ADAMS, MELANIE M., Ph.D. On Our Feet: Feasibility Trial of an Intervention to Reduce Sedentary Behavior and Increase Physical Activity. (2012)
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Sedentary behavior (SB) is emerging as an independent risk factor for cardiovascular disease and type 2 diabetes (Katzmarzyk, 2010; Owen et al., 2010), and is a target for intervention. This study examined effects of a Social Cognitive intervention to increase self-efficacy (SE) for reducing SB and increasing PA. Female members (M_{age}=58.5, *SD*=12.5 yrs) from seven weight loss support clubs were enrolled in a 6-week intervention (n=40) or waitlisted (n=24) based on club randomization. The intervention, delivered via group sessions and email, used mastery feedback from goal-setting activities along with behavioral cues and modeling to reduce SB and increase steps. Quantitative and qualitative process evaluation data were collected throughout. PA and SB were measured by accelerometers. SE (to reduce SB, to increase light & moderate PA) were measured pre, mid, and post. Repeated-measures MANOVA found no significant change over time or Group x Time interaction for behavior. A significant effect for time was noted for SE to reduce SB (F=3.34, p<.05) and the Group x Time interaction approached significance. SE decreased at mid-point, but increased for the intervention group while the waitlist group continued to fall. Differences between rural and urban women in SB (F=4.69, p<0.04) and SE to reduce SB (F=4.75, p<0.05), were significant, with rural participants having less SB and lower SE to reduce SB than urban peers.

Participants' perceptions were examined to provide a contextualized understanding of SB and methods to change behavior. Analysis identified compliance barriers, including required sitting, accuracy of self-monitoring, work and family responsibilities and questions of relevance. Significant differences in SE to reduce SB were seen when compliant participants were compared to non-compliant participants ($F=2.44$, $p<0.05$). Behavioral cues and modeled behaviors were less impactful than anticipated. Participants were receptive to monitoring PA via pedometer, though challenges in self-monitoring SB were noted.

The role of SE in changing SB needs further study. Findings suggest that interventions must consider contextual factors, such as location and occupation as well as individual factors (SE) and barriers. Future studies should consider the effect of modifying the built-environment on SE to reduce SB and improve methods for self-monitoring.

ON OUR FEET: FEASIBILITY TRIAL OF AN INTERVENTION TO REDUCE

SEDENTARY BEHAVIOR AND INCREASE

PHYSICAL ACTIVITY

by

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Approved by

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Committee Chair

To Amy, my partner in all things.

APPROVAL PAGE

This dissertation has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

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LIST OF ABBREVIATIONS

ACC	Accelerometer
ACSM	American College of Sports Medicine
AHA	American Heart Association
BMI	Body Mass Index
BRFSS	Behavioral Risk Factor Surveillance System
CVD	Cardiovascular Disease
DHHS	U.S. Department of Health and Human Services
INV	Intervention Group
IPAQ	International Physical Activity Questionnaire
LPA	Light Physical Activity
MET(S)	Metabolic Equivalent(s)
MPA	Moderate Physical Activity
NHANES	National Health and Nutrition Examination Study
NHIS	National Health Interview Survey
OE	Outcome Expectations
PA	Physical Activity
SB	Sedentary Behavior
SBQ	Sedentary Behavior Questionnaire
SCT	Social Cognitive Theory

SE	Self-efficacy
VPA	Vigorous Physical Activity
WC	Waitlist Control Group

CHAPTER I

INTRODUCTION

The study of sedentary behavior offers a new approach in physical activity promotion. The term sedentary does not just indicate a lack of exercise (Pate, O'Neill, & Lobelo, 2008). It also reflects low amounts of total movement. High volumes of sedentary behavior are possible in those that meet recommendations for physical activity and in those that are insufficiently-active or not active at all. Sedentary behavior is a unique risk factor in hypokinetic illnesses (Wunderlich, 1967) such as cardiovascular disease, type 2 Diabetes, and obesity (Hamburg et al., 2007; Hamilton, Hamilton, & Zderic, 2007; Owen, Healy, Matthews, & Dunstan, 2010a). There is a need to both increase physical activity and reduce time spent in sedentary activities to improve the health of Americans (Hamilton, Healy, Dunstan, Zderic, & Owen, 2008; Owen, Sparling, Healy, Dunstan, & Matthews, 2010c). Women who are overweight or obese have a greater prevalence of insufficient physical activity (Troiano et al., 2008; Carlson, Fulton, Schoenborn, & Loustalot, 2010; Tudor-Locke, Brashear, Johnson, & Katzmarzy, 2010a), are at higher risk for cardiovascular and metabolic diseases (Bray & Bellanger, 2006), and sit for longer portions of their day (Johannsen, Welk, Sharp, & Flakoll, 2008) than normal weight individuals. An intervention that reduces sedentary behavior through increases in light physical activity may enhance overweight women's current health and increase self-efficacy for future physical activity.

The Modern Sedentary Lifestyle

Over half of our waking hours are spent sitting (Matthews et al., 2008; Tudor-Locke, Brashear et al., 2010). Modern advances have increased the efficiency of how we work, travel, and obtain food. This surge in productivity has created a population that is largely sedentary compared to our ancestors (Leonard, 2010; Power & Schulkin, 2009). Most daily work and leisure activities require very little energy expenditure, at 1 to 1.5 times the resting metabolic rate (Pate et al., 2008). Declining energy expenditure has often been cited as a causal factor in rising obesity rates (Wilding, 2001; Filiault & Blass, 2008; Kumanyika et al., 2008; Power & Schulkin, 2009). While the importance of regular physical activity is well known to most Americans, its practice is lacking (Troiano et al., 2008; Carlson et al., 2010; CDC, 2010; Tudor-Locke et al., 2010a). Community programs and public health directives to engage in more physical activity are only minimally effective (Kumanyika et al., 2008; Muller-Riemenschneider, Reinhold, Nocon, & Willich, 2008).

More accurate measures of physical activity (accelerometers and inclinometers) find Americans are more sedentary than previously thought (Matthews et al., 2008; Troiano et al., 2008; Tudor-Locke et al., 2010a). Tudor-Locke and colleagues found that U.S. adults spend 56.8% of the day sitting. By the most recent account, Americans spend an average of 8.44 hours a day in sedentary behavior (Healy, Matthews, Dunstan, Winkler, & Owen, 2011a). Sedentary time was highest among late teens and adults over 60 (Matthews et al., 2008). Females engaged in more sedentary activities than males before age 40, then males became less physically active than women (Hardy, Bass, & Booth, 2007; Matthews et al., 2008; Touvier et al., 2010). Objective measures put recreational sitting at 2.73 (±2.21) hours a day (van der Ploeg et al., 2010). Differences in sedentary behavior between normal and overweight populations have identified (Brown, Miller, & Miller, 2003; Levine et al., 2005; Johannsen et al., 2007; McCrady & Levine, 2009) obese individuals as sitting 2.5 hours more a day than normal weight individuals (Levine et al., 2005; Johannsen et al., 2007).

Health Implications of Sedentary Behavior

Physical movement has been engineered out of our lives for the sake of efficiency (Hill, Wyatt, Reed, & Peters, 2003; Katzmarzyk & Mason, 2009; Leonard, 2010; Owen, Sparling, Healy, Dunstan, & Matthews, 2010b) and the adverse health effects are now being recognized. Researchers have identified sedentary behavior as a distinct risk factor for cardiometabolic diseases (Owen, Leslie, Salmon, & Fotheringham, 2000; Hamilton et al., 2008; Katzmarzyk, Church, Craig, & Bouchard, 2009; Dunstan et al., 2010; Owen et al., 2010a; Patel et al., 2010; Thorp et al., 2010; Warren et al., 2010; Healy et al., 2011a; Stamatakis, Hamer, & Dunstan, 2011). This risk remained even when public health guidelines for physical activity were met (Salmon, Bauman, Crawford, Timperio, & Owen, 2000; Katzmarzyk et al., 2009; Owen et al., 2010a). A clear association between high volume sitting (≥ 4 hours a day) and higher body mass index has been demonstrated (Salmon et al., 2000; Mummery, Schofield, Steele, Eakin, & Brown, 2005; van Uffelen, Watson, Dobson, & Brown, 2010a) and between sitting time and mortality (Katzmarzyk et al., 2009; Stamatakis et al., 2011). Greater sedentary behavior has been significantly related to metabolic syndrome (Dunstan et al., 2005; Ford, Kohl, Mokdad, & Ajani, 2005; Williams, Raynor, & Ciccolo, 2008). Early work indicated that the risk of obesity and type 2 diabetes from sedentary behavior was greater for women than for men (Jeffery & French, 1998; Hu, Li, Colditz, Willett, & Manson, 2003; Dunstan et al., 2005; Bowman, 2006), though evidence to the contrary has been reported (Healy et al., 2011a).

Sedentary behavior results in physiological responses that are distinct from those of low physical activity (Hamilton et al., 2007). The cardiometabolic outcomes (abdominal obesity, impaired glucose uptake, low HDL cholesterol, high triglycerides and hypertension) mirror those attributed to a lack of exercise, but the pathway differs (Katzmarzyk, 2010). A lack of contraction in deep postural muscles suppresses levels of lipoprotein lipase, which has a role in removing triglycerides from the blood and in producing high-density lipoprotein (Bey & Hamilton, 2003; Zderic & Hamilton, 2006). This loss of lipoprotein lipase is unique to the sedentary state as the actions of postural muscles are not increased by moderate or vigorous physical activity (Hamilton, Etienne, McClure, Pavey, & Holloway, 1998). Less frequent muscle contractions reduce glucose uptake by skeletal muscle resulting in higher levels of circulating glucose (Hamilton et al., 2007; Healy et al., 2008a; Owen et al., 2010a). High volumes of sitting reduce non-exercise activity thermogenesis resulting in positive energy balance making weight gain more likely (Levine et al., 2005). The negative relationship between sedentary behavior and abdominal obesity, impaired glucose clearance, and diabetes has been supported in longitudinal and cross sectional studies (Dunstan et al., 2007; Healy et al., 2007b; Hamilton et al., 2008; Williams et al., 2008; Healy, Matthews, Dunstan, Winkler, & Owen, 2011b; Healy et al., 2011a). Evidence of a relationship between sedentary behavior and cholesterol, triglycerides, and blood pressure has been mixed (Williams et al., 2008; van Uffelen et al., 2010b; Healy et al., 2011a; Stamatakis et al., 2011).

Relationship to Light Physical Activity

The amount of time spent in sedentary activities is known to be the inverse of time spent in light physical activity (Healy et al., 2007a; Hamilton et al., 2008; Healy et al., 2011b). Light physical activity is any standing movement that has a caloric cost between 1.6 - 2.9 METs (Pate et al., 2008; Owen et al., 2010a). Moderate physical activity by contrast has an energy expenditure of 3-5.9 METs (Pate et al., 2008). Researchers targeting leisurely walking and walking for transportation have noted reduced sedentary behavior when these light physical activities increase (De Cocker, De Bourdeaudhuij, Brown, & Cardon, 2008; Dewa, de Ruiter, Chau, & Karioja, 2009). Health benefits associated with light intensity physical activity include improved glucose uptake (Dunstan et al., 2007; Healy et al., 2011b), calorie balance to prevent weight gain (Blanck et al., 2007), reduced abdominal obesity (Healy et al., 2011b), and higher perceptions of good health (Buman et al., 2010).

Expanding the Approach to Physical Activity Promotion

The paradigm for increasing physical activity has always been based on the fitness model (Katzmarzyk, 2010). That is, a specific volume and intensity should be reached to insure a benefit. Currently, a purposeful bout of at least 10 minutes at a moderate intensity is considered to be the most beneficial for health (Haskell et al., 2007). These purposeful physical activities are distinct from the ones used to accomplish tasks in daily living. Daily physical activities are a mix of light and moderate intensities and have been described as active transport, stair-climbing, household chores, and gardening (Blair, Kohl, & Gordon, 1992; Kozey, Lyden, Howe, Staudenmayer, & Freedson, 2010). Improvements to physical health have been found in lifestyle physical activity interventions (Macfarlane, Taylor, & Cuddihy, 2006; Janiszewski & Ross, 2007; Donnelly et al., 2009; Van Roie et al., 2010). The advantage of increasing physical activity through daily tasks is that barriers to traditional exercise are reduced (Dunn, Andersen, & Jakicic, 1998; Silva et al., 2010).

Maintaining structured physical activity has proven difficult for Americans. It has long been estimated that 50-65% of those who start an exercise program will discontinue the physical activity within the first three to six months (Dishman, 1981; Annesi & Unruh, 2004). Demographic, psychological, and environmental determinants of physical activity have been well studied (King et al., 1992; King et al., 2000; Sherwood & Jeffery, 2000; Salmon, Owen, Crawford, Bauman, & Sallis, 2003). Increasing age, female gender, racial and ethnic minority, and lower levels of income and education have been associated with less physical activity (King et al., 1992). Personal barriers include lack of time, family obligations, fatigue (King et al., 1992), low self-efficacy (McAuley & Blissmer, 2000), and lack of enjoyment of the activity (Salmon et al., 2003). The environment presents challenges in terms of weather and access to locations that are safe, scenic, and used by others (King et al., 1992). Overweight and obese individuals face increased barriers (Napolitano et al., 2008), including lack of physical competence (Rimmer, Hsieh, Graham, Gerber, & Gray-Stanley, 2010), musculoskeletal pain (Heuch, Hagen, Heuch, Nygaard, & Zwart, 2010; Rimmer et al., 2010), social physique anxiety (Ekkekakis, Lind, & Vazou, 2010; Koyuncu, Tok, Canpolat, & Catikkas, 2010), greater perceived exertion (Ekkekakis & Lind, 2006), and ill fit of equipment and apparel (Allender, Cowburn, & Foster, 2006).

Most Americans are not able to overcome these challenges and our modern environment continues to reduce the amount of lifestyle physical activity that occurs naturally. As a result, humans sit for long periods with infrequent periods of light, moderate or vigorous physical activity (Katzmarzyk & Mason, 2009). Given the prevalence of sedentary behavior, its negative effects on health and the multiple barriers to structured physical activity programs, a new emphasis on increased bouts of light physical activity has been suggested (Hamilton et al., 2008; Katzmarzyk et al., 2009; Franklin, Brinks, & Sternburgh, 2010) which would reduce sedentary behavior.

Interventions to Decrease Sedentary Behavior and Increase Physical Activity

Few interventions have attempted to reduce sedentary behavior (Lee & King, 2003; Marshall, Leslie, Bauman, Marcus, & Owen, 2003; Dewa et al., 2009; Otten, Jones, Littenberg, & Harvey-Berino, 2009; De Greef et al., 2011; Gardiner, Eakin, Healy, & Owen, 2011b). Examples include a pedometer-based intervention that decreased accelerometer-determined sedentary behavior by 23 minutes a day in participants with type 2 diabetes (De Greef et al., 2011). In contrast, Lee and King (2003) found that seniors made no changes to self-reported sedentary behaviors despite increases in physical activity after a 12-month intervention. And, Gardiner and colleagues (2010b) saw a reduction in sedentary time, along with increased light and moderate physical activity when older adults were encouraged to take more frequent breaks from sitting.

Many more studies have examined methods for increasing lifestyle physical activities such as active transport and household tasks (Macfarlane et al., 2006; Largo-Wight, Todorovich, & O'Hara, 2008; Merom, Miller, van der Ploeg, & Bauman, 2008; Opdenacker, Boen, Auweele, & de Bouraudhuij, 2008; Lyerly, 2009; Opdenacker, De Bourdeaudhuij, Auweele, & Boen, 2009; Silva et al., 2010; Van Roie et al., 2010). Lifestyle physical activity is a more accommodating way to achieve the health benefits of physical activity as compared to planned exercise because shorter bouts of activity can be worked into one's daily routine (Dunn et al., 1998; Silva et al., 2010). This approach could also work for reducing sedentary behavior. Pedometer-based interventions have been effective at increasing daily steps (Bravata et al., 2007) and displacing sedentary behavior (De Cocker et al., 2008; Gilson et al., 2009; De Greef et al., 2011).

Lifestyle physical activity and sedentary behavior share some characteristics. Both are habitual and are responsive to environmental cues. According to Silva and colleagues (2010), motivation for structured physical activity is mainly intrinsic. In contrast, a single motivation for lifestyle physical activity has not been identified. Lifestyle physical activity was less associated with cognitive strategies than structured exercise and required more behavioral cues (Silva et al., 2010). Similarly, behavioral cues have been hypothesized to reduce sedentary behavior (Owen et al., 2000; Rhodes, Blanchard, & Bellows, 2008). A reduction in sedentary behavior involves changes in two behaviors; sitting and light intensity physical activity, possibly indicating that multiple strategies are needed. The sedentary behavior intervention developed for this study, *On Our Feet*, was based on the Social Cognitive Theory and included supporting elements from the Transtheoretical Model.

Strategies for Behavior Change

A number of psychosocial theories and models have tried to explain adoption and maintenance of physical activity. In particular, the Social Cognitive Theory and the Transtheoretical Model are the focus of much research (Marcus, Selby, Niaura, & Rossi, 1992; Biddle & Nigg, 2000). These two cognitive-behavioral frameworks contain overlapping constructs and are often applied in concert with each other (Lewis et al., 2006).

The Social Cognitive Theory (SCT) stipulates that behavior is the result of multiple interactions between the environment, the behavior, and the individual factors of the person (Bandura, 1986). The key individual factor in SCT is self-efficacy (SE). This belief in one's ability to successfully perform a task drives behavior (Bandura, 1997). There is considerable support for SE as predictor of exercise behavior (Biddle & Nigg, 2000) and as an outcome of physical activity (McAuley, Courneya, & Lettunich, 1991). Higher levels of SE have been predictive of exercise adoption and adherence (Biddle & Nigg, 2000) and therefore SE has been a focus of many physical activity interventions (Ashford, Edmunds, & French, 2010). Four factors are known to influence SE: 1) mastery experiences, 2) modeling, 3) verbal and social persuasion, and 4) emotional and physiological states (Bandura, 1997). Mastery experiences are considered the most influential element of the four (McAuley & Blissmer, 2000). Completion of physical activity has increased SE for physical activity (McAuley, Pena, & Jerome, 2001).

The Transtheoretical Model (TTM) combines the SE construct with cognitive and behavioral processes to differentiate between levels of readiness for behavior change (Prochaska & Marcus, 1994). An increase in SE occurs with each advancing stage (Pekmezi, Brooke, & Marcus, 2010a; Nigg et al., 2011) so that SE differentiates an individual's stage of readiness (Marcus et al., 1992). In addition to SE, behavioral and cognitive strategies are needed to transition from one stage to another. Important cognitive strategies include self-re-evaluation, dramatic relief and environmental re-evaluation. Counter conditioning, stimulus control, social support, rewards, and self-liberation are common behavioral strategies (Rhodes et al., 2008). A review by Lewis, Marcus, Pate and Dunn (2002) suggested that both behavioral processes (counter conditioning, stimulus control, social support, rewards, and self-liberation) and SE were mediators of physical activity.

Application of SCT and TTM Constructs

Physical activity interventions that employ multiple aspects of both SCT and TTM have been more effective than singular interventions or those that lack a theoretical base (Lewis et al., 2006). Recently, Raedeke, Focht, and King (2010) illustrated that pedometer-based interventions are more effective when cognitive and behavioral strategies to increase SE are used rather than just activity monitoring. Greater increases in self-efficacy and behavioral processes were seen when the intervention matched participants current stage of change, level of SE, and use of cognitive and behavioral processes versus a generic intervention (Lewis et al., 2006). Such interventions are known as tailored interventions and have been found effective at increasing physical activity (Bock, Marcus, Pinto, & Forsyth, 2001; Lewis et al., 2006; Plotnikoff et al., 2007; Greaney et al., 2008). Individualized messages about behavior are another method of tailoring an intervention. Data can be transformed into normative feedback by comparing the participant to an average or standard. Feedback can also be comparative across time for the same individual (deVries & Brug, 1999). Goal attainment has been used to tailor physical activity feedback (Lewis et al., 2006; Mihalko, Wickley, & Sharpe, 2006; Smeets, Brug, & de Vries, 2008) and for sedentary behaviors (Gardiner et al., 2011b). Goal feedback may be presented as a total or as a percentage of the goal.

Interventions aimed at reducing sitting time need to address the cognitive antecedents for sedentary behavior as well as self-efficacy (Rhodes et al., 2008). Elements of the physical and social environment require intention and planning to overcome. The Behavior Choice Theory has been offered as an explanation for picking sedentary behaviors over physical activity (Epstein & Roemmich, 2001; Lee & King, 2003). Epstein and Roemmich (2001) theorize that activities that are closest in proximity and the most immediately rewarding will be chosen over others that require effort or time to engage in. Cognitive processes of change including dramatic relief (affect for behavior), counter conditioning, and social support for TV watching have been found to be negatively correlated to participation in physical activities (Rhodes et al., 2008).

Feasibility Testing and Process Evaluation

The feasibility of an intervention is based on both its effect on the dependent variables and on its potential to be implemented on a wider scale. In order to better understand why an intervention was or was not effective a process evaluation is conducted. Process evaluations can assess the quality of intervention elements, attractiveness to participants, the delivery method, competence of intervention staff, and costs (DHHS, 2005). They also serve as a way to link theoretical constructs to outcomes (Steckler & Linnan, 2002). A process evaluation was embedded within the delivery of the *On Our Feet* intervention. Participants were asked to rate their adherence, the perceived benefits, and the barriers of each of the intervention components: stretching activity, accelerometer feedback, goal setting activity, video demonstrations, pedometer and sitting log, and tailored emails. The reasons for attrition were sought using a brief follow-up questionnaire for participants that withdrew. Participant views of the delivery methods, overall effectiveness, and ease of use were solicited following the intervention. This survey combined rating scales and open-ended requests for suggestions to improve the delivery, content, time requirements, and data collection process. The researcher also maintained a record of observations, reflections, costs and challenges in implementing the intervention. The process evaluation was used to gain insights into the intervention's effectiveness and to inform future interventions.

Purpose and Research Questions

The primary aim of this study was test the feasibility of an intervention to reduce sedentary behavior and increase light physical activity that was grounded in SCT. The study was conducted with a sample of overweight and obese women. A Group x Time design was used to determine the effect of *On Our Feet* on self-efficacy, sedentary behavior, and physical activity. Also, participant assessments of intervention components and delivery modes were used to evaluate the intervention's feasibility. Seven research questions were considered. The first six were specific to the outcome variables. Question seven addressed the process evaluation and feasibility of *On Our Feet*.

Research Question 1

Can the *On Our Feet* intervention reduce sedentary time?

Hypothesis 1:

The intervention group would reduce time spent sitting from baseline to post as compared to the waitlist control group.

Research Question 2

Can the *On Our Feet* intervention increase light physical activity?

Hypothesis 2:

The intervention group would increase the amount of time engaged in light physical activity from baseline to post as compared to the waitlist control.

Research Question 3

Can the *On Our Feet* intervention increase moderate physical activity?

Hypothesis 3:

The intervention group would increase the amount of time engaged in moderate physical activity from baseline to post as compared to the waitlist control.

Research Question 4

Can the *On Our Feet* intervention increase SE for reducing sedentary behavior?

Hypothesis 4:

The intervention group would increase in SE to reduce sedentary behavior from baseline to post as compared to the waitlist control group.

Research Question 5

Can the *On Our Feet* intervention increase SE for light physical activity?

Hypothesis 5:

The intervention group would increase SE for light physical activity from baseline to post as compared to the waitlist control group.

Research Question 6

Can the *On Our Feet* intervention increase SE for moderate physical activity?

Hypothesis 6:

The intervention group would increase SE for moderate physical activity from baseline to post as compared to the waitlist control group.

Research Question 7

How do overweight and obese women perceive the benefits, challenges and effectiveness of a SCT- based intervention to reduce sedentary behavior and increase physical activity?

Hypothesis 7:

No statistical hypothesis tests are proposed. It was expected that participants would positively evaluate the content and delivery method, and would report physical and psychological benefits. Participants' evaluations and comments provided guidance for improving the intervention.

Overview of Study

In the last decade, health promoting interventions have moved beyond face to face and print delivery to using computer technology. Computer-based interventions have the potential to reach a significant number of people at low cost (Ciccolo, Lewis, & Marcus, 2008; Krebs, Prochaska, & Rossi, 2010) and appear to be equally effective as traditional methods (Spittaels, De Bourdeaudhuij, Brug, & Vandelanotte, 2007; Ciccolo et al., 2008; Steele, Mummery, & Dwyer, 2009; Carroll et al., 2010). Computer delivery of a sedentary behavior intervention has been suggested but not reported (Vandelanotte, Sugiyama, Gardiner, & Owen, 2009). This study investigated the feasibility of combining in-person group sessions with email messages in order to reduce sedentary behavior.

On Our Feet was a 6-week educational and behavioral intervention that targeted improvements in self-efficacy specifically for reducing sedentary behavior. Female volunteers from local chapters of Take Off Pounds Sensibly (TOPS), between the ages of 35-85, were invited to enroll. The TOPS chapters were paired and then randomly assigned to the intervention group or the waitlist control group. Sedentary behavior and physical activity were measured at baseline and post by accelerometer and self-report. Self-efficacy to reduce sedentary behavior and SE for increasing light and moderate physical activity was assessed by questionnaire at baseline, mid-point and post intervention.

Potential Significance of This Study

This project extended sedentary behavior and light physical activity research by considering a novel delivery method and by specifically targeting overweight and obese women. This population is at high risk for cardiovascular disease and metabolic syndrome and known to have low levels of physical activity (Chen & Mao, 2006; CDC, 2010). Reducing sedentary behavior could be a starting point for adopting more intense physical activity, especially for overweight and sedentary individuals.

The current study improved upon previous sedentary interventions by providing multiple strategies for increasing SE, assessing task SE rather than barrier SE and it increased the total number and frequency of contacts with participants. This study was strengthened by the use of objective measures of physical activity and sedentary behavior and by measuring changes in SE over time.

As previously discussed, this population is less likely to meet public health recommendations for physical activity than normal weight adults (Tudor-Locke et al., 2010a). Developing SE has been the central focus of physical activity interventions for both weight loss and general exercise adherence (Annesi & Whitaker, 2010b; Linde, Rothman, Baldwin, & Jeffery, 2006; McAuley, Jerome, Elavsky, Marquez, & Ramsey, 2003). The intervention offered a new paradigm, reduced sitting, to build SE for physical activity. This approach may be especially useful in older and very low active adults, as well as for overweight and obese women.

CHAPTER II

LITERATURE REVIEW

It is well known that physical activity is a critical element of physical health and longevity (Paffenbarger, Hyde, Wing, & Hsieh, 1986; Blair et al., 1992). However, it may not be the only determinant of health that relates to physical movement. Time spent in sedentary behavior (SB) appears to have as much of an impact on cardiometabolic health as does purposeful physical activity (PA). Kinesiologists should no longer be focused solely on promoting moderate to vigorous PA. A new approach is needed to improve the health of Americans; one that reduces time spent in sedentary activities, encourages a range of physical activities, and is sustainable over the lifespan. A large proportion of women are insufficiently active and those that are overweight or obese are at greater risk for cardiovascular and metabolic diseases (CDC, 2010). An intervention designed to reduce SB by increasing light PA may enhance physical health and increase SE for PA.

This chapter begins with a review of the literature on PA as a health promoter and the psychosocial elements related to activity adoption. Support for current intervention strategies such as tailored messages and internet delivery will be provided. Next, the physiology and health risks unique to SB will be outlined. Prior interventions that have attempted to reduce sedentary time or increase light PA will be discussed.

Finally, the validity and reliability of the proposed study's outcome measures will be reviewed.

Health Benefits of Physical Activity

There is a wealth of research to support the current public health recommendations (American College of Sports Medicine/American Heart Association Physical Activity Guidelines and the Physical Activity Guidelines for Americans) that Americans should accumulate at least 150 minutes of moderate PA a week (Haskell et al., 2007; Nelson et al., 2007; DHHS, 2008). The cardiovascular benefits of regular PA are well known and include lower blood pressure (Vatten, Nilsen, & Holmen, 2006), improved lipid profile (Sternfeld et al., 1999), reduction of central obesity (Waller, Kaprio, & Kujala, 2008) and greater heart and lung volumes (Cheng et al., 2003; Turkbey et al., 2010). Muscle contraction encourages glucose uptake and lowers one's risk of diabetes and metabolic syndrome (Rockl, Witczak, & Goodyear, 2008; Cho, Shin, Kim, Jee, & Sung, 2009). There are also psychological benefits including reduced stress (Edenfield, Blumenthal, Contrada, & Baum, 2011), elevated mood (Ekkekakis, Hall, VanLanduyt, & Petruzzello, 2000), and lessening of cognitive decline (Sofi et al., 2001).

Meeting Physical Activity Recommendations

The most optimistic estimates say that half the population is not active enough to meet the PA guidelines. The most recent Behavioral Risk Factor Surveillance System (BRFSS) report states that 37.7% of Americans are insufficiently active (reporting some PA but not enough to meet the recommendation) 48.8% are physically active (CDC, 2010). But, these self-report measures may be seriously inflated. The National Health and Nutrition Examination Study (NHANES) for 2003-2004 measured PA via accelerometers and found that only 19% of Americans were in compliance with the recommendations (Ham & Ainsworth, 2010). Whereas, the BRFSS for 2003 found that 47% of the population met the current PA guideline.

Public health recommendations focus on the benefits from moderate and vigorous PA done in bouts of at least 10 minutes in length (CDC, 2010). They do not consider the full spectrum of PA that includes light intermittent physical activities of daily living. There is significant research to show that large quantities of sitting time has negative health implications that are not alleviated by moderate or vigorous PA (Williams et al., 2008). Time spent sitting is inversely proportion to light PA, so that increases in light PA should reduce SB (Hamilton et al., 2008; Owen et al., 2010b). The prevalence of low PA among Americans and the new insights into SB are leading researchers to consider other avenues to health besides that of physical fitness (Hamilton et al., 2008; Franklin et al., 2010).

Psychosocial Determinants of Physical Activity

The demographic, psychological, social, and environmental determinants of PA have been well studied (King et al., 1992; King et al., 2000; Sherwood & Jeffery, 2000; Salmon et al., 2003). In general, activity declines with age, is lower among women and minorities, and increases with level of education and income (King et al., 1992). Enjoyment of activity is a significant factor in selecting physically active behaviors over sedentary ones (Salmon et al., 2003). Personal barriers to PA include lack of time, family obligations, and fatigue (King et al., 1992). The environment also presents challenges for PA in terms of weather, access to locations that are safe and scenic, and have others engaging in PA (King et al., 1992). Salmon et al. (2003) contend that the environmental determinants are more overcome than individual barriers.

Those who are overweight and obese face greater psychosocial (Napolitano et al., 2008) and physical barriers to PA. These include a lack of physical competence (Rimmer et al., 2010), low self-efficacy (Gallagher, Jakicic, Napolitano, & Marcus, 2006; Jewson, Spittle, & Casey, 2008), musculoskeletal pain (Heuch et al., 2010; Rimmer et al., 2010), social physique anxiety (Ekkekakis et al., 2010; Koyuncu et al., 2010), greater perceived exertion during PA (Ekkekakis & Lind, 2006), and ill-fitting equipment and apparel (Allender et al., 2006).

A number of psychosocial theories and models have tried to explain adoption and maintenance of regular exercise, or the lack thereof. A review of key theories by Biddle and Nigg (2000), categorizes them as focused on (a) beliefs or attitudes, (b) perceptions of competence, (c) perceptions of control, or (d) decision-making. The three most supported theories from those categories are the Theory of Planned Behavior (belief or attitudes), Social Cognitive Theory (perceptions of competence) and the Transtheoretical Model (decision-making) (Biddle & Nigg, 2000). The Social Cognitive Theory provides a theoretical framework for current PA research and the Transtheoretical Model provides a guide to effective intervention. In addition to those, the Behavioral Choice Theory has also been used to explain motivation for active or SBs (Epstein & Roemmich, 2001) and has been applied as a framework for interventions on SB (Epstein, Saelens, & O'Brien, 1995).

Social Cognitive Theory

Social Cognitive Theory was developed by Bandura (1986) after research using the Social Learning Theory. The key difference between the theories is that the Social Cognitive Theory accounts for self-referent thoughts while planning behavior (Bandura, 1989). The Social Cognitive Theory illustrates the dynamic interrelationships that exist between a behavior, the environment, and the individual. There is a bi-directional relationship between each, called reciprocal determinism (Figure 1). For example, the characteristics of the PA behavior, such as the skill required, influence individual perceptions about being able to participate (person-behavior). The need for greater skill could inspire one to seek instruction and thus put enter in an environment conducive to the PA (behavior-environment). Elements in this environment, like social support, can impact personal beliefs (environment-person). Factors of the person, behavior, or environment could also be seen as too challenging to overcome. Even if one has the belief that they can do a behavior, if they perceive limited access to the behavior in terms of cost, safety, or convenience, they will not engage in the behavior. Elements of the person, behavior, and environment that interfere with participation are termed barriers.

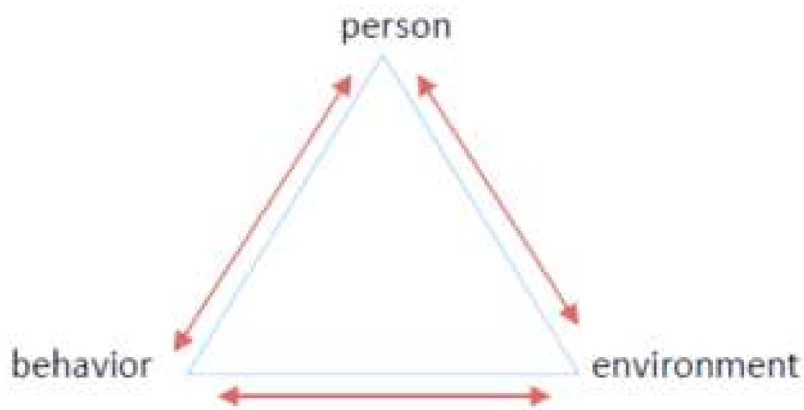

Figure 1. Reciprocal Determination (Bandura, 1986, p. 36)

Self-efficacy. The key individual element is the perception of ability and the symbolic construction of what success at a behavior looks like. Self-efficacy is formally defined as, “beliefs in one’s power to produce a given level of attainment” (Bandura, 1997, p. 382). Self-efficacy (SE) is Bandura’s (1989) term for the human capacity of behavior change and adherence of behaviors. The perceived benefits or consequences of executing a behavior are called outcome expectations (OE). Biddle et al. (2000, p. 544) called OE, “beliefs as to whether the behavior will produce a particular result.” Marcus and Forsyth (2001, p. 44) added individual judgment to OE by saying it “refers to the value a person places on being physically active.” The foundation of the SCT is that SE and OE lead to behavior.

The role of SE in exercise and PA has been extensively studied. Self-efficacy can be described along three dimensions: magnitude, generality, and strength (Tenebaum & Hutchinson, 2007). Self-Efficacy is different from self-confidence. Self-confidence is a stable general outlook about one's self, whereas SE is domain specific and somewhat dynamic (McAuley et al., 2001; Gill & Williams, 2008). Self-efficacy is both a determinant of PA and an outcome of participation in PA (McAuley & Blissmer, 2000). Several characteristics of SE have been identified. First, it can be increased with either acute or chronic PA, although the chronic effect is most dramatic (McAuley, Lox, & Duncan, 1993; McAuley & Blissmer, 2000). Second, SE is transient and rapidly declines when PA is not continued (McAuley et al., 1999; McAuley, Jerome, Marquez, & Elavsky, 2003). And, an important characteristic of SE is that gains in fitness are not required for changes in SE. In fact, activity participation had a greater effect on SE than did fitness in a group of older adults (McAuley et al., 1999). Purposeful PA requires individuals to plan for the behavior as well as execute the actual task. Specific forms of SE such as scheduling SE and coping SE have been found to be predictive of exercise adherence (Rogers & Sullivan, 2001).

According to Bandura (1997), four main factors influence SE and OE: (a) vicarious experiences or modeling, (b) mastery experiences, (c) verbal and social persuasion, and (d) emotional and physiological states. Successful completion of the behavior, whether subjective or objectively defined, is a mastery experience. It is the strongest validation of ability and provides motivation to continue the activity. A meta-analytic review of SE in PA interventions supports that mastery experiences provide the most influence on continued behavior (Ashford et al., 2010).

Outcome expectations. The second construct in SCT is that of OE. These are beliefs about what results the behavior will bring. The sources of OE are the same as those for SE (see Figure 2). Actions and environments that generate SE are also going to contribute to OE (Resnick, 2001; Resnick, Zimmerman, Orwig, Furstenberg, & Magaziner, 2001). According to Bandura (1997) those who are highly efficacious also expect positive outcomes. The strongest associations between OE and PA have been seen in older adults, whose perception of health risks are more immediate (Resnick, 2004).

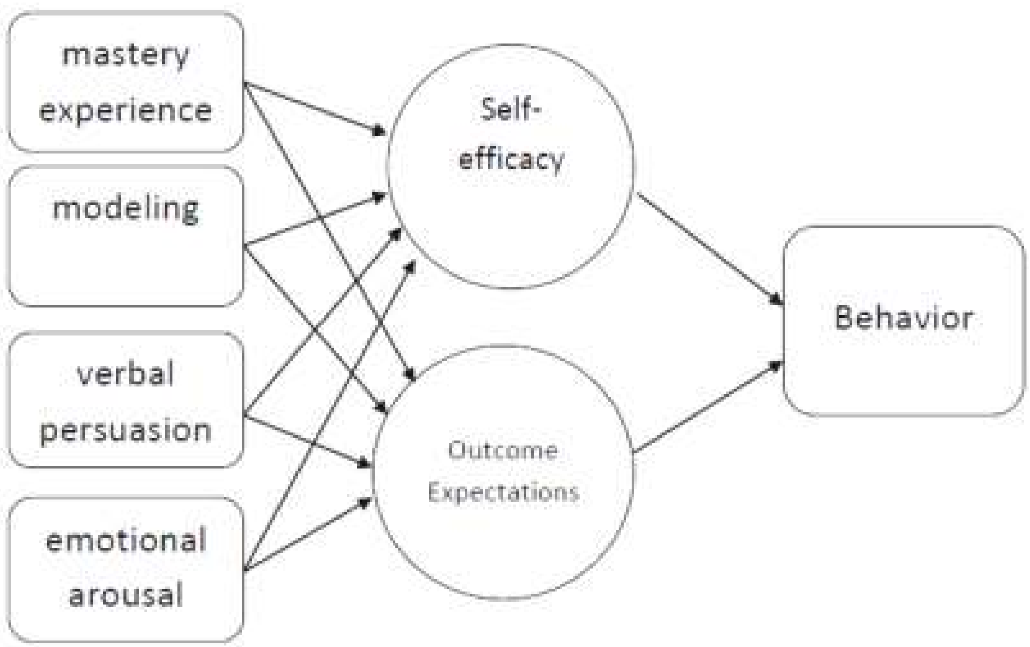

Figure 2. Models of Self-efficacy & Outcome Expectations (Biddle & Nigg, 2000, p. 297)

Studies by Resnick and colleagues (Resnick, Zimmerman, Orwig, Furstenberg, & Magaziner, 2000; Resnick, 2001) provide evidence of a positive relationship between OE and SE. In general, OE is a better predictor of PA in older adults than SE (Williams, Anderson, & Winett, 2005).

The impact of OE may be strongest at initiation and during maintenance (Marcus & Forsyth, 2009). The question of how unmet OE affect PA motivation and adherence has not been resolved. Some support for enhanced motivation exists (Merrill, Shields, Wood, & Beck, 2004; Tenebaum & Hutchinson, 2007) along with evidence of attrition (Williams et al., 2005; Anderson, Wojcik, Winett, & Williams, 2006; Wilcox, Castro, & King, 2006; Gorin et al., 2007).

Strategies to Change Behavior

Behavior is impacted by more than one's SE and OE. Specific strategies to change cognitive and behavioral factors are needed to adopt and maintain new behaviors (Prochaska & Marcus, 1994). These strategies are the processes of change and are contained within the Transtheoretical Model (Prochaska & Marcus, 1994; Nigg et al., 2011). The model proposes that behavior change happens in stages based on the individual's readiness for the activity. Five cognitive and five behavioral processes are considered required to move through the stages. There are a total of five stages; pre-contemplation, contemplation, preparation, action and maintenance. A person may cycle through several attempts at one or more stages before progressing. The cognitive processes are more essential in the early stages (Nigg et al., 2011). These include raising consciousness about the behavior and its benefits, self-re-evaluation, experiencing emotions about the new behavior, managing the consequences the activity has on others, and being aware of the social norms for or opposing the behavior (Rhodes et al., 2008). The behavioral processes help maintain and support the behavior once it is initiated (Nigg et al., 2011). These steps include counter-conditioning or substituting the new behavior for a previous one, using environmental cues to prompt the new behavior, enlisting social support for the change, rewarding the behavior, and self-liberation or commitment to the behavior (Lewis et al., 2006; Rhodes et al., 2008).

The Transtheoretical Model (TTM) is a combination approach to behavior change rather than a single theory (Nigg et al., 2011). The processes of change work with two other constructs, SE and decisional balance (Opdenacker et al., 2009; Nigg et al., 2011). Increases in SE coincide with stage advancement (Lippke, Ziegelmann, Schwarzer, & Velicer, 2009; Pekmezi et al., 2010a; Nigg et al., 2011) and individual levels of SE can discriminate one's stage of readiness (Marcus et al., 1992). The decisional balance construct weighs the benefits of the new behavior against the costs of the change. The action stage marks the point at which the benefits outweigh the costs (Marcus & Lewis, 2003). One's stage of readiness can be assessed in a simple five-item questionnaire (Marcus & Lewis, 2003; Marcus & Forsyth, 2009). Intervention strategies can be tailored to participants' stage of change. This type of specificity has been found to be effective in promoting levels of PA (Bock et al., 2001; Plotnikoff et al., 2007; Greaney et al., 2008).

Theoretical Approaches to SB

Owen et al. (2011) suggest that an ecologic approach best illustrates the multiple determinants of SB. The model describes the intrapersonal factors, social-cultural environment, perceived environment, behavior characteristics and policy environment of the four domains of sitting: (a) household, (b) occupational, (c) leisure time, and (d) transport (see Figure 3). This approach emphasizes the specific contexts, both physical and social, in which SB occurs and the interaction between the individual and the environment. Characteristics of the environment, such as seated workstations or low walkability neighborhoods, have a strong influence on sitting time and limit options to change behavior (Owen et al., 2011).

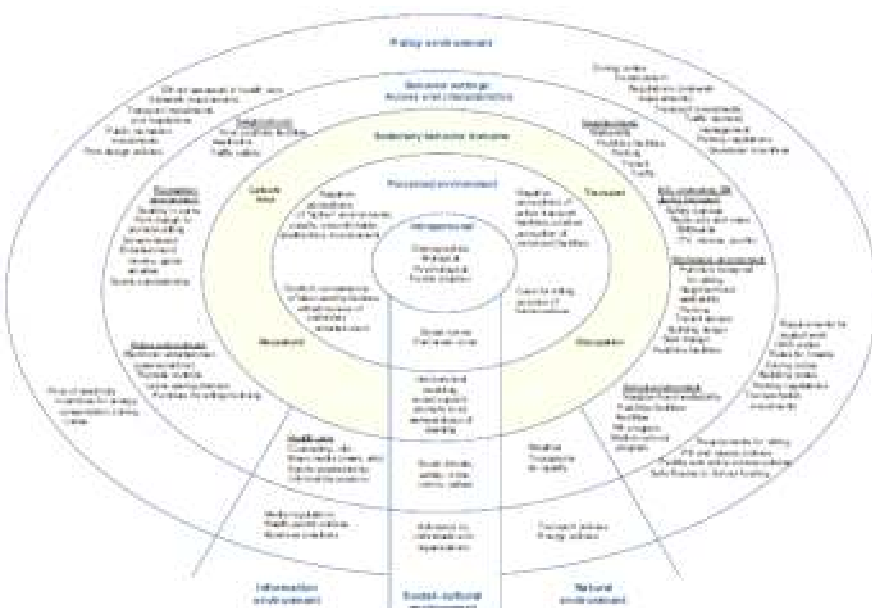

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Figure 3. Ecologic Model of SB (Owen et al., 2011, p. 191)

A cognitive behavioral theory, known as the Behavior Choice Theory, is also discussed as a possible explanation for individual preference towards SB (Lee & King, 2003). Behavior Choice Theory comes from the field of behavioral economics (Epstein et al., 1995). It proposes that environmental access and the reinforcing value of the activity are central in self-selecting a SB over a PA (Epstein & Roemmich, 2001). According to this theory, the individual difference is sensitivity to the reinforcing element, rather than SE for the behavior. The motivation for selecting a behavior is based on the rewards as long as access to both alternatives is equal. If the rewards are equal, then the most accessible activity is chosen (Epstein & Roemmich, 2001). According to Epstein and colleagues (Epstein, Smith, Vara, & Rodefer, 1991; Epstein et al., 1995; Epstein, Saelens, Myers, & Vito, 1997) physical activities have to be more highly rewarded than SBs to get overweight children to participate. For adults, the proximity of the activity was more important and they tended to choose the closest activity. There is support for Behavior Choice Theory among researchers studying SBs. Factors such as access to more active alternatives (Levine & Miller, 2007) and perceived enjoyment (Salmon et al., 2003) have been considered as operationalized constructs of the Behavior Choice Theory.

Interventions to Increase Physical Activity

PA interventions are often based on SCT or use a combination of constructs from the TTM and SCT. Their intent is to increase SE for PA and help participants develop cognitive and behavioral strategies. Interventions that build SE do so through formal and informal appraisals, removal of situational barriers, and encouragement from peers and respected others, and the experience of the benefits (OE) of PA (Ashford et al., 2010).

Effective Intervention Strategies

A systematic review of PA interventions by Kahn et al. (2002) found sufficient evidence to support the effectiveness of three types of cognitive behavioral interventions to increase PA: school-based physical education, social support in community settings, and individually adapted behavior change programs. However, the effect of the invention fades with time (Bull, Kreuter, & Scharff, 1999). An analysis of studies that followed participants for 12+ months was less positive about the impact of PA interventions (Muller-Riemenschneider et al., 2008). Interventions that were grounded by theory did better at maintaining PA than those that were atheortical.

Initial research in exercise psychology correlated behavior change to increases in one or more psychosocial constructs such as self-efficacy or the processes of change (King et al., 1992; McAuley, Courneya, Rudolph, & Lox, 1994; Marcus et al., 1998b). More recently, mediator analysis has effectively established these constructs as mechanisms for increased PA (Lewis et al., 2002, 2006; Napolitano et al., 2008). Interventions that apply multiple cognitive and behavioral strategies to increase SE are more effective at increasing PA than those that rely on a single behavior change principle (Jarvis, Friedman, Heeren, & Cullinane, 1997; Jette et al., 1999; Raedeke et al., 2010).

Tailored interventions. A greater increase in SE and more use of behavioral processes were found when the intervention was matched to either stage of change, SE, or current cognitive and behavioral processes versus standard interventions (Marcus et al., 1998b; Lewis et al., 2006; Plotnikoff et al., 2007). In order to tailor the intervention, one or more of the following are assessed at baseline: level of SE, stage of readiness and use of the processes of change (Marcus & Forsyth, 2009). Intervention messages are then more specifically targeted to the strategies likely to advance SE and stage of readiness (Kreuter & Wray, 2003). These messages are seen as more personal and relevant to the individual participant and are more likely to be considered than messages targeted to a sub-population such as age, gender, or ethnicity (Kreuter & Wray, 2003).

Interventions also provide different forms of feedback. Individual data can be transformed into normative feedback by comparing the participant to an average or standard. An illustration of one's PA minutes in relation to the PA guidelines is an example. Feedback can also be iterative, meaning that the comparison is between different assessments of the same individual. A percentage of completion, such as progress towards a weight loss goal is an example (deVries & Brug, 1999).

Feedback messages can be generated from performance and any number of psychological variables. The Coach Approach developed by Annesi and colleagues (2003, 2008, 2010a, 2011) is an example. This intervention combines exercise prescription, behavioral counseling, and nutrition education and was delivered through individual and computer interactions (Annesi, 2003; Annesi & Unruh, 2007). Feedback was provided on a large number of variables, from incremental increases in PA to affect post exercise. The feedback worked in two ways. First, by highlighting any improvements, participants experienced increased mastery and awareness of benefits. Second, assessments of mood, energy, and perceived exertion were used to plan subsequent exercise. Annesi and Unruh (2007) suggested a circular relationship between SE and mood and adherence, with increases in SE positively affecting mood, which improved adherence. The intervention significantly improved the retention of participants as compared to other gym members , SE, body satisfaction, and mood in lean and obese participants (Annesi & Unruh, 2007; Annesi & Whitaker, 2010a). Mediator analysis found that changes in SE, mood, and body satisfaction combined to explain 23% of the variance in member attendance rates (Annesi, Unruh, Marti, Gorjala, & Tennant, 2011).

Tailored interventions have been found effective at increasing PA (Jarvis et al., 1997; Marcus et al., 1998a; Bull et al., 1999; Jette et al., 1999; Bock et al., 2001; Lewis et al., 2006; Plotnikoff et al., 2007; Greaney et al., 2008). Comparisons of tailored to non-tailored interventions show better psychological and behavioral outcomes from the tailored designs (Marcus et al., 1998b; Lewis et al., 2006). Increasing the number of tailored elements also appears to improve the results (van Stralen, de Vries, Bolman, Mudde, & Lechner, 2010). In addition to stage of readiness, interventions can be tailored for the environment (van Stralen et al., 2010), for individual performance feedback (Lewis et al., 2006), barriers (Kreuter & Strecher, 1996; Bull et al., 1999), motives (Kreuter & Strecher, 1996; Bull et al., 1999), SE (Lewis et al., 2006), and OE (Kreuter & Strecher, 1996).

Latimer, Brawley and Bassett (2010) reviewed the effectiveness of tailored messages, framed messages, and messages aimed at SE to increase PA. Here tailoring referred specifically to matching one's stage of readiness for PA. The greatest support was for the use of tailored messages. Fifty-eight percent of the studies using them produced significant change in PA (Latimer et al., 2010). Messages framed as gains (benefits to engaging) rather than losses (risks of not engaging) were more effective. Only four studies were identified as using SE building messages. Significant benefits were seen in two of the trials (Stanley & Maddux, 1986; Courneya & Hellsten, 2001) and positive trends were found in the third (Miller, Trost, & Brown, 2002). The fourth study (Graham, Prapavessis, & Cameron, 2006) found no effect but their SE building tool did not relate well to the SE measure (Latimer et al., 2010). Overall, the evidence that SE could be increased by intervention messages was graded as a C (Latimer et al., 2010).

Lewis and colleagues (2006) studied the effects of a highly tailored PA intervention to those of a non-tailored intervention. The tailored elements were individualized feedback on minutes of PA, decisional balance, SE, and the 5 cognitive and 5 behavioral processes of changes. A self-help manual specific to participants' stage of readiness was also sent. Both the tailored and non-tailored interventions were successful at increasing minutes of PA and behavioral processes. But at 6 months, the tailored intervention produced significantly more PA than the non-tailored (151.4±148.6 to 97.6±98.3). Only the tailored group increased SE and decisional balance. As predicted, these two constructs were the strongest mediators of increased PA (Lewis et al., 2006).

Mediated physical activity interventions. As opposed to traditional face to face delivery, a mediated intervention is conducted from a distance. Printed materials are mailed singularly or in combination with telephone contact (Opdenacker et al., 2008; Jenkins, Christensen, Walker, & Dear, 2009). The benefits include access to a broad audience and removal of the barrier of coming to a particular setting (Ciccolo et al., 2008). Computer programs can generate feedback that is more specific than mass produced stage-of-change printed materials (Bull et al., 1999). Advantages to computerized-tailoring include cost, confidentiality, and the ability to individualize information to a large population (deVries & Brug, 1999). Computer-tailored technology consists of four elements: identification of characteristics, a library of messages, an algorithm that matches the individual's characteristics to the correct messages, and a message delivery mode (Bull et al., 1999; deVries & Brug, 1999).

Recently, there has been interest in using the internet as a delivery mode for PA interventions (Napolitano et al., 2003; Plotnikoff, McCargar, Wilson, & Loucaides, 2005; Marcus et al., 2007a; Spittaels et al., 2007; Ciccolo et al., 2008; Marcus, Ciccolo, & Sciamanna, 2009; Pekmezi et al., 2010b). Providing a PA intervention through a sedentary medium may seem paradoxical. However, associations between leisure-time internet use and PA are not high (Vandelanotte et al., 2009). Participants can access the intervention at their convenience, increasing the potential reach and lowering the costs (Ciccolo et al., 2008; Krebs et al., 2010).

Internet-based interventions appear to be equally effective at increasing PA and psychosocial mediators as traditional methods (Plotnikoff et al., 2005; Spittaels et al., 2007; Ciccolo et al., 2008; Steele et al., 2009; Carroll et al., 2010; Pekmezi et al., 2010b). A meta-analysis of internet-based health behavior change interventions found that online PA interventions (*n*=20) had the highest effect size (*d*=.24) of the health behaviors examined (Webb, Joseph, Yardley, & Michie, 2010). There have been three reviews (Norman et al., 2007; van den Berg, Schoones, & Vlieland, 2007; Vandelanotte, Spathonis, Eakin, & Owen, 2007) of internet and website-based PA interventions. Despite being published prior to four successful studies (Hurling et al., 2007; Marcus et al., 2007b; Spittaels et al., 2007; Carr et al., 2008), each analysis concluded that there is support for internet delivery though gains were usually short-lived. The lack of long-term benefit has been also noted by others (Napolitano et al., 2003; Spittaels et al., 2007), as well as small effect sizes for PA and self-efficacy (Plotnikoff et al., 2005).

The use of multiple communication components within the same internet-based intervention is supported. van den Berg and colleagues (2007) found that providing contact with the researcher and giving tailored feedback were the most effective combination. A meta-analysis of computer-tailored interventions by Krebs et al. (2010) and a systemic review of distance interventions by Jenkins et al. (2009) also suggest that using more than one communication method is more effective than a single approach.

Marcus and colleagues (2007a) tested the effects of delivery mode (print or internet) and tailoring on PA. Minutes of PA increased in all three groups (tailored print, tailored internet, and standard internet) and were not significantly different at 6 or 12 months. The standard internet group lagged behind the tailored interventions at 6 months but a steeper decline in PA minutes was seen in the tailored groups between 6 and 12 months (Marcus et al., 2007a). Given that there was no difference between the internet and print modes of delivery, the authors concluded that internet-based interventions are equally as effective as print-based ones. Spittaels et al. (2007) also found no significant differences between tailored and non-tailored groups of an online PA intervention. A cost analysis revealed that for large scale interventions (n=350), website-based interventions were more cost effective than print-based (Lewis, Williams, Neighbors, Jakicic, & Marcus, 2010).

Advancement in stage of readiness or increased use of cognitive and behavioral processes has been found more often than increased SE with internet-based interventions (Napolitano et al., 2003; Pekmezi et al., 2010b). Though, this could be due to a greater focus on those constructs in the intervention or due to difficulties in measuring SE (Buckworth & Dishman, 2007; O'Sullivan & Strauser, 2009) and detecting changes in SE (O'Sullivan & Strauser, 2009). Small effect sizes for SE were found in two meta-analytic reviews (Ashford et al., 2010; Webb et al., 2010). The first was specific to PA interventions ability to increase SE. Ashford et al. (2010) found the effect to small but significant (d = 0.16). The second report examined change in SE for several health behaviors from internet-based interventions. Webb and colleagues (2010) found the 12 studies framed in SCT produced an effect size of 0.15 for SE.

This is not totally unique to internet trials. Some tailored print and telephone interventions have found improvements in PA without significant increases in SE (Lewis et al., 2006; Marcus et al., 2007b; Dishman, Vandenberg, Motl, Wilson, & DeJoy, 2010). In the Lewis et al. (2006) study, SE approached significance (p= 0.061). One internet-based intervention did see significant improvements in SE. Hurling and colleagues (2007) provided frequent performance feedback over a 9 week period and saw significant increases to moderate PA and SE. As pointed out by Latimer et al. (2010), the intervention must affect mastery experience, modeling, persuasion, and or the emotional or physical state to modify SE for PA.

Weight loss interventions. Interventions specifically for weight loss have followed similar cognitive behavioral models that improve SE. Weight loss, however, is an OE rather than a behavior (Linde et al., 2006) and weight-related outcome expectations are not clearly related to mastery experience (Foster, Wadden, Vogt, & Brewer, 1997; Fabricatore et al., 2008). King and colleagues (2002) assert that weight loss expectations help initiate behavior changes such as PA and dieting, but maintenance of the behaviors is largely a result of satisfaction. As a result, SE for PA and SE for calorie control predict initial intervention results but not long-term weight loss (Linde et al., 2006). In studies, satisfaction with both physical and psychosocial benefits of weight loss was more positively related to adherence of PA and diet than was SE (Jeffery, Linde, Finch, Rothman, & King, 2006; Gorin et al., 2007). Also, efforts to decrease unrealistic outcome expectations have not been successful (Finch et al., 2005; Jeffery et al., 2006).

Annesi and Whitaker (2010a, 2010b) found significant improvements in body mass index (BMI), SE for exercise, body satisfaction, and mood using the Coach Approach, an intervention to increase PA in obese women (*n* = 213). Attendance was a significant predictor of weight loss with SE, body satisfaction, and mood contributing to the variance in attendance ($r^2 = 0.14$). The Coach Approach intervention lasted 6 months and only pre to post results were presented. Long-term follow-up is needed to better evaluate the effects of PA interventions on weight loss.

Sedentary Behavior

The 2005-06 NHANES found that 56.8% of American adults' waking hours are spent in SB (Tudor-Locke et al., 2010a). All seated activities such as watching television, using a computer, reading, working at a desk, or riding in a car as well as sleeping or lying down are considered SB. The energy expenditure of these activities is only slightly above the resting metabolic rate and is defined as 1.5 metabolic equivalents (METs) (Pate et al., 2008). This is a relatively new designation of the term sedentary. Prior epidemiological studies classified participants with low levels of PA as being sedentary (Paffenbarger et al., 1986; Houde & Melillo, 2002; Richardson, Kriska, Lantz, & Hayward, 2004). Typically, this definition of sedentary was based on reports of moderate or vigorous activity and not a reflection of actual time spent sitting or lying (Pate et al., 2008).

SB has been studied in both work (McCrady & Levine, 2009; van Uffelen et al., 2010b) and leisure settings (Vandelanotte et al., 2009; van der Ploeg et al., 2010) and in adults (Brown et al., 2003; Matthews et al., 2008; Touvier et al., 2010) and children (Hardy et al., 2007). In a population-based study of SB, Matthews et al. (2008) found that adolescents and older adults engaged in the greatest amount of SB. Children ages 6-11 were the least sedentary but SB rose steadily through the teenage years to an average of eight hours a day. A slight gender difference was also noted with adolescent girls spending 12 more minutes a day in SB than boys. A small reduction in SB was noted in early adulthood (20-29 years) followed by increases of 2 hours a day for middle age and older adults and SB tops off at over 9 hours a day for people 70-85 (see Figure 4). A shift in prevalence by gender was seen for this oldest group, with men being sedentary on average 24 minutes more a day. This pattern of SB by age and gender been supported by others (Hardy et al., 2007; Touvier et al., 2010). McCrady and Levine (2009) followed American subjects for 20 days and found that almost two hours more sitting occurred on work days (9.95±2 hours) than on non-work days (8±1.4 hours). Standing and walking were more prevalent on leisure days, with 58 more minutes walking time was accumulated on non-work days (McCrady & Levine, 2009). Estimates of SB taken from time use surveys put total non-work SB at8.25 (±3.23) hours. Self-reported sitting from the time use survey was moderately correlated (r=.57-.59) to participant accelerometer counts (van der Ploeg et al., 2010).

Differences in SB have also been identified between normal and overweight populations (Brown et al., 2003; Levine et al., 2005; Johannsen et al., 2007; McCrady & Levine, 2009). Brown and colleagues (2003) found that sitting time increased significantly by BMI category, so that obese participants engaged in at least one hour more of sitting a day than the normal weight participants. Studies using objective measures of SB set the disparity between lean and obese at 2.5 hours per day (Levine et al., 2005; Johannsen et al., 2007), though much smaller differences were found by another author (Tudor-Locke et al., 2010a).

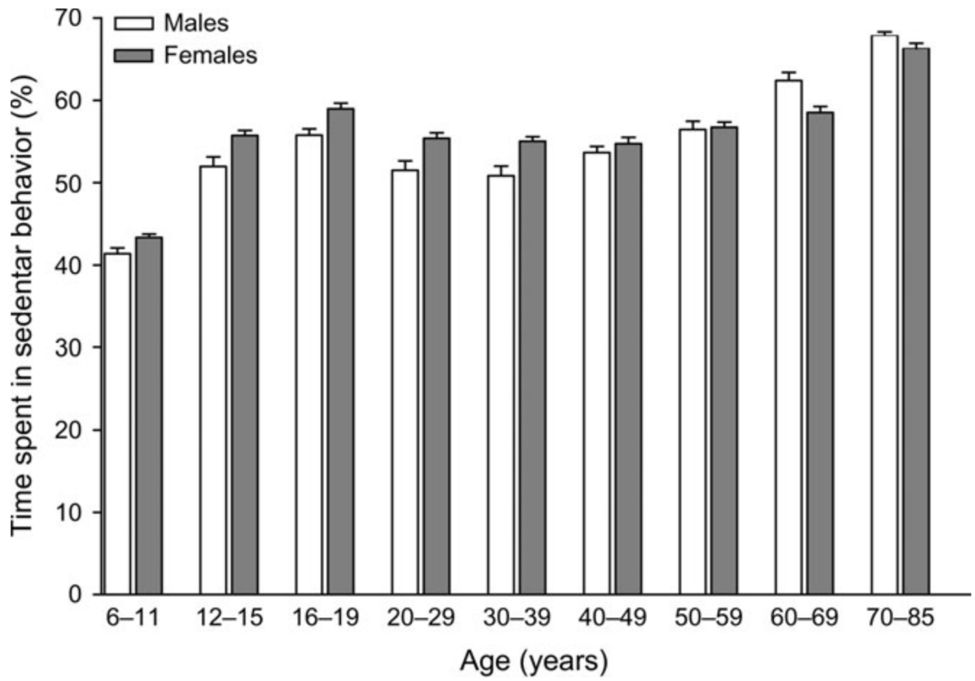

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Figure 4. Sedentary Behavior by Age (Matthews, 2008, p. 878)

Television Time

Television viewing is the second most common sedentary activity reported by Americans in time-use surveys (Tudor-Locke, Johnson, & Katzmarzyk, 2010b) and accounts for about half of adult non-work sitting time (Sugiyama, Healy, Dunstan, Salmon, & Owen, 2008). Television time is a definable SB, and recall measures have proven reliable (Clark et al., 2009). Television viewing has been used in health research in adults (Crawford, Jeffery, & French, 1999; Bowman, 2006; Swinburn & Shelly, 2008; Williams et al., 2008; Thorp et al., 2010) and children (Salmon et al., 2003; Hancox, Milne, & Poulton, 2004; Bowman, 2006; Salmon, Ball, Hume, Booth, & Crawford, 2008; Swinburn & Shelly, 2008; Williams et al., 2008; Thorp et al., 2010) for quite some time (Dietz & Gortmaker, 1985; Tucker & Friedman, 1989; Rissel, 1991). There is debate about whether TV viewing is an indicator of an overall sedentary lifestyle or simply a specific type of SB (Jeffery & French, 1998; Crawford et al., 1999; Sugiyama et al., 2008). Gender may play a role as other SB are more highly associated with female TV viewing than with male (Sugiyama et al., 2008). Greater time spent watching TV is associated with increased risk for obesity and type 2 diabetes especially for women (Jeffery & French, 1998; Hu et al., 2003; Dunstan et al., 2005; Bowman, 2006; Dunstan et al., 2007).

Hu and colleagues (2003) were one of the first American researchers to consider the role of SBs in the incidence of obesity and type 2 diabetes. Data from the Nurses' Health Study (a large longitudinal survey of women) pointed to an increased risk for both conditions that was independent of time spent in physical activities. The relative risk for obesity and type 2 diabetes doubles when more than 40 hours of TV are watched a week (Hu et al., 2003). Adjustments for exercise, diet, and BMI attenuated the results for diabetes but not obesity. For every 2 hours a day increase in TV viewing, the risk of obesity and diabetes went up 23% and 14% (Hu et al., 2003).

Dunstan and colleagues (2010) recently examined the relationship between time spent watching TV and mortality in an Australian sample. A linear relationship was found between hours of reported TV viewing and mortality. A striking increase in risk was noted at 4 hours a day of viewing for all-cause and cardiovascular mortality (Dunstan et al., 2010). Adjustment for exercise, age, gender, and waist circumference did not change the significance. For each hour of TV watching there was an increased risk of 11% for death from all causes and an 18% increase risk for cardiovascular mortality. Those that watched TV for more than 4 hours a day had a 46% greater chance of all-cause mortality and an 80% greater risk of death from cardiovascular disease (Dunstan et al., 2010).

Determining the absolute volume of TV viewing in American is difficult. Population-based studies of TV watching have grouped viewing time into low, moderate and high classifications (Salmon et al., 2000; Dunstan et al., 2004; Dunstan et al., 2010; Thorp et al., 2010; Stamatakis et al., 2011), with the highest level usually defined as more than 4 hours a day (Salmon et al., 2000; Dunstan et al., 2005) without presenting means for the total sample. These studies are also limited by their use of subjective measures.

Swinburn and Shelly (2008) report the amount of TV watched by both adults and children has remained constant over the last 30 years. Bowman (2006) found that 58.9% of US adults watch more than 2 hours of TV a day. This average of 2 plus hours a day has been reported by others (Salmon et al., 2000; Marshall, Miller, Burton, & Brown, 2010), although amounts closer to one hour a day are also cited (Pettee, Ham, Macera, & Ainsworth, 2009). Differences in weekday and weekend viewing have been noted (Marshall et al., 2010), with greater time allotted to weekend viewing. Objective measures of TV time, such as recording boxes, indicate higher viewing volumes. Otten et al. (2009) found that overweight adults watch nearly 5 hours a day of TV.

Screen Behaviors

Most recently, consideration has been given to other screen activities such as leisure time computer use and video gaming in addition to TV viewing (Gorely, Biddle, Marshall, & Cameron, 2009; Vandelanotte et al., 2009; Stamatakis et al., 2011). Earlier work focused on youth and computer use found a positive association between computer use and weight (Vandelanotte et al., 2009). Stamatakis and colleagues (2011) included non-work related computer use and video games along with TV viewing in their longitudinal study of 4,512 adults from Scotland. After 4 years, those that reported 4 or more hours of leisure screen time a day had a 125% greater chance of hospital admission for cardiovascular disease than those that spent less than 2 hours a day.

Adjustment for volume of PA did not significantly change the effect of the SB. An Australian sample was used by Vandelanotte et al. (2009), who examined the association between BMI and leisure-time computer use in adults. The reported average computer time was slightly over 2 hours a week. High leisure time users (≥ 3 hours per week) were 1.4 times more likely to be obese than low users (<3 hours per week) and 2.5 times more than non-users. The authors also considered other SB like TV watching, reading, riding in cars, and talking on the phone. Those that reported high volumes of computer use were 2.5 times as likely to spend more than 5 hours a day on other SB. Again, PA time did not ameliorate the risk of being overweight or obese (Vandelanotte et al., 2009).

Modern Life Contributes to Sedentary Behavior

Advances in technology and the development of suburban communities have made PA less necessary and less efficient than it was 50 years ago. As more work tasks became automated, jobs in manufacturing, industry and agriculture moved to more sedentary service and retail positions (Sternlieb & Hughes, 1975; Hudelson, 1996). Another change can be seen in modes of transportation. There were three times as many commuting workers in 2000 as compared to 1960. The percentage of vehicle trips for recreation and shopping increased as drivers began adding on these stops to increase time efficiency (McGuckin & Srinivasan, 2003). Less PA for transportation (active transport) is one consequence of urban sprawling that began in the 1950’s (Ewing & Cervero, 2010). Super stores and malls put food and consumer goods in centrally located areas for convenience but away from residential areas so that walking is not feasible (Zhao & Kaestner, 2010).

Low levels of active transportation are highly correlated to higher BMI (Bassett, Pucher, Buehler, Thompson, & Crouter, 2008; Pucher, Buehler, Bassett, & Dannenberg, 2010). Europeans participate in more active transport and have lower obesity rates than Americans, leading researchers to see the difference as a possible mechanism (Bassett et al., 2008; Pucher et al., 2010). Questions of casualty in obesity are difficult to answer. Many scholars point to an interaction between environmental and genetic factors to explain the population weight increase since 1980 (Ogden, Yanovski, Carroll, & Flegal, 2007; Power & Schulkin, 2009; Leonard, 2010). Low PA and high SB are only part of the phenomenon and not all comparisons between Americans and internationals have found differences in PA (Hagströmer, Troiano, Sjöström, & Berrigan, 2010b).

Inactivity Physiology

Just as authors have argued that SB is separate and distinct from PA (Owen et al., 2000; Pate et al., 2008), the physiology of inactivity is establishing itself as unique from exercise physiology (Hamilton et al., 2007; Hamilton et al., 2008). The health risks from SB mirror those of insufficient exercise and include overweight/obesity, high cholesterol, and hyperglycemia (Katzmarzyk, 2010). Their mechanisms do not follow the same pathways. Four physiologic responses to SB have been hypothesized as the root causes of chronic disease and higher mortality: low energy expenditure, lower levels of lipoprotein lipase, increased microvascular dysfunction, and a greater inflammatory response (Hamburg et al., 2007; Hamilton et al., 2007; Stamatakis et al., 2011). Each is discussed as it relates to obesity and cardiometabolic risk below.

Health Risks of Sedentary Behavior

Over the last ten years, study of SB as a unique phenomenon, rather than a lack of being physically active, has yielded a significant number of associations to poor health and mortality. Longitudinal data generally support the negative impact of increased sitting on mortality (Owen, Healy et al., 2010; Warren et al., 2010), obesity (Williams et al., 2008), and metabolic risk (Hamilton et al., 2008). A 12-year longitudinal study of sitting, leisure time PA, and mortality in 17, 000 Canadians found a dose-response relationship between reported time spent sitting and mortality (Katzmarzyk et al., 2009). Those in the highest quartile for sitting for every sub-group (male/female, physically active/insufficiently active, non-smoker/previous smoker/current smoker, normal BMI/overweight BMI/obese BMI) had the highest mortality rates from all causes and cardiovascular disease. Time spent in leisure time PA did not affect the mortality risk from sitting. This finding supports that the health risks from SBs are specific and not part of low PA (Pate et al., 2008).

Dunstan and colleagues (2010) recently examined the relationship between time spent watching TV and mortality in an Australian sample. Again, a linear relationship was found between hours of reported TV viewing and mortality. A precipitous increase in risk was noted at 4 hours a day of viewing for all cause and cardiovascular mortality (Dunstan et al., 2010). Adjustment for exercise, age, gender, and waist circumference did not change the significance. For each hour of TV watching there was an increased risk of 11% for death from all causes and an 18% increased risk for cardiovascular mortality. Those that watched TV for more than 4 hours a day had a 46% greater chance of all-cause mortality and an 80% greater risk of death from cardiovascular disease (Dunstan et al., 2010).

Obesity. The metabolic demands of SB are so low that even with sufficient moderate PA, weight gain is still likely (Levine, vander Weg, Hill, & Klesges, 2006; Hamilton et al., 2007). Several authors have examined the relationship between weight and SB (Brown et al., 2003; Mummery et al., 2005; Salmon et al., 2000; van Uffelen, Watson et al., 2010; Vandelanotte et al., 2009). All of these reports have been in cross-sectional and longitudinal in nature, limiting the understanding of causality.

Two reports of objectively measured PA found a significant difference in SB between obese and normal weight individuals (Johannsen et al., 2007; Levine et al., 2005). Levine et al. (2005) observed 10 lean and 10 obese of both genders wearing multiple movement sensors for 10 days. Obese participants sat an average of 164 minutes longer a day than did the lean counterparts. Normal locomotion made up 89% of both groups total body movement and was negatively associated with fat mass. This amounts to a calorie difference of 350 kcals a day (Levine et al., 2005). A similar study of 18 women produced nearly the same results. Johannsen and colleagues (2008) saw that resting metabolic rate as measured by indirect calorimetry was not different for the obese. Again, the lean participants sat 2.5 hours less than the obese and participated in twice as much PA as the obese. Unlike Levine et al. (2005), there was no difference in between groups on locomotion but rather a significant difference in standing time. Total energy expenditure was significantly lower for the obese women by nearly 400 kcal per day (Johannsen et al., 2008).

Levine and colleagues (2005) attempted to see if the increase in SBs was due to body weight. They reduced the weight of the obese group by an average of 8 kg through an 8 week diet and PA intervention and increased the weight of the lean group by 4 kg via overfeeding. A repeat assessment of movement revealed no change in PA patterns. Levine et al. (2005) proposed that SBs may be biologically based and therefore not changed through weight loss or gain. An alternative explanation is that over time those that weigh more begin to interact with their environment differently and respond more to cues to be sedentary than those that are not overweight.

While the correlation between high volumes of sitting time and greater BMI is well established, prospective studies have not shown SB to be a significant predictor of weight gain. A six-year study of Australian women found that mean sitting time (TV, driving, reading, working at desk and visiting) increased with BMI (van Uffelen, Watson et al., 2010). One hour of sedentary time was associated with an additional 110g for overweight women and 260g more for obese women at baseline. The results for weight gain differed by BMI category. There was a significant positive association between weight change and sitting time in the normal women but a negative relationship for women who were already overweight. These both were attenuated to non-significance when adjusted for levels of PA, calorie intake and general health factors (van Uffelen, Watson et al., 2010).

This finding supports an earlier study conducted by Blanck and colleagues in 2007. Data from the Cancer Prevention Study II was used to examine the odds ratio of weight gain over seven years in women aged 40-69 years. Unique to this study was the fact that non-recreational PA was measured in addition to leisure-time PA. These activities were categorized as light physical activities and included yard work, household chores and shopping. The behavior of interest was non-work related sitting time. The researchers found a gain of 10 pounds or more occurred in 27% of the women that were normal weight at baseline and in 37% the participants who started out overweight or obese (Blanck et al., 2007). Both recreational and non-recreational PA was inversely associated with weight gain in the normal group. The highest tertile of sedentary time, ≥ 6 hours a day, was associated with the greatest amount of weight gain for normal weight women. There were no significant associations for women who were already overweight or obese. Surprisingly, overweight women who reported no recreational PA had lower odds of a 5-9 pound gain than did those that reported up to 4 MET hours per week (.90 to .71). Only the highest level of sitting time (≥ 6 hours) was related to weight gain for those that were already overweight (Blanck et al., 2007). Numerous authors have documented the bias of self-reporting in overweight populations (Buchowski, Townsend, Chen, Acra, & Sun, 1999; Duncan, Sydeman, Perri, Limacher, & Martin, 2001; Irwin, Ainsworth, & Conway, 2001; Timperio, Salmon, & Crawford, 2003). More precise measures of PA are needed to determine the role of light PA and SBs have on weight gain especially for those that are already overweight or obese.

Cardiometabolic risks. The term cardiometabolic identifies the overlapping risk factors for cardiovascular disease (CVD), metabolic syndrome, and type 2 diabetes mellitus. These risks include abdominal obesity, impaired glucose uptake, low high density lipoprotein cholesterol, high triglycerides, and hypertension (Levine et al., 2005; Ogden et al., 2007). Both laboratory and population studies have demonstrated that increases in total cholesterol, lower high density cholesterol, higher systolic blood pressure, and greater risk of type 2 diabetes are the likely outcomes of high volumes of inactivity (Bey & Hamilton, 2003; Hamburg et al., 2007; Hamilton et al., 2007; Healy et al., 2011). The deleterious relationship between SB and the risk factors for CVD and type 2 diabetes are at least partially due to lower energy expenditure. According to Ford and colleagues (2005), positive calorie balance impacts each of the components associated with metabolic syndrome; obesity, blood pressure, triglycerides, glucose levels, and high density lipoproteins. Metabolic syndrome is predictive of both CVD and type 2 diabetes (Grundy et al., 2004).

Hu and colleagues (2003) found an increased risk for both CVD and type 2 diabetes based on SB that was independent of time spent in PA. The relative risk for obesity and type 2 diabetes doubles when more than 40 hours a week of TV are watched (Hu et al., 2003). Adjustments for exercise, diet, and BMI attenuated the results for diabetes but not obesity. For every 2 hours increase in TV viewing, the risk of obesity, and type 2 diabetes went up 23% and 14% (Hu et al., 2003). The ability to uptake glucose from the blood (glucose clearance) was the focus of another large population study in Australia (Williams et al., 2008). Television viewing time was significantly associated with both initial glucose levels and glucose levels two hours after ingesting sugar (oral challenge test) in women. In men, only the oral challenge was related to TV watching, providing evidence of gender differences in the disruption of metabolic system of gender differences with prolonged sitting (Williams et al., 2008).

An earlier study by Manson et al. (2002), considered sitting time in concert with walking and vigorous PA as predictors of cardiovascular incidents in women over a three year period. Total energy expenditure was inversely related to risk and appeared to be a dose-response. When leisure-time PA was controlled for, the relative CVD risk was 32% greater for those that reported sitting 16 hours a day compared to four hours. Significantly less sedentary time was related to CVD risk in a longitudinal study by Stamatakis and colleagues (2011). Using self-reported screen time (combination of TV, computer and video entertainment), the authors found the hazard ratio for CVD events was 2.30 for ≥ 4 hours a day as compared to < 2 hours a day. Moderate PA only improved the risk by .05 (Stamatakis et al., 2011).

In addition to low energy expenditure and weight gain, other mechanisms have been proposed as causal pathways including low levels of lipoprotein lipase, microvascular dysfunction and inflammatory responses.

Lipoprotein lipase. Inactivity results in physiological responses that are distinct from those found with PA. Lipoprotein lipase is a protein enzyme found in the lining of blood vessels that breaks up very low density lipoproteins (Mead, Irvine, & Ramji, 2002). Animal studies found that 24 hours of complete inactivity of deep postural leg muscles reduced lipoprotein lipase by 95% (Bey et al., 2003). Lipoprotein lipase is crucial for the removal of triglycerides from the blood stream. As a result of low enzyme activity, triglycerides and low density lipoprotein levels increase rapidly along with a decrease in high density lipoproteins (Bey & Hamilton, 2003). Zderic and Hamilton (2006) found that ambulating improved lipoprotein lipase levels significantly, establishing that light muscle contractions are important mediators of lipoprotein lipase. The postural muscles are not affected by more intense PA (Hamilton et al., 1998) and thus the loss of lipoprotein lipase is unique to the sedentary state. A human bed rest study confirmed that triglyceride and low density lipoprotein increase with inactivity (Hamburg et al., 2007). However, high density lipoproteins did not significantly reduce as hypothesized.

The role of muscle contraction is also critical to the increased risk for type 2 diabetes. Sedentary time is negatively associated with blood glucose levels (Dunstan et al., 2007; Healy et al., 2007a). The action of the muscles themselves provides the greater stimulus for glucose uptake. Glucose transporter type 4 proteins within the muscle cells travel to the membrane to facilitate diffusion of glucose from the blood into the muscle so that it can be converted into energy (McArdle, Katch, & Katch, 2007). More frequent muscle contractions, particularly from large muscles, regulate glucose levels. These contractions do not need to be vigorous or long lasting. Short breaks from sitting consisting of standing and easy walking are related to improved glucose clearance in adults (Healy et al., 2011b).

Microvascular dysfunction. Another possible mechanism for increased cardiovascular risks from SB is a change to the blood vessels or the functioning of the vessel. Hamburg and colleagues (2007) measured the diameters of brachial arteries and the velocity of blood flow in the arm in 20 volunteers before and after five days of bed rest. Within three days reductions in arterial diameter and resting blood flow were present. Systolic blood pressure rose along with glucose and total cholesterol. Participants were not required to lie completely still in bed and could sit and use hands while reading or watching TV. They were allowed up to 30 minutes of lifestyle PA a day, making the results more applicable to the problem of too much sitting (Hamburg et al., 2007). The findings point to a systematic response to increase arterial tone when the body is inactive. More research is needed to determine whether this response occurs within typical sitting times and the frequency of activity needed to prevent it.

Inflammatory response. The most recent mechanism put forward is that low-grade inflammatory responses are stimulated by SB and link it to increased cardiovascular risk. A longitudinal study by Stamatakis et al. (2011), considered baseline levels an inflammation biomarker, C-reactive protein in their analysis of cardiovascular events over a four-year period. An association between the inflammatory protein and four or more hours a day of screen time was found. A larger population-based study found that C-reactive protein increased linearly with quartiles of objectively measured sedentary time and was lowest amongst those that took the most breaks from sitting (Healy et al., 2011b). Hamburg et al. (2007) saw no change in C-reactive protein in the bed rest study. However, it is possible that sitting could produce different effects on systematic inflammation (Stamatakis et al., 2011).

Public Health Guidelines for Sedentary Behavior

There is no specific recommendation to limit sitting time in the United States. Australia public health agencies have endorsed a limit of four hours a week of television watching for children (DHA, 2009). Both the current ACSM/AHA Physical Activity Guidelines and DHHS Physical Activity Guidelines for Americans comment on SB, but only for older adults (age 65+). The DHHS (2008) cautions seniors to “avoid inactivity.” The ACSM/AHA refers to the need for older adults to reduce SB (Nelson et al., 2007). In the ACSM/AHA position statement it is clear that the 150 minutes of moderate PA a week should be on top of the activity required for normal daily and household tasks that last less than 10 minutes in duration (Haskell et al., 2007; Franklin et al., 2010). The DHHS (2008) calls these baseline activities and considers those that only engage in these to be inactive. A number of authors have suggested that there is enough research on health risks SB for it to be included in future national PA guidelines (Franklin et al., 2010; Hamilton et al., 2008; Owen et al., 2010a).

Light Physical Activity

The labels for intensity of PA; light, moderate and vigorous are designated by the energy required to perform the activity. The metabolic equivalent (MET) is a multiple of the energy expenditure at rest. As the intensity of PA increases so does the MET value. Light physical activities are movements judged as requiring 1.6-2.9 METS (Pate et al., 2008; Owen et al., 2010a). Moderately intense activities are 3-5.9 METS and vigorous equal 6 METS and greater (Ainsworth et al., 2000c; Pate et al., 2008). As mentioned previously, public health guidelines for PA are based on the evidence that sustained physical activities in the moderate to vigorous range provide protection against disease. However, the benefits of light PA and shorter intermittent bouts of PA may have been overlooked.

As compared to sedentary activities, which have a MET value of .8 (sleeping) to 1.5 (Ainsworth et al., 2000c), light physical activities nearly double the energy expenditure of sitting. Common light physical activities include walking to and from house or vehicle, dusting and light vacuuming or watering plants (all equal to 2.5 METS). These physical activities are generally of a short duration but occur multiple times a day. Examples of moderate physical activities include push mowing the lawn (4.5 METS), walking more briskly (3-5 METS) or mopping floors (3.5 METS) (Ainsworth et al., 2000c). Kozey and colleagues (2010) re-examined a subset of the activities listed in the compendium of physical activities (Ainsworth et al. 2000c) and report higher MET values for common activities of daily living. Physical activities such as climbing and descending stairs and straightening up a room may require more METS than previously thought. For example, ascending stairs was equal to 9.6 rather than 5 METS. While other household tasks like washing dishes and gardening were actually lower than the established MET value. Dishwashing averaged 1.9 METS instead of 2.3 (Kozey et al., 2010). While some significant discrepancies were found most did not change the intensity category of the activity.

Light PA is the inverse of SB (Healy et al., 2007a; Hamilton et al., 2008). Any PA that is not sitting or of a moderate intensity, is by definition light PA. This intensity of PA is typically difficult to recall and is often under-reported on PA questionnaires (Buman et al., 2010; Hagströmer et al., 2010b). The use of accelerometers has made the study of light PA more feasible and reliable. The frequency of accelerometer counts indicts the intensity of the PA. Higher counts mean more intense metabolically demanding activity (Hendelman, Miller, Baggett, Debold, & Freedson, 2000; Nichols, Morgan, Chabot, Sallis, & Calfas, 2000). SBs produce < 100 counts per minute. A common cut point for moderate to vigorous intensities is 2,020 counts or higher (Troiano et al., 2008; Hagströmer et al., 2010b). Leaving light PA in the range of 101-2,019 counts per minute. Using these standards and data from the 2003-04 NHANES, showed that the average daily volume of light PA varies by gender and age. Males aged 18-39, accumulated the most; 6.35 hours a day compared to 5.86 hours a day for females. Women maintain this level of activity through middle age, while the amount of light PA of men declines with each age group. By age 60, women have the highest average at 5.35 hours a day (versus 4.88) (Hagströmer, Ainsworth, Oja, & Sjöström, 2010a).

Displacement of Sedentary Behavior

In 2009, Mekary and colleagues offered a new model, called isotemporal substitution, as a way to consider the health effects of different activities. Because the total time an individual can allot to leisure or non-work activities is limited, the selection of one activity usually comes at the cost of another activity. In women that had lost more than 5% of their body weight, Mekary et al. (2009) found that when a SB (TV watching) was replaced with any level of PA weight regain over 6 years was significantly less likely. The ability to move up the movement continuum, replacing lower intensity activities with higher ones appears to be important to maintaining lost weight (Mekary et al., 2009) and may also be a useful model for understanding why reduced SB is associated with better health (Dunstan et al., 2010; Thorp et al., 2010; Stamatakis et al., 2011).

A recent follow-up of a walking intervention evaluated the intervention’s effect on SB. De Cocker and colleagues (2008) assessed a sub-set of participants to see what differences, if any, there were between intervention and control groups 12 months after the intervention. Though not intended, the step counting intervention had displaced some daily sitting. An average of 12 minutes of sitting was replaced in participants that reported increases in steps since baseline (De Cocker et al., 2008). Touvier et al. (2010) also identified some activity substitution in a sample of French seniors. PA and television viewing data were taken before and three years after retirement. Women who increased their walking duration reported decreasing the time they spent on television. Men on the other hand, increased both PA and TV watching (Touvier et al., 2010). However, increased PA does not always create reductions in SB. Lee and King (2003) found that older adults maintained their sedentary hobbies while adding bouts of moderate PA.

Benefits of Lifestyle Physical Activity

A prospective study of seniors found that replacing 30 minutes of sitting with light physical activities would improve physical health scores by almost half a standard deviation (Gilson et al., 2009). Buman and colleagues (2010) found that self-reported physical health and well-being was highest in seniors that performed more light physical activities. The relationship between seniors' perceptions of health and level of PA has been seen with moderately intense PA (Belza et al., 2006). PA that is incorporated into one's day is known as lifestyle PA. It has the advantage of fewer actual and perceived barriers than structured PA (Dunn et al., 1998; Silva et al., 2010).

Rather than meeting a prescription for mode, duration and intensity, lifestyle physical activities are naturally occurring. They include daily tasks such as household chores, child care, gardening and active transport as well as recreational and occupational PA (Ainsworth, Irwin, Addy, Whitt, & Stolarczyk, 1999; Murrock & Madigan, 2008). Lifestyle physical activities are a mix of light and moderate intensities (Blair et al., 1992; Gordon, Kohl, & Blair, 1993). Accumulating intermittent bouts of PA through the lifestyle method is an effective means of improving fitness (Macfarlane et al., 2006; Van Roie et al., 2010). Current public health guidelines for PA state that multiple 10 minute bouts of moderately intense activity is an appropriate way to obtain health benefits from PA (Haskell et al., 2007). However, few lifestyle tasks are done continuously for the prescribed duration.

Methods for increasing lifestyle physical activities such as active transport, chair exercise and household tasks have been considered (Macfarlane et al., 2006; Largo-Wight et al., 2008; Merom et al., 2008; Opdenacker et al., 2008; Lyerly, 2009; Opdenacker et al., 2009; Silva et al., 2010; Van Roie et al., 2010). Opdenacker and colleagues (2008) found active transport and total steps to be higher for home-based PA participants than participants in a structured gym-based program at a 1 year follow-up. Pedometer-based interventions have been effective at increasing daily steps (Bravata et al., 2007). Mediator analysis by Silva and colleagues (2010) found that lifestyle physical activities are motivated differently from structured physical activities. Women that completed a moderate and vigorous PA program had higher intrinsic motivation and satisfaction from perceived autonomy and competence than women that participated in a lifestyle PA program. Possibly the habitual nature of lifestyle PA requires less cognitive processing (Silva et al., 2010).

It is not clear how much light PA is optimal or how much sedentary time should be replaced to provide clinically relevant results. This should be a priority for future research (Brown, Bauman, & Owen, 2009).

Interventions to Reduce Sedentary Behavior

Only a few PA interventions have focused on reducing SBs, such as sitting time or screen time (Salmon et al., 2008; Dewa et al., 2009; Gilson et al., 2009; Otten et al., 2009; De Greef et al., 2011; Gardiner et al., 2011b). The results are promising but not overwhelming. Three basic weaknesses have limited the findings. First, not assessing both PA and sitting objectively produces an inconsistent relationship between SBs and light PA. The combination of objectively measured PA with self-reported sitting time has produced only a weak association between the two variables (Dewa et al., 2009; Gilson et al., 2009). Questionnaires are not sensitive enough to note small changes in behavior such as standing instead of sitting. Second, researchers have not considered a psychological mechanism for behavior change. The interventions have been largely information based and have not reported SE, stage of change or attitudes towards the new behavior. More careful study of a mechanism for reducing sitting behavior is needed. Third, only one author has examined changes to a biomarker for cardiometabolic disease. Salmon and colleagues (2008) reported weight as a dependent measure. However, weight may not be as directly impacted by light PA and sitting time as other variables such as waist circumference (Slentz et al., 2004) or circulating glucose (Healy et al., 2008a).

The workplace has been a target for reduced sitting interventions due to the high volume of work done at desks. Dewa et al. (2009) found that simply providing workers with pedometers to track their daily steps improved self-reported sitting time over a four-week period. Average sitting time fell 22% in this pilot study. However, a lack of objectively-measured PA prevented the researchers from seeing increases in PA. Rather than record weekly pedometer steps, participants were administered the International Physical Activity Questionnaire. This instrument is not sensitive to very short bouts of light PA (Hagströmer et al., 2010a), which are likely to replace sitting. Use of accelerometers would address this weakness and help to better demonstrate the relationship between lightPA and SB. An additional outcome measure, mental health status, was examined here. Scores on the Short-form 12 Health Survey significantly improved in those that participated as compared to those that declined the pedometer (Dewa et al., 2009).

A larger workplace study examined the differences between an intervention designed to increase steps through route-based continuous walking and an intervention targeting higher step counts through intermittent task-based walking (Gilson et al., 2009). University workers from three countries were randomly assigned to control or one of two types of interventions. Both intervention groups were given the 10,000 steps a day target. The route-based group was given information for on-site walking routes (maps, time required and average steps). The task-based group instead was encouraged to lengthen the distance they normally walked for routine tasks (parking lot, water break) and to replace some sedentary tasks with walking (walk to colleague rather than email). Standard weekly emails were sent as reminders to participants of the program goals. At the end of 10 weeks, both groups showed significant increases in pedometer steps as compared with a control group. Only a trend for reduced sitting time was found in the task-based group. The sitting time measure was a single item asking how many hours had they sat while at work that day. Better measures of both PA and sitting time would strengthen this study. The effectiveness, again, was highest immediately following the intervention. Week one walking and sitting time showed the greatest percentage of change. In particular, the task-based group had a 21% decrease in reported sitting (Gilson et al., 2009). Possibly tailored messages or positive feedback on performance would extend the initial effect. Again, SE or other psychological variables were not measured.

Two recent studies showed improved quality by using objective measures and targeting at risk groups. Gardiner and colleagues (2011b) tested an intervention that aimed to increase breaks from sitting in older adults. Accelerometer-determined sedentary time, number of breaks from sitting and PA all increased significantly. Total sedentary time was reduced by 3.2%, and increases in PA of all intensities were found even though PA was not addressed by the intervention. A pedometer-based intervention conducted by De Greef et al. (2011) found significant improvements in steps, light PA and SB in participants with type 2 diabetes. The significant gains were still present at 1 year post intervention.

Measurement of Physical Activity and Sedentary Behavior

There are a number of variables of interest within the activity-inactivity spectrum including duration, frequency, energy expenditure and change over time for each behavior. Tools to quantify these behaviors range from questionnaires to technical laboratory procedures. The subjective methods; self-reported surveys, logs, and indexes, are limited by recall bias and social desirability (Prince et al., 2008), but are inexpensive and feasible with large populations (Westerterp, 2009). The commonly reported objective measures; doubly labeled water, indirect calorimetry and cardiorespiratory fitness, remove participant bias but are burdensome and time intensive for participants and researchers (Westerterp, 2009).

In terms of validity, doubly labeled water is considered the gold standard for total energy expenditure (Westerterp, 2009). However, it does not provide information about the frequency, duration or type of PA completed. Techniques that measure oxygen consumption (indirect calorimetry and VO_2 testing) provide accurate data on intensity and level of cardiovascular fitness, a surrogate measure of volume of PA. Self-report instruments can gather information on duration, frequency, type of activity and intensity, but accuracy is their highly variable (Prince et al., 2008).

The use of activity monitors, particularly the accelerometer, offers a middle ground between the subjective and objective extremes. It provides objective data on duration, frequency, intensity and activity patterns without being intrusive (Westerterp, 2009). Quality data from accelerometers and pedometers still depends on compliant participants. The current generation of accelerometers is considerably more accurate and user friendly than prior models.

Accelerometer Assessed Physical Activity

An accelerometer is a small device, roughly the size of matchbox that can measure acceleration of the body in one direction (uniaxial) or three planes or movement (triaxial). The technology was developed in the 1970's (Morris, 1973) and was applied to human PA research shortly after (Wong, Webster, Montoye, & Washburn, 1981; Montoye et al., 1983). Accelerometers take advantage of the piezoelectric properties of matter. An electrical charge is generated by mechanical tension or compression of a sensor as the device accelerates or decelerates (Chen & Bassett, 2005). These directional pulses are converted to an all positive format called the raw counts. An internal algorithm then selects the maximum count, the sum or average of the raw counts for a specific time internal. The output displays the count for the time interval or epoch. The most commonly used epoch is one minute (Chen & Bassett, 2005; Trost, McIver, & Pate, 2005). Figure 5 is an example of the PA counts produced by an accelerometer.

Figure 5. Raw Accelerometer Counts

Accelerometers are most frequently attached to a belt so that they are waist-level and positioned over one hip for PA research, though they can be worn at the wrist

(Bassett et al., 2000) or lower back (Yngve, Nilsson, Sjostrom, & Ekelund, 2003). There are many advantages to using accelerometers to quantify PA including the ability to collect duration, frequency and intensity data in free-living situations over days to weeks so that patterns of PA can be assessed (Nichols et al., 2000). The size and weight are unobtrusive to participants and the units do not register an output that participants can see as with many pedometers. The biggest advantage of accelerometers is that provides an objective alternative to self-report measures (Matthews, 2005). However, the method is not without limitations. These include the inability to recognize body motion at sites other than the device (Bouten, Westerterp, Verduin, & Janssen, 1994; Chen & Bassett, 2005). For example, if placed on the hip, then arm movements while sitting are ignored. And, classifications for light, moderate and vigorous intensities are derived from laboratory tests (Freedson, Melanson, & Sirard, 1998) and field tests (Hendelman et al., 2000) that assume a linear correlation between energy expenditure and accelerometer output (Chen & Bassett, 2005; Troiano, 2006). Complex movements that combine arm and leg actions are a poor match for the linear models (Matthews, 2005; Kozey et al., 2010) and as a result most lifestyle physical activities are underestimated by accelerometers (Bassett et al., 2000). The detection of slow-paced walking and walking on soft surfaces is poor due to lower forces (Karantonis, Narayanan, Mathie, Lovell, & Celler, 2006). The last limitation is that accelerometers cannot be used with water-based activities (swimming, water aerobics) and its ability to detect cycling is still under investigation (Bonomi, Plasqui, Goris, & Westerterp, 2009).

A great deal of research has been conducted to establish this instrument's validity, especially the ability of activity count cut-points to differentiate between intensities of PA (Troiano, 2006). Initial calibration testing of accelerometers found a linear relationship between activity counts and the relative intensity and energy expenditure of walking or running on a treadmill. A linear regression equation was calculated and applied to the activity counts to create cut-points that mark the absolute intensity in METS (Freedson et al., 1998). For example, 3 METS, or moderate PA is classified as 1,952-5,724 counts per minute by Freedson et al. (1998). Over 30 different prediction equations have been published so far (Crouter, Churilla, & Bassett, 2006a; Kozey et al., 2010). Differences in the type of activity (Nichols et al., 2000; Welk, Blair, Wood, Jones, & Thompson, 2000; Kozey et al., 2010), terrain (Hendelman et al., 2000; Yngve et al., 2003), grade (Melanson & Freedson, 1995; Sirard, Melanson, Li, & Freedson, 2000), age of participants (Yamada et al., 2009; Miller, Strath, Swartz, & Cashin, 2010) and the location of the accelerometer (Bouten, Sauren, Verduin, & Janssen, 1997; Yngve et al., 2003) impact the accelerometer counts and the recorded activity intensity.

While most researchers concluded that the technology is a valid method for assessing PA, there are limits to its ability to compute energy expenditure. In general, light physical activities like casual walking are overestimated while moderate lifestyle physical activities such as housework are underestimated (Bassett et al., 2000;

Matthews, 2005; Crouter, Clowers, & Bassett, 2006b; Troiano, 2006). The following section is a brief review of the validity testing of accelerometers.

Convergent validity. The accelerometer's ability to estimate energy expenditure has been compared to indirect calorimetry, doubly labeled water and self-report measures. The vast majority of the calibration and validation research has been conducted using indirect calorimetry methods as the criterion measure. This method allows for simultaneous measurement of METS and accelerometry counts. Though differences in type/brand of accelerometer have been studied (Bassett et al., 2000; Welk et al., 2000), the main focus of this research has been on specific regression equation's ability to predict METS. The best correlations to energy expenditure are found when the physical activities more closely resemble the laboratory calibration activities; walking and running on a treadmill. Welk et al. (2000) found the uniaxial Freedson cut-points to be effective (R^2=.58-72) at estimating energy expenditure for three treadmill speeds. Though triaxial accelerometer cut-points from Nichols et al. (1999) were better correlated (r=.91-93). Others have noted significant differences in the prediction quality for track, field or inclined activities (Hendelman et al., 2000; Nichols et al., 2000).

The energy gap between the measured METS and accelerometer derived METS for lifestyle physical activities reflects the fact that arm movements and leg force against gravity cannot be measured by waist-worn accelerometers (Matthews, 2005). As a result, lower correlations are reported when lifestyle physical activities are examined.

Strath, Bassett, and Swartz (2003) compared the accuracy of 5 regression derived cut-points on accelerometer and oxygen consumption data collected during 6 hours of daily activities that included all intensities of PA. The shared variance between the objective measure and the cut-points ranged from R^2=.03-.55 (Strath et al., 2003). The highest correlations among all models were for light and vigorous intensities. Only the Hendelman et al. (2000) cut-points were consistent across light, moderate and vigorous categories, R^2=.33, .29, .38. More recently, a study of the Freedson, Hendelman and Swartz cut points to participant heart rates found misclassifications for all intensities (Ham, Reis, Strath, Dubose, & Ainsworth, 2007). Over a third of minutes spent in moderate PA according to heart rate (45-59% of heart rate reserve) were classified as light by the accelerometer cut-points. When the accelerometer cut-points were the criterion for moderate intensity, most of the heart rates were below 45% of heart rate reserve, indicating light PA (Ham et al., 2007).

Such results lead investigators to conclude that no single linear regression equation can accurately estimate all ranges of PA (Chen & Bassett, 2005; Matthews, 2005). Testing of systems to apply a different equation to different physical activities did improve the estimates of energy expenditure for all intensities (Crouter et al., 2006b; Bonomi et al., 2009). Table 1 provides a list of commonly used cut-points for the Actigraph accelerometer. The selection of cut-points is guided by the type of PA being observed and the comparability of that model to other studies (Trost et al., 2005).

Table 1

Selected Validated Cut-points

Reference	Light		Moderate	Vigorous	Sedentary	Activity Source Walk/run	Lifestyle
Freedson et al. (1998)	<1951		1952-5724	>5725		●	
Nichols et al. (2000)[1]	1577-3284		3285-5676	>5677	<1576		●
Hendelman et al. (2000)	≤191		192-7526	≤7527			●
Hendelman et al. (2000)	≤2191		2192-6893	≥6894		●	
Swartz et al. (2000)	≤573		574-4944	≥4945			●
Troiano et al. (2008)[2]			2020-5998	5999		●	
Matthews et al. (2005, 2008)			>760[3]		<100		●
Copeland et al. (2009)[4]	100-1040	1041-1951	≥1952			●	
Actigraph Users Manual[5]	101-759	760-1952	1953-5724	>5725	0-100		

[1] based on 2-3.99 METS light, 4-6.9 METS moderate, ≥7 METS vigorous
[2] used for 2003-04 NHANES study
[3] established a moderate intensity to capture daily physical activities that were being underestimated
[4] of low-light and high-light and combine moderate and vigorous as one category for older adults
[5] Uses a combination of Matthews and Freedson cut-points to distinguish light PA, 101-759 counts per minute from *lifestyle* PA is 760-1952, p.63

Doubly labeled water. Validity studies of accelerometers to doubly labeled water report significant correlations, ranging from r=.45-.83 (Bouten, Verboeket-van de Venne, Westerterp, Verduin, & Janssen, 1996; Ekelund et al., 2001; Leenders, Sherman, Nagaraja, & Kien, 2001; Yamada et al., 2009). A literature review of eight devices by Plasqui and Westerterp (2007) found that validity ranged from poor to good. The Actigraph model was the only commercially available accelerometer that had proven validity for energy expenditure (Plasqui & Westerterp, 2007). Differences between uniaxial and triaxial devices are most apparent when compared to doubly labeled water.

Also, improvements to accelerometers in the last few years have increased correlation coefficients. Early work by Bouten and colleagues (1996) found a correlation of r=.73 after correcting for vibrations caused by vehicle transportation using a triaxial accelerometer. Energy expenditure was underestimated by 37%. Leenders et al. (2001) saw greater error in uniaxial versus triaxial devices. The correlation between the uniaxial Actigraph was r=.45, while the Tritrac was r=.54. More recently, Yamada and colleagues (2010) found that new accelerometers (Kenz EX and Actimarker EW4800) had higher coefficients. The uniaxial Kenz EX correlates well to doubly labeled water (r=.70) and the triaxial Actimarker even better at r=.84. These improvements reflect more precise prediction equations, filters and sensors. Currently, these units are not widely available outside of Japan (Matsumura, Yamatmoto, & Kitado, 2008).

Single versus multiple axis. While the triaxial accelerometers theoretically would be more accurate, studies comparing the two found that the additional planes provide only minimal benefit (Matthews, 2005). The majority of activity counts are produced in the vertical direction (Bouten et al., 1994). The correlations between the two devices using indirect calorimetry are good, ranging from .84-.90 (Welk et al., 2000; Trost et al., 2005) for walking and running. Yamada et al. (2009) found even better agreement using doubly labeled water (r=.94). Leenders, Sherman, and Nagaraia (2000) saw that activity counts between a uniaxial and a triaxial accelerometer were highly correlated (r = .91). Agreement for the number and duration of bouts is also high (Mâsse, Fulton, Watson, &

Heesch, 1999). Concern over which is a more valid measure has diminished as the widely used Actigraph has upgraded to a triaxial device (John, Sasaki, & Freedson, 2010).

Compared to self-report. Studies validating accelerometer output to self-reported PA have a wide range of results based on the type of reporting measure. Leenders and colleagues (2000) used the METS calculated from a seven day recall as the criterion for energy expenditure and then compared it to the predicted PA expenditure from two accelerometers. There was a high level of agreement as the coefficient for both accelerometers, one uniaxial, one triaxial, was r=.90. Napolitano and colleagues (2010) suggested more modest agreement. Interviewer-administered recalls had small to moderate correlations with minutes in moderate and vigorous PA over three time points (r = .28-.48). This range captures most previously published comparisons between self-report and accelerometry (Ainsworth et al., 2000b; Timperio et al., 2003). Generally, higher correlations occur with vigorous PA. The intensity bias of specific regression equations and in the PA recall explains this result (Ainsworth et al., 2000b). Recently, Hart, Ainsworth, and Tudor-Locke et al. (2011) found differences between two uniaxial accelerometers when compared to the Bouchard Activity Record for walking. The Actigraph identified 58.9% of the type spent walking compared to 79.1% of the activPAL. Most likely the reason for this is that the method for quantifying counts in the activPAL closely matches the instructions for the Bouchard Activity Record. In a 15-minute period, the activity of the longest duration is recorded.

Reliability. Less attention has been given to inter-instrument reliability. Overall, the results with the same unit are highly reproducible (Ward, Evenson, Vaughn, Rodgers, & Troiano, 2005). Reported intra-instrument variability ranges from 8-20% (Welk, Schaben, & Morrow, 2004). Welk et al. (2004) tested two uniaxial and two triaxial accelerometers. The activity counts for any single bout of activity varied by 16 to 31%. The uniaxial Actigraph had the largest intra-class correlation at .80 followed by the triaxial Tritrac at .73. The other two units were significantly lower at .68 and .62. Welk et al. (2004) concluded that variations among participants (size, clothing, posture) create slight location shifts to accelerometer and were the greatest source of variability. The effect of body location has also been considered. Nichols, Morgan, Sarkin, Sallis, and Calfas (1999) compared the reliability coefficients at each hip during treadmill walking and running. The intra-class coefficient for the right was better than the left (.87 to .73). McClain, Craig, Sisson, and Tudor-Locke (2007) tested the Kenz Lifecorder EX for steps and time in moderate and vigorous PA. This model provided non-significant differences between hips and had high reliability (ICC=.95-.99) for each output. Recently, Cook and Lambert (2009) found no differences from right to left hip for the Actigraph accelerometer on activity counts, bouts or time in moderate and vigorous PA. This unit also displayed high intra-class coefficients (ICC=.93-.95).

Studies that evaluated the location of the accelerometer on the body found that other sites are acceptable but that the anterior hip is the most feasible (Bouten et al., 1997; Bassett et al., 2000; Yngve et al., 2003). Specific placements on the hip have been considered as well. The mid-axillary line produces significantly higher activity counts than anterior axillary placement (Welk et al., 2000). Most manufacturers suggest the anterior axillary line of the right hip (Ward et al., 2005). The number of days that accelerometer data are collected can impact the reliability. In 2002, Matthews, Ainsworth, Thompson, and Bassett reported that three to four days of monitoring are needed to achieve 80% reliability in identifying PA intensities and seven days are needed to increase reliability to 90%. Epoch length should also be considered and standardized. The widely used one-minute interval captures fewer bouts and underestimates the intensity of short bursts of PA, like those seen in children (Trost et al., 2005).

Self-reported Physical Activity

Nearly all epidemiological studies of PA use self-reported data. The advantages of using survey measures for large populations are clear. In addition to cost, surveys do not change behavior and collect a full range of PA data; frequency, duration, intensity and mode (Sallis & Saelens, 2000). However, differences among the instruments have created a blurry picture of Americans' PA. For example, the 2003 BRFSS found that 47% of the population met the current PA guidelines (CDC, 2010), but, the National Health Interview Survey (NHIS) reported the prevalence to be 33% for the same time period (Ham & Ainsworth, 2010). Those numbers seem even more disparate when compared to the National Health and Nutrition Examination Study (NHANES) for 2003-2004, which measured PA with accelerometers and found that only 19% of Americans were meeting the recommendations (Ham & Ainsworth, 2010). Obviously, the variability of these measures presents a problem for Kinesiologists. The following is brief overview of the limitations and psychometrics of self-report PA measures.

There are numerous questionnaires, logs, scales and indexes that assess PA. Sallis and Saelens (2000) cite validity correlations between .14-.53. Often instruments are adapted from existing measures creating multiple versions (van Poppel, Chinapaw, Mokkink, van Mechelen, & Terwee, 2010). Despite reports of low validity and reliability (Prince et al., 2008; Westerterp, 2009; van Poppel et al., 2010), there are methodically sound self-report instruments. Considering both construct validity and reliability, van Poppel et al. (2010) found seven measures that qualified as good. The four most widely used are the Kaiser Physical Activity Survey (Ainsworth, Sternfeld, Richardson, & Jackson, 2000a), the International Physical Activity Questionnaire (IPAQ, long US version) (Craig et al., 2003), the 1-week recall questionnaire (Timperio et al., 2003) and the Godin Leisure-time Physical Activity Questionnaire (Godin & Shephard, 1997).

Limitations. Errors in self-reported PA center on three opportunities for participant bias. The first is that recall of physical activities which are planned or effortful is more likely than those that are habitual and less intense (Yore et al., 2007). As a result, assessment of all daily PA is less accurate than that of specific modes of activity, such as sports or conditioning activities (Prince et al., 2008). Light PA is typically overlooked or underreported (Yore et al., 2007; Besson, Brage, Jakes, Ekelund, & Wareham, 2010). Next, participants' overestimate the intensity or duration of the PA and inflate results (Timperio et al., 2003). Authors report that errors in activity intensity cause an over reporting of the next higher category (Troiano et al., 2008; Besson et al., 2010) . This may be especially true of overweight participants, whose perceptions of effort may differ from the validation population (Timperio et al., 2003). The last bias is social desirability, where recall is exaggerated to please the researcher (Warnecke et al., 1997). The extent of this type of bias is difficult to calculate or control (Sallis & Saelens, 2000).

Objective comparisons. Accelerometers are a commonly used criterion in self-report validation studies (Timperio et al., 2003; Besson et al., 2010; Hagströmer et al., 2010a; Hart et al., 2011). As previously mentioned, such comparisons often find large discrepancies between the subjective and objective reports (Troiano et al., 2008; Ham & Ainsworth, 2010). This is not entirely the fault of the self-report instrument. Ham and colleagues (2007) took simultaneous measures of heart rate and accelerometer counts and found both underestimation and overestimation by the accelerometer when percentage of heart rate reserve was the intensity criterion. As Prince et al. (2008) stated, recall is generally limited to activities that last approximately 10 minutes or longer. While, the accelerometer can collect PA data in time intervals as short as 1-60 seconds (Chen & Bassett, 2005). Comparisons between accelerometer data and the Bouchard Activity Record show that when the epoch and summation parameters match the subjective measure agreement is high (Hart et al., 2011). Accelerometer prediction equations that classify intensity share a bias with self-report measures. They underestimate lifestyle physical activities (Bassett et al., 2000). Generally, participant recall of light or routine physical activities is low or is misclassified, so that the range between sedentary and vigorous PA is the least well documented (Jacobs, Ainsworth, Hartman, & Leon, 1993; Trost et al., 2005; Hagströmer et al., 2010a). The truth is somewhere between the self-reported estimates and the objective calculations. Both methods are reliable markers of change in PA (Timperio et al., 2003; Napolitano et al., 2010; Gardiner et al., 2011a).

Self-report measures will always be a challenge for PA researchers and practitioners. There are some suggestions to maximize the validity and reliability (Sallis & Saelens, 2000). Shorter recall periods, such as one week rather than one month or one year improve participant recall and remove seasonal variations from the estimate. Combining both subjective and objective measures provides more information than either method individually (Timperio et al., 2003; Napolitano et al., 2010). Sallis and Saelens (2000) caution against developing new questionnaires and favor the use of established measures so that results are most generalizable.

Godin leisure-time physical activity questionnaire. The Godin measure is a 4-item instrument that asks participants about the frequency and duration of their PA over a 7-day period (Godin & Shephard, 1985). See Appendix B for copy of the questionnaire. Participants indicate the number of bouts of activity (at least 15 minutes) they had at each of three intensities (mild, moderate, and strenuous). A list of intensity specific activities follows each term. The number of reported bouts for each category is multiplied by 3, 5, or 9 METS. The sum of all the categories is the estimated weekly PA

METS. Some authors have reduced the MET values making moderate 4 METS and strenuous 7.5 (Plotnikoff et al., 2007). The last item of the survey asks how often in a 7-day period does the participant sweat during PA (often, sometimes, rarely, never). This question gauges the frequency of leisure-time PA, though many recent studies have not used this item because it is specific to exercise and not PA (Plotnikoff et al., 2007; Rhodes et al., 2008; Godin, Amireault, Belanger-Gravel, Vohl, & Perusse, 2009). The Godin can determine sufficient and insufficient levels of PA (Jacobs et al., 1993; García Bengoechea, Spence, & McGannon, 2005).

There is well established validity and reliability for the Godin (Godin & Shephard, 1997; van Poppel et al., 2010). Significant correlations between cardiovascular fitness and accelerometry were found. Initial validation by Godin and Shephard (1985), saw correlations ranging from .04 for the light subtotal to .38 for the strenuous subtotal, with an overall R=.24 with VO_2max. Jacobs and colleagues (1993) found higher agreement for total METS at .56. Accelerometer studies have correlation coefficients ranging from .32-.45 (Jacobs et al., 1993; Miller, Freedson, & Kline, 1994). The reported reliability for the full questionnaire is r=.74 (Godin & Shephard, 1985), with correlations as high as .84 for strenuous PA (Jacobs et al., 1993).

Limitations of this instrument are similar to all self-report measures. It has greater validity and reliability for high intensity PA and is subject to participants' misunderstanding of the mild, moderate and strenuous labels. While it was originally designed to capture exercise behavior, the survey can assess a wider range of PA than planned exercise. Strengths of the Godin are the simple scoring method and its concise format.

Measurement of Sedentary Behavior

Similar to the study of PA, the measurement of SB originated with self-report and advanced to the use of accelerometers. Because the negative health effects of sitting are relative to volume and number of breaks (Healy et al., 2008a; Healy et al., 2011b), the focus of researchers has been on identifying behavior to develop dose-response relationships (Oliver, Schofield, Badland, & Shepherd, 2010). Unlike PA, there is little need for exact data on energy expenditure. More important are the distinctions between sitting, standing and light PA. Recent improvements in accelerometry have enhanced its utility in this regard. The limitations of subjective PA measures also apply to questionnaires regarding SB (Sallis & Saelens, 2000). Additionally, the self-report measures are not sensitive to short bouts of either sitting, standing or light PA (Oliver et al., 2010). Though, some habitual SBs, such as TV viewing, have better recall than lifestyle PA (Marshall et al., 2010).

Accelerometers

The appropriate cut points for SB are much less debated than those for PA. The most commonly used count is less than 100 per minute (Matthews et al., 2008; Hagströmer et al., 2010b). This threshold was initially taken from observational data on female adolescents activity patterns (Treuth et al., 2004). SB actually created counts less than 50, but Matthews and colleagues (2008) saw that sitting in moving vehicles increased the counts to almost 100 per minute. In order to collect all possible SB, Matthews et al. set the criteria as ≤100 counts per minute. When compared to self-report measures, the cut point has fair but significant correlations for sitting time (R^2=.26) and strong agreement (65-81%) to observed sitting (Hagströmer et al., 2010a; Hart et al., 2011). Oliver et al. (2010) investigated cut points for a shorter epoch of 15 seconds. Counts between 0-25 had higher specificity and less error than counts of ≤50 or ≤100. However, no direct comparison between ≤100 per minute and ≤25 per 15 seconds was made. If any true differences exist it is a reflection of the epoch and not the threshold, as ≤ 25 times 4 (intervals of 15 seconds per min) is ≤100.

While the accelerometer has established validity and reliability for SB (Hart et al., 2011), determining the difference between sitting and standing was a serious limitation to sedentary research (Oliver et al., 2010). Standing still produces as few activity counts as does sitting but weight bearing requires deep muscle contractions so that the cardiometabolic risks are lessened (Hamilton et al., 2008). Inclinometers are devices that provide information on posture and body position relative to gravity (Tanaka, Yamakoshi, & Rolfe, 1994). Several researchers have collected accelerometer and inclinometer data simultaneously (Levine et al., 2005; Grant, Ryan, Tigbe, & Granat, 2006; McCrady & Levine, 2009; Oliver et al., 2010) and were successful at distinguishing between sitting, standing and locomotion. The use of multiple devices was burdensome on both the participant and the researcher (Murphy, 2009). Mathie, Celler, Lovell, and Coster (2004) developed a single unit with combined functions that was worn at the waist. This device has shown exceptional accuracy (97-100%) in discerning sitting and standing transitions (Karantonis et al., 2006). The latest generation of commercial accelerometers (Actigraph GT3X and activPAL) has an embedded inclinometer. Validation studies have found the activPAL to be more accurate for standing than the Actigraph, but free-living sitting was above 97% for both instruments (McMahon, Brychta, & Chen, 2010; Hart et al., 2011; Taraldsen et al., 2011). Significant differences may be related to location of the monitor. When the Actigraph was positioned on the back detection of standing improved but detection of sitting worsened (McMahon et al., 2010). The activPAL is attached to the anterior thigh and use of multiple sensors (both legs and torso) improved its accuracy (Taraldsen et al., 2011).

Self-report

Surveys of SB began with studies of obesity and television watching in youth in the 1990's (Robinson & Killen, 1999). Television provides a salient medium for self-reported SB and is the most studied aspect of sedentary time (Clark et al., 2009). American televisions are on over 5 hours a day (Nielsen, 2011). In addition to television viewing, surveys ask about time spent at a computer, reading, doing arts or crafts, riding in a vehicle or talking on the phone (Rosenberg et al., 2010). Brief composite items for sitting have been added to population-wide surveys of health behaviors (Pettee et al., 2009). Particular challenges in measuring SB subjectively are how to count multiple activities that may occur simultaneously while sitting (multitasking), whether to use a multi-item survey versus a single question and which type of recall is most reliable;

typical or actual behavior. Also, no instrument has measured breaks from sitting (Oliver et al., 2010).

Reviews by Bryant et al. (2006) and Clark et al. (2009) found that few measures of SB had established validity. Validation of questionnaires for sitting time is limited because criterion measures like accelerometry, heart rate monitoring or doubly labeled water, cannot discriminate between types of SB (occupation versus leisure, TV versus reading). Video observation is the only method for absolute convergent validity (Clark et al., 2009). Some authors have used a combination of accelerometers or fitness testing and activity logs to establish the validity of instruments (Pettee et al., 2009; Marshall et al., 2010; Rosenberg et al., 2010). Agreement to accelerometer counts tends to be low to moderate (Rosenberg, Bull, Marshall, Sallis, & Bauman, 2008; Marshall et al., 2010; Gardiner et al., 2011a).

Self-report instruments for SB may include a number of sitting behaviors that are domain specific (Salmon et al., 2003), may only ask one or two questions about total sitting time (Rosenberg et al., 2008) or ask about one particular behavior (Pettee et al., 2009). The advantage to short measures is that they can be added to PA surveys such as with the IPAQ or to health surveillance surveys like the BRFSS. While inventories of sitting behaviors provide more specific information on type of sedentary behavior, it is possible for participants to double count activities that they do jointly (Rosenberg et al., 2010).

The reliability of television and computer use recall is the highest (Clark et al., 2009) and a single question on television watching has been found to be a valid indictor of health risk (Pettee et al., 2009). Reliability coefficients for television time range from .72-.92. While the range for other sitting behaviors is .23-.76 (Salmon et al., 2003). Clark et al. (2009) found little differences in the use of typical versus actual behavior, though recall separated as weekday or weekend typically had slightly better results than actual. There were higher reliabilities for weekday activities than weekend ones (Clark et al., 2009; Marshall et al., 2010). Some demographic differences have been found. Reports of lower reliability for African-Americans and women have been published (Evenson & McGinn, 2005; Rosenberg et al., 2008; Rosenberg et al., 2010). As compared to self-report PA measures, the reliability of television viewing is better than that of light or moderate PA measured by the Godin, IPAQ and 7-day recall questionnaire (Marshall et al., 2010; van Poppel et al., 2010).

There are five sedentary behavior surveys commonly used in PA literature. They are the IPAQ long, IPAQ short, BRFSS, the Sedentary Behavior Questionnaire [SBQ] (Rosenberg et al., 2010) , and the sitting inventory by Salmon and colleagues (2003). Each have reliabilities r >.80 or ICC >.50. The IPAQ, BRFSS and SBQ were validated using objective criterion. The Salmon survey validation was with activity log. The reliability and validity data for each are displayed in Table 2.

Table 2

Psychometrics of Common Sedentary Behavior Measures

	Reliability	Validity	Source
IPAQ long	Total r= .81 Men r=.83 Women r=.77	P = .31*	Rosenberg et al., 2008
IPAQ short	Total r= .81 Men r= .84 Women r= .77	P = .34*	Rosenberg et al., 2008
BRFSS	1 wk ICC =.55 3 wk ICC= .42	P = -.25, -.35#	Pettee et al., 2009
SBQ	Weekday ICC=.85 Weekend ICC = .77	Men r =-.01* r = .31^ Women r = .10* R = .28^	Rosenberg et al., 2010
Salmon	ICC= .79 Seniors ICC=.52	P = .40& P = .30	Salmon et al., 2003 Gardiner et al., 2010

* Validated against accelerometer sedentary time
\# Validated against accelerometer moderate and vigorous PA time
^ Validated to IPAQ
& Validated to activity log

Measurement of Self-efficacy

The self-efficacy construct is measured by survey methods. There are a number of established instruments, such as the Self-Efficacy for Exercise (Resnick, Jenkins, Resnick, & Jenkins, 2000) or the confidence scales from Courneya and McAuley (1994). Nearly all measures were developed according to the guidelines put forth by Bandura (1997) and by McAuley and Mihalko (1998). However, the specific type of SE measured by each differs.

McAuley and Mihalko (1998) reviewed the current assessment practices for SE related to exercise and determined that there were two main types of measures being used. The first were task efficacy scales. These asked participants to rate their confidence for specific behaviors on a scale from 10%-100%. The average of multiple scales for the same behavior was suggested by Bandura (1997) to be a composite of one's SE cognitions. The scales should be arranged in a hierarchical fashion beginning with the easiest task and increasing in difficulty. According to McAuley and Mihalko (1998) this format best addresses the level and strength dimensions of SE. For example, the question "how certain are you that you can walk for 10 minutes without stopping" would be followed by a series of questions that increase the time component up to a set target (McAuley & Mihalko, 1998, p. 390).

The second major type measurements target one's SE to overcome obstacles to the behavior and are known as barrier efficacy scales (McAuley & Mihalko, 1998). These are widely used in PA interventions and health promotion initiatives (Marcus & Forsyth, 2009). They measure what Bandura (1997) refers to as self-regulatory efficacy. Rodgers, Hall, Blanchard, McAuley, and Munroe (2002) have reported that this type of SE is more directly related to exercise behavior than task efficacy. An example of barrier efficacy questions would be "how confident are you that you could do your PA if the weather was bad?" As with the task efficacy scales there are multiple questions that increase in challenge and the average of the scales represents one's SE for that behavior.

McAuley and Milhalko (1998) reported a low range of validity for SE measures (R^2 = .04-.26). Construct validity is largely inferred with these instruments, such that if the behavior increases and the SE score is appropriately correlated, then the measure is valid. Test-retest reliability of individual scales is normally moderate to high. The Self-efficacy for Exercise scale has a Cronbach alpha of .90 (Resnick, Luisi, Vogel, & Junaleepa, 2004) and the Exercise Self-Efficacy Scale by Marcus and colleagues has been reported range of .76-.90 (Marcus & Simkin, 1994; Annesi & Whitaker, 2010a). McAuley and Milhalko (1998) advise against the use of single item scales for reliable SE data as they are too general to capture the specific levels of the behavior.

Anthropometric Measurements

Measures of body size and distribution of body fat are widely used indicators of cardiometabolic risk (Farin, Abbasi, & Reaven, 2006; Racette, Evans, Weiss, Hagberg, & Holloszy, 2006). Body mass index is a ratio between body weight and height [weight in kilograms/(height in meters)^2]. This measure better correlates to overall fat mass than do height weight charts (Brown, Miller, & Eason, 2006). The limitation of this measurement is that it does not distinguish between lean and fat mass, so misidentification of obese and non-obese is high (Burkhauser & Cawley, 2008). Waist circumference is a more direct measure of deep visceral fat. Fat deposits near vital organs such as the liver and pancreas are more strongly related to risk factors for cardiovascular disease and metabolic disorders in adults (Angleman, Harris, & Melzer, 2006; Racette et al., 2006). Changes in waist circumference are useful predictors of increased or reduced health risk (Grundy, 2004). The delineation point for increased risk is 88 centimeters for women and 103 centimeters for men (WHO, 2008).

A recent study found that the combination of BMI and waist circumference measures provided similar accuracy in predicting metabolic syndrome as dual-energy x-ray absorptiometry (Sun et al., 2010). There are variations in measurement site reported in the literature (Ross et al., 2008). The World Health Organization standard is to locate the midpoint between the last palpable rib and the top of the iliac crest (WHO, 2008).

Summary

The cardiovascular and metabolic risks posed by SB are unique from those associated with a lack of PA (Hamilton et al., 2008). The mechanisms for this risk may stem from the low metabolic costs of SB (Levine et al., 2006), a lack of muscle activity (Bey & Hamilton, 2003), or microvascular changes to the circulatory system while not weight bearing (Hamburg et al., 2007). Our environment is more suited for sedentary activities than ever before so that humans have to make special efforts to be more physically active. The estimated number of Americans that meet public health recommendations for PA ranges from 3.5-48.8% (Troiano et al., 2008; CDC, 2010). At best, over half the population is not benefiting from PA and are at higher risk for obesity, diabetes, cardiovascular disease, depression and cognitive decline (Sofi et al., 2001; Saxena, Van Ommeren, Tang, & Armstrong, 2005; Vatten et al., 2006; Rockl et al., 2008; Waller et al., 2008).

There are useful models of behavior change that can be applied to SB. Social Cognitive Theory suggests that improving self-efficacy for reducing sitting time and increasing light PA is key. The Transtheoretical Model provides a framework of cognitive and behavioral processes that help initiate and maintain behavior change. Re-evaluating current behavior, adjusting the environment to promote standing and substituting active behaviors for non-active ones are examples of the cognitive and behavioral steps needed to reduce SB. Interventions that employ multiple strategies; feedback, modeling, counter-conditioning, self-regulation are more effective than those with a narrow focus (Annesi & Unruh, 2007; van Stralen et al., 2010).

Opportunities to use technology to deliver PA interventions continue to increase as more people have access to computers. This may be particularly helpful when trying to encourage less SB. An email delivered intervention message will reach participants at the exact time they are sedentary and provide them with the opportunity to practice the new behavior suggested in the email. Previous SB interventions have been mainly based on the Behavior Choice Theory (Epstein et al., 1997; Salmon et al., 2003; Gardiner et al., 2011b). No studies have purposefully tried to increase self-efficacy through mastery, modeling, persuasion, or emotional arousal (Bandura, 1997).

The measurement of PA and SB is best done with a combination of subjective and objective measures (Timperio et al., 2003; Napolitano et al., 2010). While accelerometers provide data on the duration, intensity and number of bouts of PA or postural allocation (Trost et al., 2005) they cannot tell you the mode of PA (Prince et al.,

2008) or domain of SB (Salmon et al., 2003) and are not good at recognizing the energy costs of many lifestyle physical activities (Bouten et al., 1994).

Intervening at the level of SB has advantages over traditional PA interventions. A number of the barriers to PA are removed. Physical activities that interrupt sitting are known and well-practiced in daily life, so no new skills are required. Structured physical activities often require special attire and access to facilities. Light and lifestyle physical activities can be introduced without disrupting work or home schedules and are not physically fatiguing or sweat producing. There is evidence that reductions in SB are related to increased moderate PA (Gilson et al., 2009; Gardiner et al., 2011b). Interventions that target reduced sitting may provide a starting point for adopting more intense physical, especially for older, overweight or highly sedentary individuals.

CHAPTER III

METHODS

The purpose of this study was to test the feasibility of an intervention to reduce SB and increase light PA. The *On Our Feet* intervention was grounded in SCT. The study was conducted with a sample of overweight and obese women. A group x time design was used to determine the effect of the intervention on SE, SB, and PA. Sedentary behavior and PA were measured objectively and by self-report, prior to and after a 6-week intervention in women who attend a weight loss support group. The *On Our Feet* intervention combined face-to-face interactions and email messages. The content was intended to increase self-efficacy for reducing SB and for increasing light PA by highlighting mastery experiences related to both behaviors.

Study Design

A quasi-experimental, group x time design was used to make group comparisons on the dependent variables pre and post intervention. The two groups consisted of the intervention group (INV) and the waitlist control (WC) group. The dependent variables, SB and PA were assessed two times (pre-post). Self-efficacy was measured three times (pre, week 3, post). See Appendix C for diagram of design. Prior SB-light PA interventions have seen the greatest increases in behavior immediately following intervention elements (Gilson et al., 2009, Gardiner et al., 2010). Thus, a mid-point observation was used to detect change in SE during the intervention.

Study participants were members of a national weight loss support group, Take Pounds Off Sensibly (TOPS™). A quasi-experimental design best matched the local chapter organization structure of the support group. Rather than randomizing individuals into control or intervention groups, entire chapters were randomly assigned to either intervention or waitlist conditions. Half the chapters received the intervention. The other half was followed as a comparison group and received the face-to-face intervention following the post assessment. This format provided an adequate representation of the non-intervention environment without denying volunteers the benefits of the intervention.

Participants

Participants were actively recruited by the researcher at a regular TOPS chapter meeting. Two regional TOPS leaders granted access to 10 chapters in mid-North Carolina. A purposeful sample of 60 female volunteers was sought. TOPS members are predominately white, female, middle-aged and older adults who have been attempting to lose weight for many years. Recruitment meetings were scheduled with chapters that anticipated eight or more volunteers. The sample goal of 60 was determined from a power analysis (Faul, Erdfelder, Lang, & Buchner, 2007) using the effect size of d =.17 for SE (Ashford et al., 2010) with α = .05, β =.20, and a 9% attrition rate.

Seven chapters from Alamance, Forsyth, Guilford, Rockingham, and Randolph counties were enrolled. These chapters had active memberships greater than 12 and were recommended by the TOPS leaders. Chapters were designated as rural (<25,000) or metropolitan (>25,000) according to the community's U.S. Census (2010) population. Chapters 3, 5, and 6 were labeled rural and chapters 1, 2, 4, and 7 were considered urban. Chapter 6 was deemed rural despite not being designated as such by the US Department of Agriculture (USDA, 2004) due to its proximity to an urban area.

Inclusion Criteria

Women between the ages of 35-85, with a BMI > 25 were asked to take part in the study. Participants also had to be willing to receive intervention materials and messages by email and plan to attend all program and data collection sessions. Additional exclusion criteria were any reported conditions that prohibited them from standing or walking. All sessions were scheduled as regular chapter meetings and volunteers were provided with a list of study dates.

Prior Study of Target Population

Take Off Pounds Sensibly Club, Inc. is a non-profit organization that offers nutrition, PA and health information, and weight loss tools to members at a low cost (TOPS, 2011). Along with self-monitoring of food intake and PA, the TOPS program provides members with social support to change emotional eating habits. Goal weights are established by the member's physicians so that they are realistic, healthy and maintainable. Prior work with TOPS found that members engaged in low levels of PA as assessed by the Godin LTPA questionnaire (Adams & Gill, 2011).

An initial survey of their SBs was conducted in the fall of 2010. Fifty TOPS members from four regional chapters completed a questionnaire designed to assess their current levels of PA and SB and their SE for sitting less and engaging in more light PA (see Appendix D). The reported volume of daily sitting was 4.6 (±2.5) hours. This is significantly lower than the average suggested by Matthews et al. (2008). Poor reliability and validity for self-reported sedentary time (Gardiner et al., 2011a; Hart et al., 2011), makes objective measurement of SB an important facet of intervention. Thus, assessment and feedback from the accelerometer was a key element of *On Our Feet*.

Total weekly METS from this small sample ranged from 3 to 97 with an average of 35. The mean light PA MET value was 8.9 (±8.9) and contributed the least to total METS. Based on these data, there appeared to be room for growth in PA, especially at lighter intensities. Age was not related to sitting or light PA in this sample whose ages ranged from 38-83 with a mean of 60 ± 10.01 years, suggesting that age should not be a limiting factor in participation. Mean SE for decreasing total sitting time was 3.58 ± 1.25 on a five point Likert-type scale (1 equal to not at all confident, 5 equal to absolutely confident). TOPS members reported the highest SE for increasing household chores (3.9) and the lowest for climbing more stairs (2.9). The women had SE for light physical activities, especially those that they already did, with some area left for improvement.

This sample did not appear to be purposely reducing SB, so an intervention aimed at SB was deemed appropriate.

Measures

A combination of behavioral, psychological, and physiological factors were assessed. They included measures of PA and SB, self-efficacy for reducing SB, self-efficacy for increasing light and moderate PA, stage of change for SB, stage of change for PA, BMI, and waist circumference. The baseline questionnaire (see Appendix B) asked for participants' age, race/ethnicity, education, employment, and health status. Items related to participation in TOPS (length of and regular attendance at meetings) and the number of meals they take while watching TV provided additional information on their engagement in weight loss behavior and sedentary habits. Likert-type scales for commitment to weight loss and satisfaction with TOPS were included as measures of participant motivation for weight loss.

Physical Activity and Sedentary Behavior

The PA and SB measures were time spent in SB, light and moderate PA. They were assessed by accelerometer and self-report. Data from the accelerometer provided a percentage of time spent in SB, light PA (LPA), and moderate PA (MPA). These percentages were used as the primary dependent variables. For participant feedback, a daily average for time spent in SB was calculated by multiplying the number of minutes the accelerometer was worn by the SB percentage, divided by the number of valid days of data [(wear minutes x .00% SB) ÷ valid days worn]. The self-report measures provided estimates of METS per week from PA and hours spent on specific SBs weekly and daily. The self-reported measures provided backup data for the accelerometer and offered alternative measures of behavior.

Accelerometer. Participants were asked to wear an Actigraph model GT3X plus tri-axial accelerometer during waking hours for seven days at baseline and for seven days immediately following the intervention. Instructions for wearing the device included attaching to waist over the right hip (mid-axillary line) and removal for any water-related activity. The accelerometer recorded activity counts corresponding to intensities of PA, logged bouts of sitting, standing, MPA and vigorous (VPA), and counted steps taken. The following cut points were applied to categorize each 60-second interval based on vector magnitude: sedentary (<100), light (101-1951), moderate (1952-5724) or vigorous (>5725) (Freedson et al., 1998; Matthews, 2005). The accelerometer data were analyzed using the ActiLife software, version 5.8.3. Ten hours of wear time was necessary to be considered a valid day (Gardiner et al., 2011a) and participants with 4 or more valid days were included in the analysis (Trost et al., 2005). Any period with 60 minutes of consecutive zero counts was labeled as non-wear time (Tudor-Locke, Johnson, & Katzmarzyk, 2011b). Wear periods less than one minute were ignored and one-minute spike tolerance was used to prevent inadvertent movement of the device from breaking up non-wear periods (Oliver, Schofield, Badland, & Shepherd, in press). Otherwise, all counts between 0 and 50,000 were retained. The software calculates the percentage of time spent in SB, LPA, MPA, and VPA, bouts of MPA and VPA, steps, and daily energy expenditure.

Pedometer. Participants wore an Advanced Technologies-82 pedometer concurrently with the accelerometer at baseline. This unit held seven days of step counts and provided a weekly total. Participants were instructed to attach the pedometer to their waist over the left hip (mid-axillary line) as to not interfere with the accelerometer. Baseline step counts were used in the initial intervention sessions for self-evaluation and goal setting. Intervention participants reported their steps at week 5 and received a feedback message based on the percentage of their goal that was achieved.

Self-reported PA and SB. Subjective estimates of time spent in SB and PA were collected to complement the accelerometer and pedometer data. Six pen and paper measures were given to participants at baseline and post. Copies of each instrument are available in Appendix B along with a list of reliabilities for each of the self-report measures.

***Physical Activity*.** The Godin Leisure-time Physical Activity Questionnaire (Godin & Shephard, 1997) asked participants to recall the number of 15 minute bouts of light, moderate, or strenuous PA they engaged in over the last week. A score for each intensity was calculated by multiplying the bouts by a MET value (light 3, moderate 5, and strenuous 9). The previously reported test-retest reliability of the Godin in a middle-age sample of women was $\alpha = .62$ for total METS (Jacobs et al., 1993). For the study, the consistency was slightly lower at .52. The internal consistency for light and moderate intensities of PA was better than Jacobs et al. (1993) and Godin et al. (1986). The Cronbach's alpha for light was .59, .44 for moderate, and .38 for strenuous compared to the .24, .36, and .62 reported by Jacobs, et al (1993).

The stage of change for PA was assessed using the five item scale published by Marcus and Forsyth (2009). The reported reliability of the measure is k=.78. However, in the current sample, the test-retest reliability was unacceptable at .30.

Sedentary Behavior. Two questions from the IPAQ (long version) were used to examine weekday versus weekend sitting. For each, participants estimated the total number of hours (whole and fraction) they spent sitting in the last seven days. Examples of SB are included in the question. These questions had a combined test-retest reliability of .82, which matches the established alpha of .81 (Rosenberg et al., 2008). Another sitting measure was borrowed from Salmon et al. (2003), in which participants provide the number of hours and partial hours (in minutes) they engaged in 7 specific SBs (watching TV or video, using computer or internet, reading, socializing, riding in a vehicle, and doing crafts or hobbies). This measure has established intra-class reliability in both adult and senior populations [*ICC* = .79, .53] (Gardiner et al., 2011a; Salmon et al., 2003). In the current study, the reliability was only α=.62.

Stage of change for SB was assessed by two questions developed by Norman and colleagues (2004). No internal consistency statistics have been published. This measure did not perform well in this sample with a test-retest of only .16.

Self-efficacy

The psychological outcome, SE was measured at baseline, mid-point, and post intervention. Three measures were developed to assess SE to reduce SB, SE for light PA, and SE for moderate PA. A total of twelve confidence scales (4 for each measure) were developed based on the guidelines published by Bandura (1997) and McAuley and Mihalko (1998). Each item is a likert-type scale, ranging from 1 to 5. Participants were asked to rate their level of confidence (not at all confident to completely confident) for specific sitting and PA behaviors. The average of the four items produced the score for that particular SE sub-scale. Items were specific to domain (work-related or leisure) and to activity (TV, computer, household chores, exercise). A test-retest for reliability found good consistency, α = .79, .84, and .97, for SE to reduce SB, SE for LPA, and SE for MPA respectively in a pilot sample (n=15). However, consistency in the study sample was less than the pilot. The reliability of the SE to reduce SB and SE for MPA sub-scales was good at α=.76 and .91. The SE for light PA was lower at α = .69, but still acceptable.

Body Composition

Two anthropometric measures, BMI and waist circumference, were recorded as descriptors of the sample. Waist circumference was measured at the narrowest part of the trunk between the iliac crest and last rib (Willis et al., 2007). A Gulick measuring tape with tension device was used to insure correct tension. With the tape lying flat on the skin and parallel to the floor the number to the closest 0.25 of a cm was recorded. Two measurements are taken and the average of the two numbers was used. Body mass index is a ratio between weight and height [wt in kilograms / (ht in meters)^2]. Body mass index is commonly used in research and medical practice to designate one's body size as underweight, normal weight, overweight, or obese (WHO, 2000). A Registered Nurse, blinded to group assignment took the height, weight and waist circumference measures.

Process Evaluation

The aims of the process evaluation were to assess the user-friendliness, the challenges to participants and researchers, and the perceived benefits of the *On Our Feet* intervention. Participants were asked to evaluate individual intervention elements, the data collection and study protocol, and the overall effectiveness of the intervention. Suggestions for improvement were sought. Attendance and retention data were collected to determine how well volunteers were maintained and what factors led to attrition. Participants that did not attend both face-to-face sessions or failed to complete the mid-point evaluation (weeks 3) were considered drop-outs. Make-up sessions were offered and participants received a reminder phone call for the mid-point evaluation. Drop-outs were asked to complete a four-item online questionnaire (Appendix E). A follow-up phone call was made if participants did not respond to the questionnaire within one week. Baseline and post stage of change for SB and stage of change for PA were examined to determine if the timing of the intervention matched individual intentions to change behavior.

Participant evaluations of the intervention elements were collected by an online assessment linked to the intervention emails. Participants were asked to rate their level of interest, effectiveness and ease of use for each of the intervention elements; stretching activity, accelerometer feedback, goal setting activity, video demonstrations, pedometer step tracking, sitting log, behavioral cues, and tailored feedback messages. For elements that are presented singularly (initial presentation, accelerometer feedback, goal setting, videos 1 & 2, behavioral cues), the process evaluation questions were sent 1 week after the element was introduced. The elements that were used in multiple weeks (active stretching, pedometer, sitting log, and tailored feedback) and the third video were assessed approximately 1 week after last use. Participants were also asked about the effectiveness of the pedometer, sitting log, and email messages at the end of the study. The following are examples of the process questions; "On a scale from 1 (not at all) to 5 (very), how interesting was the presentation on sedentary behavior?," "On a scale from 1 (not at all) to 5 (very), how clearly was the information presented?," "On a scale from 1 (not at all) to 5 (a lot), how often have you used the information to change your sitting behavior?" A complete list of the process evaluation questions is in Appendix E. Participant views of the data collection, email delivery, researcher interaction, perceived benefits, barriers, and suggestions for improvement were solicited after the intervention using a questionnaire with both ratings and open-ended items (Appendix E).

The researcher also recorded her observations of challenges, benefits, and costs in implementing the intervention. All qualitative data were listed and grouped into themes to be used in future revisions of the intervention.

Procedures

One intervention chapter (INV) and one waitlist control chapter (WC) were paired together, so that two groups were observed simultaneously. When possible, chapters were matched according to club characteristics. In order of priority, the characteristics for pairing were meeting schedule, email use, and size of chapter. In one instance, the chapters were matched based on the timing of enrollment and the lack of additional interested chapters. Once paired, the chapters were randomized into intervention and waitlist control groups by coin toss. Chapters entered the study on a rolling schedule. Starting times were staggered by two or three weeks to allow for a limited number of accelerometers. Baseline assessments were taken after matching and randomization so that the appropriate data collection and intervention sessions could be scheduled. An introductory session was conducted with each chapter 3-5 weeks in advance of their baseline assessment to answer questions and to gauge the number of volunteers from each chapter.

The entire study period was 13 weeks long. The first intervention and waitlist control pair was enrolled the week of July 11th, 2011. The second pair of chapters began two weeks later and the third pair started 5 weeks after the first. A single invention chapter was added to the third pair because chapter recruitment had been exhausted. Figure 6 illustrates the group schedule. Data collection concluded the week of October 10th, 2011.

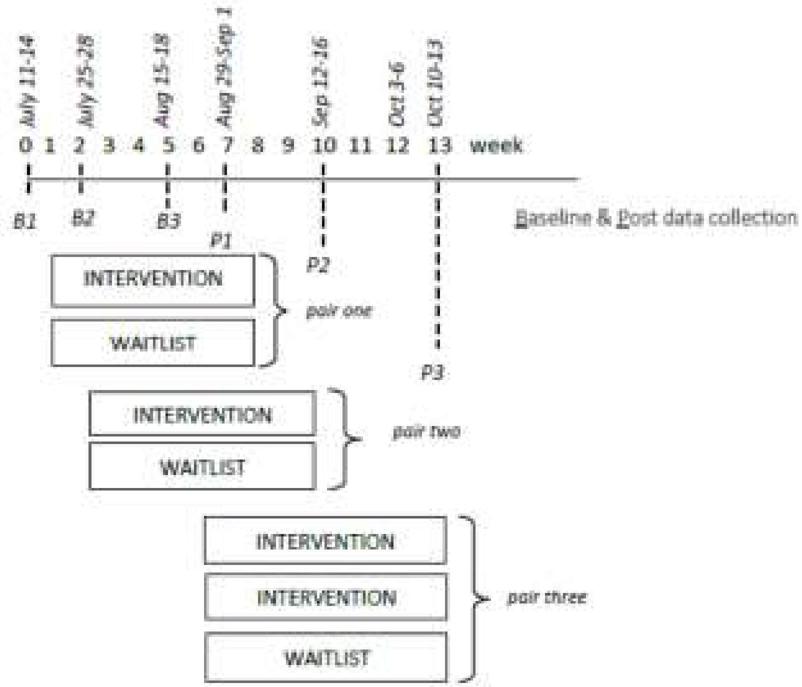

Figure 6. Schedule for Paired Groups

Baseline measurements were conducted one week prior to the intervention. Once volunteers read and signed the informed consent documents (Appendix F), they were asked to complete a demographic questionnaire and the self-efficacy measures and their height, weights and waist circumferences were recorded. Participants were assigned an identification-coded accelerometer and pedometer. Written and verbal instructions were provided for wearing both devices. Accelerometers were collected one week later at the next chapter meeting by the researcher. At that time, participants finished the baseline data collection by completing the PA and SB recall and stage of change questionnaires. The past week's pedometer steps were recorded. Accelerometer and self-report measures were repeated at the post assessment along with the process evaluation survey. Figure 7 illustrates the delivery schedule and measures over the 9 weeks of contact. Participants retained the pedometers to use in the intervention. The mid-intervention measurements of SE and pedometer steps were completed online. All intervention elements (presentations, accelerometers, self-monitoring logs, questionnaires, web links, video demonstrations, tailored feedback, email) were pilot tested with non-TOPS participants prior to the first round of the study.

Pre								***Post***	
1 week prior		*Wk 1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Accelerometer Pedometer SE BMI WaCir	*INTERVENTION*	*Group session*	*Group Session 1 Email*	*2 Email*	*2 Email*	*1 Email*	*1 Email*	***Accelerometer Godin SB recall SE BMI WaCir Process evaluation****	*Individual Feedback by email*
		Godin SBrecall		***SE***					
	WAITLIST CONTROL								*Initial & goal setting Present-ation*
		Godin SBrecall		***SE***					

*Intervention group only
Godin= self-report leisure-time PA, SB recall = self-report measure by Salmon et al. (2003)
BMI = body mass index, WaCir = waist circumference

Figure 7. Timeline of Intervention Components & Measures

Intervention

The *On Our Feet* intervention was developed to improve participant SE to reduce SB and increase PA using a SCT framework. The elements targeted mastery experience, modeling, and persuasion mechanisms for increasing SE. Table 3 describes the intervention elements and the construct they were intended to engage. Tailored feedback on behavior completion was used to highlight mastery experiences. New behaviors were modeled in the face-to-face session and with video demonstrations to increase vicarious experience. During the goal setting activity, participants rated their confidence in accomplishing the goals. This rating was intended to increase participant recognition of their SE and to insure that goals were achievable. Cognitive and behavioral strategies were incorporated. The sitting behavior inventory provided re-evaluation along with the accelerometer and pedometer feedback. Group discussions initiated ideas for behavior change. Methods for counter conditioning and the use of behavioral cues were found in the video demonstration and stretching activity. All email messages were framed positively to encourage the participants to continue making behavior change. The delivery method was a combination of two face-to-face sessions and six email messages. Weeks 1-2 were led in-person by the researcher. Weeks 3-6 were conducted over the internet, mainly by email.

Table 3

Intervention Elements & Measures

Intervention Segment	Description of intervention element	Construct Impacted
Initial Presentation		
	Differences between activities to reduce SB & "exercise"	Consciousness raising
	Health benefits of reduced SB	Cognitive processes & decisional balance, OE

Table 3 (cont.)

Intervention Segment	Description of intervention element	Construct Impacted
	Feedback on pedometer steps SB recall questionnaires	Mastery & self re-evaluation
	Group Brain-storming on reducing SB	Modeling, counter conditioning, & stimulus control
	Stretching Routine to break up sitting time	Modeling & Mastery
Group Goal Setting		
	Accelerometer Feedback – NHANES comparisons	Cognitive Processes; self re-evaluation,
	Goal Setting worksheet - participant lists specific behaviors & rates confidence for goals	SE, counter conditioning
Emails		
	Week 2 - 1 wk goal reminder, encouragement & activity tip (stand up while reading email)	Persuasion, counter conditioning, behav. cue
	Week 3 - #1 – short-term goal feedback, SE feedback #2 - video demonstration of 2 light PA behaviors (standing while on phone, not using remote control)	Mastery Modeling
	Week 4 - #1 – 3wk goal reminder, encouragement & tip #2 - photo examples of where to put behavioral cues	Persuasion, modeling, counter condition, behavioral cue
	Week 5 - feedback on 3 week goal attainment,	Mastery
	Week 6 – Video demonstration (taking stairs) encouragement, blank Goal Setting worksheet	Modeling, Goal Setting, persuasion
Individual Feedback	Accelerometer Feedback - individual profiles of time spent sitting & in Light, Moderate, & Vigorous PA compared to NHANES age group data Feedback on 2 Goals, SE and behavioral processes	Mastery , self-liberation, Persuasion

Face-to-face segment. The first intervention session took place one week after the baseline assessment. This session consisted of an assessment of self-reported PA and SB, a 30-minute presentation on sedentary behavior, two group activities, and pedometer feedback. Differences between light PA and structured exercise were reviewed in the presentation. The potential health benefits of reducing SB were highlighted. A participant workbook was distributed (see Appendix G).

Following the presentation, the chapter members broke up into small groups to discuss ways to decrease their sitting time. Next, the researcher led the group in an active stretching routine as an example of how to break up sitting time. This routine consisted of seven dynamic upper and lower body movements. The exercises are the mini squat, military press, standing hip flexion, horizontal shoulder adduction/ abduction, hamstring curl, calf raise, and ankle dorsi-flexion. Photographs and written descriptions of the exercises were in the participant workbook (Appendix G). Eight to ten repetitions of each movement were suggested. The entire routine took 6-7 minutes. While presenting the activity, the researcher pointed out that half the routine is about the length of a TV commercial break and that it was fine to break the exercises up into smaller segments. Step counts from the prior week were recorded in the participant workbook and the use of a pedometer for tracking light PA and SB was reviewed. No specific step goal was given but participants were encouraged to think about a sitting behavior they would like to change. The researcher ended the session by suggesting that participants review the tips for reducing SB in their workbooks.

At the second session each participant received individual feedback from their accelerometer data. The feedback included their overall percentages of time spent in SB, light PA, and exercise (MPA and VPA), a graph of their most and least sedentary days, and a comparison to their self-reported sitting time. Figures 8 and 9 illustrate the comparative feedback participants viewed. The remainder of the session was used to identify goals for decreasing sitting time and increasing PA. The researcher led a goal setting activity to develop realistic achievable goals for increasing breaks from sitting and increasing daily steps. Participants referred to their accelerometer feedback and 7-day step history to develop individual behavior targets. Two goals were set; one short-term (1 week), one medium range (3 weeks).

Sedentary Time	Time in Light Physical Activity	Time in Moderate Physical Activity	Time in Vigorous	% in Sedentary	% in Light	% in Moderate
6H 44M 0S	3H 49M 0S	11M 0S	2M 0S	62.54	35.45	1.7

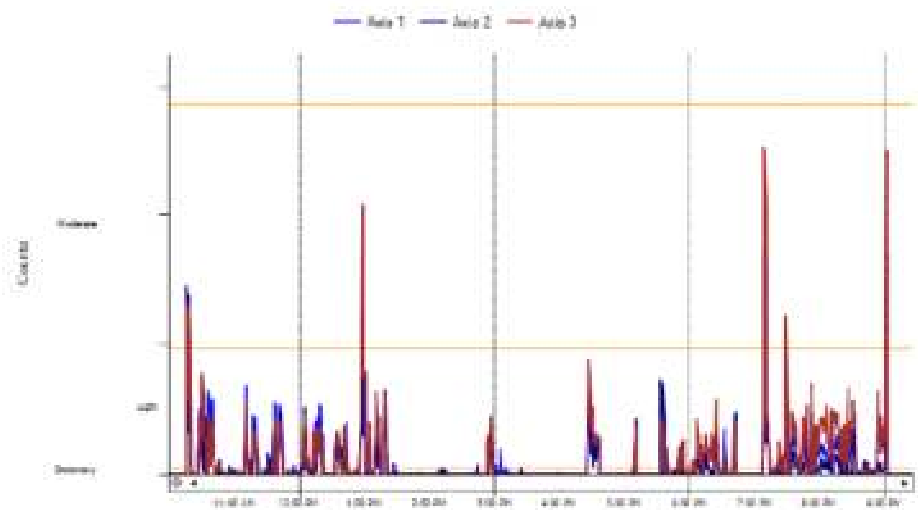

Figure 8. Individualized Accelerometer Feedback Most Sedentary Day

The short-term goal was to increase breaks from sitting and the medium range goal was to take more steps daily. Participants completed a goal worksheet during the session for both behaviors (Appendix H). The worksheet asked participants to list specific behaviors or tasks they would use to achieve each goal. For example, do the active stretching activities during a commercial break or walk to the bathroom furthest from them. Participants rated their confidence for completing the goal on a scale from

1-5. Those with ratings lower than three were asked to revise their goal so they would feel more confident in it. Participants then listed three things that would make them more confident in achieving their goal. These items included ways to remind themselves or get support from others. Both behaviors are related so that engaging in one will promote the other. The completed worksheets were collected by the researcher. An electronic copy was emailed to the participant within 24 hours of the session. The goals, suggested counter behaviors, efficacy promoters, and confidence ratings were used for the tailored feedback during the online segment of the intervention. The second intervention session ended with instructions for using both the sitting log and the step log (see Appendix I) found in the participant workbook.

Sedentary Time	Time in Light Physical Activity	Time in Moderate Physical Activity	Time in Vigorous	% in Sedentary	% in Light	% in Moderate
4H 53M 0S	4H 0M 0S	1H 25M 0S	1M 0S	47.33	38.77	13.73

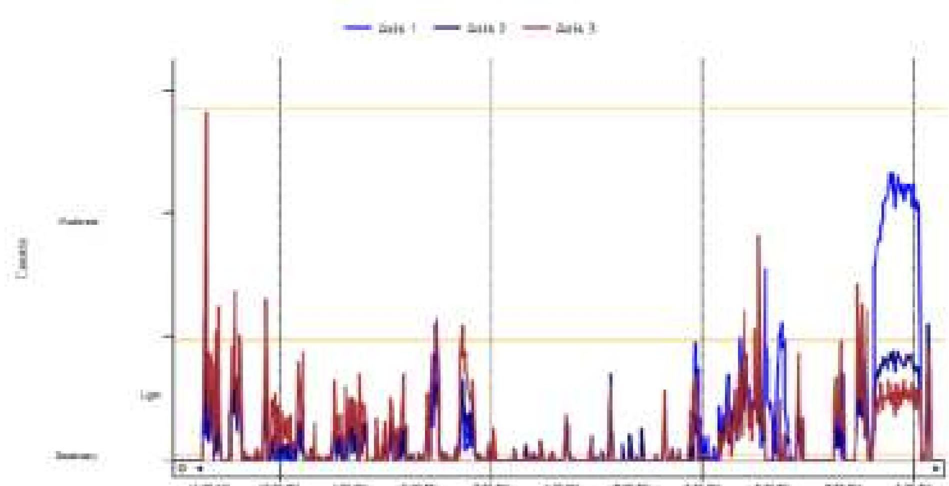

Figure 9. Individualized Accelerometer Feedback Least Sedentary Day

Online segment. Participants received their first email during week 2, following the goal setting session. This message reminded them of their individual goals and suggested doing one of the behaviors listed on their goal worksheet immediately. This cue was presented to them when they were seated at their computer and provided an opportunity to substitute a new behavior. A process evaluation survey for the initial presentation and active stretching activity were linked to the first email.

In week three, participants were asked to complete an online questionnaire containing the SE measures, the Salmon sitting inventory, reported breaks from sitting, and a process evaluation of the goal setting session. After completing the questionnaire, participants received an email providing feedback on their performance of the short-term goal (breaks from SB) and the two highest SBs from the Salmon sitting inventory. The email message also contained a reminder of the counter-conditioning behaviors they listed on the goal worksheet that could be used during their most frequent sitting activities. The message was encouraging and suggested process strategies if improvement was needed or were congratulatory if the goal was at least 85% attained. Suggestions for improvement were tailored to their level of SE. The messages are provided in Appendix J. A second email in week three contained two video demonstrations that showed peers (obese middle aged females) engaged in tasks that reduced sitting time. The first video was of a woman standing and walking while talking to friend on the phone. The second presented a woman changing the TV channels by standing and walking to the TV instead of using the remote. Each video depicted the SB and the new more active behavior and contained a brief commentary about changing the behavior.

The emails in week 4 followed the same format. The first reminded participants of their 3 week goal and encouraged the use of behaviors from their worksheet. The second email contained photographs of places to put behavioral cues along with four ready to print notes. For example, one picture showed a note on the computer screen that read, “stand up every hour” and one by the door said, “lighter loads, more trips.” Step counts were reported online in week five. A reply email provided participants with feedback about their performance on the mid-range goal. In week six another video demonstration was sent. This one presented a peer taking the stairs instead of an elevator. Attached to this email were blank logs sheets and a blank goal worksheet for participants’ future use. A process evaluation survey for the pedometer, tailored feedback, and video elements of the intervention was included in the email Participants were reminded of the date and time of the post-assessment data collection. One week after completion of the post assessment, INV participants received a final email containing comparative feedback on baseline and post daily average SB time.

Data Analysis

Quantitative data were entered into SPSS version 18.0. Descriptive statistics (frequencies, means, standard deviations, ranges, skewness, and kurtosis) were calculated to summarize characteristics about the sample, the dependent variables, and process evaluation responses. Boxplots were scanned for outliers. Baseline differences between intervention participants, waitlist control participants, and drop-outs were examined using chi-square tests, and t-tests. Subjects with incomplete accelerometer data at the post-assessment were removed from the SB and PA analysis, but retained for the SE analysis. Missing mid-point scores for self-efficacy were replaced with the chapter mean.

Comparisons between INV and WC were made for percentage of time spent in SB, light or moderate PA using a Group x Time (pre-post) repeated measures multivariate analysis of variance (MANOVA) with follow-up univariate analysis of variance (ANOVA). Comparisons between groups for SE for reducing SB, SE for LPA, and SE for MPA were made using a repeated measures Group x Time (2 x 3) MANOVA with baseline, mid-point, and post data. Statistical significance was set apriori at $\rho \leq 0.10$. Exploratory MANOVA and ANOVA were conducted with BMI, waist circumference, and steps as dependent variables. The univariate analysis of variance was repeated for SB and self-efficacy with rural-urban location as an independent variable. Bivariate correlations between self-reported SB and PA and objectively-determined SB and PA were examined, along with the associations between SE and change in behavior.

A significant Group x Time interaction was hypothesized with the intervention group decreasing SB and increasing PA over time. Similarly, a Group x Time interaction was hypothesized for self-efficacy with the intervention group increasing more than the waitlist control group in all SE 3 categories.

Participant ratings of the intervention and of individual intervention elements were assessed with descriptive statistics. Compliance with key intervention elements was used as the independent variable in exploratory ANOVAs for SB, PA, and SE. Open-ended responses from the process evaluations and participant emails during the intervention were listed and reviewed for recurring themes. Next, the researcher's notes and records of implementing the study were reviewed for themes. Simple frequencies were then tallied for each appearance of the theme and similar themes were grouped and labeled.

CHAPTER IV

RESULTS

Four chapters of TOPS participated in a 6-week intervention targeting SB and SE to reduce SB, while three chapters were observed as waitlisted controls. It was expected that the INV group would have increased SE, reduced SB, and increases in PA as compared to the WC. The dependent variables were grouped into two categories, behavior and SE, for the primary analysis. The behavior variables came from the accelerometer data and were the percent of time spent in SB, light PA, and moderate PA. Research questions 1-3 are addressed by the behavior variables. The second category included the participants' average score on three scales of SE; SE to reduce SB, SE for light PA, and SE for moderate PA, and answered research questions 4-6. Each category was examined with a repeated-measures MANOVA, followed by a repeated-measures ANOVA for each individual dependent variable. Exploratory analyses included multivariate testing of body size (BMI and waist circumference), univariate analysis for accelerometer-determined and pedometer steps, repeated-measures ANOVA for SB and SE with rural/urban location as the independent variable, and bivariate correlations between objective and self-reported behavior and between behavior and SE. Research question number 7 was addressed through a review of participant ratings and qualitative data from the process evaluation. Multivariate analyses of behavior and SE were repeated to compare INV participants that were most compliant with the intervention to those that were least compliant.

Sample Characteristics

Sixty-four women completed the 8-week study (40 INV, 24 WC). Participants ranged in age from 35 to 84 years old, with a mean of 58.47 (*SD*=12.55) years. The average length of membership at the start of the study was 5.80 (*SD*=6.41) years. According to the National Institutes of Health, National Heart, Lung, and Blood Institute classifications (Sandmaier, 2005), 18 participants had class I obesity (BMI 30-34.9), 12 met the criteria for class II (BMI 35-39.9), and 18 were in class III (BMI $\geqslant$ 40). The remaining 16 participants were overweight (BMI 25-29.9). Eighty-nine percent of the sample was Caucasian with the remainder being African-American. All but three participants had completed high school and over half (53.13%) had education beyond high school. Fifty-five percent of the women were working full-time or part-time. There were 17 (26.5%) retirees and 12 (18.5%) reported not working due to disability. Cardiovascular disease (hypertension, high-cholesterol, history of heart attack or stroke) and type 2 diabetes were the most commonly reported health issues, affecting 43.75% and 45.31% of the sample, respectively. Thirty-seven percent of participants were from communities with populations less than 15,000.

A summary of the demographic information for the INV and WC groups is presented in Table 4. The rates of full-time employment, $x^2(3, n = 64) = 7.75$, $p = .05$, and non-sedentary job, $x^2(1, n = 64) = 3.24$, $p = .05$, were significantly higher for the INV participants as compared to the WC participants. The groups did not differ significantly on any other characteristic.

Table 4

Sample Characteristics

	INV n=40	WC n= 24
Age in years	56.73 (±12.64)	61.38 (±12.1)
BMI	36.37 (±8.19)	36.56(±6.96)
White	36 (90%)	21 (88%)
African-American	4 (10%)	3 (13%)
Education		
< high school	1 (2%)	2 (8%)
high school	15 (38%)	12 (50%)
college or trade school	19 (48)	8 (33%)
graduate school	5 (13%)	2 (8%)
Employment		
full-time	22 (55%)*	5 (21%)
part-time	3 (8%)	5 (21%)
retired	9 (23%)	8 (33%)
disabled	6 (15%)	6 (25%)
Non-sedentary job	11 (28%)*	5 (21%)
Rural Location	18 (45%)	6 (25%)
Membership years	6.31 (±6.91)	4.95(±5.52)
Cardiovascular Disease	16 (40%)	12 (50%)
Type 2 Diabetes	16 (40%)	13 (54%)
Arthritis	3 (8%)	4 (17%)
Depression	3 (8%)	4 (17%)

* $p<.05$

Correlations

The relationships between the sample characteristics and baseline SB, PA, and SE were examined with Pearson (r) and Point Biserial (r_{pb}) correlations. Point Biserial correlations determine the strength of a relationship between a dichotomous variable and a continuous or interval variable (Pett, 1997). A complete table of the correlations is in Appendix K. The dichotomous variables were rural location, non-sedentary job, heart disease, and diabetes and coded affirmatively with a one. There were significant associations for age, rural location, non-sedentary job, heart disease, and diabetes, but the correlations were weak, ranging from 0.26-0.29. Age was negatively associated with time spent in moderate PA (r=-0.26, p<.05). Living in a rural community was negatively related to SE to reduce SB (r_{pb}=-0.28, p<.05) and time spent in SB (r_{pb}=-0.27, p<.05), and positively related to time spent in light PA (r_{pb}=0.29, p<.05). Having a non-sedentary job was positively associated with SE for moderate PA (r_{pb}=0.27, p<.05) and time spent in moderate PA (r_{pb}=0.29, p<.05). Heart disease was associated with SB (r_{pb}=0.26, p<.05) and diabetes was inversely related to time spent in moderate PA (r_{pb}=-0.27, p<.05).

Retention

Seventy-eight women participated in the baseline assessment. Eleven participants withdrew and the data of three individuals were excluded for not meeting the age or BMI criteria, leaving a total of 64 participants (n=40 INV, n= 24 WC). An equal percentage of drop-outs occurred in both groups (14%) and participants withdrawing did not differ significantly in sample characteristics from those that remained. The results of chi-square and one-way ANOVA for the sample characteristics and baseline measures are in Appendix K. At the post assessment, the accelerometer data for six participants (2 INV, 4 WC) were not analyzed for a lack of valid wear days. The self-report data for these individuals were retained and used in the SE analysis. Therefore, the sample size for behavior variables is 58.

Descriptive Analysis

The associations among the objective and self-report behaviors, and the relationships between SE and behavior were assessed with bivariate (Pearson) correlations. Prior literature has established that SB is inversely proportionally to light PA and that exercise (vigorous PA) is not associated with SB (Hamilton et al., 2008). A significant negative correlation was found between the percentage of time the TOPS women spent in SB and light PA. The relationship was moderate at baseline (r=-0.47, p<.001), but stronger at post (r=-0.91) and closer to reported levels (-0.95 to -0.98). Sedentary behavior was not related to vigorous PA, though it was negatively related to moderate PA at the post assessment (r=-0.60, p<.001). Table 5 provides the baseline and post means and correlations.

Because both objective and self-reported measures of SB and PA were obtained from participants, the correlations between these measurement tools were considered. The IPAQ weekday sitting question was significantly related to percentage of time spent in SB (r=0.29, p<.05), but neither the IPAQ weekend nor the Weekly Sitting Time measures were related to SB. The relationship between self-reported sitting and percentage of time spent in light PA was in the expected direction at baseline, mid-point, and post (r=-0.26, -0.31, -0.39) and was significant (p<.05). The Godin item for moderate PA was significantly correlated to percentage of time spent in vigorous PA

Table 5

Correlations and Means of Accelerometer-determined Behavior

				Baseline Inter-correlations			***Post Inter-correlations***		
n=58	**baseline mean**	**post mean**	***test-retest r***	% SB	% LPA	% MPA	% SB	% LPA	% MPA
% SB	48.36±11.84	49.59±11.94	.451**	1			1		
% LPA	43.56±9.65	42.5±9.88	.791**	-0.474**	1		-.906**	1	
% MPA	7.92±4.94	7.5±4.67	.698**	-.113	.132	1	-.603**	.216	1
% VPA	.43±1.58	.36±.91	.325*	-.076	-.112	0.464**	-.184	-.075	.433**

* $p < .05$
** $p < .01$

(*r*=0.48, *p*<.01), but not percentage of moderate PA. Except for the Godin moderate to vigorous PA association, all correlations between the self-report behavior and accelerometer-determined behavior were weak. The correlation table for the behavior measures is in Appendix L.

Associations between the three sub-scales of SE were all significant and moderately strong (*r*=0.43-78). The relationships between SE to reduce SB and SE for light PA, and between SE for light PA and SE for moderate PA were higher at the post assessment, while SE to reduce SB to SE for moderate PA was highest at baseline. A table of the SE correlations is in Appendix M.

Results for Behavior

Both objective and self-reported SB and PA were examined for time and group effects, and for interaction. Changes in accelerometer-determined SB and PA were assessed with a Group x Time MANOVA and were the outcome variables used to address research questions 1-3. The hypothesized Group x Time interaction was not significant for any of the objective behavior measures. No significant changes in time spent in SB, light PA, or moderate PA were identified from baseline to post and there were no significant differences between the INV and WC groups for objectively measured behavior. Complete multivariate and univariate results are in Appendix N. The baseline and post means for SB, light PA, and moderate PA are in Table 6.

The self-reported measures of SB and PA were not intended as the primary dependent variables for research questions 1-3. The four self-report measures are

Table 6

Baseline and Post Means for Behavior

	INV (n=40)		WC (n=24)	
	baseline	**post**	**baseline**	**post**
Objective Behavior				
% SB	47.42±10.77	49.16±10.23	50.7±13.78	50.39±14.92
% LPA	43.51±8.61	42.17±8.24	43.65±11.61	43.30±12.63
% MPA	8.55±4.17	8.21±4.10	6.74±6.09	6.14±5.45
% VPA	.55±1.94	.45±1.09	.21±.33	.18±.39
Self-reported Behavior				
Godin Light METS/wk	8.82±11.74	12.1±15.07	10.73±13.04	7.38±6.79
Godin Moderate METS/wk	11.05±13.37	12.8±13.9	10.67±11.35	5.94±6.38*
Godin Strenuous METS/wk	8.62±14.14	10.35±15.6	6.9±14.75	5.06±9.87
self-reported weekly sitting hrs/wk	57.99±29.70	46.00±28.91*	45.18±34.88	40.33±40.68
IPAQ weekday sitting time hrs/wk	6.51±2.28	6.62±3.06	6.16±2.99	7.29±4.26
IPAQ weekend sitting time hrs/wk	5.99±2.64	5.71±2.76	6.05±2.41	6.95±4.62

* $p \leq 0.05$

described after the objective results. A Group x Time MANOVA of the self-reported SB and PA found no significant changes in self-reported behavior from baseline to post (p=0.16) and no significant differences between the INV and WC groups (p=0.19). The Group x Time interaction was significant, $F(1,63)=2.01$, $p<0.10$, $\eta_p^2=.03$. The relationships between self-reported and objectively determined SB and PA were weak, though statistically significant (see Appendix L).

Sedentary Behavior

Contrary to the hypothesis, the percentage of SB actually increased non-significantly in the INV from 47.42(SD=10.77)% to 49.16(SD=10.23)%, whereas the WC percentage of SB was constant over time (50.13±13.78 to 50.39±14.92). Figure 10 illustrates the SB percentages for the two groups.

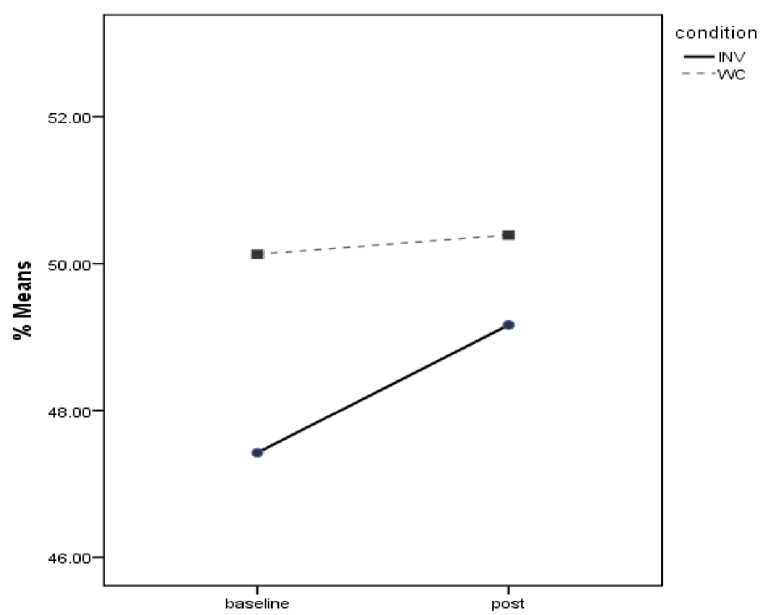

Figure 10. Percentage of Time Spent in SB

Light Physical Activity

Light PA was similar and unchanged in both groups. The INV group decreased slightly from 43.5(*SD*=8.6) % to 42.17(*SD*=8.24)% and light PA stayed slightly higher in the WC group (43.65±11.61 to 43.3±12.63%).

Moderate Physical Activity

The percentage of time spent in moderate PA did not change significantly over time for either group. At baseline the INV participants were engaged in moderate PA for 8.55(*SD*=4.18)% of the monitored time and 8.21(*SD*=4.1)% at post. The WC was slightly less active overall going from 6.74(*SD*=6.1) % to 6.14(*SD*=5.5)%.

Self-report Measures of Behavior

Changes in the amount of sitting (IPAQ sitting questions and Salmon weekly sitting measure) and in the metabolic scores for self-reported light, moderate and strenuous PA (Godin Leisure-time Physical Activity Questionnaire) were examined with a repeated-measures MANOVA. There were no significant changes in self-reported behavior from baseline to post or group differences between the INV and WC participants. A significant Group x Time interaction was seen, $F(1, 63)=2.01$, $p<0.08$, $\eta_p^2=.03$.

The multivariate Group x Time interaction was followed-up with univariate tests for self-reported behavior. Repeated-measures ANOVA found significant Group x Time interactions for light PA, $F(1,63)=5.22$, $p=.03$, $\eta_p^2=0.61$, and moderate PA, $F(1, 63)=3.90$, $p=.05$, $\eta_p^2=0.49$. In each case, the INV group reported increasing their level of PA while the WC participants reported less PA. Figures 11 and 12 illustrate the data for self-reported light PA and moderate PA. Univariate tests also found a significant change from baseline to post for weekly sitting time, $F(1, 63)=4.88$, $p=.03$, $\eta_p^2=0.59$, in both groups. Intervention participants reported sitting for 57.99±29.70 hours a week at baseline. This dropped to 46±28.91 hours at the post assessment. The change was not as great in the WC, going from 45.18±34.88 to 40.33±4.68. There were no significant differences or interactions for the IPAQ sitting questions. A graph of the weekly sitting time data is in Appendix O.

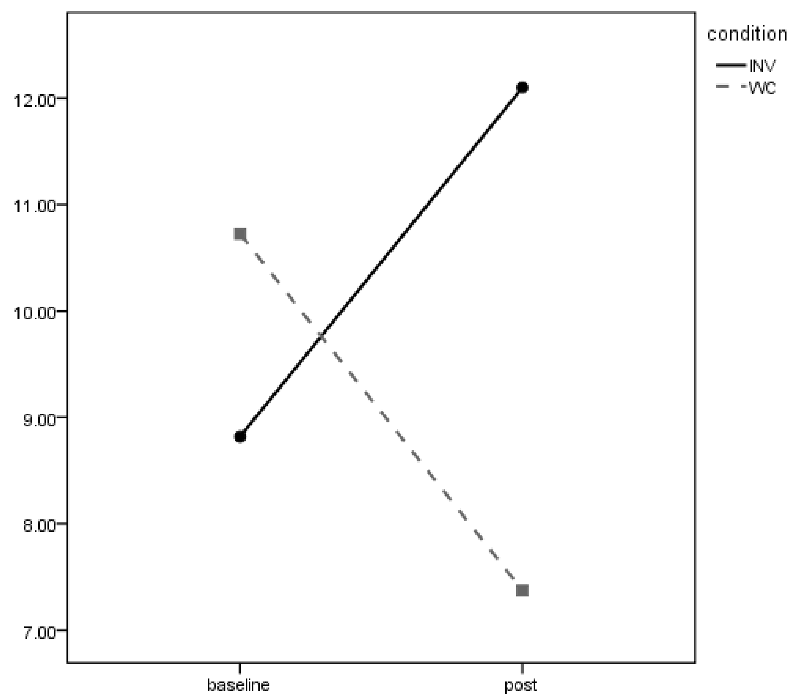

Figure 11. Self-reported Light PA

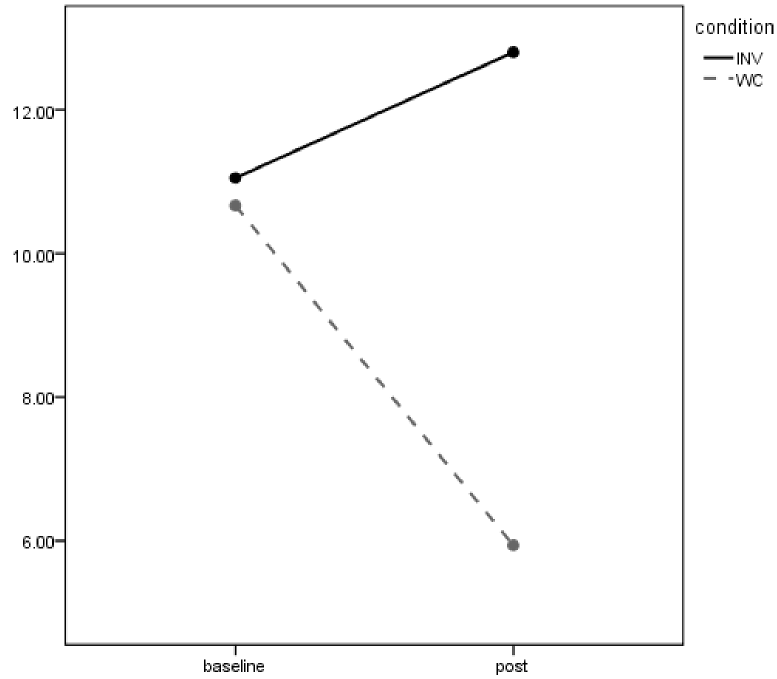

Figure 12. Self-reported Moderate PA

Research Questions 1-3

It was hypothesized that the INV group would reduce time spent sitting and increase time spent in light and moderate PA as compared to the WC group. Hypotheses 1-3 were not supported. There was no significant change in objective behavior in the INV group as a result of the intervention and no significant Group x Time interaction was seen for time spent in SB, light PA, or moderate PA.

Results for Self-efficacy

Overall changes to SE were assessed by a repeated-measures MANOVA, followed by a repeated-measures ANOVA for each of the three sub-scales. There was no significant group difference, but a significant change in SE from baseline to post was revealed, $F(2,63)=2.08$, p,0.10, $\eta_p^2=.05$. However, the hypothesized Group x Time interaction was not significant. Repeated-measures ANOVA found a significant group difference in SE for moderate PA, $F(1,63)=5.52$, $p=.02$, $\eta_p^2=.08$, and significant time effects for SE to reduce SB, $F(2,63)=3.34$, $p=.04$, $\eta_p^2=.05$, SE for light PA, $F(2, 63)=2.74$, $p=.07$, $\eta_p^2=.05$, and SE for moderate PA, $F(2,63)=3.95$, $p=.02$, $\eta_p^2=.06$. The results of the follow-up tests and effect sizes are described below. Table 7 provides the baseline, mid-point, and post means for each SE sub-scale.

Self-efficacy to Reduce Sedentary Behavior

The ANOVA for SE to reduce SB revealed a significant time effect. Mean SE dropped from baseline ($M=3.65$, $SD=71$) to mid-point ($M=3.37$, $SD=81$) and increased at post ($M=3.48$, $SD=.80$). Within-Subjects contrasts showed that the decline between baseline to mid-point was significant, $F(1,63)=5.35$, $p=.03$, $\eta_p^2=.08$. The increase from mid-point to post was also significant, $t(1, 63)=-2.00$, $p=.05$. The SE to reduce SB Group x Time interaction approached significance ($p=.15$) and the time patterns differed for the groups. The INV group increased SE from the mid-point to post assessment, so that post SE ($M=3.61$, $SD=0.75$) was nearly equal to initial levels ($M=3.63$, $SD=0.69$), whereas SE in the WC group continued to decrease from mid-point to post ($M=3.27$, $SD=0.85$). The difference between groups at posttest was significant, $t(1,63)=1.68$, $p=0.10$. Figure 13 illustrates the rebounding pattern seen in the INV group and the decline of SE over time in the WC group.

Table 7

SE Means

	INV *n*=40			**WC *n*=24**		
	baseline	**mid**	**post**	**baseline**	**mid**	**post**
SE to reduce SB	3.63±.69	3.36±.89[#]	3.61±.75[@]	3.69±.75	3.39±.66[#]	3.27±.85
SE for LPA	3.78±.64	3.55±.67	3.59±.77	3.58±.87	3.35±.60	3.40±.80
SE for MPA	4.03±.93	3.54±.94[#]	3.88±.88[@]	3.5±1.34	3.15±.97[#]	3.45±1.17[@]

*baseline-post, $p \leq .05$
[#] baseline to mid-point, $p \leq .05$
[@] mid-point to post, $p \leq .05$

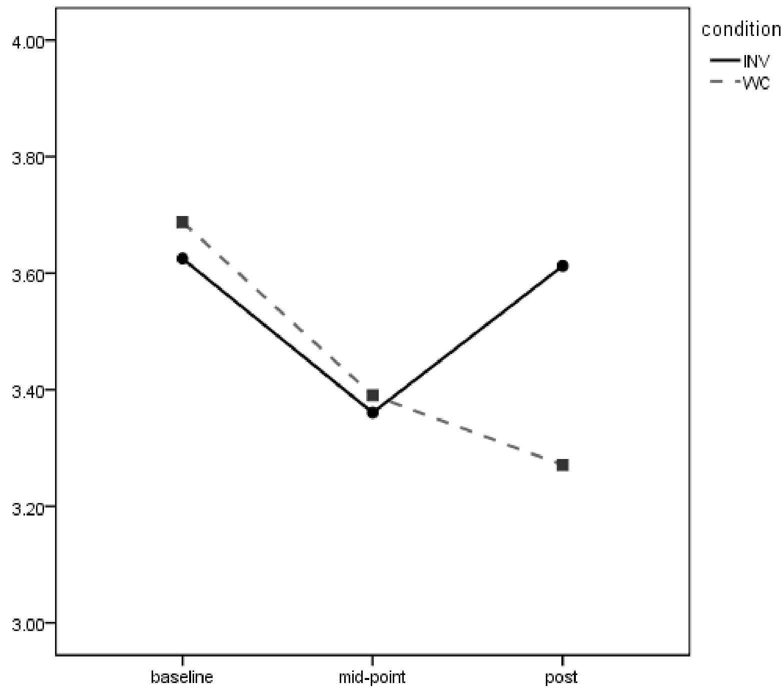

Figure 13. SE to Reduce SB

The SE to reduce SB sub-scale asked participants to rate their confidence in decreasing non-work (item 1) and work-related (item 4) sitting time. Significant Group x Time interactions were found for non-work, $F(2,63)=3.94$, $p=.02$, $\eta_p^2=.07$, and work, $F(2,63)=3.03$, $p=.05$, $\eta_p^2=.05$. A significant time effect was present in SE to reduce non-work sitting, $F(2,63)=2.87$, $p=.06$, $\eta_p^2=.05$. The WC group had a significant decrease, $t(18)=2.17$, $p=.04$, in non-work SE from baseline to mid-point (3.89±.87 to 3.21±.79) and levels remained low at posttest. The INV participants had a non-significant increase in confidence to reduce non-work sitting from baseline to post (3.51±.85 to 3.74±.79), with most change occurring mid-point to post. The Group x Time interaction for work-related sitting resulted from non-significant changes in both groups between baseline and mid-point. The INV group decreased (3.82±.82 to 3.18±1.17) and the WC increased (3.26±1.28 to 3.53±1.02). See Appendix O for graphs of these data.

Self-efficacy for Light Physical Activity

Results of the repeated-measures ANOVA showed a significant time effect in SE for light PA, $F(2,63)=2.74$, $p=.07$, $\eta_p^2=.04$. Both groups experienced decreased SE from baseline to mid-point (3.7±.74 to 3.48±.65), $F(1,63)=3.37$, $p=0.08$, $\eta_p^2=.05$. Self-efficacy was stable from mid-point to post (3.48±.65 to 3.52±.78). See Figure 14 for a graph of the SE for light PA data.

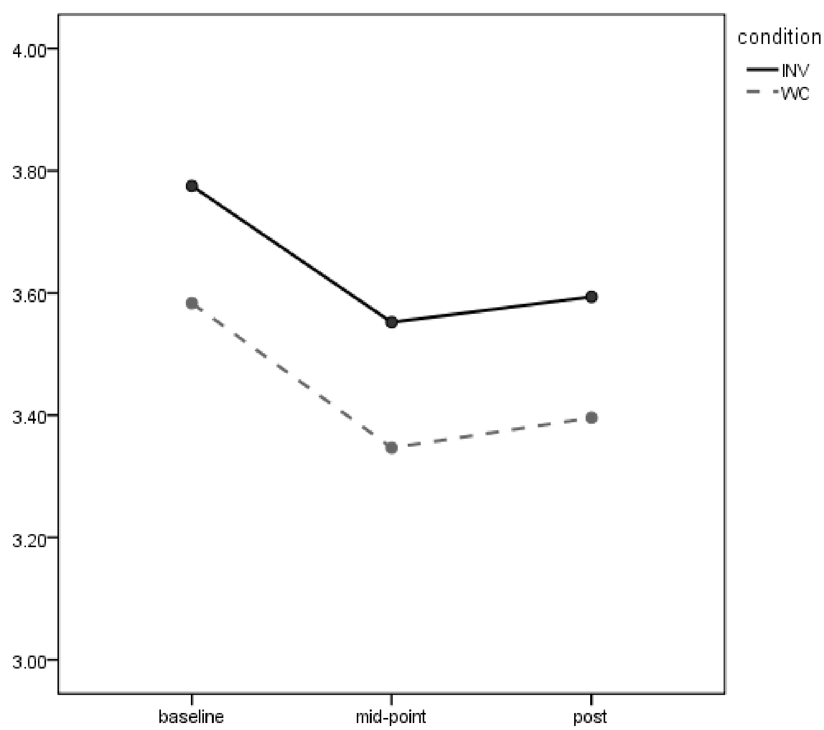

Figure 14. SE for Light PA

Self-efficacy for Moderate Physical Activity

The repeated-measures ANOVA for SE for moderate PA revealed a significant difference between the groups, *F*(1,63)=5.52, *p*=.02, η_p^2=.08, and a significant change in SE over time, *F*(2,63)3.95, *p*=.02, η_p^2=.06. There was no Group x Time interaction. The INV baseline mean (*M*=4.03, *SD*=.93) was higher than the WC mean (*M*=3.5, *SD*=1.33) and remained higher throughout the study. Both groups changed in SE for moderate PA over time with post-hoc comparisons showing significant change from baseline to mid-point (3.83±1.12 to 3.39±.97, *F*(1,63)=6.37, *p*=.01) and from mid-point to post (3.39±.97 to 3.71±1.01, *F*(1,63)=4.06, *p*=.05). The rebound is evident in the graph (see Figure 15).

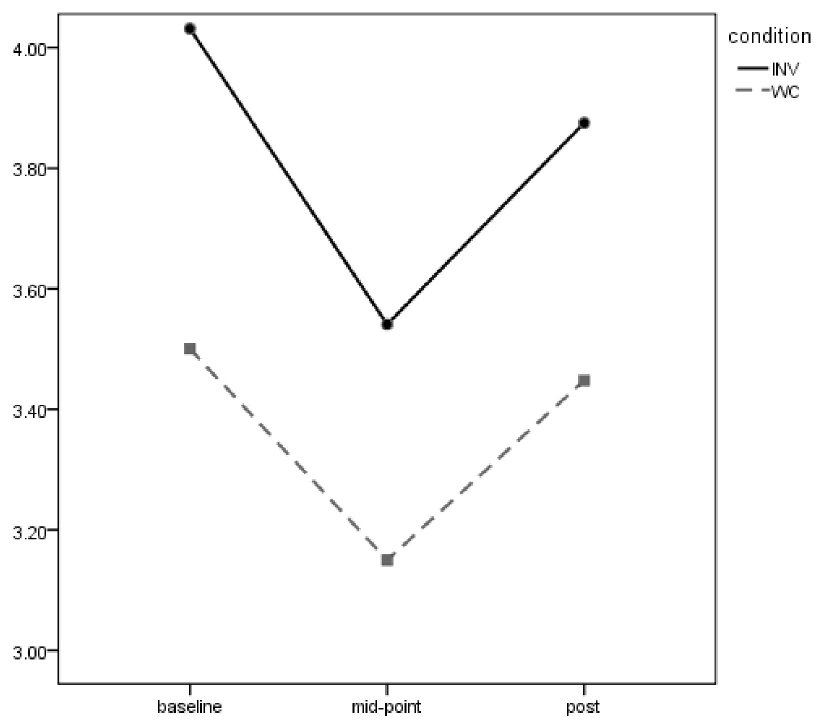

Figure 15. SE for Moderate PA

Correlations between Self-efficacy and Sedentary Behavior

According to the SCT, self-efficacy is the key predictor of behavior (Bandura, 1997) and should be highly correlated to actual behavior. This study did not find a significant relationship between SE and SB at any assessment (baseline, mid-point, post). Self-efficacy was not a significant predictor of change in SB in linear regression analysis. Complete correlation and regression results are in Appendix P.

Research Questions 4-6

It was hypothesized that the INV group would have increased SE to reduce SB, increased SE for light PA, and increased SE for moderate PA as compared to the WC group. These hypotheses were not confirmed by the data. Self-efficacy was not changed in the INV group from baseline to post. There was a significant decline in SE to reduce SB at mid-point. The pattern between INV and WC suggests a response to the intervention for SE to reduce SB though this was not significant.

Process Evaluation

The aims of the process evaluation were to assess the user-friendliness, the challenges to participants, and the perceived benefits of the *On Our Feet* intervention. Intervention dose was examined with repeated-measures MANOVA for behavior and SE, using compliance as the independent variable.

The process evaluation contains both quantitative and qualitative data. Participants were asked to evaluate individual intervention elements, the data collection and study protocol, and the overall effectiveness of the intervention. The quantitative data came from rating scales for enjoyment, effectiveness, and frequency of use. Compliance was determined using the use frequencies for three intervention elements (pedometer step tracking, sitting log use, and reading of emails). Participants who rated two of three elements as 4 (Always) were designated as compliant with the intervention. Open-ended responses to survey items, participant comments, and the researcher's notes provided the qualitative data. The open-ended responses were listed and reviewed for recurring themes. The researcher's notes which contained comments from participants were then reviewed for themes. Simple frequencies were tallied for each appearance of the theme and similar themes were grouped and labeled. These analyses were used to identify factors related to behavior and SE in the study.

Retention

Eleven participants (14%) withdrew during the 8-week study. Attrition in the INV was slightly higher than that of the WC group, with a loss of 7 (14.9%) participants versus 4 (14.3) from WC. Appendix K provides the baseline characteristics of each group and of the drop-out participants. Six of the participants who left the study completed the drop-out feedback form. Nine of the 11 drops occurred within the first 2 weeks of the study. The mostly commonly reported factors related to dropping out were the hassle of wearing the activity monitors and missing an intervention session. Reasons for missing the session included unexpected travel, discontinuing TOPS membership, and illness or injury. Six participants (55%) cited having to wearing the monitors as their primary reason for leaving the study and reported that not having to wear them would be the only thing that would have prevented their attrition. Others indicated that the time commitment was too great (2) or they had not understood the length of the study (2). One went out of town unexpectedly.

Dose Analysis

Twenty-three of the 40 INV participants (58%) were compliant with key elements of the intervention (pedometer, sitting log and reading emails). Compliance did not relate to behavior. There were no significant effects for time or group, and no Group x Time interaction in the repeated-measures MANOVA for behavior. However, SE was different according to compliance. A significant effect for time, $F(2,39)=2.44$, $p=.03$, $\eta_p^2=.09$, and a significant Group x Time interaction, $F(2,39)=2.33$, $p=.04$, $\eta_p^2=.09$, was found for SE. The repeated-measures ANOVA revealed a significant time effect, $F(2,39)=3.89$, $p=.03$, $\eta_p^2=.09$, group effect, $F(1,39)=4.02$, $p=.05$, $\eta_p^2=0.10$, and interaction, $F(2,39)=4.48$, $p=.02$, $\eta_p^2=0.11$, for SE to reduce SB. Significant time effects were seen for SE for light PA, $F(2, 39)=2.33$, $p=0.10$, $\eta_p^2=.06$, and for SE for moderate PA, $F(2,39)=3.99$, $p=.02$, $\eta_p^2=0.10$. The compliant participants maintained SE to reduce SB from baseline to post assessment (3.63±.70 to 3.77±.78), while those who were non-compliant declined at mid-point (3.62±.69 to 2.92±.95) and did not recover at post (3.40±.71). The compliant participants had significantly higher SE to reduce SB at posttest (*M*=3.77, *SD*=0.78) than the non-compliant participants (*M*=3.40, *SD*=.67). See Figure 16 for a graph of the SE to reduce SB data. Both groups had a significant decrease in SE for moderate PA from baseline (*M*=3.98, *SD*=0.15) to mid-point (*M*=3.51, *SD*=0.16) and a non-significant increase in SE for moderate PA at post (*M*=3.84, *SD*=0.14). Self-efficacy for light PA significantly decreased in both groups from baseline (*M*=3.70, *SD*=0.74) to mid-point (*M*=3.48, *SD*=0.65) and remained similar at post.

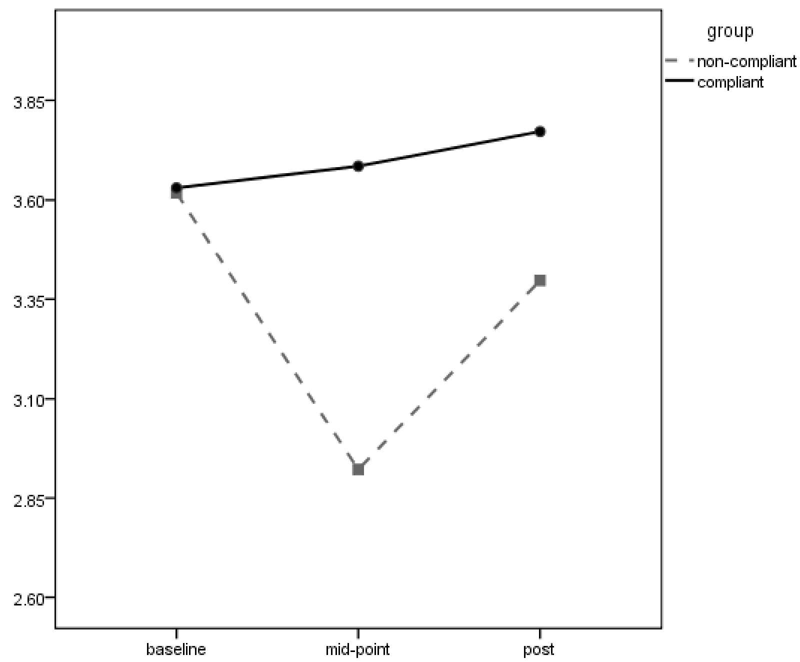

Figure 16. SE to Reduce SB for Compliant vs. Non-compliant

Feasibility

The feasibility of an intervention is not only based on its effect on the dependent variables, but also on its acceptability to participants and its potential for future implementation. Participant views of the delivery methods, overall effectiveness, and ease of use, and suggestions for improvement were solicited at the post assessment. Participants were also asked to rate their level of adherence, perceived benefit, and the barriers of specific intervention elements during the intervention. The researcher maintained a record of observations, reflections, costs, and challenges in implementing the intervention.

Participant ratings of *On Our Feet*. The INV participants (*n*=40) were asked to complete process evaluation questionnaires (Appendix E) during and at the conclusion of the intervention. The questionnaires during the intervention contained rating scales for frequency of use, effectiveness, enjoyment of, and barriers of specific intervention elements. The end-of-study questionnaire asked for ratings of overall satisfaction, effectiveness, and ease of use, and for the use frequency of the pedometer, sitting log, and emails. Complete descriptive statistics for the rating scales are in Appendix T.

Overall perceptions. The post questionnaire contained 13 Likert scales for participants to rate the degree (1-5) to which *On Our Feet* was effective, met their needs, was enjoyable, and was easy to use. The majority of the ratings were positive. The mean for overall satisfaction was 4.07 (*SD*=0.94), with 11 participants indicating that they were only somewhat satisfied and one not at all satisfied. While 67% of the participants said the intervention met their needs, three participants wanted an intervention with more intense PA. Thirty-three respondents (84%) said the intervention was beneficial (≥4) to them. In general, they believed *On Our Feet* was effective at reducing their SB. The average rating for effectiveness was 4.07 (*SD*=0.87), with no one reporting no effect from the intervention. In terms of user-friendliness, participants rated the accelerometer as somewhat hard to wear (*M*=2.84, *SD*=1.31), but indicated that the email messages (*M*=1.74, *SD*=1.27) and study measurements (*M*=1.27, *SD*=0.59) were easy to manage. The ratings for the appropriate time commitment question were more widely spread. While no one marked the time commitment as being too much, only 13 (33%) indicated it was reasonable. Twenty-seven (67%) believed too much time was required. Over half (56%) of the INV participants would definitely recommend *On Our Feet* to others.

***Ratings of intervention elements*.** Ten elements were evaluated during the intervention: the initial presentation, the active stretches, the goal-setting activity, the accelerometer feedback, the behavior cue cards, the pedometer and step log, the sitting log, and videos 1-3. One week after an intervention element was introduced participants were asked to fill-out a brief on-line survey. Each survey followed the same format, first asking how often the element was thought of or used in the last week (4 choices), next rating the interest or enjoyment or ease of the activity (1-5 scale), and then rating the effectiveness of the element (1-5 scale). The post questionnaire asked specifically about the use, effect, and barriers of the pedometer and step log, the sitting log, and the weekly emails. Between 23 and 38 participants completed the surveys each week and all 40 participants responded to the post questionnaire.

The element most frequently used was the pedometer. Mean for pedometer use was 3.68 (*SD*=0.63) initially and 3.63 (*SD*=0.58) at post. Sixty-seven percent of participants said they used the pedometer every week. Two indicated that they stopped using it after the second week of the intervention. The next highest rated intervention element was the goal-setting activity (*M*=3.32, *SD*=0.67, 54%) with 89% of respondents saying they looked at their goals every day or 2-4 times during week 3. Scoring lowest on frequency of use was the sitting log (*M*=1.78, *SD*=0.80) and the third video (*M*=1.87, *SD*=0.92). Only nine participants (22%) reported using the sitting log daily or 2-4 times in week 3 and only six (16%) reported using the log every week. One third of participants (n=13) abandoned the sitting log after the first or second week; while another 12 (30%) reported never using it. Six participants (15%) did not watch video 3 and only eight (23%) of those that viewed it considered doing the behavior demonstrated. See Table 8 for the mean scores of each element's use.

Table 8

Frequency of Element Use or Consideration

Used / Thought Of	***M* (*SD*)**
pedometer	3.68±.63
goals	3.32±.67
acc feedback	2.85±1.30
initial presentation	2.7±.73
active stretches	2.5±1.49
use email	2.48±.72
video 2	2.42±.97
video 1	2.34±.91
behavioral cues	2.17±1.15
video 3	1.87±.92
sit log	1.78±.80
Read, Viewed, or Printed Initially	
read emails	3.96±.75
video 2*	1.11±.32
video 1*	1.15±.36
video 3*	1.15±.37
behavioral cues*	1.6±.50

* yes/no, reverse score

The highest average enjoyment ratings were given to the email messages (4.00±.77) and the pedometer (3.83±1.20). The weekly emails were rated 4 or 5 (greater than some or a lot) by 77% of the participants. The pedometer was also widely enjoyed with positive ratings from 74%, though 26% said they did not like the pedometer at all. The least-enjoyed element was the goal-setting activity (1.6±.50), which had no rating higher than 3 (of 5). Appendix T contains the rankings and statistics for enjoyment.

Participants' beliefs about what elements were effective followed their perceptions about what was enjoyable. The pedometer (*M*=3.82, *SD*=1.07), email messages (*M*=3.6, *SD*=0.96), and the accelerometer feedback (*M*=3.63, *SD*=1.13) were thought of as the most effective intervention elements during *On Our Feet*. Twenty-seven respondents (68%) viewed the pedometer as effective (≥4), while the accelerometer feedback and emails were considered effective by 23 (58%) and 20 (52%) participants, respectively. Though highly used, goal setting was the least effective element (*M*=1.56, *SD*=0.5) according to participants. Eighteen participants (44%) felt that the goal-setting was not at all effective and no one rated it higher than 2(of 5). Only ten respondents (26%) felt that the sitting log was effective at reducing their SB. The post mean for the sitting log was 2.78 (*SD*=1.21), higher than the videos and behavioral cues. See Table 9 for the mean scores of each element's effectiveness.

Table 9

Ratings of Element Effectiveness (1-5 Scale)

	M (*SD*)
pedometer	3.82±1.07
acc feedback	3.63±1.13
email	3.6±.96
active stretches	3.34±.96
sit log	2.78±1.21
video 1	2.63±1.13
video 3	2.60±1.2
video 2	2.57±1.17
behavioral cues	2.40±1.33
goals	1.56±.50

Questions about the ease of use (user-friendliness) of the intervention elements and study procedures were included in the post survey. Participants rated the initial presentation as easy to understand (*M*=4.68, *SD*=0.62). Email and the active stretches were also thought to be easy by 32 (79%) and 33 (82%) respondents. The sitting log (*M*=2.95, *SD*=1.21) and activity monitors (*M*=3.16, *SD*=1.31) were rated as considerably harder to manage and only about one third (n=14) of the participants gave them scores above somewhat easy. Table 10 shows elements ranked by their user-friendliness mean and percentage.

Table 10

Ratings of User-friendliness (1-5 Scale)

	M **(*SD*)**
initial presentation	4.68±.62
body measures	4.51±.59
staff helpfulness	4.4±.70
active stretches	4.29±.90
email	4.26±1.27
time commitment	3.93±.89
activity monitors	3.16±1.31
sit log	2.95±1.21

Participant open-ended responses. Participants had the opportunity throughout the study to provide feedback on the intervention in their own words. The mid-intervention surveys asked for barriers and suggestions for improving each element. The post questionnaire asked participants to explain why they volunteered for the study, what benefits they received, what aspect they found most helpful, what aspects they disliked, and what improvements should be made. A complete list of participant themes and frequencies is available in Appendix U.

Barriers. The barriers cited by participants were consistent for all intervention elements. These included job or family responsibilities that required sitting, an injury or illness that limited the amount of time they could be active, general fatigue, and forgetfulness. Many responded that there were no barriers for the email messages

(38%) or for using the pedometer (23%). For a larger number (63%), accuracy or wear issues of the pedometer was a barrier. The open-ended responses pointed to a greater lack of compliance than indicated by the rating scores. Delays in reading email, not watching videos, and not printing out the cue cards were noted by 17 participants as a barrier to changing their SB. Use of the sitting log was limited by both the format of the log sheet (too small, too detailed) and by the challenge of tracking breaks and sitting time.

The concept of relevance emerged in participants' comments about the active stretches and videos. Seven participants chose not to do the stretches because they felt that exercise activities they were already doing were superior to the suggested movements or they had chosen other activities to do during their breaks from sitting such as household chores. Twelve participants indicated that the activities in the videos were either things they already did or were things they could not do because of lack of access. For example, one woman reported not having a cordless phone and could not walk while talking on the phone.

Improvements. The most suggested improvement was to use a more accurate pedometer. This was followed by finding a more secure way to attach the accelerometer and pedometer, and preventing the accelerometer from rubbing against the skin. Participants also suggested ways to increase compliance with behavioral cues and videos, such as handing out the behavioral cues cards in person, printing the cues on sticky notes, and embedding the videos into the emails rather than linking to YouTube.

Suggestions for the sitting log were to discontinue using it or to re-design it so that there were larger spaces to write in. Specific improvements the women would like to see were focused on behavior monitoring with the accelerometer and pedometer.

Motivation to participate and benefits. The three most common reasons for participating in the study were to change their behavior (sitting, light PA or exercise), to increase awareness about their sitting or steps, and to realize some benefit (weight loss, health, or calorie expenditure). The benefits participants listed reflected their initial intentions. Awareness and behavior change were by far the most frequently mentioned benefits. Five statements were made regarding realizing particular outcomes. Participants noted less fatigue (2), reduction in body size (1), less joint pain (1), and lower blood sugar (1).

Most helpful for behavior change. Participants also listed multiple elements of the intervention they considered the most helpful in changing their behavior. Using the pedometer had the highest response frequency and was mentioned by 32 of the 40 participants. This was followed by the accelerometer feedback and the weekly emails. Only one participant noted the sitting log and just three felt that the videos were helpful.

Summary of Emerging Themes

All open-ended responses were read for themes, and similar themes were grouped together. Seven themes within two categories (motivation and barriers) were identified from the process evaluation open-ended responses of participants. A diagram of these themes and their tallies is in Appendix U along with selected participant quotes. The researcher kept a record of the study's implementation. Her impressions of the challenges, successes, and her interactions with participants were reviewed for themes. Statements from the journal along with those found in email messages from participants revealed four broad themes related to challenges and needed improvements. The list of researcher themes and a collection of quotes are available in Appendix V.

Participant motivation. The first category summarizes participants' motivation for the intervention and the benefits they perceived. These themes were awareness and behavior change. Participants cited increasing their awareness of either sitting time or daily steps as a reason for participating. For example, a 56-year old participant wrote; "I needed to find out how little activity I normally do." Awareness of these behaviors was the most common benefit listed by participants. Behavior change had fewer confirmations as a benefit than did awareness. One 47-year old participant responded that "I enjoyed it. Made me try to walk more, not take shortcuts." But, statements about awareness post intervention were more common, such as "realizing that light physical activities count too" (35-year-old).

Participant barriers. The second category of themes relates to challenges and barriers faced by participants as they used the intervention to change their behavior. The five themes address both specific situational barriers and more global attitudes or influences. The theme of job or family responsibilities requiring SB was repeated across nearly all questions. The women felt that work outside the home restricted their ability to move more, and that many tasks at home had to be done seated. Sarah, age 37, remarked that "required meetings that you can't get up from" were limiting her ability to reduce SB. Some comments about responsibilities merged with the theme of physical limitations, citing that fatigue kept them from being more physically active. For instance, a 53-year-old grandmother responded, "After dealing with stressful work and watching after a 3-year-old, my feet are ready for a sit-down break." Physical limitations were the second most common barrier to reducing sitting behaviors. Included in this theme were comments of injury, illness, or general fatigue that made the intervention elements difficult to engage in. A third, more global theme, was that of routine. Many participants cited being busy and forgetfulness as the main barrier. References to habit, laziness, and desire to spend quiet time with loved ones were included in the routine theme.

A surprising theme was that participants felt that aspects of the intervention were not relevant to them and chose not to engage with them. The active stretches and videos were most often cited for this barrier, but the not relevant theme was also found in statements about the sitting log, behavioral cues, and email messages. For example, a 52 year-old wrote "I don't sit long enough at one time to do the stretches." Reasons for considering the element not relevant included selecting other active options, feeling that the suggested change was not possible because they either did not do that behavior (watch television), or that they did not have access to that option (stairs), or that they were exercising at a level that made the suggestions seem too easy to be beneficial for them. An 84-year-old stated that "I usually do a more intensive series of yoga stretches which far surpass the ones demonstrated . . ."

The last barrier theme was specific to the pedometer. Keeping the device on, willingness or ability to wear it to certain events (for instance with a dress to church), and the pedometer's missed steps were seen as limiting factors in the intervention's effectiveness and created a barrier to compliance. A 61-year-old participant wrote of the pedometer, "Frustration—used it on one day, walked on treadmill and it didn't register!"

Researcher themes. Journal entries contained both the researcher's observations and thoughts during the study, and comments from participants. The researcher's notes were slanted towards a more critical view of the intervention's implementation with most entries reporting an issue, challenge, or needed improvement. Comments from participants more often were positive accounts of perceived benefits, raised awareness, and gratitude. Four broad themes emerged: (a) the reliability of accelerometer output affected the researcher's workload and the quality of feedback, (b) careful planning is needed to execute intervention consistently for all participants, (c) participants were generally positive about their experience despite significant issues with the monitors, and (d) improvements.

Reliability of accelerometer output. The first theme was the greatest frustration the researcher experienced during the study. The Actigraph software used to analyze the accelerometer activity counts went through four revisions during the study. Initially, the software was not removing non-wear time from its analysis causing overestimates in SB. In order to provide chapter 1 with their accelerometer feedback on schedule, the researcher had to develop a patch formula in *Excel* (©Microsoft, 2010) to adjust the SB and PA percentages. A journal update on the feedback process began, "So far I have spent 6 hours on the problem and have sheets for five participants. I am concerned that the overall data has too high of a wear time because the daily average SB times range from 13-19 hours." Later software updates adjusted how non-wear time was determined and filtered, so that the initial feedback differed slightly by chapter. In particular, participants in chapter 1 received estimates of SB that were inflated. This issue was very time-intensive as each participant's data had to be analyzed twice to create the feedback and several emails and phone calls with the software company were needed to fix the problem. Baseline and post assessment data for the study were re-analyzed using the most up to date Actigraph procedure so study findings were not affected.

Careful planning. This theme points to a lack of fidelity and variations in the intervention schedule that could have impacted the results. The most significant issue was the schedule difference between chapter 3 and the other INV chapters. Due to schedule conflict with the chapter's host, the initial presentation and the goal setting activity took place at the same meeting. Participants received extra email and phone contact to answer any questions during the second week of the intervention. Another scheduling difficulty was that the post assessment for chapters 1 and 2 fell over Labor

Day weekend. Comments from INV participants suggested that they did much more sitting than they had been doing since the start of *On Our Feet*. Because no match was found for chapter 7, it was started between pair 2 and 3, putting it a little ahead of schedule of the other INV chapter. Journal entries indicated a concern that this group was not getting the same amount of contact as the other INV chapters. Time during the in-person sessions also affected the fidelity. While the visual aids were the same for each presentation, some aspects were more deeply explained than others based on participant questions. An example of this concern was found in the journal after chapter 3's goal setting session, "I'm not sure how well they are getting the concept of this not being exercise. Many of their strategies for the breaks and steps were MPA related." Also, the proposed activity of small group discussions on the emotions they associated with sitting had to be removed to keep the sessions within their time allotment.

Positive experiences. Participants were generally positive about the opportunity to participate in spite of several noted difficulties (accelerometers rubbing skin, computer issues, and unreliable step counts). The chapter 3 leader wrote the following, "Kudos to you for bringing a new concept of 'movement' to our chapter. I know that for me and my mom, it has brought a lasting and creative change to our daily routines." Some participants were very helpful in suggesting solutions for the activity monitors or in sharing their ideas for taking breaks from sitting.

Improvements. The last theme groups together all of the areas for improvement. The first improvement must be to the activity monitors. There were numerous entries about wearing the accelerometer and the pedometer. Problems included broken skin, discouraging low step counts, and devices falling off frequently. Next, there were several researcher miss-steps in feedback, email delivery, and the in-person sessions that can be corrected. Lack of automation with the feedback was mentioned specifically. “What I have seen of the *DirectLife* program is pretty much what I was going for—personalized feedback and positively framed behavior coaching. My problem is not being automated.” The 30-minute presentation time was too short and segments of the presentation had to be cut or rushed. Finally, concerns about how well the intervention matched the lives of participants were found in the journal. The infrequency of email use among some of the women was surprising. Differences in daily activities, hobbies and jobs meant that not all the suggestions would work for everyone.

Research Question 7

It was hypothesized that participants would positively evaluate the content and delivery method, and report physical and psychological benefits. This hypothesis was confirmed. Overall, participants gave *On Our Feet* positive ratings for effectiveness, user-friendliness, and enjoyment. They reported increased awareness of sitting time and motivation for light to moderate PA with a few noted physical benefits. Additionally when compliance with key intervention elements was considered, the effect of the intervention on SE to reduce SB was significant.

Results of Exploratory Analyses

A number of dependent variables were measured for which there were no formal research questions or hypotheses. Researchers have identified decreased waist circumference as a potential benefit of reduced SB (Healy et al., 2008b; Tremblay, Colley, Saunders, Healy, & Owen, 2010), but few trials have tested this relationship. Participant BMI (in kilograms) and waist circumference created a third category, called body size, examined by repeated-measures MANOVA. In light of participant responses to process evaluation question, the differences between the feedback provided by the pedometer and the accelerometer-determined steps were considered. Changes in steps were assessed in a Group x Time repeated-measures ANOVA. The amount of agreement between the two measures was examined with bivariate correlations. Finally, the researcher noticed that women from rural communities reported fewer sitting activities (TV, computer, etc.) and more active hobbies or chores (gardening, caring for animals, cooking at home). Therefore, the effect of rural versus urban location was examined with univariate tests on SB, PA, and SE.

Body Size

Repeated-measures MANOVA for BMI and waist circumference found a significant Group x Time interaction $F(2,63)=8.17$, $p=0.001$, $\eta_p^2=.21$. There were no effects for time or group for body size.

BMI. The univariate Group x Time interaction for BMI was non-significant (*p*=.14*)*. For both groups BMI was unchanged over time (36.44±7.70 to 36.48±7.85). There were no significant differences between the groups.

Waist circumference. Univariate analysis found a significant Group x Time interaction for waist circumference, $F(1,63)=16.0$, $p=.001$, $\eta_p^2=.21$. The INV group's mean baseline waist circumference of 108.54 (*SD*=15.91) cm dropped significantly to 106.24 (*SD*=15.82) cm at posttest, $t(1,39)=5.09$, $p=.001$. Waist circumference was not significantly changed (105.40±13.52 to 107.01±13.07 cm) in the WC group. There was no group effect. See Figure 17 for a graph of the waist circumference data.

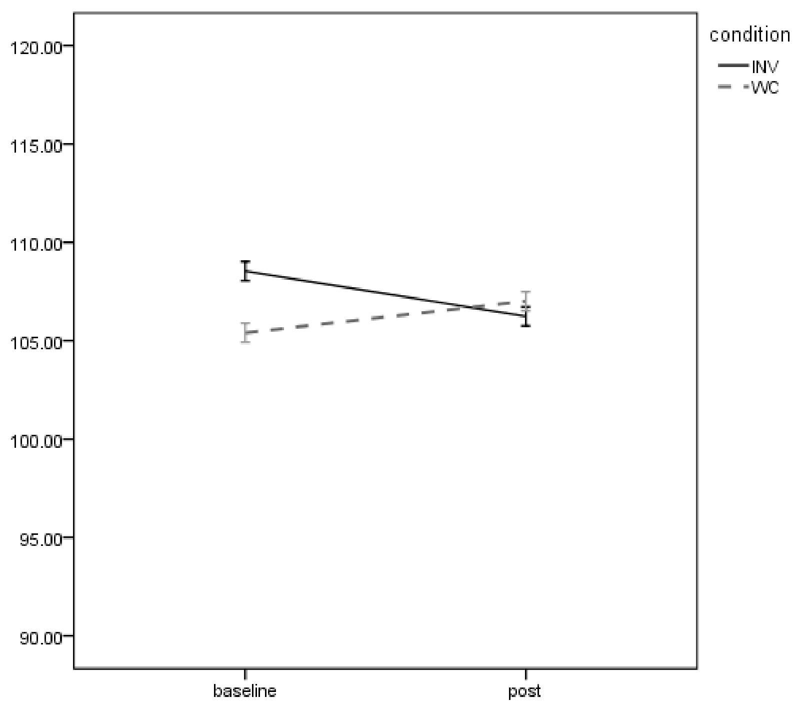

Figure 17. Waist Circumference

Steps

Accelerometer-determined steps in the INV group increased from 37878 (*SD*=17766) to 38252 (*SD*=22904), while the WC participants decreased from 30883 (*SD*=18169) to 26222 (*SD*=19245). However, repeated-measures ANOVA found no effect for time or Group x Time interaction. Accelerometer-determined steps were significantly different by group, $F(1,56)=2.98$, $p=0.09$, $\eta_p^2=.05$, with the INV group having greater steps at the both assessments. Pedometer steps were only tracked for the INV group. Mean steps rose from 15178 (*SD*=13543) per week at baseline to 25359 (*SD*=22143) at week 5 and to 29383(*SD*=38065) at the post assessment. Time x Chapter repeated-measures ANOVA found that pedometer steps increased significantly over the intervention, $F(2,39)=8.46$, $p=.001$, $\eta_p^2=.20$, and that a significant Time x Chapter interaction was present, $F(6,39)=3.19$, $p=.01$, $\eta_p^2=.22$. The change from baseline to post is significant, $F(1,39)=28.21$, $p=.01$, $\eta_p^2=.44$ as is the increase from baseline to week 5, $t(1, 39)=-4.91$, $p=0.001$. Figures 18 and 19 illustrate the change in pedometer steps over time. For each INV chapters, except chapter 7, pedometer steps peak at week 5 and decreased at post assessment.

The correlation between accelerometer-determined steps and pedometer steps was stronger at baseline ($r=.72$, $p<.01$) than at posttest ($r=.52$, $p<.01$). The lower level of agreement between the measures at post may explain the difference in the time effects between the accelerometer steps and the pedometer steps.

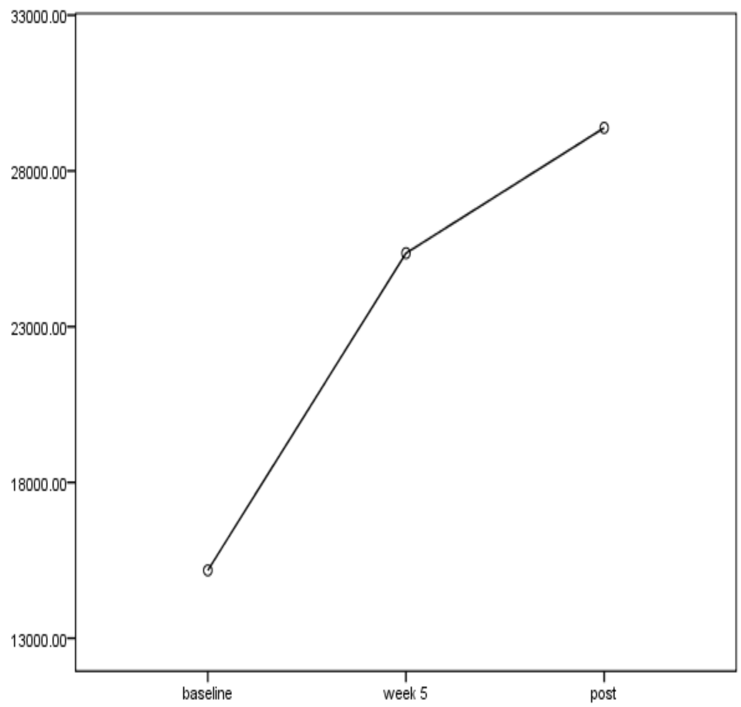

Figure 18. INV Pedometer Steps

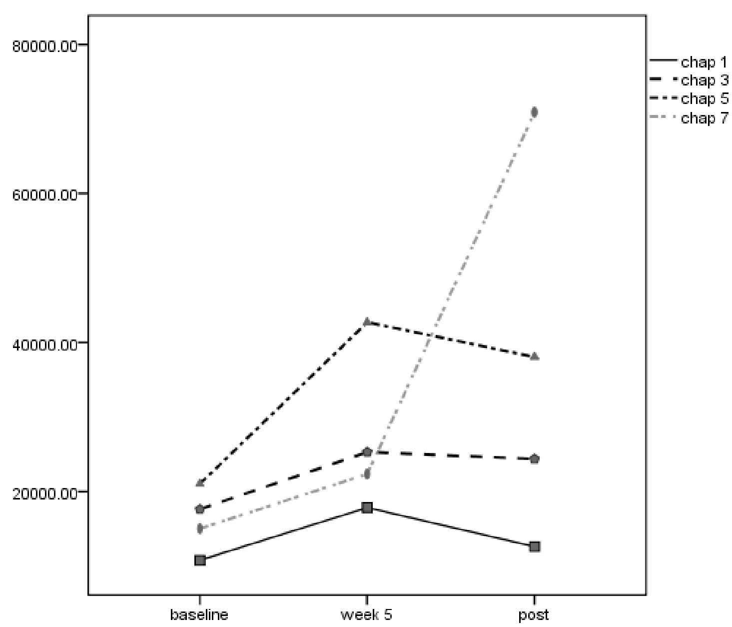

Figure 19. Pedometer Steps by Chapter

Tudor-Locke and colleagues (2004; 2008; 2011a) have established categories based on daily step cut points. The six categories range from basally active (<2500 steps a day) to highly active (≥12,500 steps a day). Using the post accelerometer-determined steps, 41% of participants would be labeled as having limited activity (2500-4999) and 34% were in the low active category (5000-7499). A chi-square test found no significant differences between the groups for activity category.

Rural Location

Analysis of variance for SB, light PA, moderate PA, and SE were repeated using location as the independent variable. Two INV chapters (3 and 5) and one WC chapter (6) were labeled rural (*n*=24). The four urban chapters included two INV chapters (1 and 7) and two WC chapters (2 and 4), with a total of 40 participants.

The ANOVA for SB found a significant group effect for SB, $F(1,57)=4.69$, $p=.04$, $\eta_p^2=.08$, with rural participants having a lower percentage of SB ($M=45.53$, $SD= 2.05$) than the urban ones ($M=51.23$, $SD=1.66$). Significant group differences were also found in light PA, $F(1, 57)=2.85$, $p=0.10$, $\eta_p^2=.05$, and in moderate PA, $F(1, 57)=2.93$, $p= 0.09$, $\eta_p^2=.05$, with rural participants engaged in higher levels than urban participants. A significant Time x Group interaction occurred for light PA, $F(1, 56)=3.04$, $p=0.09$, $\eta_p^2=.05$. Rural participants had a non-significant decrease in light PA while the urban women maintained a lower level of light PA over time (See Figure 20). Table 11 provides the SB and PA means for rural and urban participants.

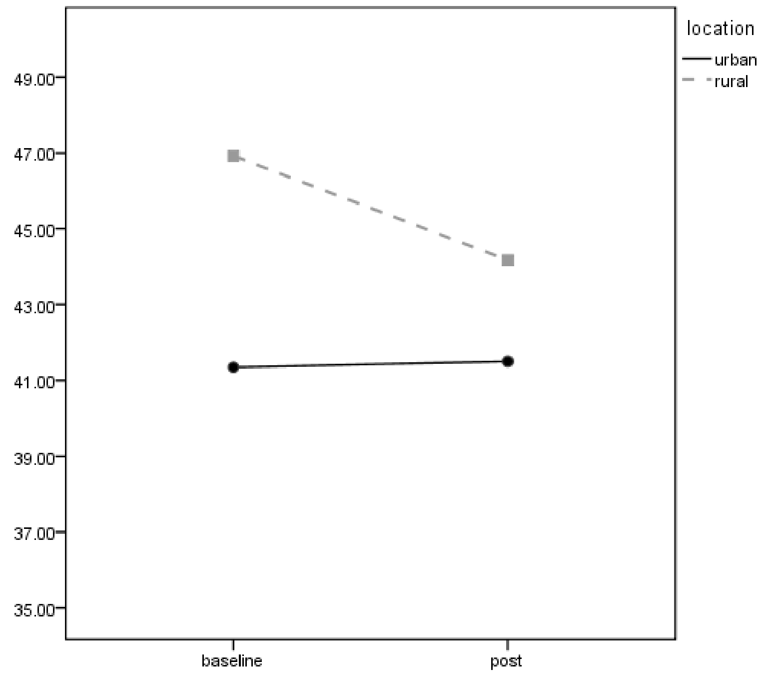

Figure 20. Light PA by Location

Table 11

Behavior by Location

	Urban (*n*=35)		**Rural (*n*=23)**	
	baseline	**post**	**baseline**	**post**
% SB	50.93±12.31	51.54±12.29	44.44±10.13	46.61±10.96
% LPA	41.35±10.23	41.5±10.55	46.92±7.73	44.17±8.73*
% MPA	7.05±3.76	6.78±4.17	9.25±6.19	8.58±5.25

*baseline-post, $p \leq .05$

The repeated-measures ANOVA revealed a significant difference between groups for SE to reduce SB. Baseline means for SE to reduce SB were higher in urban participants than for the rural group, $F(1, 63)=4.75$, $p=.03$, $\eta_p^2=.07$. This gap narrowed some at mid-point and remained at the post assessment (see Figure 21). Significant time effects were seen in SE to reduce SB, $F(1,63)=2.43$, $p=.09$, $\eta_p^2=.04$, and in SE for moderate PA, $F(2, 63)= 4.22$, $p=.02$, $\eta_p^2=.06$. Self-efficacy to reduce SB decreased significantly from baseline to mid-point, $F(1, 63)=4.33$, $p=0.04$, $\eta_p^2=.07$, but was unchanged from baseline to post. Self-efficacy for moderate PA changed significantly from baseline to mid-point, $F(1,63)=6.76$, $p=0.01$, $\eta_p^2=.10$, and from mid-point to post assessment, $F(1, 63)=4.12$, $p=0.04$, $\eta_p^2=.07$, for both locations, and was similar to previous findings for SE for moderate PA (see Figure 15). Table 12 contains the means and standard deviations for SE. A complete ANOVA results are in Appendix N.

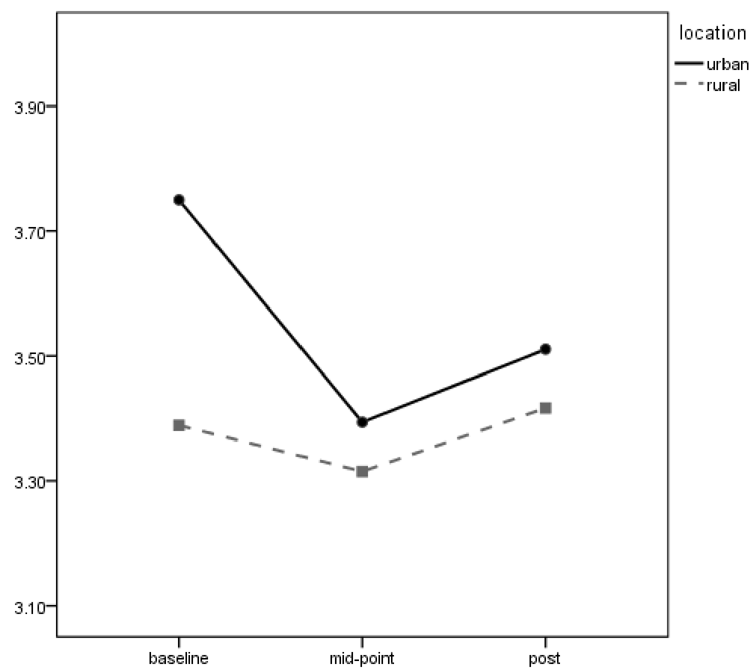

Figure 21. SE to Reduce SB by Location

Table 12

Self-efficacy Means by Location

	Urban (*n*=40)			**Rural (*n*=24)**		
	baseline	**mid**	**post**	**baseline**	**mid**	**post**
SE to reduce SB	3.8±.73	3.45±.76*	3.61±.82	3.4±.58	3.25±.89	3.27±.73
SE for LPA	3.74±.71	3.43±.69*	3.51±.81	3.65±.79	3.55±.57	3.54±.74
SE for MPA	3.79±1.15	3.34±.94*	3.64±1.06	3.9±1.08	3.48±1.02	3.84±.92

*baseline-post, $p \leq .05$

Bivariate correlations between location and behavior, found that living in a rural location was significantly related to lower percentages of SB (r_{pb}=-.27, p<.05) and higher percentages of light PA (r_{pb}=.29, p<.05), whereas, urban location was negatively associated with light PA (r_{pb}=-.27, p<.05) and positively related to SE to reduce SB (r_{pb}=.30, p<.05). Appendix Q contains the Pearson correlations between several participant characteristics and behavior and SE.

CHAPTER V

DISCUSSION

The purpose of this study was to test the feasibility of an intervention to reduce SB and increase PA. The *On Our Feet* intervention was based on the SCT and targeted SE through mastery experiences from reducing sitting time and increasing light PA. The intervention was delivered in group sessions and by weekly emails over six weeks. Participants were given feedback on their initial levels of SB and PA, were led through a goal setting activity, and provided with self-monitoring tools. Positively-framed email messages that contained peer-modeled alternatives to sitting and additional behavioral feedback were sent weekly. Changes in behavior and SE over 8 weeks were compared between INV and WC groups using repeated-measures analysis.

Interpretation of Findings

No differences were found for SB, PA, or SE between the INV and WC groups. The exploratory analyses and the process evaluation reveal a number of positive outcomes and provide many opportunities to refine the intervention. The results for each of the seven hypotheses are discussed, followed by the exploratory findings.

Sedentary Behavior and Physical Activity

Objective measures of SB and PA did not improve with the intervention. The univariate tests on self-reported PA indicate that INV participants perceived an increase in PA and a reduction of SB.

Hypothesis 1. *The intervention group would reduce time spent sitting from baseline to post as compared to the waitlist control group*. There was no difference in time spent sitting between the INV and the WC group. Generally, SB from baseline to post was unchanged in the INV group. Eighteen INV participants (47%) decreased their SB, but nearly as many WC participants (45%) did as well.

Three factors contributed to the lack of significant change. The first was the uniqueness of the sample itself. The second factor was participant compliance and the barriers to reducing SB. Finally, there were deficiencies in the planning and implementation of the intervention that contributed to the lack of significant change.

Sample. The percentage of time spent in SB in this sample differs from those previously reported in the literature. Both groups engaged in less SB than expected for their age and BMI, creating a floor effect. The average daily SB in non-Hispanic Caucasian women aged 40 to 59 years in the U.S. is 7.74 hours (Matthews et al., 2008) and prior literature had reported that obese women tend to sit even greater amounts (Johannsen et al., 2007). The expectation was that participants from TOPS would be at least as sedentary, if not more so than the NHANES estimate of 56.8%. However, the average daily sedentary time of this sample at baseline was only 6.03 (±1.95) hours or approximately 48% (47% INV, 50% WC). In the INV group, SB at baseline ranged from 30% to 74%.

While no standard exists for how much sedentary time is too much (Owen et al., 2010a), Healy et al. (2011a) found increased cardio-metabolic risk in people who spent 8.5 hours a day (53% of the average 16 hour wake time) in SB compared to those who had 7.24 hours of sitting (45%). Only nine women (23%) in the INV had sedentary time equal to or greater than this risk level. The fact that 18 INV participants improved an average of 6.1% is remarkable given the low prevalence of SB. Ten of those who improved were below 53% already. These decreases were offset by the 20 INV participants who increased their SB by an average of 5.8%. Among those who increased were women that initially had the lowest amounts of SB. Sixteen INV participants had baseline percentages below 53% and eight were under 40%. These participants had large changes in their behavior, ranging from 10-30%, possibly indicating that either the baseline or post week was unusual for them. A significant reduction from 47% was not likely given the variability of the SB and the limited number of women who had high amounts of SB.

Factors that may have contributed to the uniqueness of this sample include age, location and type of employment. The age range (35-84 years) meant that participants came from different life stages. Some were working and caring for children; some were working but without children at home, and others were retired. Grouping them into a single sample, may have hurt the study's ability to create meaningful estimates of women's SB. A difference in SB between the women from urban and rural communities was seen in the study. Rural participants made up 38% of the sample. While it's assumed that population-based data such as the NHANES would be geographically diverse, reports on SB (Matthews et al., 2008; Tudor-Locke et al., 2010a) do not provide this information. Lastly, 16 participants were employed in non-sedentary jobs (nurse, teacher, factory labor, and cashier). Though not statistically significant, those with non-sedentary jobs sat less and contributed to the lower than average SB of the sample. Post-hoc analysis with these factors as a covariate did not change the results for behavior.

Compliance and barriers to reducing sedentary behavior. There was an even split between INV participants who reduced their sedentary time and those who increased it. No specific individual characteristic explained why someone did or did not improve. Age, rural location, sedentary versus non-sedentary job, and SE were not related to decreased SB in the INV group. Even participants who were highly compliant with the intervention did not have a change in SB. Participants' open-ended responses to the process evaluations were useful in identifying barriers and areas of non-compliance.

Barriers to reducing SB included physical limitations such as fatigue or illness, home and work tasks that required sitting, and difficulties related to creating new habits such as forgetfulness, valuing current routines or a lack of time. Lack of energy and a busy life are often cited as a reason for not engaging in regular PA (King et al., 1992; King et al., 2000). It is interesting to note that these factors could be a challenge to reducing SB as well. Daily tasks that participants felt confined to sitting positions included using a computer, attending professional meetings, assisting children with homework, and spending time with family. Aspects of both the built-environment and the social environment appeared to influence participants' ability to reduce their sitting time. Built-environment issues, such as no access to stairs and having conventional sitting workstations, were mentioned as a barrier to being more physically active at work.

The intervention itself may not have been strong enough to help participants overcome barriers. The changes suggested in *On Our Feet*, either were not specific enough to combat these challenges or participants had not internalized the message of making their daily tasks more active. Possibly it takes longer than six weeks to form the intention to change and develop the necessary adjustments to rote behavior patterns and the environment.

Compliance issues were found with intervention elements intended to prompt specific behaviors. Only 40% of participants reported printing and using the behavioral cues compared to the 97% that used the pedometer or 55% that used the email messages. The videos of peers choosing more physically active behaviors also were not widely used by participants (23-53%). The dose analysis was based on compliance with step counting, reading emails, and using the sitting log, so the particular impact of not using the behavioral cues or videos is not known.

The four behavioral cues (stand up every hour, leave the remote at TV, lighter loads- make more trips, and be a walkie talkie) were prompts for specific non-sedentary behaviors. Participants were asked to print the notes and put them in locations that would remind them to do the behavior (stand up every hour card on their computer monitor). Videos one and two were demonstrations of leaving remote at TV and walking while on the telephone. Had participants followed the behavioral cues a noticeable change might have occurred in SB and in step counts. Gardiner et al. (2011b) detected a 3% change in SB with a sample size of 59. In the TOPS sample, a 3% change equals approximately 11 minutes a day. By taking a one-minute stretch break for every hour of sitting, the TOPS women would have reduced SB by seven minutes and been much closer to a detectable change. Behavioral cues have been successful in changing planned exercise behavior (Prestwich, Perugini, & Hurling, 2009) and stair use (Boutelle, Jeffery, Murray, & Schmitz, 2001). Situational and environmental cues have been described as a key in habit formation (Maddux, 1993; Rhodes & Nigg, 2011). Reasons for not using the cue cards included the belief that activity was not relevant or that the cue would not be effective. Participants reported that their sitting was often interrupted by other tasks so planned breaks were not needed, they were already doing the cued behavior (TV remote was broken so channels were always changed by hand), or that they could not do the behavior because they did not have a cordless phone (walkie talkie) or they didn't watch TV. Perceptions about the lack of effectiveness of the cue cards were both specific to the card itself and to the overall concept of increasing PA through tasks of daily living. Comments that cue cards would become un-noticed scenery and that doing moderate PA afforded them the privilege of sitting were less common than those about the relevance of the suggested activities.

Maintenance of behavior change. The third factor was the timing of the post assessment. It is possible that reductions in SB peaked prior to the post assessment. Intervention participants reported a significant decrease in self-reported weekly sitting at the mid-point assessment (Appendix O). Week 5 pedometer step counts were significantly higher than baseline counts (Figure 17) and had peaked for all but one chapter (Figure 19). Though not intended, the completion of the step goal may have signaled the end of the intervention to the participants. The post assessment occurred 2 weeks later. Email messages in weeks 5 and 6 provided individual feedback on the step goal, contained a video of a peer modeling taking the stairs instead of the elevator, and offered participants a blank goal setting worksheet, step log, and sitting log to continue their progress. Unfortunately, no data were gathered on how many of the women set new goals related to reducing their SB. This was an oversight by the researcher. The process evaluation ratings show that goal setting was the least-enjoyed element of the intervention and that the last video (week 6) was the least-viewed of the videos. More than likely, a majority of the INV did not develop new goals for their SB. Without a specific plan or goal, maintenance of the new behavior would not be expected. A meta-analysis by Williams and French (2011) found that action planning had the second largest impact of PA (d=.38) and resulted in the highest effect size for SE (d=.49).

Maintenance of PA behavior change has been associated with greater frequency of prompts and use of self-monitoring (Fjeldsoe, Neuhaus, Winkler, & Eakin, 2011). Improvements to the intervention such as additional step goals and other self-monitoring elements for SB are warranted.

The assertion that SB changed prior to the post assessment is based on multiple measures that indicated a behavior change during the intervention; step counts and self-reports of sitting and PA, SE, and the process evaluation ratings showing that participants were engaging in most of the elements during the first 3-5 weeks of the intervention.

Another methodology concern is the recent literature indicating that pedometer steps may not be accurate markers of reduced SB. Tudor-Locke and colleagues (2011a) found only a modest relationship between uniaxial accelerometer-determined steps and SB (R^2=-.25). The relationship between pedometer steps, a self-monitoring tool in the intervention, and SB could be even smaller given that pedometers are not sensitive to low intensity movements (Behrens & Dinger, 2011). Post hoc analysis found the R^2 value between time spent in SB and pedometer steps to be low (.03 -.04). Step counting to reduce SB has been used successfully in other studies (De Cocker et al., 2008; Dewa et al., 2009; Gilson et al., 2009). While pedometers are widely available, easy to use, and provide participants with immediate feedback, their utility may be limited in SB interventions when the key variable is sitting time rather than steps.

Hypothesis 2. *The intervention group would increase the amount of time engaged in light physical activity from baseline to post as compared to the waitlist control.* There was no change to the amount of time spent in light PA in the INV group. No difference between the groups was seen for light PA. The amount of light PA engaged in is normally inversely proportional to SB (Hamilton et al., 2008). Percentage of time spent in light PA for study participants was 44% at baseline and 43% at posttest. The correlations between light PA and SB improved over the course of the study, from -.47 to -.91, but, without changes to SB, it would be unlikely that light PA would change.

One explanation specific to light PA could be that the self-monitoring tools (pedometer and sitting log) and the goal setting activity did not account for standing. The feedback back given to participants was based on meeting or not meeting two goals; breaks from sitting and weekly steps. Standing options, such as standing while the computer boots up or reading at the kitchen counter instead of a table, were suggested to participants and standing was demonstrated in the active stretches. But, there was no specific monitoring of standing, which is a light PA. Participants could gauge their daily movement from their pedometer step count, but if participants chose to reduce sitting by standing for some tasks they were not provided any reinforcing feedback. Possibly participants tried the standing alternatives in the initial weeks of the intervention, but discontinued them because they did not see increases in their step count.

Participants also had difficulty distinguishing between activities that reduced SB through light PA and those that would be categorized as moderate physical activities. In the group brainstorming and goal-setting elements participants often suggested lengthening their walking time or doing exercise, rather than shorter activities of daily living. Pedometer counts for the INV showed steady increases at 5 weeks and at posttest, whereas participants' self-report of light PA peaked at mid-point (week 3) and declined at post. This may indicate that participants added more intense PA to increase their step counts. While there was no significant change in self-reported moderate physical activities, the post mean for the INV is slightly higher than baseline (12.8±13.9 from 11.05±13.37) and self-reported vigorous PA increased from mid-point to post assessment. Those increases to moderate and vigorous PA were short lived and were not detected in the accelerometer data. The fact that pedometer and accelerometer-determined steps were higher at post but the accelerometer-determined percentages of light and moderate physical were unchanged, points to the lack of congruence between these outputs reported by Tudor-Locke, et al (2011a).

Hypothesis 3. *The intervention group would increase the amount of time engaged in moderate physical activity from baseline to post as compared to the waitlist control.* Moderate PA was not changed by the intervention. The factors limiting the change in moderate PA, timing of post assessment and behavior maintenance, were described previously as they related to SB and light PA. Increases in moderate PA may have peaked between weeks 3 and 5 and thus were not detected by the posttest in week 7. Self-reported moderate PA was elevated at mid-point as were week 5 pedometer steps.

Participants in this study would be categorized as insufficiently active for not meeting the guideline of 150 minutes a week of moderate PA (Haskell et al., 2007). Actual bouts of moderate PA (what counts towards the 150 minutes goal) only averaged 1.3 per week with a mean duration of 26 minutes each. However, when compared to national averages this sample was more active than norms for gender and BMI. The TOPS women spent slightly less than 8% of their time in moderate PA, which amounted to a total of 53 minutes a day. A study using NHANES data from 2005-06 found that the average adult female accumulates just 20 minutes in total moderate PA a day (Tudor-Locke et al., 2010a). Women who are overweight or obese engage in even less, 18 and 13 minutes respectively. When considering the full PA panel (levels of SB, light PA, moderate PA, and steps) provided by the accelerometer (Tudor-Locke et al., 2010a), the participants in this sample may have been better served by an intervention to increase weekly bouts of moderate PA rather than trying to reduce SB, as it appears to be the greatest deficiency. Possibly sensing this, some participants' goals to reduce SB included items that would be considered moderate PA. For example, taking a walk at lunch or riding an exercise bike while watching television.

Self-efficacy

Interesting changes in SE occurred in both groups over the course of the study. The decline in each SE sub-scale at mid-point was not hypothesized, but may be a part of the behavior change process and seemed to indicate that participants were attempting new behaviors.

Hypothesis 4. *The intervention group will have a greater increase in SE to reduce sedentary behavior from baseline to post as compared to the waitlist control group.* This was partially confirmed. While there was no difference in SE to reduce SB between the INV and WC groups at post, there was a trend towards a Group x Time interaction. Self-efficacy to reduce SB rebounded at post from its mid-point low for INV participants but continued to decline in the WC group. This rebounding pattern for SE may be the result of participants' initial optimism about the behavior, which was adjusted at mid-point as they engaged in the new behavior. Schwarzer and Renner (2000) describe this as two distinct types of SE; pre-intentional and post-intentional. Pre-intentional or action SE is based on confidence in initiating a new behavior and emphasizes perceived outcomes, whereas post-intentional or coping SE reflects the ability to overcome barriers experienced during behavior change (Renner & Schwarzer, 2009). Thus, increases from mid-point to post could be a reflection of mastery and a more valid expression of their SE to engage in that behavior. Particularly with unfamiliar and somewhat vague goals like reducing sitting time, participants may think that they can easily engage the non-sedentary activities as they are less intense routine movements as compared to exercise. Once they have tried incorporating more breaks from sitting and doing tasks in more active ways they more fully realize the challenges associated with them such as changing their environment, habits, or just remembering. Participants in the WC were not asked to make any changes to their behavior or given any specific strategies for reducing their sitting time. Their lower SE at mid-point could be a reflection of having tried to make the behavior change on their own. Without the feedback and alternatives provided by the intervention, they did not experience enough mastery with reducing SB to raise their post SE scores.

As previously mentioned, compliance issues were found with the video elements intended to model non-sedentary behavior. Each video featured an obese woman engaging in the conventional behavior and in the more active behavior. Modeling or vicarious experience is one of the four contributors to SE (Samson & Solmon, 2011) and the use of relevant peers as models has been shown to increase the effect on SE for PA (Corbin, Laurie, Gruger, & Smiley, 1984). Interventions targeting SE for PA that included modeling had significantly greater effect sizes than those that did not have a modeling component (Ashford et al., 2010). The barriers related to the videos were technical (download speed) and a lack of relevance. In particular, access to stairs was limited and use of cordless phones was less than anticipated.

Hypothesis 5. *The intervention group would increase SE for light physical activity from baseline to post as compared to the waitlist control group.* There were no differences between the INV and WC groups in regards to SE for light PA. The expectation was that light PA would increase in the INV as a way to reduce SB and change in light PA behavior would be associated with increases in SE for light PA. Instead, both groups experienced a non-significant decline in SE for light PA at mid-point. Self-efficacy levels remained fairly stable from mid-point to post assessment. As seen with SE to reduce SB, the decrease at mid-point could be a sign that both groups were attempting a change in their behavior and were encountering challenges that caused them to doubt their ability to increase light PA.

There are a limited number of light PA interventions (Largo-Wight et al., 2008; Lyerly, 2009; Macfarlane et al., 2006) to draw from and none have specifically measured SE for light PA. Conceptually, SE should be relatively high, given that most light physical activities are ambulatory movements or tasks of daily living. Three of the four confidence scales asked participants how confident they were that they could *increase* specific light physical activities. In essence, this was not SE for doing light PA but for doing more than what they were currently doing. An alternative interpretation of the decrease from baseline to mid-point could be that participants believed they had maximized their options for increasing light PA after making some of the suggested behavior changes. Distinguishing between declines in SE due to encountered barriers or from exhausting options should be considered more fully as it may have implications to how the confidence scales are worded.

Hypothesis 6. *The intervention group would increase SE for moderate physical activity from baseline to post as compared to the waitlist control group.* There was a difference between the INV and WC groups in regards to SE for moderate PA, but this was not the result of the intervention. Intervention participants began the study with higher SE for moderate PA and the difference remained over time. Self-efficacy in both groups was lowest at mid-point and rebounded at post. As with the previous SE results, this may demonstrate that participants were engaged in making a PA behavior change. This seems reasonable for the INV, but not for the waitlisted participants. The waitlist group was aware of the study's focus on SB, so some effort to change SB and light PA is understandable. But, participating in the study should not have directly prompted them to increase moderate PA. Physical activity is encouraged by TOPS as part of a weight loss strategy, possibly this message became more salient because of contact with an exercise researcher. This is only a partial explanation, and the fact that the effect is equal to that of the INV is puzzling.

The increase in SE for moderate PA at the post assessment is also curious because the volume of moderate PA was unchanged. This is the same rebounding pattern seen in the INV group's SE to reduce SB and according to Renner and Schwarzer (2009) means the end of the study SE is more valid and based on experience with the behavior. If true, any future attempts at moderate PA will begin with this adjusted level of SE and possibly be more successful.

Increases in SE for moderate PA following PA intervention have been well documented (McAuley & Blissmer, 2000), but data on SE level during the intervention are scant. In a study by Dishman and colleagues (2010), SE was measured every two weeks during a 10-week intervention. Self-efficacy appears to decrease, but was not significantly different from pre to post. The largest declines were seen at weeks 2 and 4, followed by a plateau to week 10. While the decline in the early part of their intervention matches the SE results for *On Our Feet*, the rebound to baseline levels of SE did not occur. Differences in the aims of the studies should be noted. Dishman et al. (2010) specifically targeted moderate PA, whereas the current study focused on reducing SB. The question of increased SE for moderate PA during a SB intervention was raised because Gardiner et al. (2011b) found increases in moderate PA after an intervention to reduce sitting time. Possibly increases in SE for moderate PA would only occur if the intervention presents moderately intense physical activities as a method to reduce SB.

Feasibility of Intervention

While the expected outcomes were not realized, the process evaluation provided evidence of participant satisfaction and interest in interventions that reduce SB. Responses from participants were encouraging and offer a number of avenues for future research.

Hypothesis 7. *It was expected that participants would positively evaluate the content and delivery method, and report physical and psychological benefits.* Despite the lack of behavior change from baseline to post, INV participants experienced benefits related to lower SB. These included a decreased metabolic risk (waist circumference), increased motivation to reduce SB, and awareness of a new health risk. Overall, participants gave *On Our Feet* positive ratings for effectiveness, user-friendliness, and enjoyment. The retention rate was quite high for an 8-week study. Participants reported increased awareness of sitting time and motivation for light to moderate PA. When compliance is taken into account, the intervention's effect on SE to reduce SB is more promising. A few noted changes to their blood sugar, joint pain, or energy level. The process evaluation also revealed a number of areas for improvement.

Intervention dose. The dose analysis found that *On Our Feet* helped to maintain SE to reduce SB in the INV participants that were most compliant. Those who were less compliant experienced a drop in SE at mid-point. Compliance was based on participants' self-reported use of two out of three key elements; pedometer step counting, the sitting log, and reading all intervention emails. Typically, self-monitoring of PA (pedometer step counting) results in both increased behavior and increased SE for the behavior (Dishman et al., 2010; Raedeke et al., 2010; Richeson, Croteau, Jones, & Farmer, 2006). In this study, there was no change in SB or PA in even the most compliant participants. Possibly, the impact of the key intervention elements on SE to reduce SB was strong enough to maintain levels of SE and behavior but not strong enough to increase either.

The pedometer was the most used element of *On Our Feet*. An increase in mean pedometer steps was seen in the INV, though the accelerometer-determined steps were not significantly different from baseline to post. Higher step counts, while not a direct measure of SB, were expected to reflect less time spent sitting and as participants improved their sitting time an increase in SE to reduce SB was anticipated. Tudor-Locke and colleagues (2011a) have reported that the relationship between steps and SB is much weaker than initially thought. It stands to reason that SE to reduce SB would also not be highly related to step counting. In the present study, step counting was not associated with increased SE for light or moderate PA.

Participant acceptance. Overall, the TOPS women had a positive impression of the intervention. *On Our Feet* received high marks (4/5) for satisfaction, effectiveness, and benefit. Though inconvenienced by wearing the accelerometer, only 10% of the participants failed to provide sufficient wear time. The attrition rate was 14%, which is lower than reports of other PA interventions of a similar duration (Sniehotta et al., 2011; Tudor-Locke & Chan, 2006). User-friendliness ratings were above average for the presentations, email messages and study measures. Participants' open-ended responses point to gains in awareness of SB and recognition of barriers to making this behavior change. Their comments were invaluable in identifying the root of some compliance concerns, particularly with the behavioral cues and video modeled tasks.

The view that some of the promoted activities were seen as not relevant or inaccessible to participants requires attention. The concept of SB was new to most of the participants and a distinction from increasing moderate PA was hard to make. There was a fair amount of heterogeneity within this small sample. Differences in frequency of email use, amount and type of planned exercise activities, and built-environment tended to impact how meaningful certain intervention elements were to participants. Those women that regularly engaged in fitness activities saw the active stretching during breaks from SB as too easy. The modeled behaviors (not using the television remote or walking while talking on the phone) were off target for some participants.

Others felt they did not do the behavior enough to warrant the change. There also was a perception that the behavioral cue cards would become part of the background and not be effective.

Key improvements. The process evaluation provided valuable information on under-performing intervention elements and barriers to compliance. There are three key areas for improvement; self-monitoring tools, relevant goal behaviors, and built-environment aides.

Improved self-monitoring tools for SB are needed. The sitting log, which was designed to be used to self-monitor breaks from sitting and time spent in sitting behaviors (TV, computer, reading) was not widely used by participants. Many women reported that tracking SB required too much attention and reported that the log was hard to use. Pedometer steps, which provide immediate feedback to participants, do not measure sitting or standing. Pedometers also range in their degree of accuracy (Butte, Ekelund, & Westerterp, 2012) and the participants were frustrated by lapses in step recording. A direct measure of sitting time could improve participants' focus on reducing SB, as opposed to increasing PA as with pedometers. Consumer-level accelerometers are available that provide feedback via a website on PA (*DirectLife* [Royal Philips Electronics, Netherlands] and *BodyMedia FIT* [BodyMedia, Inc., Pittsburgh] and SB (*Fitbit* [Fitbit, Inc., San Francisco] *and Gruve* [Muve, Inc., Minneapolis]). However, the raw data from these devices are not accessible to researchers (Welk, McClain, & Ainsworth, 2012) and few studies have been published on these monitors (Amini, Sarrafzadeh, Vahdatpour, & Xu, 2011; Bonomi, Plasqui, Goris, & Westerterp, 2010).

The second improvement to the intervention is better matching of the goal behavior and intervention elements to the participant. Tailored interventions match some baseline characteristic of the participant to elements of the intervention (Marcus et al., 1998a). The majority of the TOPS women were much less sedentary than expected, but lacked sufficient bouts of moderate PA. For some the activity suggestions (active stretching, stair climbing, and walking while on the phone) were not applicable because they were already engaged in similar behaviors or they didn't relate to the women's specific circumstances. To correct this, intervention elements need to be tailored to the actual deficits in behavior and to the participants' contextual experience of SB. One possibility is to modify suggestions and behavioral cues based on the individuals' baseline percentage of SB. For example, participants who are more sedentary and at risk for disease (spend 53% or more time in SB) would be given a different set of elements than women that sit between 43-53%, and those that engage SB less than 43% could be given intervention elements specific to increasing moderate PA. More research is needed to determine the cut-points and the appropriate intervention elements. Compliance with the intervention may be improved if the participant feels the intervention's objectives are in line with their actual needs.

Participants also felt that some of the elements of *On Our Feet* were not relevant to them. The modeled and cued behaviors need to be contextually appropriate to the population. This requires increasing the number of examples and re-designing the behavioral cue and modeling elements so that they can be tailored to individuals based on their job, location, preference or availability. As seen in the women from rural areas, some elements were not used because of lack of access (stairs, dial-up internet, cordless phones). More testing is needed to identify specific sedentary reducing behaviors that are relevant to different settings.

The best intervention approach is likely to be one that is both targeted to specific populations and also tailored to the individual. For example, targeting people who work in offices and tailoring the intervention elements to their current levels of SB and PA. Different versions of *On Our Feet* would target different sub-groups; retired seniors, office workers, or college students. Recruiting a more homogenous sample may reduce the large variations in behavior seen in the current study. A greater level of specificity is needed in recruitment. Instead of targeting a gender or race (Kreuter & Wray, 2003), the targets would be based on setting or employment. This could increase the participants' sense of relevance with the intervention.

While participants seemed to enjoy learning about their SB, awareness and step tracking were not enough to change their actual sitting time. The effect of the intervention might be strengthened by having participants modify some aspect of their built-environment to assist in changing their SB. Tips for changing their environment were given in the participant workbook, but there was no formal assignment to the participants to make these changes. This could be added to the goal-setting activity by asking participants to list the environment changes they would make and be part of the goal feedback provided. The environmental changes would not have to be as dramatic as standing desks. Some simple ideas include moving the computer printer out of arm's reach, hiding the television remote, moving the trash and recycle containers further away from a desk and putting the outdoor bins further from the house, or moving commonly used items (tools, batteries, office supplies) to more distant locations.

Exploratory Findings

Reductions to BMI and waist circumference were not specifically hypothesized, as the focus of the intervention had been on SE. The positive outcome for waist circumference supports the efficacy of SB interventions. The differences between rural and urban women were unexpected and stem from the researcher's observations. Thus far, a limited amount of attention has been given to contextual factors such as location and their relationship to SB.

Body size. A reduction in waist circumference was noted in the INV along with maintenance of their BMI. This may be another reflection of the gap between peak behavior change and the post assessment. While post PA levels did not indicate any improvement, women in the INV decreased their waist circumference at the same time that the waitlist controls were increasing. The immediate explanation would be that the INV restricted dietary intake to a greater degree than the WC group and lost weight. However, weight was unchanged in both groups. Reductions in waist circumference have been reported without significant decreases in weight from aerobic exercise

(Slentz et al., 2004a). According to the post assessment, light and moderate PA had not changed. But a physiological adaptation like decreased central adiposity would reflect previous changes in the energy expenditure rather than the posttest level. It is possible that increases to PA did occur prior to the post assessment and facilitated the improvements to waist circumference for INV participants.

Rural location. The differences in SB and in SE to reduce SB between rural and urban participants are interesting, especially if the relationships can be reproduced in larger samples. Rural participants engaged in less SB than their urban counterparts. Rural location was associated with less SB and more light PA. Self-efficacy to reduce SB was lower in women living in rural communities, possibly because it was difficult to imagine sitting less given their particular daily tasks and work responsibilities. Rural women commented more frequently about their household chores, such as tending gardens, caring for animals, and preparing meals. While rural location has been associated with low levels of PA (Trost, Owen, Bauman, Sallis, & Brown, 2002), location as a factor in SB has only be discussed in regards to walkability in urban areas (Sugiyama, Salmon, Dunstan, Bauman, & Owen, 2007). The contextual differences between the rural and urban environment are important to consider, but complex. Rural women may have more physical tasks related to their environment, but have longer commutes. Urban women may have more conveniences, such as restaurants and hired services, but have more opportunities for active transport and to take stairs. There are multiple contexts that overlap with location, such as socioeconomic status, gender, and occupation. More research is needed to understand these relationships.

Role of SCT and SE in Changing Sedentary Behavior

The Social Cognitive Theory proposes inter-connections among the person, their environment, and a given behavior (Bandura, 1986). As a predictor of behavior, this framework has been narrowed down to the single construct of SE. If the behavior is highly related to the environment, SE may not be enough to overcome the cues for that behavior. Sedentary behavior may be one such behavior. The association between SE to reduce SB and actual change in SB was not established in this study. Possibly elements of the intervention; step counting, mastery experience, and modeling were not sufficient to produce changes in SE. An alternative hypothesis is that in concert with SE, changes to the built-environment are needed to change this behavior. As seen with this study, self-regulation of sitting behavior is difficult. The available tools, pedometers and logs, are not actually measuring SB and are burdensome to use.

Owens and colleagues (2011) have proposed an ecological approach for SB interventions. This model recognizes that there are multiple domains for sitting (work, leisure, transportation and household) and that the environment of each domain contains cues for behavior that interact with qualities of the person and even broader elements of society (public policy). The finding that women in rural locations have less SE to reduce SB fits with this broader approach. Living in a rural community was associated with less SB and the rural women were less certain that they could further reduce their sitting behavior. Other contexts and domains of sitting to be examined. Methods that are effective for reducing SB may only apply to specific environments, so a number of strategies will need to be developed and tested. Self-efficacy possibly will differ by domain as well. For example, INV participants maintained their confidence in reducing non-work sitting while controls lost confidence. Confidence in decreasing work-related sitting was unchanged in both groups. Possibly *On Our Feet* would have been more successful in changing behavior if it's focus had been narrowed to a specific domain of SB.

Limitations of Study

This study has several limitations to consider. Issues with intervention fidelity, statistical power and study design were present. The behavioral cues and modeling components of the intervention were not highly used and there was no strategy to maintain behavior after week 5. The initial feedback given to participants was not consistent due to revisions in the software and the time allotted to topics in the presentations varied slightly by chapter. The participant workbook, pedometer, and goal-setting were consistent elements throughout. The original power analysis called for a sample size of 56, but was based on the four assessment periods that were initially proposed. A corrected analysis revealed that 74 participants were required to achieve sufficient power (Appendix Y). Possibly, the findings for SE would be strengthened by a larger sample. However, the effect sizes for SB and PA are so small that it is unlikely that even an additional 16 participants would have produced significant results for behavior change.

The first design factor is that the TOPS chapter pairs were not well matched. Interest, access to email, and meeting time were considered before chapter location or size. As result, two large rural chapters were randomized to the INV and the only rural chapter in the WC had a smaller membership. The effect of the intervention on behavior and SE may have been constrained by the fact that women from more rural locations had less SE to reduce SB because they already engage in many light physical activities as part of their daily tasks. The nested nature of these data suggests that hierarchical linear modeling would have been appropriate. However, given the sample size, the non-significant results for behavior from baseline to post would likely remain regardless of the analysis used.

Second, the lack of dietary intake measures prevents the researcher from concluding that decreased waist circumference was the result of the intervention. While both groups were part of the same weight loss support program and uniform nutritional information is provided to all chapters, the degree of calorie reduction and self-monitoring varies. The fact that all four INV chapters had a decline in waist circumference and no WC chapter did indicates the potential for health benefits from reducing SB.

Nine WC participants (45%) reduced their SB from baseline to post. While the overall group mean was stable, the average decline of the nine was 13%. Waitlist control participants were given pedometers at baseline. No information about tracking or increasing steps was provided. In hindsight the pedometers should have been collected after the baseline assessment as some participants continued to use them and were able to reduce SB without the full intervention. The remaining waitlisted participants increased their SB by 11%. Possibly, without those nine, an increase in SB would have occurred in the WC group that would have outpaced the 6% increase seen in the INV. The prospective outcome being that *On Our Feet* attenuated the increase over time in SB.

Lastly, accelerometer wear time decreased significantly from baseline to post in both groups. While not a flaw of the study's design, the change in wear time does potentially affect the reliability of the post data (Paul et al., 2008). It is important that participants maximize wear periods and don't select times to wear the device based on activity level. A few older women commented that they waited until dressing to put on the accelerometer, which could be a number of hours after waking. Thus, morning activities like reading the paper, breakfast, and any house chores were missed, but possibly the more active aspects of their day; shopping, walking dogs, or going to the gym were captured. Chapters one, two, and three had the greatest reductions in wear time. Reminder phone calls were implemented after those data collections and seemed to improve participant compliance with the accelerometer in chapters four through seven.

Recommendations for Future Research

Target Populations

A wide range of SB was present in this sample and the initial low level of SB was a factor in the intervention's lack of effect. More research is needed to establish the norms of different segments of the population to better determine the need for SB intervention. Accelerometer studies should be conducted in different environments to best understand for whom, where and when SB is occurring. So far there have not been any studies to objectively determine which professions are the most or least sedentary. Until such data are reported, interventionists must rely on more intuitive means for identifying potential target populations.

Populations that seem reasonable targets for intervention include office workers, older adults, and those at risk for cardiometabolic disease. Certainly people who work in offices or whose job involves lots of computer use should be considered. Only the short-term impact of replacing conventional office furniture with standing desks has been examined (Levine & Miller, 2007). Questions about willingness and sustainability of standing options at work should be addressed before workplace initiatives are begun. The effects of programs that increase SE to reduce SB should be compared to those that only change the built-environment. Possibly a combination of the two methods would provide the best outcomes for behavior and compliance.

Sedentary behavior increases with age and older adults (70-85 years) spend the most time in sitting (Matthews et al., 2008). Retired seniors have greater amounts of leisure time than working adults and may fill it with reading, watching TV or other sedentary hobbies. Older adults may also have more joint pain and physical limitations than younger adults. There are several questions to be considered in this population. The first is whether or not reducing SB affects health variables, such as blood pressure, glucose, and cholesterol, or quality of life variables, such as functional ability or cognitive function. Second, the relationship between joint pain and SB in older adults should be considered. The older TOPS women cited pain as barrier to reducing their SB. Physiological states, such as pain, impact SE (Bandura, 1997) and decrease motivation for PA. Moderate PA has been shown to decreased pain in arthritis suffers (Baruth & Wilcox, 2011). The effect of a SB intervention on joint pain should be examined. Lastly, the utility of seated exercise programs for seniors is another area for research. Chair exercises have been suggested as a viable option for older adults wishing to engage in PA (House-Nooney, 2007). The effects of an intervention to reduce SB in seniors should be compared to those of a chair exercise program.

Individuals at risk for type 2 diabetes should be included in trials to decrease SB given this study's positive results on waist circumference. There is evidence to suggest that light PA improves glucose uptake (Healy et al., 2007b; Hostmark, Ekeland, Beckstrom, & Meen, 2006). Possibly an intervention that focuses on decreasing sitting time through short-bouts of light PA would have a positive effect on glucose and central obesity.

The results of this study point to possible differences between rural and urban location. This and other contextual correlates need to be considered. Broader and more diverse segments of the population should be included. For instance, recent accelerometer studies found Hispanics to be more physically active than previous studies using self-report measures showed (Ham & Ainsworth, 2010). Some of the established determinants of PA, such as ethnicity should be re-examined with accelerometers. The effect of social and physical environments can be seen more directly through accelerometry than through self-report as its data is time-stamped and can be connected to specific locations. Therefore, differences between domains of SB (occupational, leisure-time) and environments (socioeconomic status, geographic location) can be analyzed for their effect on physical and psychological markers.

Length of Study

Most of the studies conducted so far have only considered short time frames, typically 1 week. Longer periods of observations are important for establishing typical behavior and to consider seasonal changes in PA. A one-month time frame would help even out the variations between busy and less busy weeks and could improve the consistency of the data as wearing the device becomes more habitual. Longer periods could help identify the point during an intervention when behavior change occurs or help associate behavior change to SE during the intervention.

Enhance Tailoring of Interventions

Participants in this study did not fit the norms for SB or moderate PA. They sat less than expected and engaged in more moderate PA than previous literature would have led investigators to believe, though still below the recommended minimum for health benefits. A future application of accelerometer data could be interventions tailored specifically to participants' needs; to increase moderate PA or to decrease SB. Physical activity of any intensity conveys benefits to those that participate. But, if the intervention is tailored to the specific needs and contexts of the participants, it might be better received and possibly maintained.

Summary

Findings suggest that effective interventions to increase SE, reduce SB, and increase PA must consider contextual factors, such as location and occupation as well as individual factors and barriers. Interventions to reduce SB potentially can improve health risks, but better tools for self-monitoring are needed. The use of accelerometers and computer technology to improve levels of PA holds promise. Interventions that match participants to targets of reducing SB or increasing moderate PA should be considered.

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APPENDIX A

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Publication: American Journal of Epidemiology

Publisher: Oxford University Press

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Author: Neville Owen,Takemi Sugiyama,Elizabeth E. Eakin,Paul A. Gardiner,Mark S. Tremblay,James F. Sallis

Publication: American Journal of Preventive Medicine

Publisher: Elsevier

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APPENDIX B

ON OUR FEET STUDY QUESTIONNAIRE

Demographic Information

Age __________

What is your Ethnicity?

☐	1) Hispanic
☐	2) Non-Hispanic

What is your Race?

☐	1) Caucasian
☐	2) African American
☐	3) Asian
☐	4) Native American
☐	5) Other (write in) ____

Do you work outside of home? _____ full-time _____ part-time
_____ retired ______ not employed

Job title or occupation________________________________

What is the **highest** level of education you completed?

☐	1) Elementary/Middle School - less than High School
☐	2) High School Diploma or GED
☐	3) Associates degree, Community College
☐	4) Technical or trade school diploma
☐	5) Bachelors College Degree
☐	6) Graduate Degree/ Professional Degree

How long have you been a member of TOPS? _____ years _______ months

On a scale from 1 to 5, how committed are you to losing weight?

A Little				Very
1	2	3	4	5

How often do you attend TOPS meetings?

- ☐ 1)every week
- ☐ 2)twice a month
- ☐ 3)once a month
- ☐ 4)only enough to keep my membership current

On a scale from 1 to 5, how satisfied are you with the TOPS program?

A Little				Very
1	2	3	4	5

What is your goal weight? ________________________________

In general, how would you rate your health ?

Excellent	Very Good	Good	Fair	Poor
1	2	3	4	5

Has your doctor told you that you have any of the following health conditions?

DISEASE

- ☐ 1) HEART DISEASE
- ☐ 2) DIABETES – SPECIFY TYPE _____________________
- ☐ 3) HIGH BLOOD PRESSURE
- ☐ 4) HIGH CHOLESTEROL / TRIGLYCERIDES
- ☐ 5) STROKE
- ☐ 6) ARTHRITIS (OSTEO OR RHEUMATOID)
- ☐ 7) LUNG DISEASE (EMPHYSEMA, ASTHMA, CHRONIC BRONCHITIS)
- ☐ 8) OSTEOPOROSIS
- ☐ 9) CANCER – SPECIFY TYPE ____________________
- ☐ 10) DEPRESSION
- ☐ 11) ANXIETY / NERVOUS DISORDER

Chronic Pain

Do you frequently have pain in your joints, back or muscles?

____Yes ____No

Do you have chronic pain that makes standing and/or walking difficult?

____Yes ____No

Physical Measurements Pre

Ht ___________ cm

Wt __________ lbs converted to ___________ kgs

WC __________ cm (1)

_________ cm (2) average ____________

Baseline Step Count ________________________________

Initials ______________

Date ________________

Level of Current Physical Activity (Godin Leisure-time Physical Activity Questionnaire)

In the last week (past 7 days), how many times on the average do you do the following kinds of exercise for more than 15 minutes during your free time (write the number on the appropriate line).

	Times per week
a) STRENUOUS EXERCISE (heart beats rapidly) (running, soccer, basketball, racquetball, judo, skating, vigorous swimming, vigorous biking)	____________
b) MODERATE EXERCISE (not exhausting) (fast walking, baseball/softball, badminton, volleyball, tennis, easy swimming, easy bicycling, dancing, heavy yard work)	____________
c) MILD EXERCISE (minimal effort) (yoga, archery, fishing, bowling, golf, easy walking, gardening)	____________

Do you participate in any planned physical activity (brisk walking, aerobics, jogging, bicycling, swimming, weight training, yoga, pilates, sports) for at least 20 minutes at a time, on 3 or more days a week? (PA Stage of Change)

☐	Yes, I have been doing so for less than 6 months (continue to page 9).
☐	Yes, I have been doing so for more than 6 months (continue to page 9).
☐	No.

Do you think you begin doing regular physical activity sometime in the future?

☐	No, I do not intend to in the next 6 months.
☐	Yes, I intend to in the next 6 months.
☐	Yes, I intend to in the next 30 days.

Time Spent Sitting (IPAQ sitting questions)

The next questions are about the time you spend sitting while at work, at home, while doing school work and during leisure time. This may include time spent sitting at a desk, riding in a vehicle, visiting friends, reading or sitting or lying down to watch television.

Please answer as a total of hours & minutes, example 7.5 hours = 7 hours and 30 minutes.

During the **last 7 days**, how much time did you usually spend **sitting** on a **weekday**?

_____ **hours per day**

_____ **minutes per day**

During the **last 7 days**, how much time did you usually spend **sitting** on a **weekend day**?

_____ **hours per day**

_____ **minutes per**

Do you own a Television?

___Yes ____No

Do you own a Computer?

___Yes ____No

During the last week, how many days did you eat a meal while sitting and watching TV?

MEAL	**Week day**	**Weekend Day**
1) Breakfast	_____ NUMBER	______ NUMBER
2) Lunch	_____ NUMBER	______ NUMBER
3) Evening Meal	_____ NUMBER	______ NUMBER

Weekly Sitting Inventory (Salmon et al., 2003)

For each of the activities below, count the time when this was your main activity; for example if you are watching TV and doing a cross word, count it as TV time or cross word time.
During the last week, how much time in total did you spend **sitting and**…

ACTIVITY	Total
1) Television or video/DVD watching	___ HOURS ___MINUTES
2) Computer /Internet (includes electronic books - kindle, ipad, nook and video games)	___ HOURS ___MINUTES
3) Reading books, newspaper, magazines(not on computer)	___ HOURS ___MINUTES
4) Socializing with friends or family (includes time on phone if sitting)	___ HOURS ___MINUTES
5) Driving or riding in a car or time on public transport	___ HOURS ___MINUTES
6) Hobbies (crafts, cross-words, listening to or playing music)	___ HOURS ___MINUTES
7) Any other sitting (filling out forms, writing letters, at desk not using computer)	___ HOURS ___MINUTES

Have you be trying to reduce your sitting time? (SB Stage of Change)

☐	Yes, for less than 6 months (skip next question).
☐	Yes, for more than 6 months (skip next question).
☐	No.

Do you think you will reduce your sitting time sometime in the future?

☐	No, I do not intend to in the next 6 months.
☐	Yes, I intend to in the next 6 months.
☐	Yes, I intend to in the next 30 days.

Rate each item on a scale from 1 (not at all confident) to 5 (completely confident). **How confident are you that you can...**	Not at All Confident				Completely Confident
decrease the amount you sit during your non-work time? (includes TV, home computer, reading, riding in a car, socializing)	1	2	3	4	5
watch less TV each day?	1	2	3	4	5
spend less time at your home computer each day?	1	2	3	4	5
decrease the amount of time you sit while at work? (if retired or unemployed, think of work as "have to do" tasks like making appointments or paying bills.	1	2	3	4	5
take activity breaks from watching TV, using the computer or reading? (activity breaks include standing, walking, stretching, doing easy chores)	1	2	3	4	5
increase the amount of house & yard chores you daily? (includes housecleaning, straighten up, watering & planting, weeding, cooking)	1	2	3	4	5
increase the amount of walking you do during your daily tasks? (includes parking further away, making more trips to carry in bags, going to see colleagues instead of emailing them)	1	2	3	4	5
increase the number of stairs you climb daily?	1	2	3	4	5
do moderately intense exercise **once** a week for 30 minutes? This includes activities like fast walking, biking, exercise videos, sports, gym classes. (if already doing answer 5)	1	2	3	4	5
moderately intense exercise **twice** a week for 30 minutes? (if already doing answer 5)	1	2	3	4	5

do moderately intense exercise three times a week for 30 minutes? (if already doing answer 5)	1	2	3	4	5
can increase the amount of moderately intense exercise you currently do?	1	2	3	4	5

(items 1-4 = SE to reduce SB, 5-8 = SE for LPA, 9-12 = SE for MPA)

Reliability Statistics of Self-Reported Measures

Behavior	Cronbach α	Test-retest	Previously Reported	
Godin Light		0.586	0.48	Godin and Shephard (1997)
Godin Moderate		0.444	0.36	Jacobs et al. (1993)
Godin Strenuous		0.384	0.84	Jacobs et al. (1993)
Godin Total		0.517	0.62	Jacobs et al. (1993)
IPAQ sit questions	0.82		0.81	Rosenberg et al. (2008)
Total Weekly Sitting	0.616		ICC=0.79	Salmon et al. (2003)
PA Stage of Change		0.302	k= 0.78	Marcus, Selby, Niaura, and Rossi (1992)
SB Stage of Change		0.157	n/a	
Self-efficacy				
SE to reduce SB	0.76		n/a	
SE for LPA	0.69		n/a	
SE for MPA	0.91		n/a	

APPENDIX C

STUDY DESIGN DIAGRAM

Quasi-experimental Groups	Baseline		Mid-point		Post
Intervention	O	X	O	X	O
Waitlist	O		O		O

APPENDIX D

TOPS PILOT QUESTIONNAIRE

Age _______
Gender - Male Female
Are you currently employed or working? Yes No

Level of Current Physical Activity

Considering a 7-day period (a week), how many times on the average do you do the following kinds of exercise for at least **15 minutes** during your free time (write the number on the appropriate line).

	Times per week
a) STRENUOUS EXERCISE (heart beats rapidly) (competitive sports, jogging, lifting weights, vigorous swimming, long distance biking)	___________
b) MODERATE EXERCISE (not exhausting) (fast walking, badminton, easy swimming, easy bicycling, exercise videos)	____________
c) MILD EXERCISE (minimal effort) (yoga, archery, fishing, bowling, golf, easy walking)	____________

Household Physical Activity

Think about the physical activities you have done in the **last 7 days** in and around your home, like housework, gardening, yard work, and cleaning, that you did for at least **10 minutes** at a time.

Write the number of times you did these or similar tasks (carrying light loads, sweeping, washing windows, vacuuming or scrubbing floors, raking or push mowing in the yard) ____________

Physical Activity at Work

Would you describe your job as: **Check one**

_____ Highly Active - lots of lifting, carrying and physically demanding tasks
_____ Somewhat Active - lots of walking, standing and moving
_____ Low Active - sitting is the primary position at work

Walking as Transportation

During the **last 7 days**, on how many times did you **walk** for at least **5 minutes** at a time to go **from place to place** (from car to store, airport, sightseeing)? _______________

Time Spent Sitting

How much time do you spend **sitting** on a **typical day** while at work, at home, during leisure time. This includes time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. _________ **hours per day** _________ **minutes per day**

How confident are you that you could complete each task on a scale from 1 to 5.
1= certain I will not   5 = completely certain

How certain are you that you can decrease the amount of time you spend sitting?

1	**2**	**3**	**4**	**5**

How certain are you that you can increase the amount of household activity you do?

1	**2**	**3**	**4**	**5**

How certain are you that you can walk more during you day?

1	**2**	**3**	**4**	**5**

How certain are you that you can do active things during TV commercials such as chores, walking in place, or stretching?

1	**2**	**3**	**4**	**5**

How certain are you that you can increase the number of stairs you climb?

1	**2**	**3**	**4**	**5**

How certain are you that you can take a 2 minute walk or activity break from sitting every hour?

1	**2**	**3**	**4**	**5**

If you sat less and did more light activities which benefits are likely to happen?
1= not likely 5= very likely

I will lower my risk for health problems

1	**2**	**3**	**4**	**5**

I will lose weight

1	**2**	**3**	**4**	**5**

I will feel better physically

1	**2**	**3**	**4**	**5**

I will feel more relaxed

1	**2**	**3**	**4**	**5**

I will be able to concentrate better

1	**2**	**3**	**4**	**5**

I will have more social interaction

1	**2**	**3**	**4**	**5**

I will have a better quality of life

1	**2**	**3**	**4**	**5**

APPENDIX E

PROCESS EVALUATION ITEMS

Brief Survey for Drop-outs

Have you decided to not to complete the On Our Feet study?

Yes No

How many weeks did you participate in the study?

1 – 2 3 – 4 5 - 6

Why did you leave the **On Our Feet** study. (check all that apply)

☐	6) Required too much time.
☐	7) Not interested in topic.
☐	8) Activities (tracking steps, stretching, filling out surveys) were too hard.
☐	9) Required too much computer know how.
☐	10) I was unable to attend a session.
☐	11) Wearing the activity monitor was too much trouble.
☐	12) other (type in) ____

What would have helped you complete the study? (check all that apply)

☐	1) Fewer emails from the researcher.
☐	2) Not having to keep a step log.
☐	3) Not having to wear the activity monitor.
☐	4) Less of a time commitment.
☐	5) More in person interaction with the researcher.
☐	6) other (type in) ____

Intervention Components

Initial Presentation

1. On a scale from 1 to 5, how interesting was the *presentation on sedentary behavior*?

Not at All		Neutral		Very
1	2	3	4	5

2. On a scale from 1 to 5, how clearly was the information on sedentary behavior presented?

Not at All		Neutral		Very
1	2	3	4	5

3. How often have you used the information from the presentation to change you sitting behavior?

Not Much		Some		A Lot
1	2	3	4	5

4. What gets in the way of you decreasing your sitting time?

___

5. Do you have any suggestions for improving the presentation?

___

Stretching Activity

1. Did you use the stretches the researcher demonstrated while at home or work?

☐	1) Yes. Once or twice at the beginning but not recently.
☐	2) Yes. 1-4 times a week
☐	3) Yes. 5-8 times a week
☐	4) Yes. 9 or more times a week
☐	5) No.

2. On a scale from 1 to 5, how easy to use are the stretches?

Not at All				Very
1	2	3	4	5

3. On a scale from 1 to 5, how effective are the stretches at helping you change your sitting behavior?

Not at All		Somewhat		Very
1	2	3	4	5

4. What gets in the way of you using the stretches?

___

5. Do you have any suggestions for improving the stretching activity?

___

Accelerometer Feedback

1. How much did you use the activity monitor feedback?

Not at All		Some		A Lot
1	2	3	4	5

2. On a scale from 1 to 5, how much did you like the *activity feedback*?

Not at All		Some		A Lot
1	2	3	4	5

3. On a scale from 1 to 5, did the *activity feedback* help you change your sitting behavior?

Not at All		Some		A lot
1	2	3	4	5

4. What gets in the way of you using the stretches?

____

5. Do you have any suggestions for improving the stretching activity?

____

Goal Setting

1. How often have you looked or thought about the goals you set this week?
   - ☐ 1) None.
   - ☐ 2) Once.
   - ☐ 3) 2-4 times this week.
   - ☐ 4) Every day this week.

2. On a scale from 1 to 5, how much did you like the goal setting activity?

Not at All		Some		Often
1	2	3	4	5

3. On a scale from 1 to 5, how effective are the goals at helping you change your sitting behavior?

Not at All		Somewhat		A lot
1	2	3	4	5

4. What gets in the way of you decreasing your sitting time?

____

5. Do you have any suggestions for improving the goal setting activity?

____

Video Demonstrations

First Video

1. Did you view the first video of the women standing while using the phone?
   - ☐ 1) Yes.
   - ☐ 2) No.

2. How often have you looked or thought about the video this week?
   - ☐ 1) None.
   - ☐ 2) Once.
   - ☐ 3) 2-4 times this week.
   - ☐ 4) Every day this week.

3. On a scale from 1 to 5, how effective was this *video* at helping you change your sitting behavior?

Not at All		Somewhat		Very
1	2	3	4	5

Second Video

1. Did you view the second video of the women not using the TV remote?
   - ☐ 1) Yes.
   - ☐ 2) No.

2. How often have you looked or thought about the video this week?
   - ☐ 1) None.
   - ☐ 2) Once.
   - ☐ 3) 2-4 times this week.
   - ☐ 4) Every day this week.

3. On a scale from 1 to 5, how effective was this *video* at helping you change your sitting behavior?

Not at All		Somewhat		Very
1	2	3	4	5

Third Video

1. Did you view the third video of the women taking the stairs instead of the elevator?
   - ☐ 1) Yes.
   - ☐ 2) No.

2. How often have you looked or thought about the video this week?
   - ☐ 1) None.

☐	2) Once.
☐	3) 2-4 times this week.
☐	4) Every day this week.

3. On a scale from 1 to 5, how effective was this *video* at helping you change your sitting behavior?

Not at All		Somewhat		Very
1	2	3	4	5

<u>Step Log</u>

1. Did you use the pedometer and track your daily steps?

☐	1) Yes. Every week.
☐	2) Yes. Almost every week.
☐	3) Only for the first week or two.
☐	4) No, hardly ever.

2. On a scale from 1 to 5, how much did you like using the pedometer and step log?

Not at All		Some		A Lot
1	2	3	4	5

3. On a scale from 1 to 5, how easy was the pedometer and step log to use?

Not at All		Somewhat		A lot
1	2	3	4	5

4. On a scale from 1 to 5, how effective was the pedometer and step log at helping you change your sitting behavior?

Not at All		Somewhat		Very
1	2	3	4	5

5. What got in the way of using the pedometer and step log?

____

6. Do you have any suggestions for making the pedometer and step log easier to use?

____

Sitting Log

1. Did you use the sitting log to track your sitting time and breaks?

☐	1) Yes. Every week.
☐	2) Yes. Almost every week.
☐	3) Only for the first week or two.
☐	4) No, hardly ever.

2. On a scale from 1 to 5, how much did you like using the sitting log?

Not at All		Some		A Lot
1	2	3	4	5

3. On a scale from 1 to 5, how easy was the sitting log to use?

Not at All		Somewhat		A lot
1	2	3	4	5

4. On a scale from 1 to 5, how effective was the sitting log at helping you change your sitting behavior?

Not at All		Somewhat		Very
1	2	3	4	5

5. What got in the way of using the sitting log?

____

6. Do you have any suggestions for making the sitting log easier to use?

____

Tailored Email Messages

1. Did you read the weekly emails from the researcher?

☐	1) Yes. Always
☐	2) Most of them.
☐	3) Only a couple of them.
☐	5) No.

2. On a scale from 1 to 5, how often did you use the information in the weekly emails?

Not at All		Some		Often
1	2	3	4	5

3. On a scale from 1 to 5, how much did you like the weekly emails?

Not at All				A lot
1	2	3	4	5

4. On a scale from 1 to 5, how effective were the emails at helping you change your sitting behavior?

Not at All		Somewhat		Very
1	2	3	4	5

5. Was the number of emails…
   - ☐ 4) Just right.
   - ☐ 5) Too many.
   - ☐ 6) Too few.

6. What got in the way of using the information in the emails?

____

7. Do you have any suggestions for improving the emails?

____

<u>Behavioral Cues</u>

1. Did you print out the signs to remind you to stand and move more?
   - ☐ 1) Yes.
   - ☐ 2) No.

2. How often have you looked at the reminders this week?
   - ☐ 1) Every day this week.
   - ☐ 2) 2-4 times this week.
   - ☐ 3) Once.
   - ☐ 4) Not at all.

3. On a scale from 1 to 5, how much did you like the reminders?

Not at All				Very Much
1	2	3	4	5

4. On a scale from 1 to 5, how effective were the reminders at helping you change your sitting behavior?

Not at All		Somewhat		Very
1	2	3	4	5

5. What got in the way of using the reminders?

___

6. Do you have any suggestions for improving the reminders?

___

End of Study Participant Evaluation

1. Overall, how satisfied were you with the ***On Our Feet*** program

Not at All		Somewhat		Very
1	2	3	4	5

2. Would you recommend this program to others?

Definitely No				Definitely Yes
1	2	3	4	5

3. Overall, how beneficial was the program to you?

None				Very
1	2	3	4	5

4. Why did you to take part in the program?(list main reason)_____________________

____

5. Did the program meet your goals or needs? Yes No Somewhat

If no, explain;____

6. What benefits did you get from participating in the study? (list 1 or 2)

___________________________________ ____________________________________

7. On a scale from 1 to 5, how effective do you think the program was at decreasing your sitting behavior?

Not at All		Somewhat		Very
1	2	3	4	5

If 1 or 2, explain what kept it from being successful for you. _____________________

____

8. Which aspect of the program was the most helpful in changing your sitting time?

Examples; emails, goal setting, activity monitor, videos, reminder signs, pedometer

____

9. List up to 3 things that would improve the On Our Feet program.

__________________________________ ____________________________________

____

10. On a scale from 1 to 5, how hard was it to wear the activity monitor for a week?

Easy		A little		Very Hard
1	2	3	4	5

Suggestions or Comments about the activity monitor________________________

____

11. On a scale from 1 to 5, how hard was it to have your measurements taken?

Easy		A little		Very Hard
1	2	3	4	5

Suggestions or Comments about the measurements taken before and after the program

____

12. On a scale from 1 to 5, how hard was it get information by email?

Easy		A little		Very Hard
1	2	3	4	5

13. Do you like getting health information over the computer? Yes No

If no, explain:____

14. Was the number of emails…

- ☐ 7) Just right.
- ☐ 8) Too many.
- ☐ 9) Too few.

15. On a scale from 1 to 5, how helpful were your interactions with the program leader?

Not Much		A little		Very
1	2	3	4	5

If 1 or 2, explain:____

16. On a scale from 1 to 5, how well organized was the program?

Not Very		A little		Very Well
1	2	3	4	5

17. On a scale from 1 to 5, how appropriate was the amount of time you committed to the study?

Too Much				Just Fine
1	2	3	4	5

18. Did you use the pedometer and track your daily steps?

- ☐ 1) Yes. Every week.

☐ 2) Yes. Almost every week.

☐ 3) Only for the first week or two.

☐ 4) No, hardly ever.

18. On a scale from 1 to 5, how effective was the pedometer and step log at helping you change your sitting behavior?

Not at All		Somewhat		Very
1	2	3	4	5

19. What got in the way of using the pedometer and step log?

____

20. Did you use the sitting log to track your sitting time and breaks?

☐ 1) Yes. Every week.

☐ 2) Yes. Almost every week.

☐ 3) Only for the first week or two.

☐ 4) No, hardly ever.

21. On a scale from 1 to 5, how effective was the sitting log at helping you change your sitting behavior?

Not at All		Somewhat		Very
1	2	3	4	5

22. What got in the way of using the sitting log?

____

23. Did you read the weekly emails from the researcher?

☐ 10) Yes. Always

☐ 11) Most of them.

☐ 12) Only a couple of them.

☐ 6) No.

24. On a scale from 1 to 5, how effective were the emails at helping you change your sitting behavior?

Not at All		Somewhat		Very
1	2	3	4	5

25. What got in the way of using the information in the emails?

____

26. Do you have any other specific suggestions or comments about the program?

____

____

APPENDIX F

CONSENT TO ACT AS A HUMAN PARTICIPANT

UNIVERSITY OF NORTH CAROLINA AT GREENSBORO

CONSENT TO ACT AS A HUMAN PARTICIPANT: LONG FORM

Project Title: "On Our Feet" : Feasibility Study of an Intervention to Reduce Sedentary Behavior

Project Director: Melanie M. Adams

Participant's Name: ____

What is the study about?
This is a research project. Ms. Adams is studying the effects of an education program to reduce sedentary behavior.

Why are you asking me?
You have been asked to participant because you are a woman between 35-70 years old and are a member of the TOPS organization. This study is targeting overweight women that do not have diabetes or a condition that keeps them from standing and walking. You may participate in this study if you will be attending the next 3 TOPS meetings and will be at the meeting on __________________. If you agree to participate, you must also be willing to provide your email address and respond to study materials sent by email.

What will you ask me to do if I agree to be in the study?
Participants will be asked to wear an activity monitor for 1 week prior to the study and 1 week after the program. This monitor will count the number of minutes in a day that you are sitting or doing physical activities. You will also be asked to complete questionnaires in writing and on the computer. Over the six week study you will be sent email messages with activities and tips for moving more during the day. These will take you less than 20 minutes a week to read and complete. Additionally, your height, weight and waist circumference will be measured today and again in seven weeks. In total, your time commitment to this study is approximately 6 hours over 9 weeks.

Is there any audio/video recording?
No. There is no audio or video recording of this study.

What are the dangers to me?
The Institutional Review Board at the University of North Carolina at Greensboro has determined that participation in this study poses minimal risk to participants. You will be weighed and measured by trained researcher and asked to respond to questions about your health and physical activity. Possibly, this will make you feel uneasy. All study data will be collected professionally and stored without personal identification. Small increases in daily physical activity could cause mild fatigue initially, but only temporally.

If you have any concerns about your rights, how you are being treated or if you have questions, want more information or have suggestions, please contact Eric Allen in the Office of Research Compliance at UNCG at (336) 256-1482. Questions, concerns or complaints about this project or benefits or risks associated with being in this study can be answered by Ms. Adams' advisor, Dr. Gill who may be contacted at (336) 334-4683 or by email at dlgill@uncg.edu.

Are there any benefits to me for taking part in this research study?
Although there are no direct benefits to you, you may enjoy learning new information and trying new activities.

UNCG IRB
Approved Cons.nt Form
Valid 3/9/11 to 3/7/12

Are there any benefits to society as a result of me taking part in this research?
This study will help researchers better understand how to design programs to decrease sedentary behavior.

Will I get paid for being in the study? Will it cost me anything?
There are no costs to you for participating in the study. For each data collection period you attend (today &7 weeks from now) you will receive a $10.00 gift card to a local grocery store.

How will you keep my information confidential?
All information obtained in this study is strictly confidential unless disclosure is required by law. Your identity will be guarded through use of an identification code number. Your code number will be given to you in the study materials. Please keep in mind that some information will be collected over the internet and that absolute confidentiality of data provided through the Internet cannot be guaranteed due to the limited protections of Internet access. Please be sure to close your browser when finished so no one will be able to see what you have been doing.

What if I want to leave the study?
You have the right to refuse to participate or to withdraw at any time, without penalty. If you do withdraw, it will not affect you in any way. If you choose to withdraw, you may request that any of your data which has been collected be destroyed unless it is in a de-identifiable state.

What about new information/changes in the study?
If significant new information relating to the study becomes available which may relate to your willingness to continue to participate, this information will be provided to you.

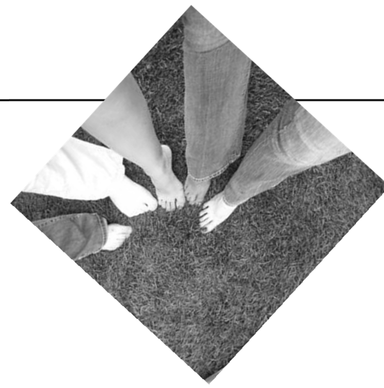
Voluntary Consent by Participant:
By signing this consent form you are agreeing that you read, or it has been read to you, and you fully understand the contents of this document and are openly willing consent to take part in this study. All of your questions concerning this study have been answered. By signing this form, you are agreeing that you are 18 years of age or older and are agreeing to participate, or have the individual specified above as a participant participate, in this study described to you by Ms. Melanie Adams.

Signature: ________________________ Date: ________________

UNCG IRB
Approved Consent Form
Valid 3/9/11 to 3/7/12

APPENDIX G

PARTICIPANT WORKBOOK



On Our Feet

UNC GREENSBORO

PARTICIPANT NUMBER ________

Welcome to On Our Feet

Thank you for volunteering for this study. TOPS members may benefit from this educational and motivational program that focuses on decreasing the amount of time you spent sitting every day.

You are the most important part of this program! Be sure to attend these TOPS meetings so that you get all the information and can participate in all the activities.

Data Collection & Presentation ________________
Goal Setting & Group Activities ________________
Data Collection ________________
Final Survey ________________

In addition to the in-person sessions, you will receive 1-3 emails a week. Please be sure to read and respond to these messages. Each will take less than 10 minutes of your time.

The study will last 7 weeks. Please contact the researcher, Melanie Adams by email at mmadams2@uncg.edu or by phone 336-430-9146 if you are going to be away for any of the dates above. Also if you have any questions or concerns about this study, you can email my advisor, Dr. Diane Gill at dlgill@uncg.edu

Thanks again for getting involved. We're very excited to be working with you!

Table of Contents

Special Thanks to Terry Eller, Rae Moreland & TOPS

TAKE OFF POUNDS SENSIBLY

Stretch & Move Breaks

Do these moves during TV commercials or any time you need a break from sitting. Go at your own pace and do as many or as few as you like – half the routine fits into a commercial break. The point is just to get up from that chair!
Be sure to use your chair to help you balance if you feel a little unstable. You get all the benefits from the movement even with your hands on the chair for balance.

← **Mini Squats**
Stand with feet parallel and a shoulders width apart; put your weight back on your heels. Start to sit down, pushing hips behind you. Go only as deep as is comfortable, keeping heels on ground. Use chair for balance.

← **Tippy Toes**
(Heel Raises)
Stand tall through the crown of your head, go up onto the balls of your feet and down again. (8-10

← Overhead Press
With elbows out away from body, imagine pushing a box or weight overhead. Go through as full of a range of motion as you can, from elbows close to sides to arms straight overhead.

← March in Place
(Knee Lifts)
Start with feet straight, shoulder width apart. Lift knees up to opposite elbows twisting slightly at the waist, alternate legs. Use chair for balance. (8-10 times each leg.)

Butt Kicks →

(Hamstring Curls)

Standing with space between your feet, pretend to kick your backside with alternating legs. Hold chair for balance. (8-10 times each leg.)

The Accelerator →

(Toe Raises)

Bend slightly at the hip. Pull toe up. Tap toe to ground and pull up again. (8-10 times on one side

Arm Clapping ↑

Start with arms straight in front of you. Spread arms wide, until you feel a little stretch in chest, then bring hands back together like you are doing a wide arm clap. Go slow. (Repeat 8-10 times)

Tips for Sitting Less

- Pick the show you want to watch before you sit down. Leave the remote next to the TV. Get up and down to change the channels. Don't channel surf. If there is nothing good on, turn off the TV and do something more active.

- Stand up to answer the phone and stand or walk for the whole conversation. Since most phones are "cordless" this is a great time to get extra steps in.

- Get up during TV commercials. You have 3 minutes to do anything; walk, stretch, chores. You will avoid those tempting food advertisements this way too!

- Put a post-it note on your computer that says "Take a break every hour." Make sure you get up for a minute or two every hour. At work, you can get water, go to the bathroom, or go talk to a colleague instead of emailing them. At home, break up computer time with some housework like, starting a load of laundry or vacuuming a room. This doesn't mean cleaning the whole house, just one item at time.

- Cooking your own meals is another opportunity to move more. When we eat out or go to the drive thru, we sit. Serve your food from the stovetop rather than from serving dishes on the table. This way you have to get up to get seconds. Packing a lunch instead of buying out is one small change that will decrease your daily sitting time.

- Make multiple trips to the car to bring in bags from shopping. You're less likely to drop the lighter loads and you increase the amount of energy you use doing it this way. Think "light loads and more trips."

- Park further away from the store or office. You'll actually save time. Circling the lot for the "best" spot takes longer than walking from the last row. And, you won't be sitting.

- Be less efficient. It's good for you to walk from one end of the house or store to get things you forget. Rather than feeling silly about it, tell yourself that life is too hurried and that taking the long way is a way to slow down.

➢ Try reading your email while standing. There is no rule that says we have to sit while we read or talk on the phone. Same goes for reading the paper or doing hobbies like knitting! Try standing at your kitchen counter or other tall table when you would normally sit.

➢ Volunteer to get up and get things for people. You will seem extra nice and keep yourself moving.

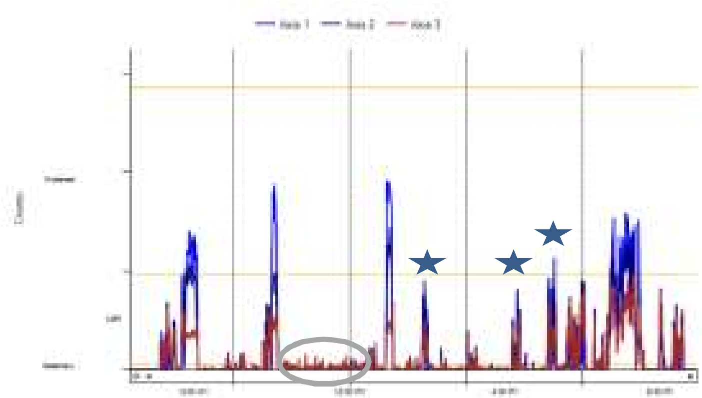
How to Read Your Activity Monitor Graph

The handout you got on the amount of time you spent sitting will show you **5** things.

1. Which day you were most sedentary. For most people this will be a weekday. If you can, try to remember anything about that day that made you sit so much. Was it a big project or meeting at work? Was it a long visit with a friend?

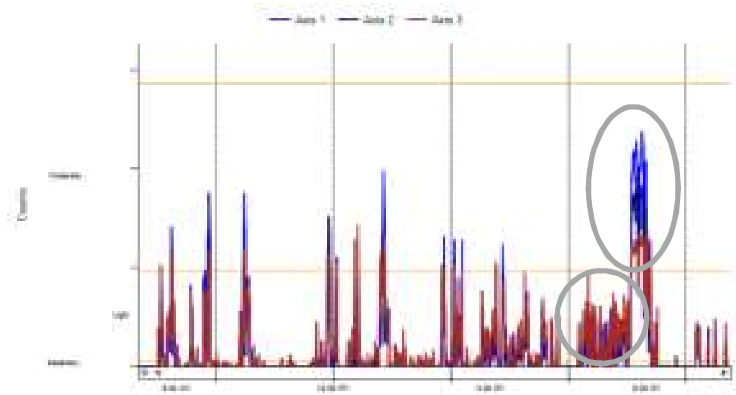
2. The day you were least sedentary. Think back to what activities you did that day and see if you can repeat them more frequently. For example, if it was a weekend and you did shopping, chores, played with grandkids or gardened, could you do just a little more of that during the week to reduce your sitting.

3. The times of the day that you are more or less sedentary. Look for stretches of time when the lines stay at the bottom of the graph. This is when you are sitting. Like the circled section below.

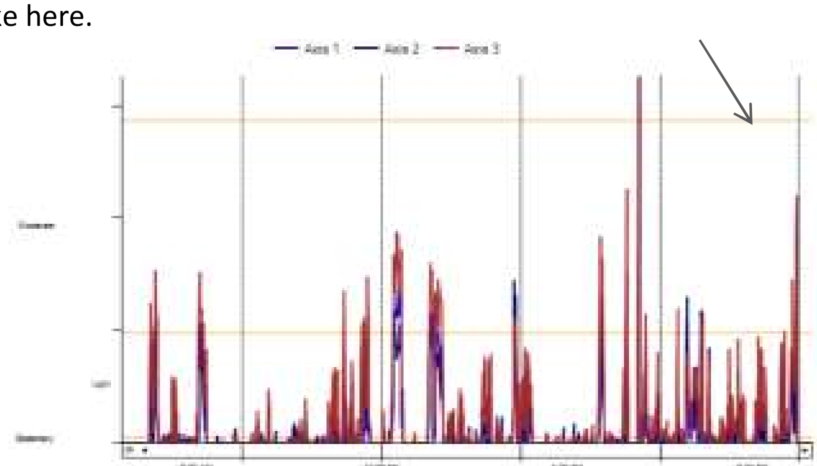


4. Where you took a break from sitting and stood up. Anywhere that the lines move straight up movement. If the lines only get to the 'light' range then you stood up and walked casually. See the stared areas above.

5. The areas where the line stays high and is thicker are times when you stayed in motion longer. These can be doing light physical activities like easy chores or casual walking or if the lines go into the 'moderate' range you were exercising or doing harder activities like fast walking, climbing stairs or heavy chores. See the circled area on the next page.



The color of the lines tells you which direction your body was moving – Blue is for up and down and side to side. Red is forward to back motions. Really short straight up and down lines mean that you either move very quickly or that your activity monitor fell off. Like here.



Goal Setting Reminder

Goal #1 - Take _____________ breaks from sitting during the day.

I am going to meet my goal by doing…

1) ____
2) ____
3) ____

Things that would make me feel more confident in meeting this goal are…

a. _____________________________________
b. _____________________________________
c. ____________________________________

While keeping up the number breaks for my first goal, think about a daily step goal for three weeks from now.

By ____________________, I will: Take _____________ steps a day.

I am going to meet my step goal by doing…

1) ____
2) ____
3) ____

Sitting Time Log

Use these sheets to record how much time you spend sitting or how many breaks you take from sitting. Remember that the first program goal is to take more breaks. The breaks don't have to be long, just enough time to get a drink of water or take something to another room.

Be specific about what you do when you sit! This way you will learn what your 'trouble' activities are and can focus on reducing them.

There are enough logs for 3 weeks. More will be passed out at TOPS. Use the example below to fill in your charts once or twice a day.

Activity	Morning	breaks	Mid-day	breaks	Evening	breaks	TOTALS
Computer/Desk	8-11am-work	2	2-4pm - work	1	7:30-9pm - email, bills		6.5hr 3
Television/Video	6-6:30 - news				9-10pm	2	1.5 2
Reading			12-1 - newspaper				1
Hobbies							
Socializing			5-6 - phone				1
Other (list with time)	11-12 - meeting						1
					TOTALS		12hr 5breaks

Date ______________________________

Activity	Morning	*breaks*	Mid-day	*breaks*	Evening	*breaks*	TOTALS
Computer/Desk							
Television/Video							
Reading							
Hobbies							
Socializing							
Other (list with time)							
					TOTALS		

Date ______________________________

Activity	Morning	*breaks*	Mid-day	*breaks*	Evening	*breaks*	TOTALS
Computer/Desk							
Television/Video							
Reading							
Hobbies							
Socializing							
Other (list with time)							
					TOTALS		

Step Log

Keep track of your daily steps here. Your pedometer will record 7 days in a row. The more frequently you check your steps the better! If you don't catch it on the 7th day it will write over the oldest day's steps, so keep up!

There are enough charts here for the full 6 weeks of the program. Just ask for more charts at the end of the study to continue tracking your steps.

Week 1 ________________

Day	Steps	Physical Activity	Thoughts, Feelings, Ideas
M			
T			
W			
TH			
F			
SAT			
SUN			

Week 2 ________________

Day	Steps	Physical Activity	Thoughts, Feelings, Ideas
M			
T			
W			
TH			
F			
SAT			
SUN			

Frequently Asked Questions

- The light on the red activity monitor has stopped blinking?
  Answer – Nothing to worry about. It turns off when collecting data. It has been programmed to start and stop at certain times.
- I can't find my study ID number?
  Answer – It should be written on the front of this booklet. If not, contact Melanie Adams at mmadams2@uncg.edu for it.
- I am not getting any of the emails?
  Answer – You could be blocking them by accident. Check the spam folder in your email and allow make sure that you are accepting email from uncg.edu in your email settings.
- I cannot open any of the attachments?
  Answer – You may need to change your email settings allow the attachments from mmadams2@uncg.edu to open. You could also save the attachment to your computer and open it that way. Click on the attachment, then click save as or download and type a name and select place to save it to.
- Can I go stop and go back to a questionnaire later?
  Answer – Yes, just make sure you save the email with the link to the survey and that you go back to it within 3 days.
- Why are there some questions I cannot skip in the online survey?
  Answer – Some questions are key to the research study and some are for extra information.
- I cannot open the link in the emails?
  Answer – If clicking on the link doesn't automatically open it, then copy the entire link and put in the address window of your internet program.
- I cannot make one of the meeting dates listed on page i?
  Answer – Contact Melanie Adams at mmadams2@uncg.edu or 336-430-9146 and arrange a make-up appointment.
- My computer or internet is not working?
  Answer – It is important that you check your email twice a week for the first 4 weeks of the study. Ask a friend or family member to borrow their computer or go to your local library. They have free computer asses

APPENDIX H

GOAL WORKSHEET

Next week, _________________, I will:
Take ______________ breaks from sitting during the day.

I am going to meet my goal by doing (list specific activities you will do during your breaks from sitting). Example: *I will do the stretching exercises during TV commercials*.

4) ____
5) ____
6) ____

How confident are you that you can meet this goal?

1	2	3	4	5
Not at all Confident				Completely Confident

If you rated it less than a 3, then revise your goal so that you feel more confident in it.

List things that would make you feel more confident in meeting this goal. Example: a daily reminder

d. ____
e. ____
f. ____
g. While keeping up the number breaks for your first goal, think about a daily step count goal for three weeks from now.

By _____________________, I will: Take ______________ steps a day.

I am going to meet my step goal by doing (list specific activities you will do to get more steps):

example: I will walk to the bathroom that is furthest away.

1) ____
2) ____
3) ____

How confident are you that you can meet your three week goal?

1	2	3	4	5
Not at all Confident				Completely Confident

If you rated it less than a 3, then revise your goal so that you feel more confident in it.

List things that would make you feel more confident in meeting this goal. Example: checking my step count at lunch

1) ____
2) ____
3) ____

APPENDIX I

ON OUR FEET STEP LOG

Week 1

Day	Date	Steps	Physical Activity	Thoughts, Feelings, Ideas
M				
T				
W				
TH				
F				
SAT				
SUN				

Week 2

Day	Date	Steps	Physical Activity	Thoughts, Feelings, Ideas
M				
T				
W				
TH				
F				
SAT				
SUN				

Week 3

Day	Date	Steps	Physical Activity	Thoughts, Feelings, Ideas
M				
T				
W				
TH				
F				
SAT				
SUN				

Week 4

Day	Date	Steps	Physical Activity	Thoughts, Feelings, Ideas
M				
T				
W				
TH				
F				
SAT				
SUN				

Week 5

Day	Date	Steps	Physical Activity	Thoughts, Feelings, Ideas
M				
T				
W				
TH				
F				
SAT				
SUN				

Week 6

Day	Date	Steps	Physical Activity	Thoughts, Feelings, Ideas
M				
T				
W				
TH				
F				
SAT				
SUN				

On Our Feet

Sitting Time Log

EXAMPLE

Activity	Morning	*breaks*	Mid-day	*breaks*	Evening	*breaks*	TOTALS
Computer/Desk	8-11am- work	2	2-4pm - work	1	7:30-9pm - email, bills		**6.5hr** **3**
Television/Video	6-6:30 - news				9-10pm	**2**	**1.5** **2**
Reading			12-1 - newspaper				**1**
Hobbies							
Socializing			5-6 - phone				**1**
Other (list with time)	11-12 - meeting						**1**
					TOTALS		**12hr** **5breaks**

week 1 date ________________

Activity	Morning	*breaks*	Mid-day	*breaks*	Evening	*breaks*	TOTALS
Computer/Desk							
Television/Video							
Reading							
Hobbies							
Socializing							
Other (list with time)							
					TOTALS		

week 1 date _________________

Activity	Morning	*breaks*	Mid-day	*breaks*	Evening	*breaks*	TOTALS
Computer/Desk							
Television/Video							
Reading							
Hobbies							
Socializing							
Other (list with time)							
					TOTALS		

week 1 date _________________

Activity	Morning	*breaks*	Mid-day	*breaks*	Evening	*breaks*	TOTALS
Computer/Desk							
Television/Video							
Reading							
Hobbies							
Socializing							
Other (list with time)							
					TOTALS		

week 1 date ________________

Activity	Morning	*breaks*	Mid-day	*breaks*	Evening	*breaks*	TOTALS
Computer/Desk							
Television/Video							
Reading							
Hobbies							
Socializing							
Other (list with time)							
					TOTALS		

week 1 date ________________

Activity	Morning	*breaks*	Mid-day	*breaks*	Evening	*breaks*	TOTALS
Computer/Desk							
Television/Video							
Reading							
Hobbies							
Socializing							
Other (list with time)							
					TOTALS		

week 1 date ________________

Activity	Morning	*breaks*	Mid-day	*breaks*	Evening	*breaks*	TOTALS
Computer/Desk							
Television/Video							
Reading							
Hobbies							
Socializing							
Other (list with time)							
					TOTALS		

week 1 date ________________

Activity	Morning	*breaks*	Mid-day	*breaks*	Evening	*breaks*	TOTALS
Computer/Desk							
Television/Video							
Reading							
Hobbies							
Socializing							
Other (list with time)							
					TOTALS		

APPENDIX J

FEEDBACK MESSAGES

Week 0 – Email 1 – morning after baseline meeting

Reminder to wear activity monitors & copy of instructions

"Hello Jane & Welcome to the On Our Feet program! I am so glad you signed up. This week is all about what you normally do. The activity monitors will count everything for you! Be sure to wear your red monitor on your RIGHT hip and the black monitor on your LEFT hip for at least **10** hours a day."

Email 2 – 4 days after baseline meeting

Reminder to wear activity monitors & date of initial presentation

"Hi Jane, Just a quick reminder to wear your activity monitors every day! We will meet again on <day, time> and start learning about your daily movements."

Week 1 – Email 1 – 2 days after initial presentation

Summary from presentation

" Hi Jane, Hope you enjoyed the session on <day> as much as I did! It's important to stop and think about how much sitting we do. So much of it is just out of habit! The On Our Feet program is designed to help you change those habits and put more activity into your day. Like I said <day>, this is not an exercise program and shouldn't replace the planned activities you have been doing. Trying to sit less is a great idea for everyone regardless of how much exercise they get! Remember, that sitting less decreases your risk of type 2 diabetes, high cholesterol, heart disease, and obesity. Continue to wear you pedometer daily and practice your active stretches whenever you take a break from sitting. We will set more specific goals next <day>. See you then!"

Week 2 – Email 1 – no more than 2 days after goal setting session

Review of short-term goal

"Hello Jane! Your goal of taking X breaks from sitting this week is well within your reach. You have X % confidence in meeting this goal. Why don't you start right now by standing up to read the rest of your email.

Some strategies to help you are X, Y, and Z. Remember there are many things you can do in place of sitting like X, Y and Z. I've attached a copy of your goal worksheet, please print this out and keep it near your desk or favorite chair to help remind you to get up a move more."

Process Evaluation Link - Initial presentation & active stretching exercises

"Please click here to fill out a short survey on last week's presentation. Your responses will help improve the On Our Feet program!"

Week 3 – <u>Email 1 – 7 days from goal setting session</u>

Video Presentations

"Jane, Here are 2 examples of how you can change the way you do ordinary things to make them more active. By the way, are you standing while you read this? If not, get on your feet to watch these 2 short videos. You can save them to your computer or keep this message in your in box to review them again as you look for more ways to break up your sitting time."

Link to SE Measures, Sitting Inventory & Breaks from Sitting Reported

"Let's check your progress on sitting less. There are 4 pages to the questionnaire. It should only take you 6-7 minutes to finish. Please click the link below. I will get back to you tomorrow to show you how you did. As always, if you have any problems getting to the survey you can contact me at mmadams2@uncg.edu."

<u>Email 2 - 1 day after Email 1</u>

Feedback on SE, short-term goal and where most sitting occurs

"Hi Jane! You did a great job of taking breaks from sitting this week. You made *85-100%* of your goal to take X breaks. Your confidence in sitting less has increased from X to Y in just 3 weeks! Most of your sitting time comes from X and Y. Remember that you can add breaks to X and Y without interrupting your tasks by <counter conditioning suggestions from week 2>."

OR

" Hi Jane! You definitely made progress on breaking up your sitting time this week. You reached *65-84%* of your goal to take X breaks. Most of your sitting time comes from X and Y. Remember that you can add breaks to X and Y without interrupting your tasks by <counter conditioning suggestions from week 2>. You have plenty of confidence <3/5 or 1 point slide from baseline> in being able to sit less. Maybe changing some things at work or home would help. Try being less efficient! You could move the printer so that you have to get up to get documents. Maybe carrying bags in from the car one at a time would help. And, you could use the bathroom that is furthest away from you or one that is on another floor. "

OR

"Hi Jane! Taking breaks from sitting seems to be a challenge for you. That's ok. Every little bit helps make a healthier you. You reached *<64%* of your goal to take X breaks. Most of your sitting time comes from X and Y. You still have plenty or confidence <3/5 or 1 point slide from baseline > to start sitting less. Think of one sitting behavior you would like to change. Maybe it's X or Y. Remember that you can add breaks without interrupting your tasks by <counter conditioning suggestions from week 2>. <Add specific behavioral cues for those 2 items>. Start with small changes and build from there!

OR

“Hi Jane! Taking breaks from sitting seems to be a challenge for you. That’s ok. Every little bit helps make a healthier you. You reached *<64%* of your goal to take X breaks. Most of your sitting time comes from X and Y. You seem to be losing confidence <1,2 or 2+ decline from baseline> in your ability to change how much you sit. It is hard at first because lots of our physical activity is based on our environment. Try being less efficient! Move things around at work and home so that you have to stand up to get to the TV remote, phone or printer. You could <efficacy promoters from week 2>. Think of one sitting behavior you would like to change. Maybe it’s X or Y. Remember that you can add breaks without interrupting your tasks by <counter conditioning suggestions from week 2>. <Add specific behavioral cues for those 2 items>. Start with small changes and build from there!

Process Evaluation Link - goal setting session, accelerometer FB & sitting log

“Please click here to fill out a short survey on last week’s session. Your responses will help improve the On Our Feet program!”

Week 4 – <u>Email 1 – 2 weeks after goal setting session</u>

Review of mid-range goal

“Hello Jane! Your goal of taking X steps this week is definitely achievable. You have X % confidence in meeting this goal. Some strategies that will help you are X, Y, and Z. Remember there are many things you can do in place of sitting like X, Y and Z. I’ve attached a copy of your goal worksheet, please print this out and keep it near your desk or favorite chair to help remind you to get up a move more. Why don’t you start right now by walking to another room to get a glass of water or say hello to a friend.”

Process Evaluation Link - videos 1 & 2, active stretching exercise

“Please click here to fill out a short survey on last week’s videos and the stretching exercises. Your responses will help improve the On Our Feet program!”

<u>Email 2 – 3 days after week 4 email 1</u>

“Jane, This week’s focus is taking more steps, but that doesn’t mean that you should forget about the breaks from sitting. You could stand now and get one of those much deserved breaks right now!

Here are 4 notecards you can print and post around your office or house to help you remember to sit less and move more! You can see by the photos where I have hung my notes. These reminders will help with many of the new activities TOPS members have been trying out. Also, both of the videos, being a walkie-talkie and leaving the TV remote at the TV will increase your daily steps and break up your sitting time!”

Week 5 – Email 1 – <u>3 weeks after goal setting session</u>

Step Count Reported

"Hello Jane! Hope you have been on your feet more and more since we started working together 5 weeks ago. Click on this link to report your step count for week 5. I will be in touch in a couple days to tell you how you did."

Process Evaluation Link - Pedometer & behavioral notecards

"Please click here to fill out a short survey on using the pedometer and notecards. Your responses will help improve the On Our Feet program!"

<u>Email 2 – within 2 days of week 5 Email 1</u>

"Hi Jane! You did a great with your steps! You made *85-100%* of your goal to take X steps. You should feel really proud of yourself. Have you noticed anything different about yourself since you started the On Our Feet program? Getting more done, feeling more active, sleep better, less stress or feeling more confident in your abilities. All super things for your health and well-being. Don't stop now. Keep it up. We will be measuring your activity levels again in two weeks. "

OR

"Hi Jane! You definitely made progress at increasing your daily steps this week. You reached *65-84%* of your goal to take X breaks. That was a really good start. A couple things might help you improve even more <counter conditioning behaviors from goal setting>." Remember your body wants to move! Wearing your pedometer every day helps us take that extra step. Stay at it. You may have noticed some good stuff like feeling less stress and having more energy. Those are big rewards for little changes. Don't stop now. We will be measuring your activity levels again in two weeks. "

OR

"Hi Jane! Adding steps to your day seems to be a challenge. That's ok. Every extra step helps make a healthier you. You reached *<64%* of your step goal. We still have two weeks left in the On Our Feet program, so there is plenty of time to improve. Remember your body wants to move! You could <counter conditioning from week 2>. If it seems like a lot, start with one simple change like parking your car further away from the office or store. The health benefits are worth a little extra time. So, stay at it. We will be measuring your activity levels again in two weeks."

Week 6 – <u>Email 1 – 4 weeks after goal setting session</u>

Video Presentation

"Jane, I hope you are now standing to read this…(hint, hint). You are ready to take on even bigger movement challenges! Watch this video to see how taking the stairs is easier than you think. When you enter a building always look for the stairs. There's no waiting and it's great to get the blood pumping.

You may be wondering how to keep progressing in your less sedentary lifestyle. I've attached a goal sheet for you fill out on your own and some new log sheets. Make as many copies as you like. We will meet again next <day, time> at TOPS to take more measurements. Thank you so much for all the time and effort you have put into this program."

Process Evaluation Link - Tailored feedback & video 3

"Please click here to fill out a short survey the email messages and the last video. Your responses will help improve the On Our Feet program!"

Week 7 – Email 1 – morning after post assessment meeting

Reminder to wear activity monitors & copy of instructions

"Hello Jane, It was good to see you again yesterday! This is the final week of the On Our Feet program. It is very important that you wear your red activity monitor for at least **10 hours** a day. You will get a copy of your study results so make it count!"

Email 2 – 4 days after post assessment meeting

Reminder to wear activity monitors & date of monitor pick up

"Hi Jane, Just a quick reminder to wear your activity monitor every day! We will meet again on <day, time> to fill out the final questionnaires. I so appreciate your help with this study and I hope you have learned a few new things."

Week 8 – Email 1 – within 7 days after final meeting

Post Accelerometer Data – comparison to NHANES & pre data

"Congratulations Jane! Your amount of sitting time decreased by X minutes since the start of the On Our Feet program. You also increased the amount of time you spent doing moderately intense physical activity, which is a great side benefit. As compared to other women your age you sit for X minutes <more or less> than the average. You should feel really good about your new activity level. Keep it up!"

OR

"HI Jane, At the start of the program you spend X minutes a day sitting and last week you spent Y. While your final results don't show much change, you shouldn't be discouraged. These are changes that you can make at any point in the future. You may just need more practice with them. It is important to remember that sitting less is good for your heart, blood sugar and waistline. Right now you are sitting <more or less> than the average woman your age. The On Our Feet workbook has lots of tips for changing your sitting habits. See if you can commit to one new behavior like <counter conditioning from week2> this week. You can contact me at mmadams2@uncg.edu if you have any questions. Good luck!"

APPENDIX K

BASELINE CHARACTERISTICS OF PARTICIPANTS AND DROP-OUTS

	INV n=40	WC n= 24	INV drop n=7 (.149)	WC drop n=4 (.143)	*p* value	Statistic
age in years	56.73	61.38	58.71	52.67	0.39	
race					0.04	x^2=(4, N=78)=10.67
Caucasian	36*	21	7	3		
African-American	4	3	1	0		
education					0.53	
< high school	1	2	1	0		
high school	15	12	1	2		
College/trade	19	8	4	1		
graduate school	5	2	1	1		
employed					0.16	
full-time	22*	5	4	0	0.05	x^2=(3, N=64)=7.747
part-time	3	5	1	1		
retired	9	8	2	1		
disabled	6	6	0	2		
active job	11*	5	2	0	0.05	x^2=(1, N=64)=3.824
membership years	6.31	4.95	1.73	4.28	0.38	
cardiovascular disease	16	12	5	1	0.38	
type 2 diabetes	16	13	0	0	0.15	
arthritis	3	4	1	0	0.73	
depression	3	4	2	3	0.19	
BMI	36.32	35.63	36.04	35.2	0.98	
waist circumference	108.54	105.4	108.29	119.667	0.47	
% SB	47.42	50.7	50.39	67.99	0.65	
% LPA	43.51	43.65	41.86	38.43	0.87	
% MPA	8.55	6.74	7.24	9.63	0.51	
bouts of MPA/week	1.45	0.95	1.57	0	0.83	
steps	37878	30882	24564	25387	0.11	
SE to reduce SB	3.63	3.69	3.71	3.67	0.98	
SE for LPA	3.78	3.58	4.04	3	0.17	
SE for MPA	4.03	3.5	3.61	3.42	0.22	

* significant difference between INV-WC

APPENDIX L

CORRELATIONS BETWEEN BEHAVIOR MEASURES

baseline (*n*=64)	***M***		**% SB**	**% LPA**	**% MPA**	**% VPA**
IPAQ weekday sitting	6.38±2.55	*r*	.075	-.236	-0.286*	-.160
		p	.577	.074	.029	.229
IPAQ weekend sitting	6.01±2.54	*r*	.124	-0.313*	-.236	-.081
		p	.353	.017	.074	.546
Weekly Sitting Time	53.18±32.08	*r*	.180	-0.39**	-.130	-.058
		p	.177	.003	.332	.664
Godin Light	9.53±12.18	*r*	.194	-.078	-.008	-.096
		p	.145	.561	.953	.473
Godin Moderate	10.91±12.56	*r*	.162	-.110	.191	.346**
		p	.223	.409	.150	.008
Godin Strenuous	7.97±14.28	*r*	.041	.100	.277*	.001
		p	.762	.455	.035	.994
post (n=58)						
IPAQ weekday sitting	6.87±3.54	*r*	0.287*	-0.260*	-.147	-.191
		p	.029	.049	.271	.152
IPAQ weekend sitting	6.17±3.59	*r*	.173	-.215	.008	.021
		p	.194	.105	.952	.875
Weekly Sitting Time	43.87±33.60	*r*	.193	-.185	-.081	-.115
		p	.146	.165	.544	.391
Godin Light	10.33±12.76	*r*	-.07	.032	.127	-.082.
		p	.603	.812	.343	.541
Godin Moderate	10.23±12.07	*r*	-.069	-.091	.273*	.478*
		p	.609	.499	.038	.000
Godin Strenuous	8.37±13.88	*r*	.190	.085	.234	.367**
		p	0.152	.524	.077	.005

** significant at .01

* significant at .05

APPENDIX M

CORRELATIONS BETWEEN SELF-EFFICACY SUB-SCALES

n=64	SE to reduce SB	SE for LPA	SE for MPA
SE to reduce SB		0.641**	0.483**
SE for LPA	0.782**		0.448**
SE for MPA	0.433**	0.558**	

baseline correlations above the shaded area, post correlations below

** significant at .01

APPENDIX N

F VALUES, EFFECT SIZE, & POWER STATISTICS FOR MANOVA & ANOVAS

MANOVA Results

	F value	p value	partial eta^2	power
Time				
behavior	.459	.712	.025	0.136
SE	2.084	.056 ǂ	.048	0.746
body size	3.072	.054*	.092	0.572
self-reported behavior	1.595	.156	.166	0.61
Time x Group				
behavior	.188	.904	.01	0.083
SE	.995	.429	.024	0.391
body size	3.902	.025*	.11	0.683
self-reported behavior	2.107	.058ǂ	.033	0.186

** significant at .01
* significant at .05
ǂ trend at .07

ANOVA Results

	F value	p value	partial eta^2	power
Time				
% SB	0.334	0.566	0.006	0.088
% LPA	0.928	0.34	0.016	0.157
% MPA	0.809	0.372	0.014	0.143
SE to reduce SB	3.339	.039*	0.051	0.622
SE for LPA	2.739	.069†	0.049	0.532
SE for MPA	3.951	0.022*	0.06	0.701
weight	3.775	.057†	0.057	0.481
waist circumference	2.324	0.133	0.036	0.323
acc steps	0.598	0.443	0.011	0.118
wear time	5.138	.027*	0.084	0.606
daily average SB	0.262	0.611	0.005	0.079
weekly sitting	4.879	0.031*	0.073	0.585
IPAQ weekday	1.482	0.228	0.023	0.22
IPAQ weekend	0.44	0.510	0.007	0.100
Godin METs/week	0.749	0.390	0.012	0.136
Godin Light	0.001	0.981	0.00	0.050
Godin Moderate	0.825	0.367	0.013	0.145
Godin Strenuous	0.001	0.979	0.00	0.050
pedo steps	1.873	0.176	0.03	0.271
Group				
% SB	0.489	0.487	0.009	0.106
% LPA	0.06	0.807	0.001	0.057
% MPA	2.596	0.113	0.044	0.354
SE to reduce SB	0.308	0.581	0.005	0.085
SE for LPA	1.925	0.170	0.03	0.277
SE for MPA	5.515	.022*	0.082	0.638
weight	0.004	0.952	0.0001	0.05
waist circumference	0.131	0.719	0.002	0.065
acc steps	2.982	0.090	0.051	0.396
wear time	2.09	0.154	0.036	0.295
daily average SB	0.03	0.862	0.001	0.053
weekly sitting	1.497	0.226	0.024	0.226
IPAQ weekday	1.02	0.317	0.016	0.169
IPAQ weekend	1.00	0.321	0.016	0.166
Godin METs/week	2.199	0.143	0.034	0.31
Godin Light	0.242	0.625	0.004	0.08
Godin Moderate	1.821	0.182	0.029	0.26
Godin Strenuous	1.348	0.250	0.021	0.21
pedo steps	2.884	0.095	0.049	0.386
Time x Group				
% SB	0.181	0.672	0.003	0.07
% LPA	0.317	0.576	0.006	0.086
% MPA	0.064	0.801	0.001	0.057
SE to reduce SB	1.953	0.146	0.031	0.398
SE for LPA	0.002	0.998	0.00	0.05
SE for MPA	0.11	0.896	0.002	0.066
weight	3.004	0.088	0.046	0.4
waist circumference	5.11	.027*	0.076	0.605
acc steps	0.936	0.337	0.016	0.158
wear time	0.043	0.836	0.001	0.055
daily average SB	0.22	0.639	0.004	0.075
weekly sitting	0.878	0.352	0.014	0.152
IPAQ weekday	0.013	0.91	0.00	0.051
IPAQ weekend	1.633	0.206	0.026	0.242
Godin METs/week	9.761	0.003**	0.136	0.87
Godin Light	5.221	0.026*	0.078	0.61
Godin Moderate	3.903	.053*	0.059	0.49
Godin Strenuous	0.779	0.381	0.012	0.14
pedo steps	5.029	.029*	0.075	0.598

** significant at .01

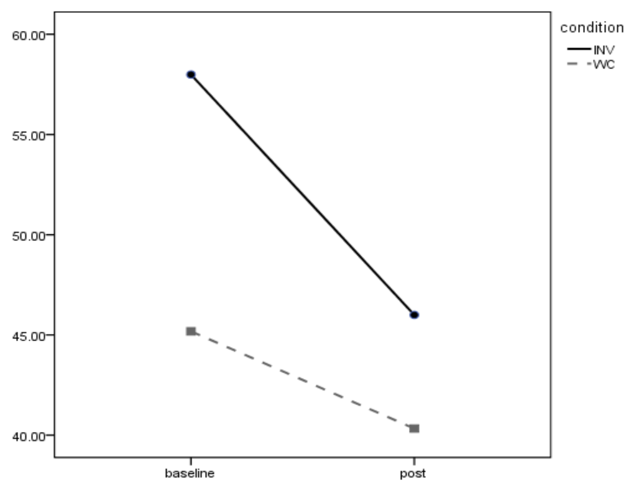
* significant at .05

† trend at .06

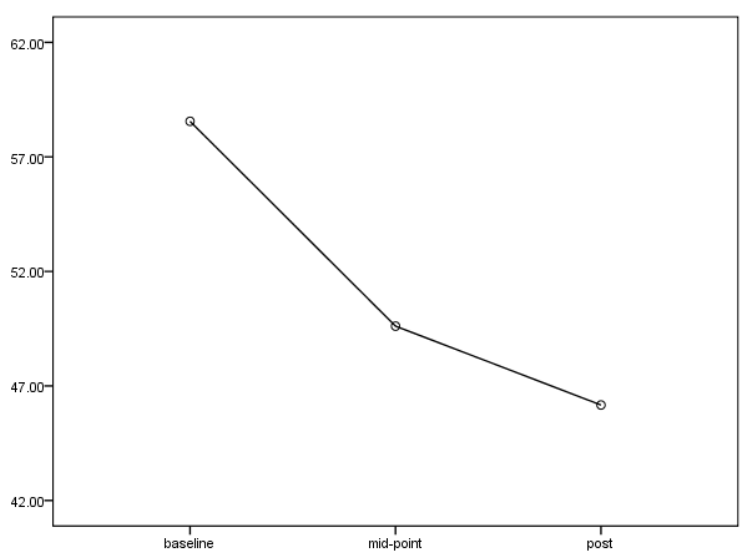
APPENDIX O

SELF-REPORTED WEEKLY SITTING

Both Groups



Intervention Group



APPENDIX P

CORRELATIONS BETWEEN SELF-EFFICACY AND SEDENTARY BEHAVIOR

n=58 **SE to reduce SB**	**mean**	**Baseline % SB**	**Post % SB**	**change in % SB @ post**	**R^2**
baseline	3.65±.71	.067	-.069	-.129	.005
mid-point	3.37±.81	.085	.154	.067	.087
post	3.48±.80	.016	.025	.009	.001
INV with decreased SB (*n* = 18)					
baseline SE	3.81±.74	.300	.403	.257	.162
mid-point	3.56±.72	.081	.292	.479*	.085
post	3.54±.84	.386	.604*	.517*	.367*

* significant at .05

APPENDIX Q

CORRELATIONS BETWEEN SAMPLE CHARACTERISTICS AND SELF-EFFICACY AND BEHAVIOR

Baseline (*n* = 64)	Age	Weight	Waist Circumference	Rural Location	Non-sedentary Job	Health Rating	Heart Disease	Diabetes	Depression
SE to reduce SB	0.064	-.067	-.101	-.280*	0.078	-.331**	-.193	0.020	-.128
SE for LPA	-0.150	-.147	-.135	-.061	0.219	-.329**	-.186	0.101	-.115
SE for MPA	-0.188	-.100	-.175	0.045	.269*	-.406	-.235	-.195	0.042
% SB	0.071	.119	.120	-.270*	-.132	0.104	.264*	0.042	-.073
% LPA	0.073	-.141	-.148	.285*	0.114	-.171	-.122	0.125	-.112
% MPA	-.261*	-.045	-.229	0.220	.293*	-.304	-.243	-.265*	-.083

* significant at .05
**significant at .01

Post (*n* = 58)	Age	Weight	Waist Circumference	Rural Location	Non-sedentary Job	Health Rating	Heart Disease	Diabetes	Depression
SE to reduce SB	-.369**	.123	-.028	-.209	0.063	-.078	-.133	-.022	-.325
SE for LPA	-.35	.178	-.035	0.022	0.114	-.130	-.099	0.099	-.041
SE for MPA	-.133	-.178	-.276*	0.100	0.165	-.349	-.330**	0.160	-.013
% SB	0.141	.073	-.057	-.204	-.238	0.228	.319*	0.054	.268*
% LPA	0.076	-.089	.124	0.133	0.122	-.154	-.171	0.124	-.250
% MPA	-.452**	.014	-.098	0.190	.302*	-.236	-.417**	-.352**	-.138

* significant at .05
**significant at .01

APPENDIX R

CHAPTER BY CHAPTER MEANS

INV	chapter 1 (n=18)			chapter 3 (n=10)			chapter 5 (n=8)			chapter 7 (n=4)		
	pre		post	pre		post	pre		post	pre		post
% SB	51.47±10.53		52.79±10.34	43.27±8.25		45.85±8.60	45.45±11.91		47.68±9.89	47.54±12.74		48.19±12.76
% LPA	40.74±9.39		39.84±9.20	49.19±4.52		44.92±5.65**	43.48±9.63		42.72±9.29	40.54±7.47		42.30±8.54
% MPA	7.55±2.91		7.27±2.86	9.17±2.84		8.71±4.68	9.18±6.74		8.59±4.93	9.00±4.96		9.06±5.05
% VPA	.24±.30		.09±.12§	.44±1.12		.52±1.19	1.59±4.06		1.00±1.9	.12±.14		.45±.50
weight in kgs	101.14±25.19		101.09±25.19	86.87±14.3		85.56±14.50*	95.14±19.71		85.56±14.50§	92.74±26.30		93.30±25.72
waist circumference	114.2±16.43		98.47±31.37*	100.8±14.29		99.1±13.59*	110.59±13.96		99.1±13.59*	103.61±16.32		101.83±17.29
BMI	38.86±8.61		52.14±53.09	32.4±5.83		31.77±5.55*	36.64±8.11		37.11±8.13§	35.92±9.97		35.65±10.15
bouts of MPA	1±1.5		0.14±.36*	1.5±2.59		01.3±2.54	2.1±4.85		02.25±5.20	1.5±1.76		03.00±2.45*
acc steps	34312±11804		28915±10456*	40235±12909		35792±19875	42796±32056		47642±31912	35716±11994		51618±29142
wear time in mins	5120±1057		4142±1284*	5370±502		4559±1144**	4558±1156		5061±1122§	5070±1101		5400±1968
daily average SB	6.44±2.34		5.62±1.85*	5.49±.89		5.41±1.14	5.54±2.36		6.09±1.9	6.11±1.79		7.35±3.80
pedo steps	10780±10556		12603±10253	17628±13817		24377±20616	21034±20298		38086±36242*	14305±6545		34601±72931*
	pre	mid	post	pre	mid	post	pre	mid	post	pre	mid	post
SE to reduce SB	3.73±.84	3.19±.83++	3.66±.76^^	3.18±.60	2.93±.92	3.1±.71	3.66±.35	3.80±.72	3.81±.68	4.04±.25	3.96±.80	4.08±.47
SE for LPA	3.83±.66	3.41±.75++	3.58±.93	3.28±.46	3.40±.53	3.23±.62	4.19±.37	3.95±.62	3.94±.62	3.92±.74	3.67±.66	3.79±.53
SE for MPA	4.02±.99	3.41±.75++	3.77±1.03	3.80±1.03	3.45±1.27	4.03±.78	4.38±.72	3.80±.98	4.00±.71	4.00±.91	3.71±.91§	3.75±.94

WC	chapter 2 (n=7)			chapter 4 (n=8)			chapter 6 (n=7)			chapter 7 (n=1)		
	pre		post	pre		post	pre		post	pre		post
% SB	51.80±9.13		53.75±9.91	49.49±16.04		47.02±14.78	49.86±16.01		50.5±18.85	50.8		66.61
% LPA	43.37±8.22		43.19±10.63	44.21±12.84		46.36±11.90	40.77±16.09		43.04±14.38	43.37		31.35
% MPA	4.77±2.79		3.03±1.82	5.93±4.58		6.54±5.39	9.18±9.55		8.28±6.89	7.2		2.04
% VPA	.05±.07		.03±.04	.19±.38		.08±.14	.29±.38		.45±.63	0.46		0
weight in kgs	101.11±26.19		101.09±26.19	87.47±20.8		90.88±18.28	97.97±18.68		97.61±19.91	73.94		76.66
waist circumference	114.2±16.43		98.47±51.37	99.42±8.44		102.44±7.68	108.07±15.61		108.45±16.93	92.75		98.75
BMI	38.86±8.61		52.14±33.09	32.16±4.68		34.58±4.02	35.97±5.60		35.81±6.08	32.2		33.4
bouts of MPA	1±1.5		0.14±.36	.89±1.54		0.33±.701	1.67±3.20		1.83±2.86	0		0
acc steps	19820±3197		17014±3075	30187±17645		25404±17271	38887±23942		39278±9788	33371		18295
wear time in mins	5189±282		3550±1039§	4653±689		4328±1410	4519±908		4778±1298	3128		3993
daily average SB	6.64±1.16		5.56±1.68	6.23±2.37		5.52±2.53	6.10±2.08		5.74±2.31	4.41		11.08
pedo steps	6476±3108		4964±3398	22029±17039		18495±16695	10078±8493		6003±2688	10034		5501
	pre	mid	post	pre	mid	post	pre	mid	post	pre	mid	post
SE to reduce SB	3.75±.79	3.89±.28	3.18±.95	3.83±.72	3.12±.33++	3.50±.98	3.32±.72	3.25±.88	3.04±.64	4.5	3.25	3.5
SE for LPA	3.46±.73	3.29±.57	3.32±.45	3.75±.77	3.31±.75	3.36±1.01	4.19±.37	3.4±.53	3.94±.62	4.25	3.44	2.75
SE for MPA	3.50±1.44	2.93±1.03	2.89±1.16	3.61±1.21	3.12±1.15	3.86±1.02	3.64±1.4	3.37±.82	3.57±2.34	1.5	3.37	2.75

** significant at .01

* significant at .05

§ trend at .07

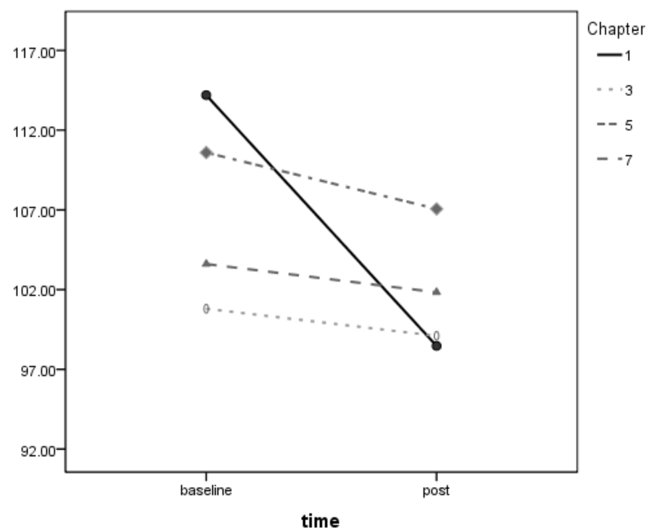
+ mid-point compared to baseline

^ post compared to mid-point

APPENDIX S

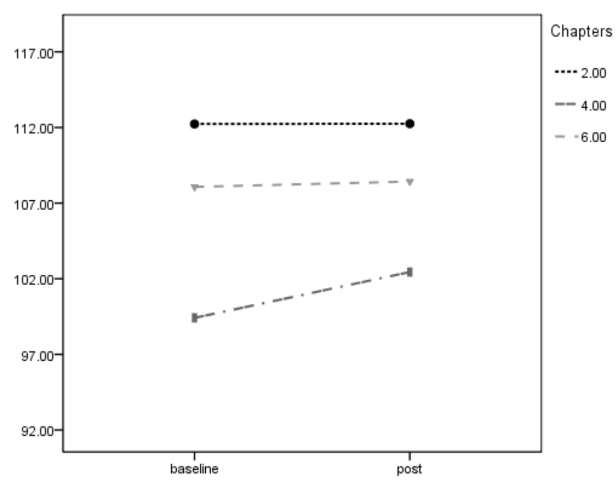
WAIST CIRCUMFERENCE BY CHAPTER

INV Chapters



Non-estimable means are not plotted

WC Chapters



Non-estimable means are not plotted

APPENDIX T

PARTICIPANT PROCESS EVALUATION RATINGS OF INTERVENTION ELEMENTS

how satisfied overall are you with program (1-5)

		Frequency	Percent	Mean Percent	Cumulative Percent
Mean	not at all	1	2.3	2.3	2.3
4.07	2	0	.0	.0	2.3
	somewhat	11	25.6	25.6	27.9
	4	14	32.6	32.6	60.5
	very	17	39.5	39.5	100.0
	Total	43	100.0	100.0	

how beneficial was the program to you (1-5)

		Frequency	Percent	Mean Percent	Cumulative Percent
Mean	none	1	2.3	2.3	2.3
4.16	2	0	.0	.0	2.3
	3	6	14.0	14.0	16.3
	4	20	46.5	46.5	62.8
	very	16	37.2	37.2	100.0
	Total	43	100.0	100.0	

would you recommend this program to others (1-5)

		Frequency	Percent	Mean Percent	Cumulative Percent
Mean	definitely no	1	2.3	2.3	2.3
4.3	2	1	2.3	2.3	4.7
	3	6	14.0	14.0	18.6
	4	11	25.6	25.6	44.2
	definitely yes	24	55.8	55.8	100.0
	Total	43	100.0	100.0	

did the program meet your needs or goals

		Frequency	Percent	Mean Percent	Cumulative Percent
Mean	no	0	0	0	0
1.3	yes	29	67.4	67.4	67.4
	somewhat	14	32.6	32.6	100.0
	Total	43	100.0	100.0	

how effective was the program at decreasing SB (1-5)

		Frequency	Percent	Mean Percent	Cumulative Percent
Mean	not at all	0	0	0	0
4.07	2	2	4.7	4.8	4.8
	somewhat	8	18.6	19.0	23.8
	4	17	39.5	40.5	64.3
	very	15	34.9	35.7	100.0
	Total	42	97.7	100.0	
Missing	System	1	2.3		
Total		43	100.0		

how hard was it to have measurements taken (1-5)

		Frequency	Percent	Mean Percent	Cumulative Percent
Mean	easy	33	76.7	80.5	80.5
1.27	2	5	11.6	12.2	92.7
	a little	3	7.0	7.3	100.0
	4	0	.0	.0	
	very	0	.0	.0	
	Total	41	95.3	100.0	
Missing	System	2	4.7		
Total		43	100.0		

how hard was it to wear activity monitors for 1 week (1-5)

		Frequency	Percent	Mean Percent	Cumulative Percent
Mean	easy	11	25.6	25.6	25.6
2.84	2	3	7.0	7.0	32.6
	a little	15	34.9	34.9	67.4
	4	10	23.3	23.3	90.7
	very hard	4	9.3	9.3	100.0
	Total	43	100.0	100.0	

how hard was it to get information by email (1-5)

		Frequency	Percent	Mean Percent	Cumulative Percent
Mean	easy	29	67.4	67.4	67.4
1.74	2	5	11.6	11.6	79.1
	a little	3	7.0	7.0	86.0
	4	3	7.0	7.0	93.0
	very hard	3	7.0	7.0	100.0
	Total	43	100.0	100.0	

was the number of emails...

		Frequency	Percent	Mean Percent	Cumulative Percent
Mean	just right	37	86.0	92.5	92.5
1.15	too many	0	.0	.0	92.5
	too few	3	7.0	7.5	100.0
	Total	40	93.0	100.0	
Missing	System	3	7.0		
Total		43	100.0		

Did you like receiving health information on the computer?

		Frequency	Percent	Mean Percent	Cumulative Percent
Mean	no	5	11.6	12.2	12.2
0.93	yes	36	83.7	87.8	100.0
	Total	41	95.3	100.0	
Missing	System	2	4.7		
Total		43	100.0		

how helpful were your interactions with the leader (1-5)

		Frequency	Percent	Mean Percent	Cumulative Percent
Mean	not at all	0	0	0	0
4.4	2	0	0	0	0
	a little	5	11.6	11.6	11.6
	4	16	37.2	37.2	48.8
	very	22	51.2	51.2	100.0
Total		43	100.0	100.0	

was the time commitment appropriate (1-5)

		Frequency	Percent	Mean Percent	Cumulative Percent
Mean	too much	0	0	0	0
3.93	2	2	4.7	4.8	4.8
	3	12	27.9	28.6	33.3
	4	15	34.9	35.7	69.0
	just fine	13	30.2	31.0	100.0
	Total	42	97.7	100.0	
Missing	System	1	2.3		
Total		43	100.0		

how well organized was the program (1-5)

		Frequency	Percent	Mean Percent	Cumulative Percent
Mean	not at all				
4.7	2				
	a little	2	4.7	4.7	4.7
	4	9	20.9	20.9	25.6
	very well	32	74.4	74.4	100.0
	Total	43	100.0	100.0	

Ratings of Element Enjoyment (scale 1-5)

	by mean		by percentage (4+/5)	
email	4.00	±.77	email	77.4
pedometer	3.83	±1.20	pedometer	74.3
acc feedback	3.58	±1.02	acc feedback	66.7
sit log	2.70	1.18	sit log	30.4
behavioral cues	2.54	±1.3	behavioral cues	28.6
goals	1.61	±.5	goals	0

questions related to ease of use and clarity were asked for presentation, stretches, videos

APPENDIX U

PARTICIPANT THEMES & SELECTED QUOTES

barriers to reducing SB or using intervention element (2+ responses)

	frequency	emerging themes
		physical
injury/illness	16	**limitations**
fatigue	24	
work	19	
home responsibilities	2	**job & family responsibilities**
stress	3	
hobbies	4	
watching TV /reading	3	
motivation	9	**routine**
routine/habit	3	
lazy	5	
foget	36	
busy	30	
family time	2	
like technology	2	
problems with computer	2	directed improvements
computer access	2	
do other exercise	5	
don't sit that much	8	**not relevant**
use breaks for chores	5	
don't have cordless, stairs, remote	7	
behind on intervention	4	
was on vacation	2	non compliance
didn't print cards	11	
didn't watch videos	2	
pedometer falls off	14	
pedometer not accurate	11	**pedometer issues**
restricting use	5	
not using log	3	
log too small	7	
log too hard to use	7	directed improvements
breaks too hard to remember	10	

motivations, expectations, & benefits (post intervention)

	frequency	emerging themes
change behavior	39	**change behavior**
motivation	5	
increase awareness	41	
learn	9	**awareness**
topic interesting	2	
help	6	
lose weight	3	
get healthy	6	outcome
increase energy	2	
feel good/better	3	

Open-ended Responses from the Process Evaluation by Theme

Awareness

"to see how active I am compared to other people" age 47, Caucasian

" I thought I would learn new ways to increase my activity." age 67, Caucasian

"I wanted to become more aware of how many steps I take every day." age 36, Caucasian

"I needed to find out how little activity I normally do." age 56, Caucasian

"realizing that light physical activity counts too " age 35, Caucasian

Change Behavior

"it keep me standing a lot and thinking about what I was doing" age 66, Caucasian

"to make a change in teh amount I sit. get healthier" age 38, Caucasian, Rural

"need a change in what I was doing & liked the idea." age 58, Caucasian

"got me moving & thinking more" age 71, Caucasian

Outcomes

"moving makes me feel better" age 70, Caucasian with arthritis

"thought it would help me lose weight" age 49, African American

Physical Limits

"I currently have a hurt foot, which is severely inhibiting the amount of time I stand." age 86, Caucasian

“WELL, BESIDES ALL OF THE WEGHT I HAVE CHRONIC LOWER BACK PAIN, AND PAIN IN MY KNEES AS WELL AS A FEW OTHER PROBLEMS.” age 50, African American
“Fatigue. If comfortable, I don’t want to move.” age 39, Caucasian

Job & Family Responsibilities
“do a stand up meeting” age 50, African American
“Being comfortable…whatever project I am involved in whether it’s work or hobby.” age 50, African American
“Work meetings. I’m too exhausted after work, just want to relaxed & unwind.” age 63, Caucasian
“Being too busy with my job and feeling down/stressed by work pressures.” age 50, Africa American

Routine
“Again, it’s all me. Even though I have some physical limitations which limit the amount of time I can comfortably spend on my feet or walking. They would not prevent me from getting up often and not moving the rest of the evening.” age 58, Caucasian, Rural
“It seems that I have recently gotten to a point in my life when I don’t feel guilty about resting, relaxing, you know, doing nothing. Now, the guilt is back and I sort of resent that…” age 69, Caucasian, Rural
“Habit to have remote close by. Have actually tried to watch less TV this week.” age 56, Caucasian, R
“just in a habit of doing things my way, I’ll do better this week” age 72, Caucasian
“weekends were hard for me- I forgot to wear it sometimes” age 53, Caucasian, Rural, non-sedentary job

Not relevant
“One email was about taking steps instead of elevator. Not many buildings with steps in area. Overall good info though” age 38, Caucasian, Rural
“I have been jogging or walking in place and just hopping around instead. I do warm ups at the gym before exercise.” age 70, Caucasian
“I do not watch that much TV, when I do I never sit through all the comericals because most of them are dumb.” age 71, Caucasian
“I basically do the ideas presents already simply by constantly getting up to do something while doing “sitting” activities.” age 69, Caucasian, Rural

“the remote for my tv has not worked in years. We have had to get up to change channels for a good while, thus no real changes there.” age 82, Caucasian, Rural

Non-compliance

“not able to get them from my computer I have dial up and it was too slow to ever download “ age 57, Caucasian, Rural, non-sedentary job

Pedometers Issues

“when steps didn’t register I was disappointed” age 58, Caucasian
“Frustration-used it on one day, walked on treadmill and it didn’t register!” age 61, Caucasian
“I wore the pedometer every day, I just didn’t record the steps every day or even weekly-had a lot going on with my children.” age 48, Caucasian
“wasit band would lean over sometimes & not count properly” age 47, Caucasian
“pedometer- it gave me hard data I could check daily” age 56, Caucasian
“pedometer that hangs on your necklace” age 47, Caucasian
“Use a accurate pedometer instead of the ones we have. They are no good.” age 74, Caucasian

APPENDIX V

THEMES FROM RESEARCH'S JOURNAL & PARTICIPANT REMARKS

Themes from Researcher's Journal & Participant Remarks (2+ responses)

	frequency	categories of challenge	emerging themes
actigraph solutions	7		
filter sleep /non-wear time	4		
excel patch for actigraph	3	challenges with Actigraph software	
daily average SB time	2		
acc feedback inconsistant	2		
time on feedback	3		reliability of accelerometer output effects workload and quality of feedback
automated feedback	3		
researcher work flow	3		
phone contact	5	workload for researcher	
slow response to email	3		
researcher fatigue	2		
study too long	3		
labor day holiday	3		
schedule changes	3	scheduling	
sessions are rushed	3		careful planning needed to execute intervention consistently for all participantsareful pl
goal setting session	2		
email access	2	delivery of intervention	
survey errors	3		
errors in emails	2		
add to workbook	2		
positive comments	8		
participants very willing	4		
thinking exercise not LPA	2		
pts solving monitor issues	2	participant reactions to intervention	
non-compliance	4		participants were generally positive about their experience despite significant issues with the monitors
like pedometer for self-regulation	4		
accelerometer falls off	4		
low step counts	5		
monitor adjustments	2	challenges with devices	
pain from monitor clips	3		aspects that can be improve by carefully targeting population, changing pedometer, & modifying sessions/elements
covariates-injury/illness, job, location	4		
future populations	2		
10K steps in obese	2	future directions	
standing desk fatigue	2		
standing desk social influence	2		

APPENDIX W

TOPIC OUTLINE FOR FACE-TO-FACE SESSIONS

#1 Initial Presentation

Complete Self-report Pa & SB items for baseline

Introduce Sedentary Behavior

- modern life that is sitting/ low movement based
- health associations to T2DM, CVD, obesity
- differences in SB-light PA between normal weight & obese

Review SB times – mention averages from lit

Opposite of Sitting is Light Physical Activity – what pedometer steps tell us about sitting

In small groups; 3-4

- Talk about when and why they are sedentary
- what are the benefits to sitting? feelings of fatigue, reward
- Suggest ways to reduce sitting - problem solving for partners

Things to consider when trying to reduce sitting time

- breaks from sitting
- replacing sitting
- re-evaluating environment
- BE INTENTIONAL

Ways to decrease SB (Pass out workbooks)

- How to use pedometer log – 5% improvement
- pick one sedentary behaviors - TV, computer, reading
- number of breaks - 2 mins every hour
- group activity - active stretching routine
    - do half for every commercial break - 3 mins

Point out tips in workbook

#2 Goal Setting Session

Explain Accelerometer Feedback & compare to self-report data

- Is it more or less than I thought?
- When/where am I sitting that I didn't consider before?
- Compare to NHANES
    - Reducing SB is for everybody regardless of size, exercise

Introduce Goal Setting

Specific, Measureable, Achievable, Realistic, Timely

Goal Setting Worksheet Explained

- complete individually but using acc, pedo & sitting inventory
- 1 goal for next week – increase # of breaks

- 2nd goal for 3 weeks from now – increase daily steps
- List ways to meet goals, rate confidence in success

Do Active Stretching as a group
Explain logs – breaks & pedometer
Online Segment of Program Explained

APPENDIX X

STUDY COMPLETION TIMELINE

April 2011
29th - Propose to Committee

May
2-13 - Pilot accelerometers, Revised Methods Chapter
16-20 - Create Michigan Tailoring System feedback library
23-31 - Pilot Qualtrics Surveys, Tailored Feedback Messages & videos

June
1-8 - Pilot pen & paper measures, logs, workbook, randomize chapters
13-17- Pilot presentations, goal setting & stretching activities
20-30 - Pilot ht/wt/WC & data collection procedure & first 2 sessions with BELT, HOPE, FBM group

July
4-8 - create study database, code book for data entry
11-14 - Baseline Measures of Pair One
18-21 - Intervention begins with Pair One
25-28 - Baseline Measures of Pair Two

August
1-4 - Intervention begins with Pair Two
8-11 - **Baseline Measures of Pair Three**
15-18 - Intervention begins with Pair Three
29-9/1 - **Post Measures of Pair One**

September
6-9 - Updates to Chapter Two
19-22 - Post Measures Pair Two
26-30 – Data organizing, run analysis for Stout presentation

October
3-6 - Post Measures Pair Three
10-13 - Literature Search
17-20 – Edit/revise Chapter 2
24-27 - Organize/clean data

November
1-4 - Organize/clean data
7-11 - Begin Statistical Analysis
14-18 – Begin Chapter 4
28-12/2 - First Draft Chapter 4

December
5-8 – Organize Process Evaluation Data
12-20 – Revise Chapter 4 with PE included

January 2012
3-6 – Edit Chapters 2 & 3
9 -13 – Complete Chapter 2
16-20 – Second Draft of Chapter 4
17th – application to graduate due
30-2/3 – Outline Chapter 5

February
6-10 – First Draft of Chapter 5
13-17 – Organize Presentation
20-24 – Revise/Edit full document
29th – Full Document to Committee

March
12-14 – Defense
28th - Deadline for Copy to Grad School

APPENDIX Y

SPSS POWER ANALYSIS

Proposed Design

F tests – ANOVA: Repeated measures, within-between interaction
Analysis:A priori: Compute required sample size

Input:	Effect size f=0.17
α err prob	= 0.05
Power (1−β err prob)	= 0.8
Number of groups	= 2
Repetitions	= **4**
Corr among rep measures	= 0.5
Nonsphericity correction ϵ	= 1
Output:	Noncentrality parameter λ=11.4688000
Critical F	= 2.6604056
Numerator df	= 3.0000000
Denominator df	= 162
Total sample size	= 56
Actual power	= 0.811461

Correct Analysis

F tests – ANOVA: Repeated measures, within-between interaction
Analysis:A priori: Compute required sample size

Input:	Effect size f=0.15
α err prob	= 0.05
Power (1−β err prob)	= 0.8
Number of groups	= 2
Repetitions	= **3**
Corr among rep measures	= 0.5
Nonsphericity correction ϵ	= 1
Output:	Noncentrality parameter λ=9.990000
Critical F	= 3.058928
Numerator df	= 2.000000
Denominator df	= 144
Total sample size	= **74**
Actual power	= 0.806409

Post Hoc Analysis for Self-efficacy

F tests – ANOVA: Repeated measures, within-between interaction		
Analysis:Post hoc: Compute achieved power		
Input:	Effect size f=0.11	
α err prob	=	0.05
Total sample size	=	64
Number of groups	=	2
Repetitions	=	3
Corr among rep measures	=	0.5
Nonsphericity correction ϵ	=	1
Output:	Noncentrality parameter λ=4.646400	
Critical F	=	3.069286
Numerator df	=	2.000000
Denominator df	=	124
Power (1−β err prob)	=	**0.463541**

Post Hoc Analysis for Behavior

F tests – ANOVA: Repeated measures, within-between interaction		
Analysis:Post hoc: Compute achieved power		
Input:	Effect size f=0.016	
α err prob	=	0.05
Total sample size	=	58
Number of groups	=	2
Repetitions	=	2
Corr among rep measures	=	0.5
Nonsphericity correction ϵ	=	1
Output:	Noncentrality parameter λ=0.059392	
Critical F	=	4.012973
Numerator df	=	1.000000
Denominator df	=	56.000000
Power (1−β err prob)	=	**0.056600**