. trying to get comfortable with that so my right hand doesnt cramp.
- I believe if a pad was available to stand on, my back would not hurt and I would stand more often.

- I wish the desks were larger. There is just enough room to use a comuter but it is difficult to use the computer and write at the same time
- The workstation is small. There isn't enough room for all my materials.
- Con-lack of space/room for my legs while seated. The size of the desk is too small for all of the required office equipement. MOST IMPORTANT: NO PRIVACY
- less desk space

3 MONTHS

Table N.4 Number of participants (% of respondents) reporting in the survey (via multiple choice) about their transition to the new workstation at 3 months

	Sit-to-stand group (n=32)	Stand-biased group (n=33)	Chi-Square test Statistic
Feel that they have transitioned or become comfortable with new workstation			
Yes	24 (75%)	25 (76%)	.643
No	2 (6%)	4 (12%)	
Unsure	6 (19%)	4 (12%)	
Time to transition for those who have become comfortable			
Less than 1 week	15 (63%)	11 (44%)	.414
1-2 weeks	4 (17%)	6 (24%)	
2-4 weeks	2 (8%)	6 (24%)	
1-2 months	2 (8%)	2 (8%)	
More than 2 months	1 (4%)	0	
Symptoms attributed to the transition			
Soreness	0	2 (6%)	.492
Fatigue	1 (3%)	3 (9%)	.613
Pain & Discomfort	2 (6%)	8 (24%)	.082
None of above	27 (84%)	21 (63%)	.057

[A]had distribution with cell count less than 5, p-value is from Fisher's exact test.

Other symptoms listed:
-a little back pain
-in my back
-clumsiness in getting in and out of the chair

Table N.5 Number of participants (% of respondents) reporting in the survey (via multiple choice) about their experience with the new workstation at 3 months (65 respondents)

	Sit-to-stand group (n=32)	**Stand-biased group (n=33)**	**Chi-Square test Statistic**
Increased pain and discomfort at work	0	5 (15%)	.053
Decreased pain and discomfort at work	4 (13%)	6 (18%)	.733
Increased focus and alertness	17 (53%)	14 (42%)	.388
Decreased focus and alertness	0	1 (3%)	1.00
Increased Productivity	8 (25%)	13 (39%)	.215
Decreased Productivity	0	0	
Increased levels of energy	13 (41%)	12 (36%)	.724
Decreased levels of energy	0	0	
None	13 (41%)	10 (30%)	.384
If participants would make the switch again			
Yes	26 (81%)	22 (67%)	.189
No	1 (3%)	6 (18%)	
Undecided	5 (16%)	5 (15%)	

[A]had distribution with cell count less than 5, p-value is from Fisher's exact test.

Other pros or cons about the workstations

Pros:

- Easy to stretch and move around while talking on the phone.
- I enjoy having the option to sit or stand.
- I still need a mat, but otherwise I like standing!
- You can stand when your tired of sitting. You can also do some exercise while you stand.
- I like being able to stand while I feel like it.
- I do crossfit regularly and I have noticed that my hips are not as tight
- I love being able to sit or stand as i please! keeps me from getting stiff and sore!
- dont feel confined to one place
- pros I can adjust the desk to my height
- Pros: Enables me to adjust seating or standing to my level of work. Example, short calls or high energy calls, I can stand to help increase motivation, focus and energy.
- love the option to stand, helps to come to desk, check emails or do work in between meetins

Cons:

- Con- the desk area is designed for a "normal" chair. It is difficult to get in the drawers and, because I don't have walls around me, the sound of my neighbor talking can be distracting.
- I think the issue I have with neck soreness is because I can never seem to get to the right level with my dual monitors. If I had only 1 monitor, I would probably experience less neck discomfort.
- Cons: feet in a constant raised position/not able to touch the floor.
- Desk could be larger, need a little more space.
- It's difficult for me to stand and take notes while on the phone.
- I feel more comfortable sitting with the low chairs. It allows me to focus more on my coaching calls than the view and noice around me.
- I like the option of being able to stand, but I rarely use this option because I feel like I have less privacy if I am standing.
- The workstation is not big enough. We aren't allowed to store any items or documents on top of the console which makes the space issue a bigger hassle. The monitor arms cause my neck to hurt. I've tried adjusting the monitors, the height of the desk top and nothing seems to help since they were installed.
- The chair is uncomfortable, and the workstation is too small. There is not enough space.
- The desk is too small, there needs to be a little more room. I use a lot of tools while coaching and I don't feel like I have adequate space to keep everything out while I am on my calls.

Misc:

-i forget to stand while at sitting at my desk. I know it would be easy to stand and i do on occasion but i really have to think about, it isnt second nature to stand while talking on the phone
- I am just wondering if you have a problem with your back would a foot stool help?

6 MONTHS

Table N.6 Number of participants (% of respondents) reporting in the survey (via multiple choice) about their transition to the new workstation at 6 months

	Sit-to-stand group (n=30)	**Stand-biased group (n=23)**	**Chi-Square test Statistic**
Feel that they have transitioned or become comfortable with new workstation			
Yes	24 (80%)	18 (78%)	1.00[A]
No	2 (7%)	2 (9%)	
Unsure	4 (13%)	3 (13%)	
Time to transition for those who have become comfortable			
Less than 1 week	11 (46%)	7 (39%)	.954 [A]
1-2 weeks	7 (29%)	6 (33%)	
2-4 weeks	4 (17%)	4 (22%)	
1-2 months	1 (4%)	1 (6%)	
3-4 months	1 (4%)	0	
5-6 months			
Symptoms attributed to the transition			
Soreness	2 (7%)	4 (17%)	.385 [A]
Fatigue	3 (10%)	4 (17%)	.451 [A]
Pain & Discomfort	4 (13%)	3 (13%)	1.00 [A]
None of above	23 (77%)	14 (61%)	.214

[A]had distribution with cell count less than 5, p-value is from Fisher's exact test.

Other symptoms listed:

- my feet and legs get a little sore if I stand too long

Table N.7 Number of participants (% of respondents) reporting in the survey (via multiple choice) about their experience with the new workstation at 3 months (65 respondents)

	Sit-to-stand group (n=30)	**Stand-biased group (n=23)**	**Chi-Square test Statistic**
Increased pain and discomfort at work	2 (7%)	1 (4%)	1.00 [A]
Decreased pain and discomfort at work	4 (13%)	8 (35%)	.098 [A]
Increased focus and alertness	12 (40%)	8 (35%)	.698
Decreased focus and alertness	0	1 (4%)	.434 [A]
Increased Productivity	6 (20%)	12 (52%)	.014
Decreased Productivity	0	1 (4%)	.434 [A]
Increased levels of energy	10 (33%)	7 (31%)	.823
Decreased levels of energy	0	1 (4%)	.434 [A]
None	12 (40%)	6 (26%)	.289
If participants would make the switch again			
Yes	24 (80%)	19 (83%)	.244 [A]
No	1 (3%)	3 (13%)	
Undecided	5 (17%)	1 (4%)	

[A]had distribution with cell count less than 5, p-value is from Fisher's exact test.

Other pros or cons about the workstations

Pros:

- Ability to exercise legs more while at work; ie, calve raises
- I enjoy the option of being able to stand and work as it can often help re-engergize me if I have been sitting too long. However, sometimes I seem to have a hard time getting my desk at the right level and strain my neck quite oftne
- ability to stand and adjust desk
- burn more calories. can stretch and do knee bends and other leg exercises, work core
- I recently was moved from a standing station to a sit down only. I do enjoy the capability of moving my desk and making myself comfortable. I feel a little back pain with the new sitting station.
- I enjoy being able to stand, it relieves pressure from sitting all day on my back
- I love my standing work station. I feel more productive and alert while working and standing. When I sit, I have lower back pain and I also feel less focused.
- feel better overall to be able to stand

- Increased energy, focus for later hours.

Cons:

- Only con is hearing others on the phone clearer.
- However, sometimes I seem to have a hard time getting my desk at the right level and strain my neck quite often
- Con-feet always in elevated position/not able to touch the floor.
- The only problem I have found is that my back will begin to hurt if I stand to long.
- I would like to stand but I feel that I don't have as much privacy as I do when I sit.
- The monitor arm allows screens to be raised some but it is limited; placing books under monitor until a "good" height seemed to work better for me; perhaps if monitors could be slid up or down on arm this may make difference. If raise desk to more easily view monitor(s) wrists/forearms begin to ache after about 15-20 minutes; if lower desk looking down craning neck to see screens which tightens neck/shoulder muscles. Not horrible either way but notice achiness I used to not experience. Thanks!
- too small and no privacy

APPENDIX O

HEALTHWAYS DATA ANALYSIS EXPLORING LOSS TO FOLLOW-UP

Table O.1 Population characteristics at baseline

	All Participants		Participants lost to follow-up		Remaining Participants	
	Sit-to-stand group (n=45)	**Stand-biased group (n=46)**	**Sit-to-stand group (n=16)**	**Stand-biased group (n=23)**	**Sit-to-stand group (n=29)**	**Stand-biased group (n=23)**
Mean (SD) age (years)	34.8 (11.5)	28.9 (6.8)	36.1 (9.8)	27.7 (4.8)	34.1 (12.5)	30.1 (8.3)
% Female	71.1	58.7	68.8	60.9	72.4	56.5
% Smokers	2.2	6.5	6.3	8.7	0	4.4
Handedness						
% Right	84.4	78.3	0	8.7	79.3	82.6
% Left	15.6	15.2	6.3	17.4	20.7	13.0
% Ambidextrous	0	6.5	93.8	73.9	0	4.4
Mean (SD) Body weight (pounds)	179.1 (57.1)	170.5 (39.5)	193.2 (63.9)	165.1 (37.8)	171.3 (52.5)	175.8 (41.3)
Mean (SD) Height (inches)	65.9 (4.1)	66.7 (3.6)	65.2 (4.7)	66.2 (4.4)	66.3	67.1
Mean (SD) BMI (kg/m^2)	29.0 (9.13)	26.8 (5.5)	32.2 (10.9)	26.3 (4.9)	27.2 (7.6)	27.4 (6.1)
BMI Categories						
% Underweight	2.2	0	0	0	3.45	0
% Normal weight	44.4	43.48	43.8	47.8	44.8	39.1
% Overweight	20.0	26.1	6.25	17.4	27.6	34.8
% Obese	33.3	30.4	50.0	34.8	24.1	26.1
Physical Activity Levels						
% Low	43.9	40.0	61.5	52.9	41.4	27.3
% Moderate	29.3	27.5	23.1	29.4	27.6	18.2
% High	26.8	23.3	15.4	17.7	31.0	54.6

Table O.1 Participant characteristics at baseline (continued)

	All Participants		Participants lost to follow-up		Remaining Participants	
	Sit-to-stand group (n=45)	**Stand-biased group (n=46)**	**Sit-to-stand group (n=16)**	**Stand-biased group (n=23)**	**Sit-to-stand group (n=29)**	**Stand-biased group (n=23)**
% Health Coach	41.5	57.5	23.1	64.7	50.0	52.2
% Customer Service	31.7	22.5	53.9	29.4	21.4	17.4
% RD/RT	4.9	0	0	0	7.1	0
% Clinician	17.1	10.0	7.7	0	21.4	17.4
% Leader	4.9	10.0	15.4	5.9	0	13.0
% Other	0	0	0	0	0	0
Race						
% American Indian	0	0	0	0	0	0
% Asian	0	0	0	0	0	0
% African American	24.4	25.0	46.2	41.2	14.3	13.0
% Native Hawaiian	0	0	0	0	0	0
% Non-hispanic white	68.3	67.5	46.2	52.9	78.6	78.3
% Hispanic white	2.4	2.5	0	5.9	3.57	0
% multiracial	4.9	5.0	7.7	0	3.6	8.7
Musculoskeletal pain in past 12 months, pain in each region						
% Neck	33.3	39.0	38.5	27.8	31.0	47.8
% Shoulder	31.7	30.0	30.8	29.4	32.1	30.4
% Upper Back	12.2	20.0	15.4	5.9	10.7	30.4
% Elbow	7.3	5.0	0	0	10.7	8.7
% Low Back	53.7	60	69.2	58.8	46.4	60.9
% Wrist	17.1	22.5	15.4	23.5	17.9	21.7
% Hip	22.0	12.5	23.1	5.9	21.4	17.4
% Knee	12.2	17.5	15.4	17.7	10.7	17.4
% Feet	4.9	7.5	15.4	11.8	0	4.35

No significant difference between s2s and sb groups at baseline among those who finished study (only difference among those starting study was at baseline)

Table O.2 Mean (SD) activity habits recorded by Sensewear^{TM} and reported in the survey at baseline

	Started Study		**Completed Study**	
	Sit-to-stand group (n=45)	**Stand-biased group (n=46)**	**Sit-to-stand group (n=29)**	**Stand-biased group (n=23)**
Hours of armband use	15.8 (4.9)	17.1 (3.6)	16.9 (4.4)	18.1 (3.1)
Proportion of Monitored time in each activity level				
Sedentary	.79 (.14)	.72 (.17)	.78 (.16)	.73 (.18)
Light Activity	.14 (.10)	.19 (.13)	.15 (.09)	.17 (.13)
Moderate Activity	.06 (.07)	.09 (.08)	.07 (.08)	.10 (.09)
Vigorous Activity	.001 (.002)	.002 (.003)	.001 (.003)	.002 (.004)
Steps per minute	3.7 (2.05)	5.0 (2.5)	3.7 (2.07)	5.4 (2.77)
Calories per minute	1.8 (.41)	1.9 (.41)	1.8 (.48)	2.0 (.41)
METs per minute	1.4 (.40)	1.6 (.37)	1.5 (.43)	1.6 (.42)
Reported time at workstation on a typical day	7.4 (.83)	6.8 (1.24)	7.5 (.92)	7 (1.13)
Proportion of time reported sitting	.75 (.17)	.65 (.19)	.74 (.19)	.65 (.22)
Proportion of time reported standing	.25 (.17)	.35 (.19)	.26 (.19)	.35 (.21)

Comparing the finishers to each other, the only significant difference between s2s and sb was in Steps per minute (p=.0302). (significant differences with all measured at baseline: sedentary, moderate, steps per minute, proportion of time standing and sitting.)

Table O.3 Mean (SD) activity habits recorded by Sensewear^{TM} and reported in the survey at 3 months

	Still in study at 3 months		**Completed Study**	
	Sit-to-stand group (n=32)	**Stand-biased group (n=33)**	**Sit-to-stand group (n=29)**	**Stand-biased group (n=23)**
Hours of armband use	16.0 (2.9)	15.6 (4.4)	16.4 (2.5)	16.6 (3.4)
Proportion of Monitored time in each activity level				
Sedentary	.75 (.18)	.76 (.15)	.75 (.19)	.73 (.17)
Light Activity	.16 (.10)	.16 (.09)	.16 (.10)	.17 (.10)
Moderate Activity	.09 (.09)	.08 (.08)	.08 (.09)	.10 (.09)
Vigorous Activity	.00 (.00)	.00 (.01)	.00 (.01)	.00 (.01)
Steps per minute	4.9 (2.6)	5.2 (3.0)	4.5 (2.2)	5.6 (3.0)
Calories per minute	1.8 (.50)	1.9 (.45)	1.8 (.50)	2.0 (.47)
METs per minute	1.5 (.51)	1.5 (.37)	1.5 (.53)	1.6 (.39)
Reported time at workstation on a typical day	7.3 (1.5)	6.3 (2.1)	7.3 (1.6)	6.3 (2.1)
Proportion of time reported sitting	.75 (.18)	.69 (.22)	.75 (.19)	.67 (.24)
Proportion of time reported standing	.25 (.18)	.31 (.22)	.25 (.19)	.33 (.24)
Transitions reported per day	2.8 (2.2)	3.3 (1.8)	2.9 (2.3)	3.3 (2.0)
Duration of standing reported per bout	31.9 (35.6)	35.5 (54.2)	33.4 (36.8)	40.0 (64.4)

Comparing the finishers to each other, the only significant difference between s2s and sb was in Reported time at workstation (p=.0335).