

Can America's Top Sedentary Activity be Made More Active?: Physical
Activity and Leisure-time Study (PALS)

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Abstract

This dissertation investigated 1) the energy expenditure of stepping in place during TV commercials (commercial stepping), 2) determined the best objective tool to measure commercial stepping, 3) and assessed the efficacy of commercial stepping to increase the activity levels of sedentary, overweight adults.

First, twenty-three adults (normal to obese) had their energy expenditure measured while at rest, sitting, standing, stepping in place and walking at 3.0 mph on the treadmill, followed by one hour each of sedentary TV viewing and commercial stepping in the laboratory. Stepping in place, walking at 3.0 mph, and commercial stepping, had a higher caloric requirement than either rest, or sedentary TV viewing. One hour of commercial stepping resulted in an average of 2111 actual steps. The waist mounted Digiwalker and New Lifestyles pedometers counted 72% and 80% of steps, while the ankle mounted Omron and Stepwatch counted 100% and 98% of actual steps respectively.

Having established commercial stepping as a moderate intensity-measurable activity, eleven adults, participated in a 3-week pilot study to investigate the effects of commercial stepping at home (one week baseline, followed by two weeks commercial stepping across ≥ 90 min/day of TV watching). Compared to baseline, adults took more steps when watching TV, and watched 34% less TV during the 2nd two weeks. In the free-living environment, the StepWatch counted significantly more steps than the Omron pedometers (ankle and waist).

Thirdly, this study compares two physical activity prescriptions: 1) commercial stepping across ≥ 90 min/day of TV watching; and 2) walking ≥ 30 min/day in 58 sedentary overweight adults. Outcomes were daily steps, adherence, dietary intake, TV watching and weight after 12 wks in a behavioral intervention. Both groups adhered equally to their prescriptions, and daily steps significantly ($P < 0.05$) increased (~ 3000 steps/day) from 0 to 12-wks, with no difference between groups. TV viewing was significantly ($P < 0.05$) reduced in both groups. Despite a reduction ($P < 0.05$) in self-reported dietary intake, there were no changes in weight in either group. Instructing people to step in place during 90 minutes of TV watching results in a change in daily steps roughly equivalent to encouraging people to walk 30 min/day.

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Part I

Introduction

A contributor to the continued increase in weight gain in the U.S. is the growing problem of physical inactivity [1,2]. Despite existing physical activity (PA) guidelines and the multiple health benefits of PA, less than half of U.S. adults report not being active at levels associated with the promotion and maintenance of health (engaging in moderate physical activity for ≥ 30 minutes at least five times/week or who reported vigorous physical activity for ≥ 20 minutes at least three times/week) [3]. The physical inactivity of adults is a major health risk factor and is driving health care professionals to identify effective PA solutions that can result in sustainable increases in PA. On the other hand, TV watching has increased dramatically since 1965; making it the most prominent leisure-time activity in the U.S. [4,5]. Several studies have reported positive correlations between TV watching time and adiposity [6,7]. This chosen sedentary leisure-time activity is hypothesized to negatively influence weight status by reducing energy expenditure and increasing energy intake [8-10]. Studies that reduced TV watching produced decreases in energy and dietary fat intake [10].

One of the most frequently reported reasons for not engaging in healthful PA is “lack of time” [11,12]. For this reason, there is a need for simplistic interventions that can be worked into everyday behaviors to motivate sedentary individuals to regularly engage in PA. Lifestyle-based programs afford individuals flexibility in how, when, and where they obtain their PA [13]. It has been suggested that using the lifestyle approach involving small-changes needs to be embraced by those interested in addressing the inactivity epidemic [14]. The standard half-hour TV show contains 8-12 minutes of commercials. Thus, for the average person who watches 2.6 hours/day of television [15] there are approximately 40-60 minutes of commercials. This represents time periods

when they are not “watching” their program and could be encouraged do to some alternative behavior (PA). The idea of stepping during commercial breaks has been used anecdotally (J. White, personal communication, March, 2009), however, no research has been conducted examining the ability of adults to change their sedentary TV commercial watching behaviors to active behaviors (stepping in place during commercials). Experimental research investigating the feasibility and effectiveness of this strategy is needed and may prove it to be a simple, realistic strategy to increase PA and influence food intake in sedentary adults who place a high priority on TV time.

Statement of the Problem

Physical inactivity is a major issue in North America and a key component contributing to the obesity epidemic. Most Americans do not meet the PA guidelines but do choose to watch many hours of TV per week. Currently there is research investigating turning off or limiting TV viewing on its effects on PA and dietary intake. Can a traditionally sedentary activity (TV watching) be modified into a behavior where PA is gained? There is no scientific research looking at an alternative method, leaving the TV on and modifying behavior by stepping in place during commercials while watching TV, in terms of its effectiveness in reducing sedentary behaviors, increasing PA, and improving diet in previously sedentary, overweight and obese adults.

Statement of Purpose

The purpose of this dissertation is to investigate the energy expenditure (EE) of TV commercial stepping and determine the best objective method to measure this activity, then to assess the efficacy and feasibility of using TV commercial stepping to

increase the activity levels of sedentary, overweight and obese men and women. First, Part III determines the EE of stepping in place at a self-selected place in comparison to the EE at rest (REE), sitting, standing and walking at 3.0 miles per hour on the treadmill, and quantifies the number of calories, steps taken and total PA time accumulated during one hour's worth of stepping in place during TV commercials in comparison to one hour of TV viewing while seated. It also determines the accuracy of four different activity monitors (Yamax Digiwalker, New Lifestyles 2000, Omron HJ 303 and Stepwatch) during 60-minutes of TV commercial stepping in place since stepping in place is different than normal walking. Second, Part IV evaluates the effects of TV commercial stepping on physical activity, TV viewing time, and sitting time in normal, overweight and obese men and women during a short 3-week intervention (1-week observation-only phase followed by a 2-week TV commercial stepping intervention). Finally, Part V compares the effects of a standard PA recommendation (at least 30-minutes of walking daily, with bouts lasting at least 10 minutes in duration) vs. multiple shorter bouts of intermittent exercise (TV commercial stepping for at least 1.5 hours of TV programming daily) on exercise adherence, dietary intake, TV watching, liking of PA and TV watching, PA self-efficacy, weight, and adiposity in sedentary overweight and obese men and women.

Significance of this Study

This study infuses small, achievable bouts of PA into TV watching time through TV commercial stepping for sedentary overweight and obese adults. This approach will be compared to a standard PA prescription (30 minutes of daily walking). Based on behavioral theory this idea should work because it removes barriers such as perceived access to facilities and potentially lack of time or money. Individuals do not need to leave

their homes or purchase walking shoes. It is an individually adapted health behavior, incorporating short and intermittent bouts of PA potentially making them seem easier. People watch large amounts of TV [15,16], and for most, TV viewing is considered enjoyable and entertaining [17]. It has the ability to be a key strategy for increasing physical activity levels and preventing weight gain in sedentary adults. We hypothesize that through modifying TV watching behaviors there will be a significant increase in objectively measured daily PA. Analysis of the results of this 3-month study will allow us to better determine the ability of at least 1.5 hours of TV time daily to successfully increase and maintain PA, and change dietary intake.

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Part II

Review of Literature

Physical Activity and Health

Physical activity is increasingly recognized as an important factor influencing health and disease status. Increases in physical activity have long been recognized to reduce the incidence of and mortality risks of many chronic diseases, including cardiovascular disease, diabetes, stroke, and various types of cancer including colon and postmenopausal breast cancer [1-5]. Those with the highest levels of physical activity are at the lowest risk for chronic disease and premature death [6]. The beneficial health effects of physical activity, such as improved cardiovascular fitness, decreasing coronary heart disease and diabetes, preservation of fat-free mass, can often occur independent of weight loss itself [7,8] and in the absence of changes in aerobic fitness [9]. Physical activity can also produce psychological benefits such as improvement in mood and self-esteem [10-12]. Even engaging in physical activity below recommended levels is associated with some positive health benefits, as evidenced in the dose-response relationship between physical activity and improved health outcomes [1,3,6,13-15]. The benefits of physical activity need not be restricted to “exercisers” who purposefully engage in leisure-time physical activity. There are positive health benefits (i.e., lowering all-cause mortality, lowering cardiovascular mortality, improving function and enhancing quality of life) associated with all forms of physical activity [1,3,5]. In fact the greatest improvements in health status are the result of the least fit individuals become more fit through participation in regular physical activity [6].

Individuals may accrue physical activity through lifestyle activities such as occupational activity, housework, and walking or bicycling for transportation [16]. Most Americans participate in everyday activities such as yard work, household cleaning, and

occupations requiring some physical exertion on a regular basis. These activities of daily living (such as occupational or household activities) are the greatest contributors to most Americans' total physical activity-related energy expenditure [17]. Habitual physical activity acquired in various domains throughout the day is important for long-term weight management [16,18]. Due to the multitude of health benefits associated with being physically active, everyone should be encouraged to engage in regular physical activity.

Physical Activity Recommendations

In recent years, two major updates to the physical activity recommendations for Americans have emerged. In 2007, the American College of Sports Medicine and the American Heart Association (ACSM/AHA) made a recommendation about the minimum amount of physical activity necessary to reduce the risk of chronic disease, and promote and maintain health [15]. Healthy adults should accumulate 30 min or more of moderate aerobic activity, 5 d/wk, or 20 min or more of vigorous aerobic activity, 3 d/wk, or a combination of the two intensities, as long as the activity is at least 10 minutes in duration [15]. In addition, it is recommended that adults perform muscle-strengthening activities at least 2 nonconsecutive d/wk. Specifically adults should perform 8-10 resistance training exercises involving major muscle groups, using a resistance that allows for 8-12 repetitions. The ACSM/AHA recommendation recognizes that more physical activity is better, and that meeting the minimally recommended dose of physical activity will only provide minimal benefits above the maintenance of general health. In order to further reduce health risks, obtain additional health benefits, acquire higher levels of physical fitness, and prevent unhealthy weight gain, adults may need to

accumulate at a greater volume of physical activity (aerobic and muscle-strengthening) than recommended [15].

In 2008, the U.S. Department of Health and Human Services (DHHS) issued the 2008 Physical Activity Guidelines for Americans indicating the types and amounts of physical activity associated with substantial health benefits [16]. These guidelines provide specific recommendations for certain sub-populations, and adults of various ages, and levels of fitness [16]. The Physical Activity Guidelines for Americans acknowledge that any amount of physical activity is better than none. For inactive adults, there are health benefits to be gained from as little as 60 min/wk of moderate intensity physical activity. They recommend that adults accumulate at least 150 min/wk of moderate-intensity, or 75 min/wk of vigorous-intensity aerobic activity, or a combination of the two, ideally, but not necessarily spread out over at least 3 days a week and in bouts of at least 10 min [16]. Adults can expect to gain additional health benefits by performing more aerobic physical activity (i.e., 300 min/wk of moderate-intensity, or 150 min/wk of vigorous-intensity aerobic activity). Muscle-strengthening activities provide additional health benefits, and as such, should be performed on two or more days a week. Resistance training exercises should involve all major muscle groups. The Physical Activity Guidelines for Americans recognize that flexibility can be an important component of a physical activity program, but because they have no known health benefits, other than improving the mobility of an individual, they do not count toward meeting the Guidelines [16]. Meeting the Guidelines may be enough to allow some adults to achieve and maintain a healthy weight, however, many adults seeking energy balance, will need to increase their activity level towards 300 min/week and/or further restrict caloric intake [16]. With regards to physical activity for

energy balance, these guidelines highlight that, “it all counts”, and that physical activity need not be restricted to leisure-time exercise/physical activity [16].

An Epidemic: Physical Inactivity in America

Physical inactivity continues to be a major public health problem [15]; potentially the most important public health issue of the 21st century [8]. Despite existing physical activity guidelines and the multiple health benefits resulting from engaging in physical activity, less than half of U.S. adults are not active at levels associated with the promotion and maintenance of health based on self-report [19]. When objectively measured by accelerometer, 2003-2004 NHANES data report that less than 5% of the U.S. population met the recommended 30 min/day of physical activity [20]. The total physical activity of American adults has declined over the last 100 years due to decreases in occupational, transportation, and domestic physical activity [21]. Although, leisure-time physical activity gradually increased from 1990-2000 [21], there has also been a substantial increase in the use of sedentary leisure-time entertainment like television (TV) [22,23]. Approximately 25% of the population engages in no leisure-time physical activity (LTPA) on a daily basis [24]. Recently, the amount of time spent in sedentary behaviors was objectively examined in a nationally representative sample of American adults (N=6308) [25]. The accelerometer data (Actigraph 7164) showed that almost 55% of their waking hours were spent engaged in sedentary activities, and that women tended to be more sedentary than men [25].

It is believed that a sedentary lifestyle is an important determinant of obesity [26-28]. The increased amount of time spent engaged in sedentary leisure-time pursuits like watching TV [29], combined with sedentary jobs effectively promote physical inactivity

and obesity [30,31]. Developments in technology (cars, electricity, TV, computers, Internet) have led to a gradual and substantial erosion of lifestyle physical activity [32]. Changes to society have had negative effects on daily energy expenditure (adults are sedentary 9.3 h/d, engage in light activity 6.5 h/day, and only spend 0.7 h/day in moderate to vigorous PA) [33]. The lower levels of daily energy expenditure of a sedentary lifestyle are associated with an increased risk for weight gain independent of any amount of daily physical activity [34-36]. Technological changes and economic incentives tend to promote physical inactivity [15]. The energy expenditure necessary to perform activities of daily living has decreased due to advancements in technology [15]. Economically, sedentary occupations are paying more than occupations involving manual labor [15]. The proportion of adults employed in sedentary occupations almost doubled (23.3 to 42.6%) between 1950 and 2000, while the percentage of adults working in high-activity occupations declined from 30 to 22.6% [21]. As lifestyle activities have become increasingly sedentary, obesity rates have increased [21,37-40]. The American style of life and environmental influences are important mediating factors of obesity.

The advent of TV, followed by video games, and now the Internet have resulted in increased opportunities for leisure-time sedentary behaviors [41]. Several studies have reported positive correlations between TV watching time and adiposity [42,43]. This chosen sedentary leisure-time activity is hypothesized to negatively influence weight status by reducing energy expenditure and increasing energy intake [44-46]. TV watching is potentially linked to obesity in many ways: displacement of physical activity causing reduced energy expenditure, increased energy intake due to unhealthy snacking during watching, effects of food advertising on food and beverage purchasing, and decreased

metabolic rate while watching TV (often time seated) [47-49]. In light of the numerous mechanisms by which television may promote obesity, it is surprising how little data exist on interventions to alter TV viewing in adults [50].

The decision to be physically active during leisure-time depends on prioritizing physically active behaviors rather than sedentary behaviors [51]. The most common leisure-time sedentary activity is television watching [52]. Currently, Americans report spending almost 38 hr/wk watching television (TV), approximately 30 min/wk watching video on computers and mobile phones, and spend almost 4 hr/wk on the Internet [29]. Still, many adults (50.8%) report not achieving the recommended 150 minutes/week of PA [19]. TV viewing has increased dramatically since 1965; making it the most prominent leisure-time activity in the U.S. [22,23]. TV viewing is also the predominant source of leisure-time sedentary screen time (89.8%) according to the 2010 Nielson Three Screen Report [29]. According to the American Time Use Survey conducted by the U.S. Bureau of Labor Statistics, TV watching accounts for over 50% of leisure-time [52]. Adults were projected to spend about 65 days over 1 year watching TV, according to the U.S. Census (2007) [53]. These statistics make it clear that Americans have increased their sedentary time and decreased their physical activity levels, two independent factors that contribute towards elevating the risk for weight gain, metabolic and cardiovascular diseases, and premature mortality. The benefits of exercise have been long established; currently researchers are starting to investigate what happens when people sit too much.

Consequences of Physical Inactivity = ‘Globesity’ and Other Chronic Diseases

Although the benefits of regular participation in physical activity are well accepted both scientifically and by the general public, the potential adverse health impacts of

prolonged sitting are only just being realized. The increased prevalence of many chronic diseases is attributed to the epidemic of physical inactivity [54]. Obesity, because it is more easily measured than physical inactivity, is often focused on as a reflection of the physical inactivity level of a population. Around the world there are over 1 billion adults that have a body mass index (BMI) greater than 25 kg/m^2 [54]. The World Health Organization (WHO) has coined the term, 'globesity' to emphasize the global impact of obesity [54]. Those who engage in little or no physical activity across all domains can be expected to have the highest likelihood of being categorized with abdominal obesity and its associated pathologies [55]. The prevalence of obesity in U.S. adults has risen from 11.6% in 1990 [56] to 33.8% in 2008 [57], and the prevalence of adult overweight and obesity has increased to 68% in the United States [57]. Being physically inactive is a modifiable risk factor associated with the increased risk of obesity, cardiovascular disease, and many other chronic diseases [6,31,58]. In Canada, physical inactivity has a greater prevalence (51%) than all other modifiable risk factors [6]. The relative risk of physical inactivity approach those associated with moderate cigarette smoking, and is comparable to those of obesity, hypertension, and hypercholesterolemia [6].

There have been many long-term prospective follow-up studies that have assessed the relative risk of death from any cause associated with physical inactivity, beginning in the 1950's with the work of Morris et al. [59,60], and the early work of Paffenbarger et al. [61,62] in the 1970's. More recently, the newly emerging field of inactivity physiology is studying the consequences of prolonged sedentary behavior and finding ways to reduce the amount of time spend being sedentary and increasing light intensity activity throughout the day.

Previously, sedentary behavior was over simplified and was considered the absence of moderate-vigorous physical activity [63]. Currently, sedentary behaviors and light physical activities are more clearly defined. Sedentary behaviors (e.g, sitting, lying down, TV viewing, etc.) are quantified as activities having an energy expenditure between 1 and 1.5 METs [64], and light activities (e.g., household activities, light gardening, slow walking etc.) are quantified as activities having an energy expenditure between 1.6 and 2.9 METs [63]. This has enabled researchers to study sedentary behavior, primarily total sitting time, as an independent and important risk factor to weight gain and health. Several studies have shown a positive association between sitting time and obesity, type 2 diabetes, cardiovascular disease risk factors [35,58,65].

Many adults spend most of their day sitting while doing various tasks: driving in the car, at desk during the workday, and in front of the TV [66]. In the Nurses Health Study, [67], both greater amounts of TV viewing and sitting at work, were associated with increased obesity risk. In a study of 17,000 Canadian adults; those that sat almost all the time had an increased risk of cardiovascular (60%) and all cause mortality (67%) compared to those who rarely sat during the day [66]. Regardless of physical activity level, total daily sitting time was a major independent risk factor for cardiovascular disease [66,68]. Those who sat little and exercised more than 7.5 MET/hr/wk had a 40% reduction in risk for all-cause mortality compared to those who acquired the same amount of exercise but sat almost all the time [66]. Even more alarming was the finding that obese individuals who sat almost all the time had a 400% increase in their risk for all-cause mortality compared to obese individuals who sat almost none of the time [66]. In addition to mortality risk, sitting time has also shown a strong independent association

with weight status. In comparison to women who sat less than 3 hours a day, women who were seated for more than 4.5 hours / day were more likely (35-50%) to gain more than 11 pounds over a five year time span [69].

A recent study from the American Cancer Society found that greater amounts of sitting during leisure-time was linked to a higher risk of death, independent of physical activity levels [68]. Independent of physical activity levels, sitting for more than 6 hours a day was associated with all-cause mortality rates in men and women (18% and 37% respectively) compared to those who sat for less than 3 hours a day [68]. Compared to men and women who sat little and were physically active, being inactive and sitting more was associated with an increase in death rate from all causes (48% and 94% respectively). The metabolic consequences of prolonged time spent sitting, independent of physical activity, may influence biomarkers (triglycerides, high density lipoprotein, cholesterol, fasting plasma glucose, resting blood pressure, and leptin) of obesity, cardiovascular disease, and other chronic diseases [58,70-72].

Using cross-sectional data (N= 30,778) collected from the Southern Community Cohort Study (SCCS) (2002-2006), researchers examined the associations between time spent in sedentary and active behaviors and BMI [73]. Women reported spending an average of 8 –10 hours/day in sedentary behaviors. BMI was directly related to time spent in sedentary behaviors; women with higher BMIs reported spending significantly more time in sedentary behaviors. Conversely, time spent in active behaviors was inversely associated with obesity [73].

Since adults spend many hours of their leisure-time sitting in front of the TV, TV viewing has been used as a marker of sedentary behavior [74]. In a study of Australian

adults (N=4064) that examined the dose-response relationship between TV viewing time and physiological markers of metabolic risk, there was a positive association between TV time and metabolic risk [75]. They also found positive relationships between TV time and obesity-related risk factors (anthropometrics and body composition) [75].

Another study from the same group tracked the lifestyle habits of 8,800 Australian adults for more than six-years and found that every hour of television watched per day was associated with an 11% increased risk of all cause mortality, a 9% increased risk of cancer death, and an 18% increased risk of dying earlier from cardiovascular disease [42]. When compared with people who watched less than two hours of television daily, watching more than four hours a day was associated with an increased risk of all cause mortality and CVD-related death (46% and 80%, respectively). This direct association remained, regardless of other independent lifestyle and typical cardiovascular disease risk factors; including: smoking, high blood pressure, high blood cholesterol, unhealthy diet, excessive waist circumference, and leisure-time physical activity [42].

Most recently, Stamatakis et al. [76] published the first study that examined the association between time spent on screen-based entertainment (watching TV, using the computer, or playing video games) and non-fatal as well as fatal cardiovascular events. A representative sample consisting of 4,512 adults who were respondents of the 2003 Scottish Health Survey, a household-based survey, had a total of 325 all-cause deaths and 215 cardiac events during the 4.3 years of follow up. Compared to men and women who spent less than two hours / day on screen-based entertainment, there was a 48% increase in risk of all-cause mortality in those who spent four or more hours a day. Those who spent two or more hours a day engaged in screen-based entertainment were at a 125%

increase in risk for having a major cardiac event. Spending too much time in front of the TV or computer screen appears to dramatically increase the risk of heart disease and all causes of premature death, regardless of traditional risk factors such as exercise, smoking, social class, BMI, and hypertension. Results from this study also suggested that metabolic factors and inflammation may help explain the link between prolonged sitting and the risks of heart disease. In people who spent more than four hours / day on screen time, C-reactive protein (CRP), a well-established marker of low-grade inflammation, was approximately two times higher compared to those who spent less than two hours a day. Collectively CRP, BMI, and high-density lipoprotein cholesterol explained one fourth of the association between screen time and cardiovascular events. This suggests that inflammation and deregulation of lipids may be one pathway through which the risk for cardiovascular events is increased due to prolonged sitting [76].

It has become well established that, too much sitting, independent of too little exercise, is bad for people's health. Fortunately, the harmful effects of prolonged sitting or sedentary time can be attenuated by disrupting sedentary time through standing or taking a few steps [77], or by replacing sedentary time with light intensity activity [78]. Healey et al. [77] demonstrated that taking breaks from sedentary time independently improved anthropometric measurements, triglycerides, and 2-hour plasma glucose. In this study, the sedentary time of 168 participants from the Australian Diabetes, Obesity, and Lifestyle Study (AusDiab) was measured using the Actigraph 7164. A break in sedentary time was defined as at least one minute where accelerometer activity counts were more than 100 counts/min. Interrupting prolonged bouts of sedentary behaviors with an increased number of breaks was positively associated with lower waist circumference,

BMI, triglycerides, and plasma glucose.

Another study by the same researchers, examined the effects of objectively measured light-intensity physical activity on 2-hour plasma glucose in non-diabetic adults [78]. The Actigraph 7164 accelerometer measured physical activity. Light intensity physical activity was defined as accelerometer activity counts between 100 and 1951 counts/min. Greater amounts of sedentary time were associated with elevated 2-hour plasma glucose levels. The percentage of time spent in light intensity activity was independently, and negatively associated with 2-hour plasma glucose levels [78].

A recent study by Healy et al. [79] examined not just the total amount of time people spend sitting, but whether the manner in which it is accumulated (breaks) may also be important. They examined whether breaks in objectively measured sedentary time were associated with cardio-metabolic and inflammatory risk biomarkers. A total of 4,757 men and women, aged 20 and over, who wore an accelerometer during all waking hours for 7 consecutive days as part of the U.S. National Health and Nutrition Examination Survey between 2003 and 2006 were analyzed. Total sedentary time was determined as the number of minutes/day during which the accelerometer had a count of less than 100/min. Any interruption of at least one minute during which the accelerometer count rose above 100 counts/min was considered a break in sedentary time. Prolonged periods of sedentary time, even independent of time in moderate-to-vigorous exercise, was associated with worse indicators of cardio-metabolic function and inflammation, such as larger waist circumferences, lower levels of HDL cholesterol, higher levels of C-reactive protein, and triglycerides. A greater number of breaks from prolonged sitting was associated with a smaller waist circumference and lower levels of C-reactive protein.

Those in the top 25 percentile of people who took the most breaks had, on average, a 4.1 cm smaller waist circumference than those in the lowest 25 percentile. This research highlights the importance of considering prolonged sedentary time as a distinct health risk behavior [79].

Future technological innovations are likely to create increased opportunities for prolonged sedentary behaviors; therefore it will be of paramount importance to avoid prolonged periods of sitting and to move more throughout the day. Results from the National Weight Control Registry [80] draw attention to the importance of limiting sedentary behaviors in an effort to reduce obesity. Successful long-term weight loss maintainers spent minimal amounts of time watching TV [80]. Public health messages and guidelines should include and promote important and distinct messages: limit the time spent in sedentary behavior (especially recreational sitting) [79], and increase the time spent performing moderate-intensity physical activity. Also, for the majority of the population, who daily spend countless hours of sedentary time sitting at a desk in front of the computer, it will be important to interrupt or reduce sedentary time with breaks or light intensity physical activity [79]. Unfortunately, regardless of how physically active we are, both the total amount of sedentary time, and the manner in which it accumulates is related to negative health outcomes. At the very least, less sitting could contribute to increased overall daily energy expenditure and could help prevent weight gain [25]. As a result, health care professionals continue to be driven to identify effective activity solutions that can result in sustainable increases in physical activity.

Behavior Modification Programs

Individuals typically do not change their activities or behaviors when they are simply told to do so [54]. For most individuals, behavior change tends to depend upon the guidance in a supportive social context [54]. Therefore, in an effort to help individuals increase their physical activity levels, interventions often incorporate behavioral and social approaches [81]. Support, through the of teaching widely applicable behavioral management skills, and by creating a structured social environment, is provided to individuals trying to initiate and maintain behavior change [81]. Physical activity interventions often provide behavioral counseling in individual or group settings, or by phone, mail, or online [81]. Primarily these sessions focus on equipping participants with the skills necessary to help them incorporate more physical activity into their daily routines; such as, recognizing cues and opportunities for being active, developing problem-solving skills for high-risk situations, and behavior maintenance and relapse prevention [81]. The following behavioral approaches are commonly used in intervention programs: 1) goal setting and self-monitoring of progress towards short- and long-term physical activity goals, 2) stimulus control by making changes to the environment, increasing cues that encourage physical activity, and reducing cues that promote inactivity, 3) problem-solving and pre-planning to handle situations that may make it difficult to reach or maintain physical activity goals, 4) cognitive restructuring: to identify and modify maladaptive thoughts (e.g., all-or-none thinking) that may interfere with the achievement of physical activity goals, and 5) prevention of relapse into inactive behaviors based on Marlatt and Gordon's Relapse Prevention Model [82]. These behavioral approaches aid participants in identifying and anticipating high-risk situations,

and encourage pro-active behaviors like developing detailed plans for challenging situations [81]

Physical Activity Interventions

Even with the use of behavioral modification techniques, increasing the physical activity levels of adults, particularly those who are inactive, overweight or obese, continues to be a challenge [20,83-85]. Therefore it is a priority to continue to investigate strategies that help individuals begin and maintain higher levels of physical activity. Several different types of programs and/or strategies have been identified and investigated for increasing the adoption and maintenance of physical activity in adults; such as: offering home- versus supervised group-based exercise [86]; using the accumulation of multiple short bouts (≥ 10 min) of exercise throughout the day [15,87]; using different exercise intensities (moderate versus vigorous) [88] and frequencies (3-day versus 5-day/wk) [88,89] ; using pedometers to monitor physical activity levels and as motivational cues for increasing physical activity levels [90]; improving access to physical activity opportunities (e.g., providing home exercise equipment) [91]; and decreasing access to sedentary behaviors (e.g., setting a limit on television use) [92].

Home- vs. Supervised Group-Based Exercise Interventions

During a twelve-month-long behavioral weight loss program, Perri et al. [86] compared two exercise programs; supervised group- and home-based, on exercise participation and adherence. All forty-nine obese women received the same weight loss treatment, and had the goal of walking 30 min/day, 5 days/week (150 min/week). Half were randomly assigned to a supervised group-based exercise program (3 supervised evening group-based exercise sessions/week for the first 26 weeks and two sessions/week

until one year). Sessions were held at a clinic facility, and used treadmills as the mode of exercise. In order to reach their weekly walking goal, these participants were directed to do an additional 2 or 3 sessions of brisk walking on their own. The participants assigned to the home-based exercise were instructed to walk 30 min/day, 5 days/week on their own. Both groups showed a significant increase in exercise participation at the 6-month time point. At 12 months, the home-based group had greater exercise participation and greater adherence.

To determine the 2-year effects of differing intensities and formats of endurance exercise on exercise participation rates, King et al. [93] randomly assigned 269 healthy older adults (50-65 years) to one of three exercise training groups: 1) high-intensity, supervised group-based 2) high-intensity, home-based, and 3) low-intensity, home-based. The estimated total caloric expenditure per week of all three-exercise conditions was comparable. All participants were sedentary and free of cardiovascular disease. The participants in the high-intensity (73% to 88% of peak treadmill heart rate), supervised group-based exercise were asked to attend three 40-minute training sessions per week. Sessions were offered 6 days/week at a local community center and community college. Each session lasted 60 minutes and included a 40-minute endurance training (walking-jogging, or stationary cycling) period. Participants in the high-intensity (73% to 88% of peak treadmill heart rate) home-based exercise received a similar exercise prescription to the supervised group-based training: three 60-minute training sessions weekly, with a 40-minute endurance training period. Written information and activity logs were provided, and a staff member telephoned the subjects at home each week to check on their progress. Those participants assigned to the low-intensity (60% to 73% of peak treadmill heart

rate), home-based training were directed to complete five 30-minute endurance sessions/week. During the first year, subjects in both home-based exercise programs, reported significantly greater exercise adherence than those assigned to higher-intensity, supervised group-based exercise training. The high-intensity home-based condition showed the greatest exercise adherence rates at the two-year follow-up. Home-based exercise programs offered additional flexibility and convenience, not typically possible with supervised group-based programs. These attributes may facilitate improvements in long-term participation rates [93].

Dunn et al. [94] compared the effects of a lifestyle physical activity program with a traditional structured exercise program on improving physical activity. During the 24-month physical activity intervention, 235 sedentary adults were randomized to either a lifestyle physical activity, or a traditional structured exercise program. All participants received six months of intensive intervention, followed by 18 months of maintenance intervention. Participants in both groups had the same physical activity goals (increase energy expenditure by 3 kcal/kg per day by 6 months, and maintain an increase in energy expenditure of 2 kcal/kg per day at 24 months). Physical activity was assessed by self-report, using the 7-Day Physical Activity Recall. Participants in the lifestyle group were given the goal to be physically active at a moderate intensity for at least 30 minutes on most days of the week. They were encouraged to make changes in their lifestyle that would allow them to more easily accumulate physical activity. Individuals in the structured exercise group were offered supervised exercise sessions (exercise intensity of 50%-85% of maximal aerobic power for 20-60 minutes) for 6 months at a fitness center. At the beginning, they were to attend at least 3 supervised sessions per week, and were to

gradually increase their attendance to 5 days/week. Both the lifestyle activity, and structured exercise group, showed similar and significant increases in physical activity. This was the first study to show that a lifestyle physical activity intervention was as effective as a structured exercise program for improving physical activity in previously sedentary healthy adults.

Multiple Short Bout vs. Continuous Exercise Interventions

Blair et al. [95] suggested that exercise adherence may be enhanced if exercise was made more convenient to the average American. One approach to improve convenience may be through performing multiple, shorter bouts of exercise over the course of a day [95].

Jakicic et al. [87] investigated the effects of continuous vs. intermittent exercise on adherence in 56 obese, sedentary adult females in a behavioral weight control program. In this 20-week study, participants were instructed to exercise 5 days/week. Initially exercise duration was 20 minutes/day, and progressed to 40 min/day by week 9. Participants in the intermittent exercise group were to perform their daily walking in short bouts lasting 10 minutes, while those in the continuous exercise group were to walk continuously to achieve their allotted time once per day. After 20 weeks, the participants in the intermittent exercise group had greater adherence, reporting exercising for significantly more days, and for a greater total duration. In conclusion, when prescribing exercise to obese adults, shorter bouts of exercise may be a preferable strategy to help maintain adherence to the volume of exercise prescribed.

In another study, Jakicic et al. [91] evaluated the effects of different bouts (continuous exercise, intermittent exercise, and intermittent exercise plus provision of

home exercise equipment) of home-based exercise on adherence during an 18-month behavioral weight-loss program. All three groups showed an increase in exercise participation, with no significant difference between short- and long-bout exercise (this paper is highlighted in greater detail in the Increasing Access to Physical Activity section).

In a short eight-week study comparing long versus short bouts of exercise, DeBusk et al. [96] randomly assigned 18 men to exercise once a day for 30 minutes (long), and 18 men to exercise three times daily in bouts of at least 10 minutes (short). Both groups were instructed to exercise at a moderate intensity (65-75% of peak treadmill heart rate). After eight weeks both groups showed excellent adherence to their unsupervised exercise sessions. The men in the long bout group completed the full 30 minutes 96% of the time, and completed 92% of their total sessions. The men in the short bout group completed 30 minutes of exercise, in three 10-minute bouts, 93% of the time, and completed a 93% of their total sessions. For individuals with a busy schedule or with short breaks during the day, short bouts of exercise may be a good alternative when a single long bout of exercise is not an option [96].

Schmidt et al. [97] examined the effects of long versus short bouts of supervised exercise in 48 overweight, sedentary female university students. Participants were non-randomly assigned to one of four groups: 30 minutes of continuous exercise accumulated in one bout daily; 30 minutes of daily exercise accumulated through two, 15 minute bouts/day; 30 minutes of daily exercise accumulated through three, 10 minute bouts/day; and a non-exercising control group. Exercisers followed an aerobic exercise program (75% of their heart rate reserve) three to five days/week for 12 weeks. During the course

of the 12-week program, all three groups demonstrated a decrease in the average number of days/week that they exercised, but there were no differences among the exercise groups regarding the average number of weekly attended supervised exercise sessions [97]. In conclusion, thirty minutes of intermittent supervised aerobic exercise was equally as effective for maintaining exercise adherence in previously sedentary overweight women when compared to thirty minutes of continuous aerobic exercise. However, being required to attend exercise sessions at a certain locations, especially when it required multiple visits per day, may be an inconvenience due to participants' schedules. This may explain the dropout of participants in the multiple, short bouts group, and the decline in total exercise days/week from the first three weeks to the final six weeks of the exercise intervention.

The effects of prescribing short or long bouts of physical activity to sedentary, middle-aged women was examined by Murphy and Hardman [98]. Participants randomized to the short bout walking group were instructed to walk for 30 minutes a day, but in three separate 10-minute bouts separated by at least 4 hours. Participants in the long bout-walking group were asked to walk for one 30-minute bout. Both groups were prescribed to walk 30 minutes at a brisk pace (70-80% of their maximal heart rate) five days a week. After 10 weeks, both the short- and long-bout walkers were equally successful in completing their prescribed sessions (85% and 88% respectively). Also, there was no difference between the two walking groups for the total time spent walking [98]. For increasing exercise participation, improving fitness and decreasing body fat, repeated short bouts of brisk walking, which were easily incorporated into their lifestyle,

were as successful as longer continuous bouts of walking in sedentary middle-aged women.

Serwe et al. [99] recently compared the effects of long and short bout walking to increase physical activity levels in 60 previously inactive women. Females were assigned to one of three groups: a non-exercising control group, a long exercise bout group (one 30-minute bout of walking, 5 days/wk), and a short exercise bout group (three separate 10-minute bouts of walking, 5 days/wk). The exercisers were prescribed specific heart rate intensity targets. Steps were assessed by pedometer, and bouts were self-reported. Compared to the non-exercising controls, both exercising groups significantly increased their physical activity levels after 8 weeks, and there was no difference between the two exercise groups. Multiple short bouts and one single bout of physical activity were equally as effective for increasing physical activity levels in previously inactive women.

There are effective options available to previously sedentary adults who are committed to increase and maintain their physical activity levels. Initiation of physical activity behavior changes may be facilitated through personal instruction and continued support. The promotion and maintenance of physical activity appears to be most effective when the activity is enjoyable, when it can be easily (i.e., convenience and flexibility) worked into activities of daily living, and when it does not require attendance to a facility. Walking, of all the varieties of physical activity, appears to be the activity of choice, because it fulfills the above criteria, and is highly utilitarian in nature.

Different Intensity (Moderate vs. Vigorous) and Frequency (3-day vs. 5-day/wk)

Exercise Interventions

Adherence to an exercise prescription may be affected by the intensity or frequency of exercise prescribed. Moderate-intensity exercise programs appear to have better adoption rates, and are more successfully maintained than those of vigorous-intensity [88,100-102]. Sallis et al. [101] found that men and women were more likely to begin and continue exercising up to 1-year later if the intensity of the exercise was at a moderate level versus exercising at a vigorous intensity. A meta-analysis of 127 physical activity interventions, conducted by Dishman et al. [100] found that low-intensity (below 50% HR_{res}) physical activity was successfully increased to a greater extent than moderate- (between 50%-70% HR_{res}) or high-intensity (above 70% HR_{res}) activities.

Perri et al. [88] compared adherence to exercise when prescribed different exercise intensities (moderate: 45-55% vs. vigorous: 65-75% HR_{res}), combined with different exercise frequencies (3-4 days vs. 5-7 days/week). Participants were randomized into either a control group or one of the four exercise groups. For 6 months all participants participated in 30 minutes of unsupervised walking. Participants in the moderate-intensity groups had better exercise adherence and fewer exercise related injuries, than those in the vigorous intensity groups. Participants in the moderate-intensity groups also completed significantly more minutes of exercise than those in the vigorous-intensity groups. There was no difference in adherence to their respective exercise prescriptions between the two different frequency groups, but those exercising at the 5-7 days/week frequency did complete more minutes of exercise than those exercising only 3-4 days/week.

Tully et al. [89] investigated the effects of a home-based walking program when prescribing different exercise frequencies (3-days vs. 5-days/week). One hundred and six inactive adults (40-61 yrs) were randomized into a 12-week walking program: 30 minutes/day, 5-days/week; 30 minutes/day, 3-days/week; or a control group. All participants were provided a pedometer and instructed to obtain their 30-minute brisk walk in bouts of at least 10 minutes. After 12-weeks there was no significant difference in exercise adherence; the 3-days a week group completed 89.3% (1254 days), and the 5-days a week group completed 82.6% (1785 days) of their prescribed walking. Both groups accumulated approximately 3500 steps during the 30 minute walk [89].

Pedometer-Based Physical Activity Interventions

Many studies have used pedometers as a tool to motivate individuals and help increase levels of physical activity. A meta-analysis of 26 randomized control trials (N=8) and observational studies (N=18) showed that the use of pedometers was a successful way to increase physical activity levels of individuals [90]. This systematic review provided an overview of: study characteristics, participant characteristics, and resulting changes in activity level from pedometer use. On average pedometer-based physical activity interventions had a mean duration of 18 ± 24 weeks, ranging from 3-104 weeks [90]. Nine interventions were successful at completing all participants they enrolled, while the remaining studies had an average drop out rate of 20% [90]. At baseline, participants were somewhat active, with an average of 7473 ± 1385 steps/day, ranging from 2140-12,371 steps/day [90]. The results of this meta-analysis suggested that pedometer-based physical activity interventions successfully increased physical activity levels to a magnitude of about 2000 steps/day [90]. Pedometer users who kept a step

dairy and set daily step goals for motivation appeared to have greater increases in physical activity than those who did not set goals or self-monitor daily steps. Regarding health outcomes, pedometer users significantly reduced their systolic blood pressure and BMI [90]. Using pedometers to motivate and track physical activity levels can result in significant increases in physical activity [90].

In one pedometer-based physical activity intervention, Araiza et al. [103] randomized 30 patients with type 2 diabetes mellitus to either a control group or to an active group. The active group received the recommendation to walk 10,000 steps/day. Following a 10-day baseline activity measurement with pedometers, the control group was instructed to maintain their baseline activity patterns, while the active group was instructed to walk at least 10,000 steps/day 5 or more days/week, for the next 6 weeks. There was no change in physical activity levels of the control group, compared to the active group who significantly increased their physical activity by 69% during the study. This short-term pedometer-based physical activity program was successful at increasing levels of physical activity.

de Blok et al. [104] used a lifestyle physical activity counseling program plus a pedometer to increase daily activity levels in patients during pulmonary rehabilitation. Twenty-one patients were randomized to either an experimental group that received a chronic obstructive pulmonary disease (COPD) rehabilitation program, plus lifestyle physical activity counseling, goals, and a pedometer, or to a control group that received COPD rehabilitation only, and no pedometer. After the 10-week program, the experimental group increased their steps by 1430 steps/day, whereas the control group only showed an increase of 455 steps/day. Pedometers, when used in combination with

goal setting and lifestyle physical activity counseling, may help increase and maintain the physical activity levels of those undergoing pulmonary rehabilitation.

In another pedometer-based physical activity intervention, Hultquist et al. [105] compared two different walking recommendations (walk 10,000 steps/day vs. walk 30 minutes/day) on their ability to increase physical activity levels of previously inactive women. Fifty-eight sedentary women were given sealed pedometers, randomized to receive one of the two walking recommendations, and monitored for four weeks. The 10,000 steps/day group received a second pedometer, this one unsealed, to allow them to track their progress towards the daily goal. Both groups increased their daily walking. The 10,000 steps/day group ($10,159 \pm 292$) walked a significantly greater average number of steps per day than the 30 minute walk group (8270 ± 354) during the intervention. The combination of being given instructions to walk 10,000 steps a day and a pedometer to monitor steps appeared to increase physical activity levels more than being instructed to walk for 30 minutes/day.

Ransdell et al. [106] evaluated the effectiveness of a home-based physical activity program compared to a control condition in daughter, mother, maternal grandmother triads over 6 months. The families randomized to the home-based condition attended two instructional classroom sessions where they were provided pedometers, physical activity goals (exercise 3 times a week; starting with 20 minutes/day and increasing intensity and duration gradually until they were walking for 60 minutes/day), and physical activity packets. Participants received a check-in phone call once a month. Participants in the control condition attended one session about correctly using the pedometer and were asked to maintain their current levels of physical activity. Both groups also kept a

physical activity diary. Daily steps were assessed at baseline and then at the end of the 6-month program. At the end of the intervention, the home-based group achieved a 37% increase in step counts, compared to a 13% decrease in the control group.

Talbot et al. [107] combined an arthritis self-management education course to increase physical activity with a pedometer-driven walking program to evaluate the effects on physical activity. Thirty-four older adults (>60 yr) with osteoarthritis of the knee were randomized to receive arthritis self-management education (EDU), or EDU plus a home-based pedometer-driven walking program (EDU + Walk). Over the next 12 weeks, the EDU group attended 12 hours of an arthritis self-management course. Individuals in the EDU + Walk program attended 12 hours of an arthritis self-management program and received a pedometer-based walking program which focused on gradually increasing their steps by 30% from baseline. At the end of the 12-week program, the EDU + Walk group had increased their daily steps by 23%, and the EDU group had decreased their steps by 15%. Although not significantly different from the posttest steps; by the 24-week follow-up, the EDU + Walk group's increase in steps was reduced to 6% above baseline, and the EDU group's decrease in steps was 10% below baseline. The addition of a 3-month pedometer-based walking program to an arthritis self-management education course initially increased walking in older adults suffering from osteoarthritis of the knee. The effect of the intervention to increase physical activity levels was only minimally maintained.

Schneider et al. [108] enrolled fifty-six obese and overweight sedentary adults in a 36-week, 10,000 steps a day, pedometer-based physical activity intervention. All participants wore pedometers daily. After two-weeks of baseline assessment (normal

daily activities), participants attended biweekly information sessions for the first two months of the intervention and were given a physical activity prescription that ramped up their walking to 10,000 steps a day by week 4. The sixty-eight percent of participants who completed the intervention increased their daily walking from 5232 to 9159 steps/day. Twenty of the thirty-nine participants who completed the 36-week intervention were successful in adhering to the exercise prescription (averaged ≥ 9500 steps/day).

Moreau et al. [109] evaluated the effect of a 24-wk pedometer-based walking program in twenty-four postmenopausal women with elevated blood pressure. The fifteen women randomized to the exercise group, were provided a pedometer and a step goal that resulted in a 3-km increase in their daily walking (the amount recommended by the ACSM-CDC). Women were given the freedom to accumulate their extra walking in whatever pattern best fit their lifestyle and at a self-selected, comfortable pace. The nine women in the control group were instructed to not change their daily physical activity levels and were only provided a pedometer for one week each month to track their walking. The women in the exercise group successfully increased their daily walking average from 5400 to 9700 steps/day, and lowered their systolic blood pressure; while the women in the control group showed no change in daily walking activity or systolic blood pressure over the 24-wk study. In conclusion, providing a pedometer and a specific walking goal (an extra 3 km/day) can be a motivational tool for increasing daily walking enough to meet the ACSM-CDC minimum physical activity recommendation.

Swartz et al. [110] evaluated the effectiveness of an 8-week walking program on physical activity levels and glucose tolerance. Eighteen inactive and obese women with a family history of type 2 diabetes served as their own controls. Participants were provided

pedometers and for the first four weeks maintained their habitual physical activity levels. For the next eight weeks participants were given the goal of accumulating 10,000 steps/day and were required to self-monitor their daily steps and physical activity patterns. During the four-week control period, participants averaged 4972 steps/day. During the intervention period, participants increased their average step/day to 9213, and two-hour post-load glucose values, glucose area under the curve, and blood pressure decreased. The provision of a specific, easy to understand physical activity recommendation (i.e., 10,000 steps/day), in combination with a pedometer to provide feedback was effective for significantly increasing physical activity in women at risk for type 2 diabetes. Independent of weight loss, there are health benefits of accumulating 10,000 steps/day in previously inactive women; including improved glucose tolerance, and resting blood pressure.

Shipe et al. [111] assessed the addition of a pedometer-driven walking program to a phase II cardiac rehabilitation program (CRP) on physical activity. Seventy phase II CRP patients were randomized to receive phase II CRP plus a blinded pedometer (controls, N = 34), or phase II CRP plus a visible pedometer accompanied with an exercise diary to self-monitor physical activity (treatment, N = 36). As part of the phase II CRP, all patients attended supervised exercise sessions (at least 30 minutes) three days a week. The control patients were encouraged to increase their overall activity levels in accordance with standard level of care (30-60 min of PA; at least 5, if not all days of the week). Patients in the experimental group were provided with the same instructions but were also encouraged to gradually increase their walking (an extra 2,000-2,500 steps/day above baseline values) on the days they did not attend phase II CRP. At baseline all

patients took more steps on CRP days compared to non-CRP days. As a result of the intervention, the experimental group took significantly more steps and increased aerobic step counts on non-CRP days, while the control patients showed no changes in either variable. On CRP days both groups significantly increased their overall and aerobic step counts. In phase II CRP patients, the addition of a pedometer and diary for self-monitoring daily steps was beneficial to helping patients increase their physical activity levels above receiving a standard CRP.

Tudor-Locke et al. [112] evaluated the effects of a 16-week pedometer-based physical activity intervention for individuals with type 2 diabetes. Forty-seven inactive diabetic adults were recruited and randomized into either the First Step Program (FSP) group or a control group. The 16-week long behavioral modification FSP involved weekly meetings during the 4-week adoption phase and used pedometers and calendars to establish baseline activity levels; and to help facilitate goal setting, self-monitoring, and feedback, which continued during the 12-week adherence phase. Postcards were mailed to the control group to thank them for their participation in the study. Levels of daily physical activity were determined at baseline and at 16 weeks in both groups using a sealed pedometer (Yamax SW-200, Yamax Corporation, Tokyo, Japan) over three consecutive days (including one weekend day). The FSP participants significantly increased their physical activity by about 3000 steps/day in comparison to the control group after 12 weeks. At the 24-week follow up, the FSP participants did not maintain their high step counts, and there was no longer a difference between the groups. This drop off occurred after contact with participants was removed, highlighting the

importance for continued support in order to maintain increased levels of physical activity in previously sedentary individuals.

Interventions Attempting to Increase Access to Physical Activity

Jakicic et al. [91] evaluated the effects of three different methods of home-based exercise (continuous exercise, intermittent exercise, and intermittent exercise plus the provision of home exercise equipment) on adherence during an 18-month behavioral weight-loss program. Subjects included 148 sedentary, overweight women, who were randomized into one of three home-based exercise groups. Each group was prescribed a comparable amount of exercise, but differed in the method in which the exercise was prescribed. Women assigned to the continuous-bout exercise group were instructed to train 5 days/week, completing their daily exercise session in one 40-minute bout. Women randomized to the intermittent-bout exercise group were also asked to train 5 days a week, 40 minutes a day, but to break their exercise bouts down into multiple shorter bouts (10-minutes), scattered throughout the day. The intermittent-bout plus exercise equipment group was provided with a motorized home treadmill, and given the same exercise prescription as the intermittent-bout exercise group. All three groups showed an increase in exercise participation, with no significant difference between intermittent- and continuous-bout exercisers, however, participants in the intermittent-bout plus exercise equipment group were the most successful at maintaining high levels of exercise. Access to equipment within the home may help facilitate the long-term maintenance of exercise.

Van den Berg et al. [113] compared the effectiveness of two, 12-month Internet-based physical activity programs on 160 inactive patients with rheumatoid arthritis (RA). Patients randomly assigned to the individualized training intervention received a bicycle

ergometer, Polar heart rate monitor, elastic Thera-Bands, and wooden exercise stick for use in their home, and access to an Internet-based program that provided a personalized weekly physical activity plan (cycling, strength training and range-of-motion exercises). This program was to be performed 5 days a week, and participants were encouraged to engage in other forms of physical activity on the remaining two days each week. These patients received training feedback from physical therapists on a weekly basis, and every three months they were invited to attend group meetings. Patients assigned to the general training intervention received access to an Internet-based program that provided general information on exercises (aerobic, strength training and range-of-motion) and physical activity for patients dealing with RA. The general training group were encouraged to exercise at least five days a week following the Internet-based program which worked towards the goal of exercising for 30 minutes a day, five days a week. Each month, new information and activities were provided on the Internet. The proportion of participants in the individualized training intervention who reported engaging in moderate intensity exercise for 30 minutes a day, 5 days a week was significantly greater than the general training group at 6 and 9 months. Also, the proportion of participants in the individualized training group reporting meeting the recommendation for vigorous intensity exercise (20 minutes a day, 3 days a week) was significantly greater compared to the general training group at 6, 9 and 12 months. Activity monitored physical activity showed no differences between the groups. Providing exercise equipment along with an individually tailored, exercise specific, supervised Internet-based physical activity intervention resulted in RA patients reporting higher levels and intensities of physical activity than when provided a general Internet-based physical activity program.

Physical Activity Interventions Attempting to Reduce Access to Sedentary Behavior

Otten et al. [92] reported the results of the first study to measure the effects of a TV reduction intervention in adults on energy expenditure. Thirty-six overweight or obese adults (age 21 to 65) who reported watching at least three hours of TV per day were recruited. In this 6-week study, all subjects completed a 3-week observational period, in which electronic monitors (BOB TV Time Managers) were attached to all home TV sets in order to measure daily “screen time.” Participants who successfully completed the 3-week observational period were randomized to either the intervention group or the control group. During the second, 3-week period, those in the intervention group had a weekly limit set for total TV viewing time (50% reduction from the objectively-measured TV viewing in the 3-week observational period). The TV would automatically shut off when this limit was reached and could not be turned on again until the beginning of the next week. The control group continued to have their TV viewing time monitored, but no limit was enforced. Energy expenditure was measured during the last week of each 3-week period using the SenseWear Pro 3 Armband. During the second 3 weeks, daily TV viewing time decreased in both the intervention and the control groups. The intervention group had a significant increase in their total daily energy expenditure and a significant decrease in time spent in sedentary activities compared with no changes in the controls. Although the intervention phase of this study was only 3 weeks long, it does appear that reducing TV viewing time may be an effective strategy for increasing physical activity levels and reducing overall sedentary behaviors.

The effect of reducing access to sedentary behaviors on physical activity levels has also been examined in a pediatric population. Epstein et al. [114],

recruited seventy 4 to 7 year olds whose BMI was at or above the 75th percentile for age and sex to evaluate the effect of reducing TV viewing on weight status and physical activity. Children were randomized into two groups: an intervention group, which had a goal of reducing their TV viewing and computer use time by 50% and a control group with no restriction placed on TV and computer use. All participating families had TV Allowances installed on their TV and computer monitors, which were set to objectively record the amount of time these screened devices were used. The TV Allowance devices could also be set to enforce a weekly time budget for TV and computer screen. After a 3-week baseline measurement period of TV and computer use, the children in the treatment group had their TV and computer usage reduced by 10% per week from their baseline amount until they reached a 50% reduction. Once the budgeted time was reached, the TV or computer monitor could not be turned on for the remainder of the week. Investigators found that the treatment group had significant reductions in sedentary behavior (-17.5 ± 7.0 hours/week) when compared to the control group (-5.2 ± 11.1 hours/week), but there was no change in physical activity in either group.

In another pediatric study Maloney et al [115], tried an alternative approach to promote physical activity and reduce sedentary screen time. Instead of trying to restrict access to sedentary screen time behaviors, this study provided a substitute active screen-time option (i.e., Dance Dance Revolution (DDR) active video game) to increase physical activity and decrease sedentary screen time in children 7-8 years old. Sixty children were

randomized into two groups: a DDR group, which was provided with DDR equipment and a written physician prescription to play 120 minutes/week of DDR; and a wait-list control group, which received no DDR equipment and instructions to refrain from any DDR for the first 10 weeks of the study. After 10 weeks, the wait list control group was given DDR equipment to use, but no physical activity prescription. Over 28 weeks, participants logged their daily DDR time. At 0, 10, and 28 weeks self-reported the time they spent engaged in sedentary screen time, and physical activity was objectively measured by accelerometer. After 28 weeks the children in the DDR group significantly reduced sedentary screen time, light physical activity, and increased vigorous physical activity. The control group had no change in sedentary screen time, or moderate or vigorous physical activity, but did increase light physical activity [115]. This study suggests that reducing or removing sedentary screen-based behaviors in youth may not be necessary to promote increase physical activity. Instead, modifying traditionally sedentary behaviors in children may be an innovative strategy for increasing physical activity and also reducing sedentary time in youth.

Physical Activity Intervention Summary

There are several effective options available for increasing the physical activity levels of previously sedentary individuals [91]. This is good news for sedentary individuals who dislike vigorous exercise or have barriers to physical activity such as lack of time or lack of access to facilities. Identifying exercise strategies that result in the greatest levels of ongoing participation is of paramount importance [93]. Home-based exercise programs appear to be convenient option available to middle-aged and older adults interested in being more physically active [93]. Short bouts of exercise are equally

effective as long bout of exercise for previously sedentary individuals trying to incorporate exercise into their lives [91]. Walking, of all the varieties of physical activity, appears to be the activity of choice for increasing leisure-time physical activity (LTPA) [116-118]. It is inexpensive, no special equipment is needed, and it can be unplanned and spontaneous [119]. Interventions that involve reducing or changing sedentary behaviors (i.e., TV viewing) may be influential in efforts to increase the physical activity levels of sedentary adult individuals [92]. Incorporating physical activity into a traditionally sedentary behavior may be an effective means to increase physical activity and decrease sedentary screen time [115], but has yet to be examined in adults. Pedometer feedback can be an important resource in tracking and helping to motivate individuals towards increasing physical activity behaviors [120].

Summary

Strategies for treating inactivity and obesity through behavioral modification and lifestyle changes often involves large permanent changes to diet and physical activity and can be difficult for individuals to maintain over time [121]. Creating small changes in exercise behavior and diet may be a superior method for increasing daily physical activity in sedentary individuals who use “lack of time” as their rationale for inactivity. Recent research suggests that anti-obesity efforts should be focused first on promoting small lifestyle changes to eliminate or reduce the gradual excessive weight gain that is occurring in people of all ages [121-124]. This is shown by a study that asked families to make small changes (consume cereal for breakfast and to increase physical activity by 2000 steps/d over baseline) for a 14-week intervention. Participants in the treatment condition were successful in implementing the behavior change and achieved favorable changes in BMI [122]. The research proposed here (see Chapters III, IV, and V) also

involves making small changes to address and modify a behavior that is typically considered sedentary (TV watching).

As emphasized in recent recommendations on physical activity and public health [16], using short, intermittent bouts of moderate intensity physical activity in sedentary individuals can be an acceptable and effective means of acquiring the recommended levels of PA and the associated health benefits. Levine found that obese people sit for 2 hours more per day than lean people [123]. A small body of research [87,91,125] shows that short, intermittent bouts of activity could be used to decrease sedentary time in obese subjects, but the research in the area needs to be further developed. Research done in a worksite wellness program that focused on increasing lifestyle activity showed considerable cardiovascular benefits resulted from using a public access staircase during a 7-week stair-climbing program in previously sedentary women [124]. In another study researchers found that accumulating multiple short bouts of light- to moderate-intensity physical activity, even when more than half the bouts were less than 6 minutes in duration, can provide significant improvements in the fitness of sedentary adults [126]. Additional research has shown that dividing one long bout of exercise into several shorter bouts can improve patients' adherence to programmed activity [87].

Behavior change is necessary for sedentary individuals to successfully increase and maintain daily physical activity. Compared to large changes, small changes are more feasible to achieve and maintain [30]. Achieving smaller lifestyle changes promotes self-efficacy and can stimulate people to make additional small changes [121]. Exercise self-efficacy, the belief that one can successfully engage in exercise, has emerged as a highly influential variable for behavior change [127,128]. Thus presenting physical activity

recommendations (such as 30 minutes of continual exercise) to a sedentary individual, without using small, behavioral changes may be overwhelming and decrease the exercise self-efficacy of the individual. Conversely, a program that promotes short bouts of activity, with longer periods of rest between each exercise bout, and allows the physical activity to be performed in the home may be an acceptable starting point that sedentary individuals would feel that they could achieve easily.

The decision to be physically active depends on prioritizing physically active behaviors rather than sedentary behaviors during leisure-time [51]. Currently, American adults choose to watch more than 32 hours of TV per week [129], while many adults do not achieve the recommended 150 minutes/week of PA [19,20]. According to the American Time Use Survey conducted by the U.S. Bureau of Labor Statistics, TV watching accounts for over 50% of leisure-time [52]. However, the number one reason people give for not exercising is, “not enough time” [130,131]. The time spent engaging in TV watching can compete with time spent in other activities that have require greater energy expenditure such as PA [132,133]. In adult observational studies, TV watching has been positively related to overweight and obesity [46]. Research investigating the effect of reducing or limiting TV viewing have shown mixed results on physical activity and dietary intake [114,134], but there are no studies examining the effectiveness of an alternative method that encourages people to simultaneously perform physical activity while watching TV. TV watching, typically a sedentary activity, can be converted to an active lifestyle choice by walking in place during the commercials.

Reducing TV viewing alone was not helpful for increasing physical activity in children [114]. In adults an increase in total daily energy expenditure and a decrease in

time spent in sedentary activities occurred only when TV viewing was forcefully reduced, and over a short period of time (3 weeks) [92]. It does appear that modifying sedentary behaviors, and changing them into more active behaviors might be an effective strategy for both increasing physical activity levels and reducing overall sedentary behaviors [115]. Taken together, this body of research suggests that an intervention focused on increasing the physical activity by stepping in place during commercial breaks may be a feasible and successful method for increasing physical activity in sedentary adults. Moreover, by modifying a behavior that is very common in this population, and allowing the activity to be performed in the home, this would help to remove barriers that prevent sedentary adults from being physically active.

Health and fitness professionals recognize that successful interventions are rooted in behavior change theory [125]. The purpose of this behavior modification idea is to help individuals change behaviors that contribute to their inactivity and initiate new physical activity behaviors needed to increase activity and prevent weight gain. The idea of walking for the duration of all commercial breaks while watching TV applies several aspects characterized in behavior modification theory; it is measurable (accelerometer and PA diary), a reasonable plan, and a single small behavioral change [135].

The First Step Program shows that individuals adhere best to a simple exercise regimen that was flexibly scheduled and individually tailored [136]. TV commercial walking can be done in the home and insures that participants initiate PA at a lower level that they can gradually increase as desired. Studies have shown that activity compliance can be enhanced by increasing lifestyle activities, developing an appropriate home-based exercise program, and considering short bouts rather than long bouts of activity for

individuals who “can’t find the time to exercise” [86,91,93,136]. Exercising at home increases accessibility and convenience, improving adherence to recommendations and decreasing barriers to physical activity, including costs and travel time [86,91,93,137]. TV commercial walking could be used as a tool for increasing physical activity in someone who does not make time to exercise daily, but does make a point of sitting down to watch television every day.

These findings suggest that TV commercial walking may be a strategy that assists in increasing physical activity and potentially affecting dietary intake, creating prevention of weight gain in sedentary adults. This study will compare the effects of two different leisure-time activity prescriptions: a standard physical activity recommendation (at least 30-minutes of exercise daily) or a novel prescription of multiple short bouts of intermittent exercise through TV commercial walking (1.5 hours of TV time daily), on physical activity level, dietary intake and weight in sedentary adults during a 6-month behavioral intervention. If the outcomes of this investigation indicate that the behavioral approaches of TV commercial walking are successful, feasible and effective in getting individuals closer to meeting physical activity recommendations, future directions will include the use of TV commercial walking as a strategy in adults to improve physical activity and possibly long-term weight loss in standard behavioral interventions. Walking in place during TV commercials could be added to the list of exercises that yield health benefits.

ACSM has declared that its goals are to enhance and maintain physical performance, fitness, health, and quality of life [138]. The research proposed here directly

addresses these priorities by investigating a practical, easily implemented solution to increasing and maintaining physical activity among sedentary adults.

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Part III

Energy Cost of Stepping in Place While Watching TV

Commercials

This part is a paper by the same name that has been submitted to Medicine and Science in Sports and Exercise in 2011 by Jeremy A. Steeves, Dixie L. Thompson, and David R. Bassett Jr.

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ABSTRACT

Modifying sedentary TV watching behaviors by stepping in place during commercials (TV commercial stepping) could increase physical activity (PA) and energy expenditure.

PURPOSE: To determine the energy cost of TV commercial stepping and to quantify the amount of activity (number of steps and minutes) performed during 1 hour of TV

commercial stepping. **METHODS:** In part 1, twenty-three adults (27.8 ± 7.0 years) had their energy expenditure measured at rest, sitting, standing, stepping in place and walking

at 3.0 mph on the treadmill. The second part of this study involved one hour of sedentary TV viewing and one hour of TV commercial stepping. Actual steps were counted with a

hand-tally counter. **RESULTS:** There were no differences ($P=0.76$) between the caloric requirements of resting metabolic rate (79 ± 16 kcal/hr), and sedentary TV viewing (81 ± 19

kcal/hr). However, stepping in place (258 ± 76 kcal/hr), walking at 3.0 mph on the treadmill (304 ± 71 kcal/hr), and one hour of TV commercial stepping (148 ± 40 kcal/hr),

had a higher caloric requirement than either resting metabolic rate or sedentary TV viewing ($P<0.001$). One hour of TV commercial stepping resulted in an average of 25.2

± 2.6 minutes of PA and 2111 ± 253 actual steps. **CONCLUSION:** Stepping in place

during commercials can increase the energy cost and amount of activity performed during

TV viewing. *Key words: physical activity, obesity, sedentary behavior, energy*

expenditure, indirect calorimetry

Introduction

The prevalence of adult overweight and obesity has increased to 68% in the United States [1]. One cause for weight gain and obesity may be the increased amount of time spent being sedentary. Both sedentary leisure time pursuits like watching television [2] and sedentary jobs that effectively promote physical inactivity [3,4] are potential links to the high obesity prevalence. TV viewing has increased dramatically since 1965; making it the most prominent leisure-time activity in the U.S. [5,6]. TV viewing is also the predominant source of leisure-time sedentary screen time (89.8%) according to the 2010 Nielson Three Screen Report [2]. American adults spend almost 38 hr/wk watching television (TV), approximately 30 min/wk watching video on computers and mobile phones, and spend almost 4 hr/wk on the internet [2]

Cross-sectional studies have demonstrated that TV viewing is linked to weight status in children [7] and adults [8,9]. This sedentary leisure-time activity is hypothesized to negatively influence weight status by reducing energy expenditure and increasing energy intake [9-11]. The time spent engaging in TV watching can compete with time spent in other activities that require greater energy expenditure such as active leisure pursuits (walking, sports, etc.) [12,13]. In addition, people often consume calories when watching television. In intervention studies, reduced TV viewing has been shown to decrease sedentary behaviors and energy intake [11], and to increase moderate-intensity PA in children and adolescents [14]. One study in adults has shown that restricting TV viewing time resulted in increased levels of physical activity [15]. However, due to the large amount of TV most Americans watch, and their reluctance to permanently give up screen time, the long-term sustainability of this approach is doubtful [16].

An alternative to forcing individuals to give up their valued screen time would be to convert sedentary screen time into active screen time. In a lab-based study, converting sedentary screen time to active screen time through the use of activity-promoting video games successfully increased energy expenditure in children [17].

Encouraging adults to exercise during their leisure time is one approach to counter the obesity epidemic [18]. Higher levels of physical activity are helpful in preventing weight gain [19], but getting adults to maintain there increased levels of physical activity continues to be a challenge [20]. Small changes in exercise behavior may be a method for increasing daily physical activity in sedentary individuals. Recent research suggests that anti-obesity efforts should be focused first on promoting small lifestyle changes to eliminate or reduce the gradual weight gain that most people experience [21-24]. Beers et al. [18] investigated the effects of encouraging small changes that could be made in the work place or work environment to increase passive energy expenditure. In this lab-based study, the passive energy expenditure of performing clerical work while sitting in an office chair, on a therapy ball and while standing were compared. The energy expenditure of office work while sitting on a therapy ball and standing was greater (~ 4.0 kcal/hr) than while sitting [18]. Another potential approach to increase workplace physical activity is the treadmill workstation [23]. Levine et al. [23] documented that the energy expenditure of walking and working at a self-selected velocity of 1.1 ± 0.4 mph on the treadmill workstation (191 ± 29 kcal/hr) was significantly greater than working while seated in an office chair (72 ± 10 kcal/hr). Over time these small increases in energy expenditure may help prevent creeping weight gain [25].

Thus, one approach for increasing energy expenditure and preventing weight gain is to incorporate physical activity into a traditionally sedentary leisure time activity (TV viewing). Encouraging a small behavior change, by having individuals step in place during television commercials (TV commercial stepping) could be one strategy to modify sedentary TV viewing. A former president of the American Dietetic Association has advocated this approach (Jane White, personal communication, March 31, 2009). However, no research has been conducted examining the amount or intensity of PA that results from adults changing their sedentary TV watching behaviors to active behaviors (stepping in place during commercials). Before this strategy can be tested as an effective method to reduce sedentary behavior and increase PA in an intervention, it must be determined whether this activity substantially increases the energy expenditure of watching TV. We hypothesize that modifying TV watching behaviors by stepping in place during commercial breaks will enable individuals to increase their energy expenditure and physical activity, while still engaging in their highly valued TV viewing time.

Therefore, the objectives of this two-part, laboratory-based pilot study were: 1) to evaluate the energy cost of stepping in place at a self-selected pace compared to the energy cost at rest (REE), sitting, standing and walking at 3.0 miles per hour on the treadmill, and 2) to quantify the number of calories, steps taken, and total physical activity time accumulated during one hour's worth of TV commercial stepping in comparison to one hour of TV viewing while seated.

Methods

Participants

Males and females between 18 and 65 years of age and across a wide range of body mass indexes (BMI) were recruited for this study. Participants for this study were recruited by word of mouth and posted flyers. The Physical Activity Readiness Questionnaire was used to screen out individuals with contraindications to exercise. Participants were excluded if they reported not being able to walk a quarter of a mile without difficulty, or taking any medication that would influence metabolic rate. Participants were asked to arrive in the morning after 10 hours of fasting and having refrained from exercise for at least 12 hours. Participants were asked to read and sign an informed consent, which was approved by the University of Tennessee Institutional Review Board (IRB) before taking part in the study.

Procedures

Participants arrived at the Applied Physiology Laboratory in the morning, dressed in comfortable clothing and shoes. Their height and weight were measured (in light clothing, without shoes) with a wall-mounted stadiometer and a Tanita bio-electrical impedance analyzer (model BC-418), respectively. Body mass index (BMI) was calculated by dividing weight (kg) by height (m) squared. Percent body fat was determined using the Tanita BC-418 bioelectrical impedance analyzer. Using a Gulick spring-loaded tape measure waist circumference was measured to the nearest 0.1 cm over bare skin at the narrowest portion of the torso (above the umbilicus and below the

xiphoid process). Hip measurements were taken at the maximal circumference of the buttocks, above the gluteal fold.

Prior to exercise, participants completed a Physical Activity Readiness Questionnaire (PAR-Q), and if they reported any contraindications to exercise they were not tested. All subjects reported compliance with the study protocol of not eating or consuming caffeinated beverages for at least 10 hours and not exercising for at least 12 hours prior to reporting to the lab.

Part I: Energy cost of stepping in place compared to other activities

Energy expenditure was measured using a TrueMax 2400 metabolic measurement system (Parvo Medics, Salt Lake City, UT) [26]. In preparation for the resting metabolic rate measurement, participants lay awake and motionless in a reclined position for 5 minutes in a quiet, dimly light room. While still lying in a reclined position, participants were fitted with a facemask used for indirect calorimetry metabolic measurements. They breathed through this facemask for the next 30 minutes, during which time their expired air was analyzed and their resting metabolic rate was measured. The last ten minutes of the measurement period was used to determine resting metabolic rate.

Following a 5-minute break, the participants were again fitted with the facemask to measure the energy expenditure. Participants then completed a protocol that involved sitting, standing, stepping in place, and treadmill walking at 3.0 mph. Each stage lasted five minutes and there was a one-minute transition period between stages. When sitting in a standard office chair, subjects sat with their feet on the floor and their ankles, knees and hips at right angles. They sat with relaxed arms and their hands rested in their lap. When

standing, the subjects stood facing forward, feet shoulder width apart, with their arms hanging relaxed by their sides. For the stepping in place condition participants stepped in place at a self-selected, moderate pace, with each foot stepping up off the ground about 15-20 cm as demonstrated by the investigator. Finally, participants performed treadmill walking at 3 mph. All participants completed the four conditions in the same order (sitting, standing, stepping in place, and walking at 3.0 mph on the treadmill). The metabolic cart measured the energy cost of each condition. The researcher counted actual steps with a hand tally counter during stepping in place and 3.0 mph walk conditions. In each condition, the first three minutes were allotted for the attainment of steady state. Metabolic data from minutes four and five were averaged and used for subsequent analysis.

Part II: Energy cost and steps during one hour of TV commercial stepping

After completing the four activity conditions participants were given the opportunity to remove the facemask, rest for a period of five minutes, and get a drink of water. Participants were refitted with the facemask prior to the start of watching two hours worth of video recorded television programming with commercials. Each one-hour segment of TV programming consisted of two 30-minute prime time programs. During one hour of programming, participants remained seated for the entire hour of programming. They sat in a standard office chair, with their feet on the floor and their ankles, knees and hips at right angles. They sat with arms relaxed and hands resting in their lap. During the second hour of television watching, participants engaged in TV commercial stepping. Participants were instructed to rise from their chair and to step in place at a self-selected, moderate pace for the duration of each commercial break. When

the regular TV program resumed, participants returned to their seated position until the next commercial break. The order of the two TV watching conditions (seated TV and TV commercial stepping) was counterbalanced. There was a 5-minute break between each hour of TV viewing to allow participants to remove the facemask and return to resting metabolic rate. Energy expenditure was measured during the entire 60 minutes of both seated television and television commercial stepping. The investigator counted the number of steps taken during the one hour of TV commercial stepping, using a hand tally counter. Participants were observed during all conditions to ensure compliance with the study protocol.

Statistical Analysis

SPSS version 17.0.0 for Windows (SPSS Inc., Chicago, Illinois) was used for statistical analysis. Height, weight, BMI, body fat percentage, hip and waist circumference, age, and energy expenditure were calculated for each individual and expressed as mean $\pm$ SD. One-way analysis of variance (ANOVAs) tested the effect of BMI category (normal, overweight, obese) on energy cost of each condition, and again to determine if there were differences in actual steps of each ambulatory condition among the BMI categories. To compare the differences in energy cost repeated measures analyses of variance were used. To compare the differences in actual steps between 5 min of stepping in place and 5 min of walking at 3.0 mph paired samples t-tests were used. For all statistical analyses, an alpha level of 0.05 was used to show significant differences, and all values are shown as mean $\pm$ standard deviation.

Results

Twenty-three healthy adults (11 men and 12 women) aged 21-48 years ranging from normal weight to obese participated in this study. Their physical characteristics are shown in Table 1. Nine adults were normal weight (BMI 19-24.9 kg/m²), ten were overweight (BMI 25-29.9), and four were obese (BMI>30). There were significant differences among groups all indicators of adiposity (body weight, BMI, waist circumference, and hip circumference).

Table 1.1 Physical characteristics of participants

	All Subjects (N=23)	Normal Weight (N=9)	Overweight (N=10)	Obese (N=4)
Age (years)	27.9 ± 7.0	26.2 ± 6.0	30.5 ± 8.4	25.0 ± 2.3
Height (cm)	176.2 ± 9.6	174.9 ± 8.9	177.0 ± 10.2	176.8 ± 12.3
Weight (kg)*	183.8 ± 36.3	156.8 ± 16.3	187.2 ± 22.1	236.0 ± 40.4
BMI (kg/m ²)*	26.6 ± 4.3	23.1 ± 2.4	26.9 ± 1.5	33.8 ± 2.4
Percent fat (%)	28.8 ± 8.1	26.7 ± 8.3	29.2 ± 8.8	32.3 ± 6.3
Waist circum. (cm)*	86.4 ± 12.3	76.9 ± 5.5	87.6 ± 5.3	104.9 ± 14.9
Hip circum. (cm)*	107.2 ± 8.3	101.3 ± 4.7	107.3 ± 5.5	120.5 ± 3.5

Data are mean ± SD. Note. N = number of participant; BMI = body mass index; circum. = circumference; * = significant difference between all groups $p \leq 0.05$.

Part I: Energy cost of stepping in place compared to other activities

When expressing energy cost as kcal/hr, there was a significant BMI group by activity interaction ($P < 0.001$) (see Fig. 1, top panel). When at rest ($P = 0.037$), and while sitting ($P = 0.037$) the obese group expended a significantly greater number of calories per minute than the normal weight group. Likewise, the obese group expended more calories per minute than the normal and overweight categories during standing, ($P = 0.003$ and

0.026) stepping in place, ($P < 0.001$ and 0.016) and walking at 3 mph on the treadmill ($P < 0.001$ and $P < 0.001$). The normal and overweight categories did not differ from one another for any activity. All activities differed in energy cost except for the resting metabolic rate and sitting conditions ($P < 0.001$). The energy cost of treadmill walking at 3.0 mph (304.3 ± 71.5 kcal/hr) was greater than that of stepping in place (257.7 ± 76.1 kcal/hr) ($P = 0.006$). The energy cost of stepping in place was significantly greater ($P < 0.001$) than that of standing (94.0 ± 22.3 kcal/hr), and the energy cost of standing was greater than sitting ($P < 0.001$) (89.4 ± 17.9 kcal/hr) or the resting metabolic rate condition ($p < 0.001$) (78.9 ± 15.5 kcal/hr).

When energy expenditure was expressed as kcal/kg/hr, there was no longer an effect of BMI category on energy cost ($P = 0.058$) (Fig. 1, bottom panel). However there were still significant differences between all of the activities ($P < 0.05$), except between reclining and sitting ($P = 0.21$). The energy cost of treadmill walking at 3.0 mph (3.65 ± 0.32 kcal/kg/hr) was greater than that of stepping in place (3.14 ± 0.53 kcal/kg/hr) ($P < 0.001$). The energy cost of stepping in place was significantly greater ($P < 0.001$) than that of standing (1.13 ± 0.13 kcal/kg/hr), and the energy cost of standing was greater than sitting ($P = 0.008$) (1.02 ± 0.17 kcal/kg/hr) or rest ($p < 0.001$) (0.95 ± 0.14 kcal/kg/hr). Stepping in place (3.14 ± 0.53 METS) was classified as a moderate intensity activity (3-5 METS).

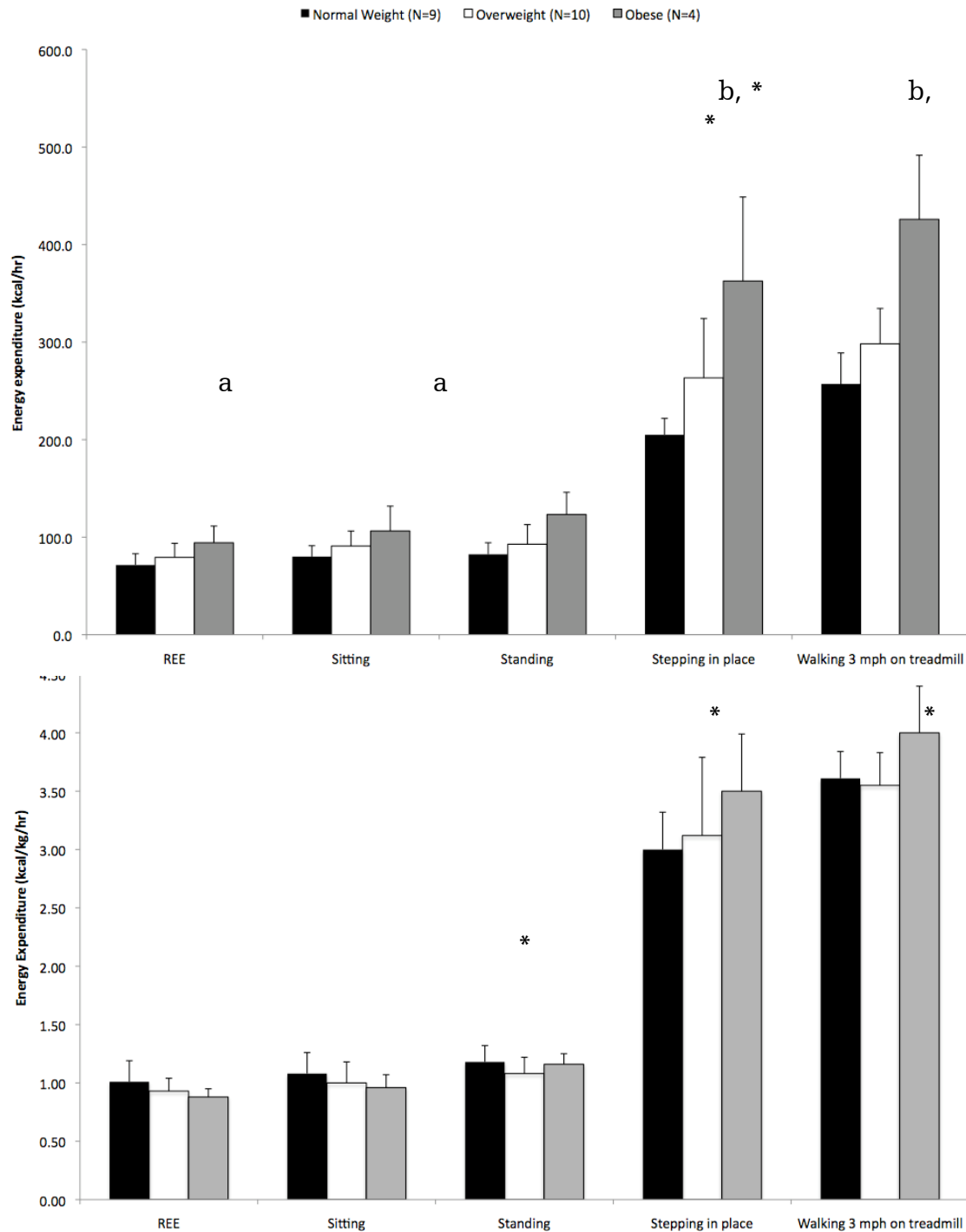


Figure. 1.1. Energy expenditure expressed as kcal/h (top) and kcal/kg/hr (bottom) during 5-min bouts of rest, sitting, standing, stepping in place, and walking 3 mph on the treadmill. Data are mean $\pm$ standard deviation. REE = resting energy expenditure; a = obese group significantly greater than normal group; b = obese group significantly greater than the normal and overweight groups; * = regardless of BMI, energy cost of the activity is significantly different from all other activities ($p < 0.05$).

Steps taken during stepping in place vs. treadmill walking at 3 mph

The obese participants took fewer steps during the five minutes of stepping in place than the other two groups (Normal=542±50, Overweight=547±80, Obese=445±81) (P=0.041). The normal, overweight, and obese groups did not differ in the number of steps taken during treadmill walking at 3 mph (Normal=564±22, Overweight=562±45, Obese=552±36). During 5 minutes of stepping in place, participants accumulated an average of 528±77 steps, compared to 561±35 steps from treadmill walking at 3 mph (P=0.022).

Part II: Energy cost and steps during one hour of TV commercial stepping

When energy expenditure was expressed as kcal/hr, there was a significant BMI group x activity interaction. (Fig. 2, top panel). The obese group expended more calories than the normal weight (P=0.001) and overweight (P=0.01) groups during 60 minutes of TV commercial stepping. The normal weight and overweight groups did not differ from one another (P=0.58). As expected, the total number of calories expended during 60 minutes of TV commercial stepping (148±40 kcal/hr) was greater than the total number calories expended during 60 minutes of seated TV viewing (81±19 kcal/hr) (P<0.001).

When energy cost was expressed as kcal/kg/hr, there was no interaction between BMI group and activity on energy cost (P=0.116) (Fig. 2 bottom panel). There was also no overall effect of BMI (P=0.429). However, the main effect of “activity” remained significant (P=0.001). The energy cost per kg was greater for 60 minutes of TV commercial stepping (1.77±0.27 kcal/kg/hr) than for 60 minutes of seated TV viewing (0.97±0.13 kcal/kg/hr).

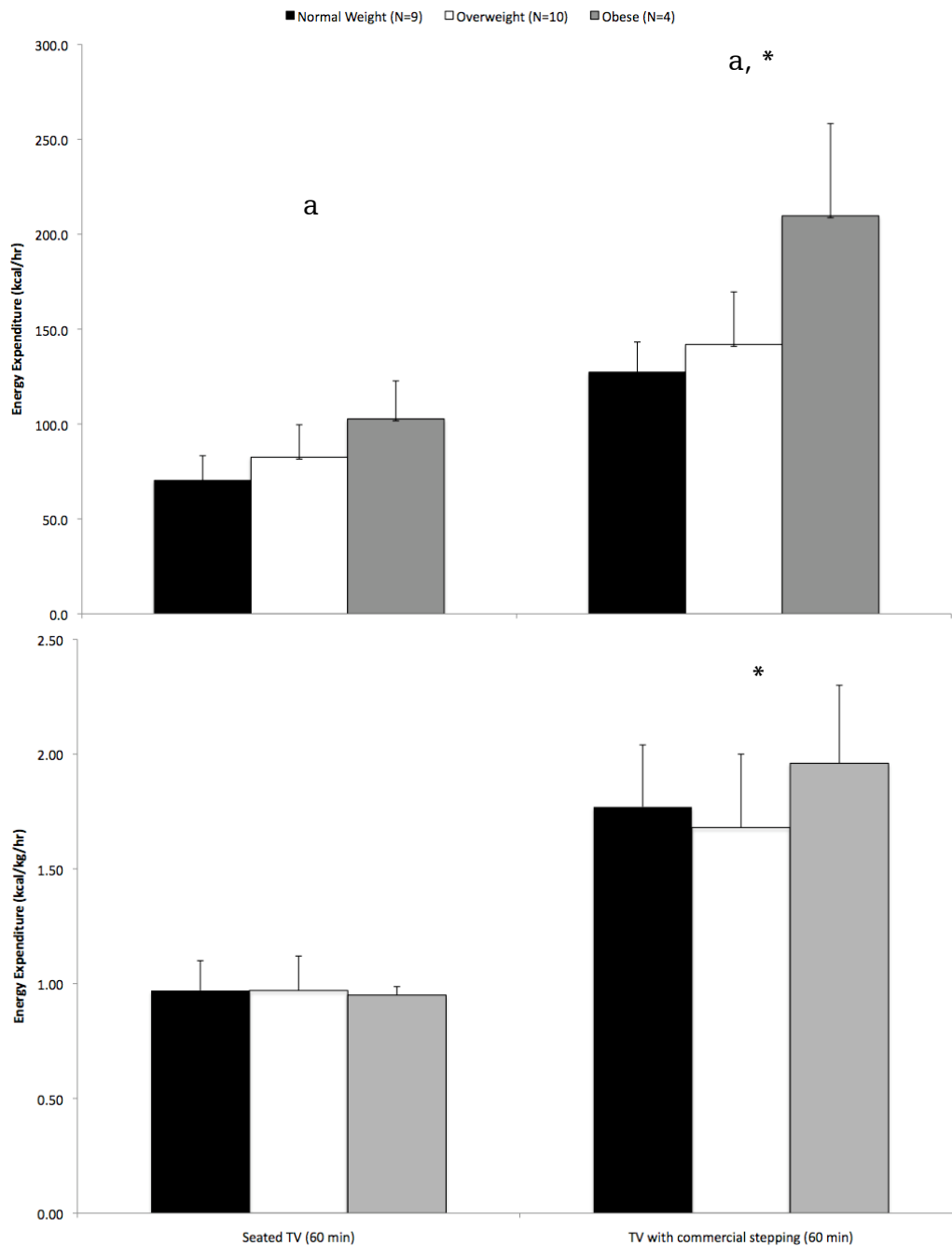


Figure 1.2. Energy expenditure expressed as kcal/h (top) and kcal/kg/h (bottom) during 60 minutes of seated TV viewing and 60 minutes of viewing TV while stepping in place during commercials. Data are mean $\pm$ standard deviation. a = obese group significantly greater than the normal and overweight groups; * = regardless of BMI, energy cost during TV with commercial stepping was significantly greater than with seated TV ($p < 0.05$).

During the 60 minutes of TV commercial stepping, subjects were physically active for an average of 25 ± 3 minutes and they accumulated 2111 ± 253 steps during commercial breaks. Subjects in all BMI categories took a similar number of steps ($P=0.98$) while performing TV commercial stepping, during the 60-minutes of TV programming (normal weight = 2125 ± 244 , overweight = 2098 ± 319 , obese = 2109 ± 72).

Discussion

The present study quantified the difference in energy cost and steps between sedentary TV viewing and active TV viewing achieved through the use of TV commercial stepping. Participants in all BMI categories expended more energy when engaged in TV commercial stepping than while watching TV in the seated position. The energy cost of TV commercial stepping was 67 kcal/hr or 55% greater compared to seated TV viewing. During one hour of TV commercial stepping participants were physically active for 41% of the time, and took approximately 2,000 steps (similar to the quantity accumulated in one mile of walking at 3.0 mph). We suggest that TV commercial stepping results in substantial increases in energy expenditure, steps and physical activity. Given the large number of hours adults watch TV, we suggest that TV commercial walking is one potential approach for reducing sedentary behavior and increasing physical activity.

The obesity rate in U.S. adults has reached epidemic levels. Sedentary behaviors are one factor that contributes to the development of obesity [27] and higher mortality rates [28,29]. Increasing levels of physical activity, achieved through small behavioral

changes, may be helpful in preventing weight gain [25]. Increasing physical activity in inactive individuals continues to be a challenge, as individuals spend many hours per day engaging in sedentary activities like TV viewing [2,30,31]. According to the American Time Use Survey conducted by the U.S. Bureau of Labor Statistics, TV watching accounts for 2.8 hr/day, or approximately 55% of available leisure-time [31]. In 2009, the results of the Video Consumer Mapping Study conducted by Ball State University's Center for Media Design reported that Americans watch 5.9 hr/day of TV and view 72 minutes/day of commercials [30]. According to the 2010 Nielson Three Screen Report, Americans, currently spend almost 38 hr/wk (about 5.4 hr/day) watching television [2]. A standard half-hour television show contains about 8-12 minutes of commercials [30]. Thus, for the average adult who watches 3 to 5 hours/day of television [2,31, 30] this could represent 48 to 120 minutes of commercials per day. This represents time periods during which individuals are not "watching" their program and could be encouraged and cued do to some alternative behavior (physical activity), which would increase the energy cost of watching television.

The conversion of sedentary screen time to active time could be an effective approach to promote physical activity [17]. Based on these findings, we propose that the energy expenditure of TV commercial stepping during 1.5 hours of TV programming would be approximately equivalent to 30 minutes of continuous walking. Taking the energy cost data from the present study, we estimate that the average number of calories (165 kcal) for 1.5 hours of TV viewing with TV commercial stepping (~38 minutes of actual stepping) is roughly equivalent to the number of calories expended during 30 minutes of walking at a pace of 3 mph (150 kcal). These findings suggest that people

could expend at least as much energy through TV commercial stepping as if they performed 30 minutes of continuous walking. Over time, this could have an important impact on energy balance (assuming that “compensation”, in the way of reduced activity during other times or increased calorie intake, does not cancel out the effect). A daily positive energy balance of 15-50 kcal/day is enough to result in typical slow weight gain in adults [3,25,32]. It is estimated that individuals who engage in TV commercial stepping for 1.5 hours would expend an additional 100 kcal/day, which could be helpful in restoring energy balance.

The current study has both strengths and weaknesses. We used indirect calorimetry, which is considered a “gold standard” for assessing energy expenditure in humans. Furthermore, participants in this study performed each activity in a controlled laboratory setting, making this study highly reproducible. However, several limitations should also be noted. In the 5-min sitting condition and 60 minutes of seated TV viewing, participants sat in an office chair; in an upright position, with their hips, knees, and ankles bent at 90 degrees so their feet rested flat on the floor, and hands resting in their lap. If participants were permitted to sit with a self-selected posture, alter their sitting position, or fidget, the energy cost of these sitting conditions might have been different. In a real life situation when watching TV for a 60 minute time period, most individuals do not remain in the same posture for the entire time. Also each one-hour segment of TV programming used in the present study consisted of two 30-minute prime time programs. It must be noted that not all TV programming contains the same number or length of commercials, and at home individuals with digital video recorder (DVR) technology have the ability to fast forward through commercial breaks.

In conclusion, our data clearly indicate that TV commercial stepping increased energy expenditure to moderate levels, nearly as high as walking at 3.0 mph. Over one hour, the energy cost of intermittent TV commercial stepping was nearly twice that of viewing TV in a seated position. Since adults are spending more time than ever in front of the TV screen, we believe that modifying TV viewing behaviors by having adults step in place during commercial breaks could be useful in promoting physical activity. The advantage of TV commercial stepping is that it is a relatively small behavior change that could easily be achieved by most adults. It would not require any reallocation of leisure time, nor would it take any additional time out of the day to perform. Moreover, by modifying a behavior that is very common in this population, and allowing the activity to be performed in the home, this could remove barriers that prevent sedentary adults from being physically active. Experimental research investigating this strategy is needed and it may turn out to be a simple, realistic strategy to increase physical activity in sedentary adults who watch TV.

The results of the present study do not constitute endorsement by ACSM.

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Part IV

Use of TV Commercial Stepping to Increase Physical Activity in Adults: A Pilot Study

ABSTRACT

The most common leisure-time activity is TV watching. An hour of TV contains ~16-20 min of commercials. Modifying TV watching behaviors by stepping in place during commercials (TV commercial stepping) could increase physical activity (PA) in adults.

PURPOSE: To evaluate the short-term effectiveness of TV commercial stepping on adults' PA and TV viewing. A secondary aim was to test objective measures of physical PA under free-living conditions. **METHODS:** Eleven adults (35 ± 15 y) participated in this study and wore three physical activity-monitoring devices [StepWatch-3 (criterion, on ankle), and 2 Omron HJ-303 (1 on ankle and another on waist)] for 3 weeks. During week 1 (baseline), adults were asked to not alter their normal activity or TV habits to establish a baseline level of steps and TV viewing. In weeks 2 and 3 (TV commercial stepping), adults received the goal of TV commercial stepping for at least 90 min/day. Adults recorded daily steps, and self-reported time (min/day) spent TV viewing, and TV commercial stepping in a logbook. **RESULTS:** During the intervention PA during TV viewing increased significantly [(week 1: 349 ± 131 steps/day, week 2: 1226 ± 1071 steps/day, and week 3: 901 ± 463 steps/day) ($P < 0.05$)]. There was a significant difference in TV-related steps when comparing days that participants accumulated at least 90 min of TV commercial stepping and the days that they did not. During weeks 2 and 3 respectively, participants averaged more TV-related steps per day on the days that they TV commercial stepped for at least 90 min (1992 ± 779 , and 1725 ± 764 steps/day), compared to 291 ± 234 and 370 ± 321 steps/day on days that they did not engage in this behavior ($P < 0.05$). TV viewing time was reduced by 34% to an average of 105 ± 47 min/day during the TV commercial stepping weeks, from 150 ± 50 min/day at baseline ($P < 0.05$). During baseline, the Omron ankle and Omron waist counted 60% and 56% of

total steps, respectively in comparison to the StepWatch ($P < 0.05$). During TV commercial stepping, the Omron ankle and Omron waist counted 65% and 59% of total steps, respectively in comparison to the StepWatch. The Omron pedometers counted an equal percentage of steps when participants adhered to at least 90 min of TV stepping and when they did not (ankle: 65% and 64% respectively; waist: 58% and 58% respectively)

CONCLUSION: TV commercial stepping may be a useful strategy to increase PA levels of adults who find it difficult to perform daily exercise, but do spend time watching TV.

It may also reduce TV viewing behavior. The Omron pedometers count about 40% fewer steps than the StepWatch, which we believe is due to the Omron under counting during free-living conditions. The effectiveness and efficacy of longer-term interventions focused on increasing the PA levels of adults through TV commercial stepping should be investigated further. *Key Words: sedentary behavior, free-living, objective measures*

Introduction

There is a growing problem of physical inactivity in America [1]. According to the Centers for Disease Control and Prevention, only about one half of Americans are sufficiently active [2], and approximately 25% of the population report being completely sedentary during their leisure time [3]. It has become well established that high levels of sedentary behaviors, independent of too little exercise, is associated with increased health risks [4-6]. While the goal of many public health recommendations is to increase participation in moderate-to-vigorous PA [1,7], decreasing sedentary behaviors may be another important public health message worth considering [8,9].

Greater levels of sedentary behavior, such as sitting and watching TV for prolonged periods, is associated with an increased risk for obesity, cardiovascular disease-related death, and all cause mortality [4,6,10]. The most common leisure-time sedentary activity is watching television (TV) [11]. Sitting and watching TV expends less energy than most other common sedentary leisure-time behaviors such as talking on the phone, reading, writing, or deskwork [12]. Fortunately, the harmful effects of prolonged sitting can be attenuated by disrupting sedentary time through standing or taking a few steps [13], or by replacing sedentary time with light intensity activity [14]

Currently, Americans spend almost 38 hr/wk watching TV [15]. Due to its relationship with disease risk, current research has focused on turning off or limiting TV viewing time in children [16-20], and most recently in adults [21]. In pediatric studies, reducing TV viewing decreased sedentary behaviors and energy intake [22], but did not increase moderate-intensity PA [16]. In adults an increase in total daily energy

expenditure and a decrease in time spent in sedentary activities occurred when TV viewing was forcefully reduced over a short period of time [21]. However, the long-term efficacy of reducing TV is doubtful, considering the amount of leisure-time currently devoted to watching TV, and the reluctance of many adults to permanently give it up [23].

Encouraging adults to exercise during their leisure time by converting sedentary TV viewing time into active TV viewing is one approach that could counter the inactivity epidemic. Recently, the Video Consumer Mapping Study reported that Americans watch 5.9 hr/day of TV and view 72 minutes/day of commercials [24]. TV commercial stepping, stepping in place during television commercials, could be an effective method to modify sedentary TV viewing and decrease the percentage of inactive adults. In a laboratory-based study, it was established that TV commercial stepping is a moderate intensity PA, and that ankle-mounted pedometers (StepWatch and Omron) were able to accurately measure this activity [25,26]. Our data clearly indicate that TV commercial stepping increased energy expenditure to moderate-intensity levels, nearly as high as walking at 3.0 mph. Over one hour, the energy cost of intermittent TV commercial stepping was nearly twice that of viewing TV in a seated position and resulted in approximately 2000 actual steps [25,26]. Encouraging individuals to step in place during TV commercials provides the opportunity to reduce sedentary behavior, while at the same time increasing moderate-intensity PA. Although related, these two factors have independent effects on chronic disease risk [4,6,10,15].

The next step in this line of research is to examine how individuals respond to TV commercial stepping as an at-home exercise intervention, and to evaluate the accuracy of

objective measures to capture TV commercial stepping outside of a controlled laboratory environment. This preliminary outcome evaluation of TV commercial stepping with a small sample, over a short period of time should provide the feedback necessary to further develop this promising strategy for increasing PA levels.

The primary aim of this study was to examine the effect of TV commercial stepping on steps occurring during TV viewing time, daily steps, TV viewing time, and breaks in TV-related sitting time in normal, overweight, and obese adults. A secondary aim was to compare the resulting step counts of three pedometers (StepWatch and Omron (worn at the waist and on the ankle) during the 3-week free-living protocol.

Methods

Participants

Eleven participants (males and females) between 18 and 65 years old were recruited by word of mouth and through publicly posted flyers around the University of Tennessee and the surrounding area. Inclusion criteria included having a BMI of 18.5 to 40 kg/m², no problems walking or contra-indications to exercise, not currently engaging in regular structured PA, and self-reported TV viewing of at least 2 h/d, or ≥ 14 h/wk. Eligible participants were informed of the protocol, and required to sign an informed consent form approved by the University of Tennessee Institutional Review Board (IRB) before taking part in the study.

During an initial screening at the Applied Physiology Laboratory, participants' height and weight were measured, and participants were provided additional details about the study protocol. Height and weight were measured (in light clothing, without shoes) with a wall-mounted stadiometer and a Tanita bio-electrical impedance analyzer (model

BC-418), respectively. BMI was calculated by dividing weight (kg) by height (m) squared.

Pedometers

The Omron (Omron Healthcare, Inc. Bannockburn, Illinois) is a new tri-axial piezoelectric accelerometer-based pedometer that can validly record steps while being worn oriented in any direction [27,28]. This allows it to be worn at the traditional waist-mounted location, and also in a pocket, backpack. For this study's purpose, the Omron was worn in an elastic strap around the ankle. A tri-axial micro-electromechanical systems (MEMS) accelerometer measures acceleration in the X, Y, and Z planes; and converts this information to steps. It can store up to 7 days of step data, and has a digital display to show daily step counts. In laboratory-based studies, Omron pedometers with this internal mechanism have been found to be valid and reliable for recording step counts at walking and running speeds ranging from 2.0 to 8.0 mph., across multiple body positions and in lean, overweight and obese individuals [28-31].

Step length is one variable required for the set-up of the Omron pedometer. Participants walked exactly 20 steps down an indoor hallway. Measuring this total distance in feet and dividing by 20 determined step length. Step length was determined from the average of two measurements.

The StepWatch is an expensive research grade device that is worn at the ankle. Its accuracy is not affected by walking speed or BMI [32,33]. To detect steps, the StepWatch uses an accelerometer, which measures directional (horizontal and vertical) acceleration. It can be set to record data in epochs ranging from 3–255 s. The StepWatch can collect 60 days worth of data when a 3 s epoch is used. The device must be downloaded to a

computer to obtain the recorded information because it does not have a digital display. [32] Data are downloaded through a docking station using software provided by the manufacturer (StepWatch 3.1; Orthocare Innovations, Mountlake Terrace, Washington).

Procedures

Eleven participants were enrolled on a rolling basis from July through November 2010. Each 3-week protocol was split into a 1-week observation-only phase (phase 1), followed by a 2-week TV commercial stepping intervention phase (phase 2). To track changes in physical activity, participants in the study were fitted with 3 activity monitors: the StepWatch monitor worn on the ankle; and 2 Omron pedometers, 1 worn on the waistline and the other worn on the ankle. Participants wore these devices daily for 3 weeks. To track changes in TV viewing and TV-related sitting behaviors, participants self-reported the number of minutes they watched TV each day. At the end of each week of the study participants self-reported the average number of breaks they took from sitting during 1 hour of TV viewing.

Phase 1

Prior to the initiation of phase 1, participants attended a brief instructional meeting at the Applied Physiology Laboratory, where they were trained in the proper placement of the pedometers. Omron pedometers were placed on the waist in mid-line of the right thigh, and worn in an elastic strap just above the ankle. The following variables were entered to set the Omron pedometer: time of day, body weight, height, and step length. The StepWatch was worn around the ankle with an elastic strap, secured with a Velcro closure. It was set to each participant's height, and the default settings (normal) for "walking speed," "range of speeds," and "leg motion" were used [32]. Although the

Omron has a 7-day internal memory, participants were requested to record the number of steps taken on their activity diary when they removed the devices at the end of each day. The Omron automatically resets to zero at midnight. The StepWatch has no digital read out and automatically stores the number of steps in the instrument's memory and is continuously collecting step data across 24 hours.

Starting the next day, participants were instructed to wear the pedometers during all waking hours except when sleeping or bathing. Participants recorded any exercise they performed, TV viewing time, number of steps, and pedometer wear time in a log at the end of each day. During phase 1, participants were instructed to maintain their normal physical activity and TV viewing patterns. Baseline activity, TV viewing time, steps during TV viewing time, and breaks from sitting during TV viewing were determined for this 7-day period. At the end of this week, participants returned to the laboratory to turn in and review their activity and TV diaries, and download the StepWatch data, prior to beginning the TV commercial stepping phase of the study.

Phase 2

The TV commercial stepping intervention lasted two weeks. A two-week period was selected to ascertain how much of an increase in PA TV commercial stepping would cause, and to gather more information about using this strategy as a potential long-term PA intervention in sedentary, overweight and obese adults. Prior to the initiation of phase 2, participants were given instructions on, and a demonstration of, appropriate TV commercial stepping technique. Participants were instructed to modify their sedentary TV viewing behaviors by getting up out of their seat and stepping in place for the duration of each commercial break during 90 min of TV programming per day

(approximately 30-36 min of stepping). Participants were instructed to step at a self-selected, “brisk” pace, with each foot stepping up off the ground about 15-20 cm. Other than TV commercial stepping, participants were instructed to continue their usual TV viewing habits and maintain normal PA patterns. During weeks 2 and 3, participants continued to keep a daily diary, where they recorded PA (type and duration), number of daily steps, TV viewing time, TV commercial stepping time, and the total time the pedometers were worn each day. At the end of each week, participants were asked to self-report the average number of breaks they took from sitting when watching 1 hour of TV.

During the 3-week study, all participants wore the 3 pedometers daily, and kept a daily record of steps, physical activity, and TV time. At the end of the 3-week period, subjects returned to the laboratory to download data from the StepWatch.

Time spent engaging in TV commercial stepping was matched from participant self-report diaries with the time stamped stepping intervals of the StepWatch step data. The time-sequenced data of the StepWatch was partitioned into: 1) steps taken during TV viewing time and 2) steps taken throughout the rest of the day. After TV viewing steps were isolated, a cutoff of at least 90 min per day of TV viewing with TV commercial stepping was chosen to define adherence.

Statistical Analysis

SPSS version 17.0.0 for Windows (SPSS Inc., Chicago, Illinois) was used for statistical analysis. A repeated measures analysis of variance (ANOVA) was used to compare weekly averages of StepWatch-determined TV commercial stepping steps, total steps per day, self-reported TV viewing time (min/day), and breaks from sitting during

TV viewing time between phase 1 (week 1) and phase 2 (weeks 2 and 3). During weeks 2 and 3 paired samples t-tests were also used to compare daily averages of StepWatch-determined TV commercial stepping steps and total steps per day on days when at least 90 min of TV commercial stepping occurred and on days when this target was not achieved. Repeated measures analysis of variance (ANOVA) was used to compare weekly averages of steps per day by pedometer (StepWatch, and Omron (ankle vs. waist)) between phase 1 (week 1) and phase 2 (weeks 2 and 3). The percentage of StepWatch-determined steps recorded by the two Omron pedometers was compared at the end of each week. Step data were converted to “percentage of StepWatch-determined steps” by dividing the Omron pedometer values by the StepWatch-determined value and multiplying by one hundred percent (i.e., [(Omron waist steps / StepWatch steps)*100%]). In our study, we report the mean “percent of StepWatch-determined steps” because both placements of the Omron pedometers always underestimated the number of steps in comparison to the StepWatch. We wanted to focus on the percentage of steps that were accurately detected by each of the pedometers. During weeks 2 and 3 paired samples t-tests comparing the percentage of Omron steps on days when participants adhered to at least 90 min per day of TV stepping, and the percentage of Omron steps on days they did not adhere were also used to determine if the Omron pedometers were accurately recording TV commercial stepping steps. For all statistical analysis, an alpha level of 0.05 was used to show significant differences. For significant interactions or main effects, pair-wise comparisons, using Bonferroni corrections, were conducted to determine where differences occur.

Results

Eleven healthy adults (5 men and 6 women) (35 ± 15 y), ranging from normal weight to obese participated in this study. Four adults were normal weight (BMI 19-24.9 kg/m^2), 4 were overweight (BMI 25-29.9 kg/m^2), and 3 were obese (BMI $> 30 \text{ kg/m}^2$). During week 1, participants averaged 349 steps/day while watching TV, 8368 StepWatch-determined total steps/day, 2.5 hours of TV viewing time, and 1.4 breaks from sitting during TV viewing time.

The intervention significantly increased the number of steps taken during TV viewing time ($F(2,9) = 7.5$, $P < 0.05$). During weeks 2 and 3 participants took significantly more steps while watching TV (1226 ± 1071 steps/day and 901 ± 463 steps/day for weeks 2 and 3, respectively) compared to week 1 (349 ± 131 steps/day).

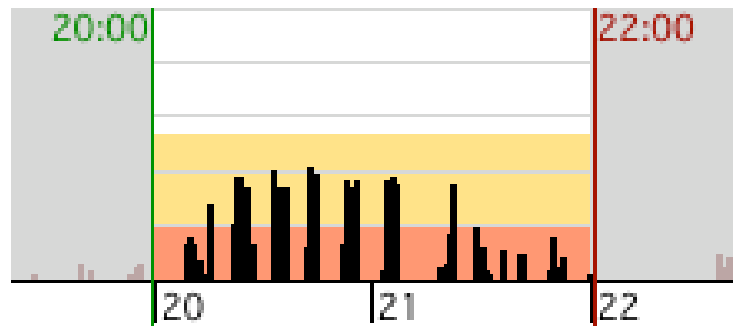
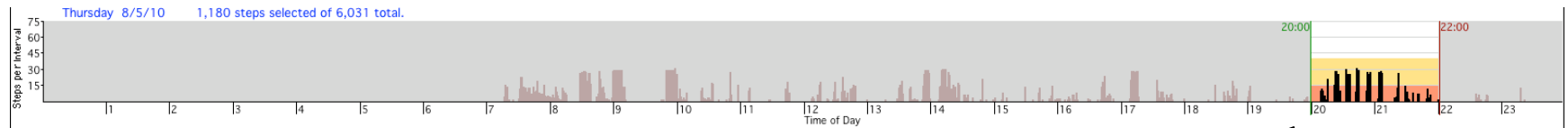
Figures 2.1 and 2.2 show a visual representation of the StepWatch output on a day when a participant completed at least 90 min of TV commercial stepping compared to the output on a day where TV was watched without engaging in TV commercial stepping. Participants did not adhere to TV commercial stepping every day during phase 2. Out of a total of 154 phase 2 intervention days (11 participants X 14 days), participants met the goal of TV commercial stepping at least 90 min per day on 64 days (42%), with an individual participant range of 1/14 days (7%) to 12/14 days (86%). Figure 2.3 shows week 1 TV-related steps and compares days when participants adhered and did not adhere to the protocol during weeks 2 and 3. Participants had higher TV-related steps during week 2 (1699 ± 369 steps/day) and week 3 (1725 ± 763 steps/day) when they adhered to TV commercial stepping for at least 90 min compared when they did not (week 2: 291 ± 234 steps/day; week 3: 413 ± 342 steps/day). Total steps per day

(determined by StepWatch) were not different ($p > 0.05$) over time (week 1: 8368 ± 3119 steps/day; week 2: 9161 ± 3075 steps/day; week 3: 8967 ± 2920 steps/day).

For TV viewing time there was a significant ($F(2,9) = 11.5, P < 0.05$) main effect of time. Compared to week 1 (150 ± 50 min/day), participants watched significantly less TV during both week 2 (108 ± 59 min/day) and week 3 (103 ± 38 min/day). Figure 2.4 shows the average TV viewing time per day for each week of the intervention.

There was a significant ($F(2,9) = 9.3, P < 0.05$) main effect of time for the self-reported number of breaks from sitting during 1 hour of home-based TV viewing. During week 1 participants' reported 1.4 ± 1.0 breaks/hour from sitting. This increased by 47% during week 2 and 3 to 3.0 ± 1.1 and 3.0 ± 1.3 breaks/hour from sitting and viewing TV.

In addition to investigating the impact of the intervention on accumulated steps, this study also compared different pedometers (StepWatch vs. Omron), and wear locations (ankle vs. hip) of the Omron devices for measuring total steps and TV commercial stepping in a free-living environment.



1,180 steps selected of 6,031 total.

Figure 2.1. StepWatch output and isolating TV commercial stepping steps from total daily steps on a day when participant adhered to at least 90 min of TV commercial stepping (2360 TV commercial stepping steps in 120 min of TV viewing time, and 12,062 total daily steps). Note: StepWatch values need to be multiplied by 2 because the device is worn on the ankle and only counts steps on 1 side of the body.

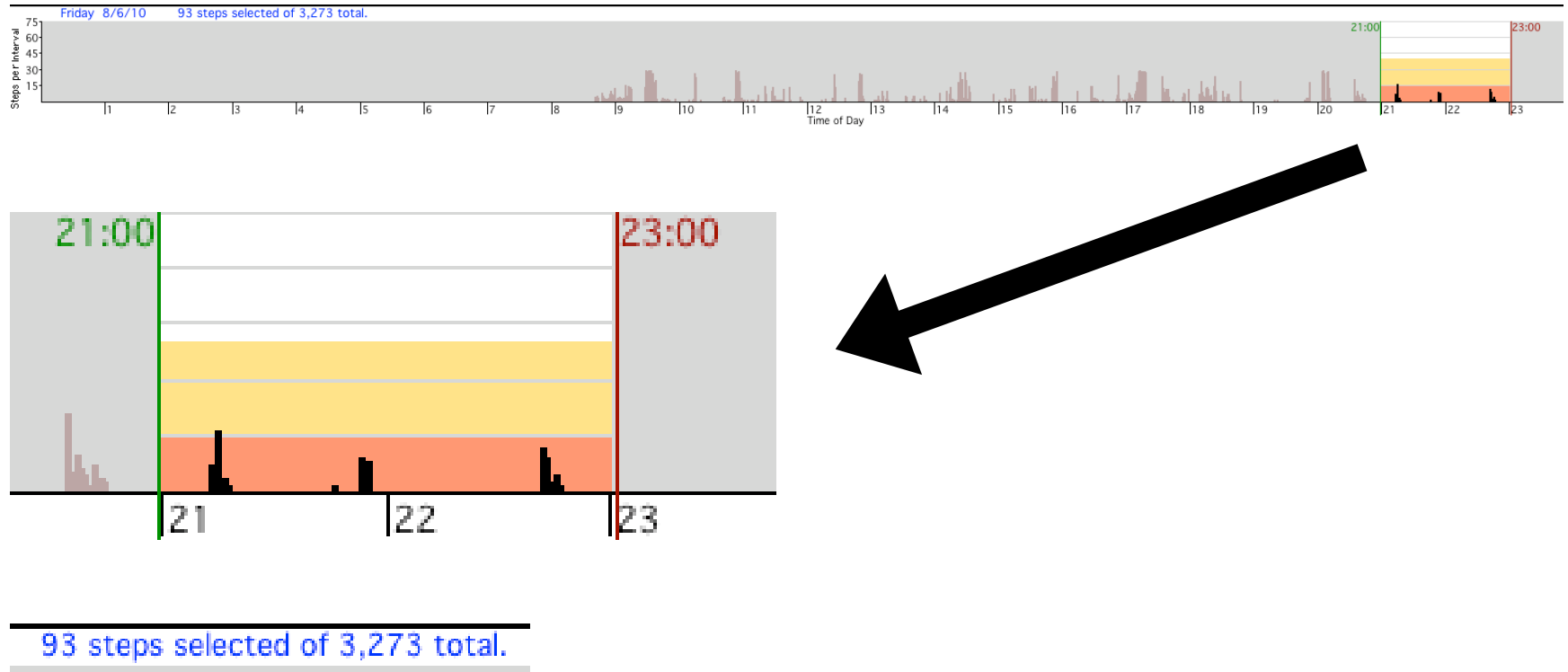


Figure 2.2. StepWatch output and isolating TV-related steps from total daily steps on a day when participant did not participate in TV commercial stepping (186 steps taken during 120 min of TV viewing time, and 6546 total daily steps). Note: StepWatch values need to be multiplied by 2 because the device is worn on the ankle and only counts steps on 1 side of the body.

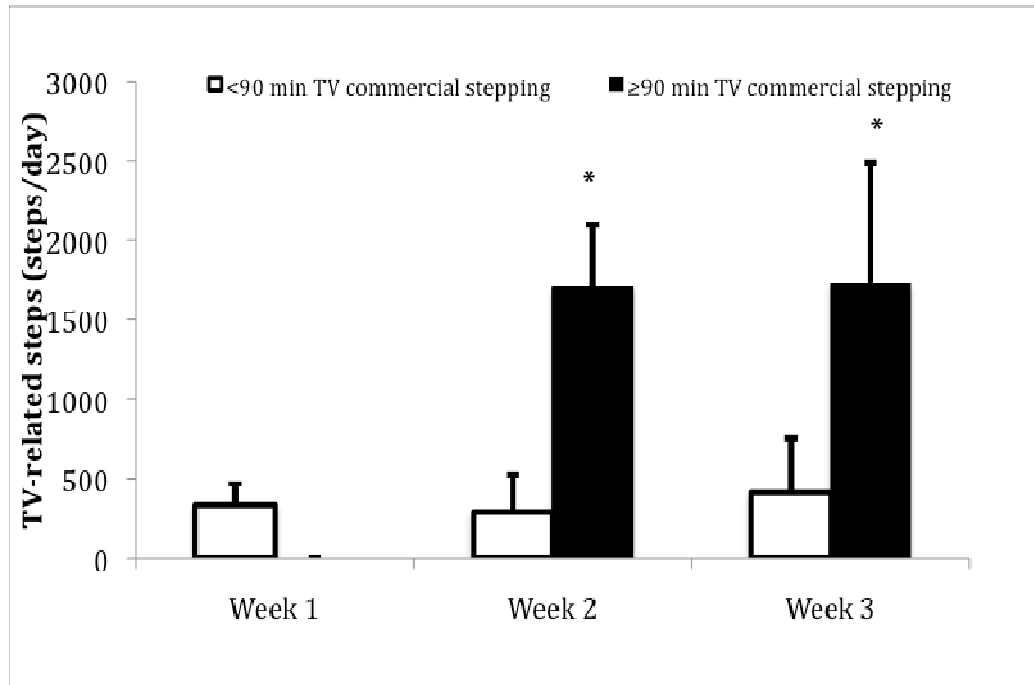


Figure 2.3. Comparison of average accumulated steps during TV viewing time when participants accumulated at least 90 min per day TV commercial stepping and when this target was not achieved. * Significant difference between ≥ 90 min TV commercial stepping and week 1 step counts ($P < 0.05$).

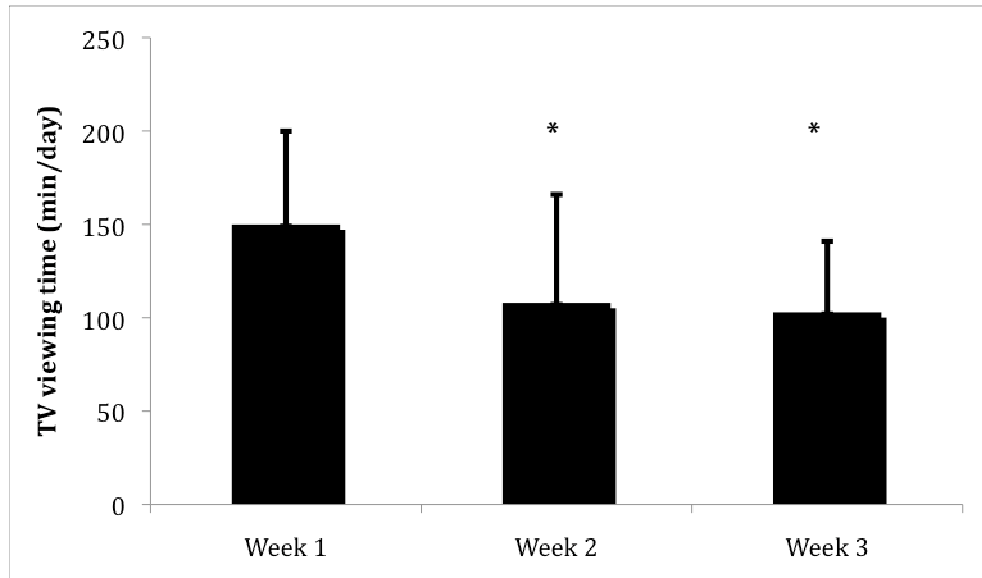


Figure 2.4. Changes in average TV viewing time per day in response to the TV commercial stepping intervention. * = Significantly different than week 1 ($P < 0.05$).

Pedometer differences of average daily step counts for each week are shown in Figure 2.5. For average daily steps, there was a significant ($F(2, 9) = 22.8$, $P < 0.05$) main effect for pedometer. The StepWatch (8832 ± 2818 steps/day) recorded more steps per day than both the Omron ankle (5515 ± 1645 steps/day; $P < 0.05$), and the Omron waist (5081 ± 1542 steps/day; $P < 0.05$). The Omron ankle recorded more steps than the Omron waist ($P = 0.04$). There was no significant interaction or main effect of time for steps per day.

During week 1, the Omron ankle and Omron waist counted 60% and 56% of total steps, respectively in comparison to the StepWatch. During both weeks 2 and 3, the Omron ankle and Omron waist counted 65% and 59% of total steps, respectively in comparison to the StepWatch. The Omron pedometers counted the same percentage of StepWatch-determined steps (ankle: 65% and 64%, respectively; waist: 58% and 58%,

respectively) when participants adhered to at least 90 min of TV stepping and when they did not.

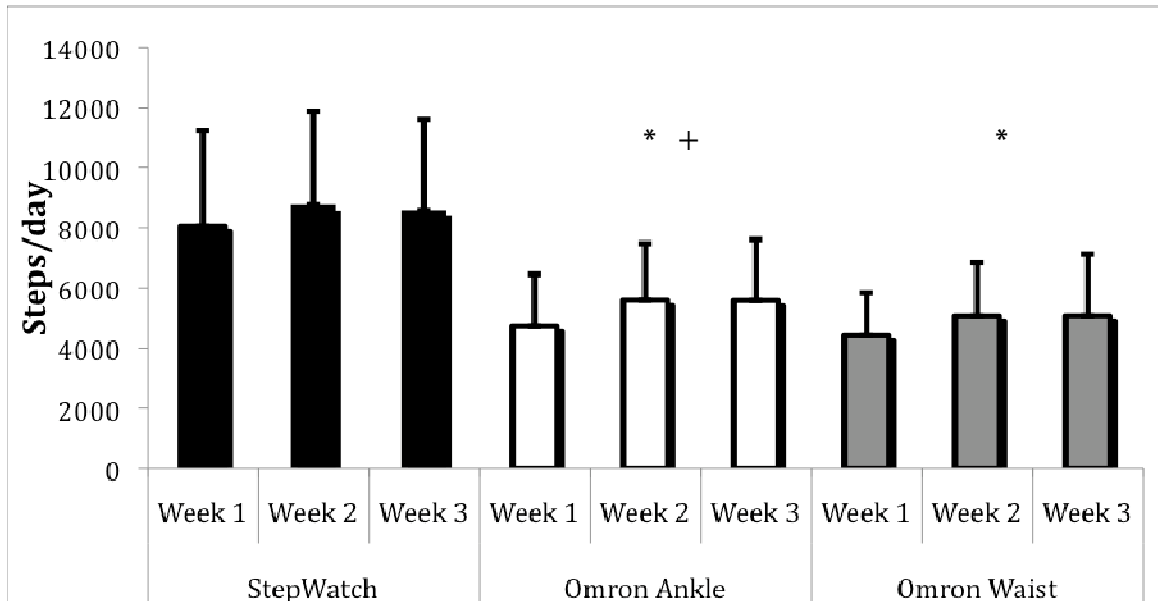


Figure 2.5. Comparison of average daily steps for each device. Values are mean $\pm$ standard deviation. * = Omron significantly different than StepWatch at all time points; + Omron ankle significantly different than Omron waist at all time points ($P < 0.05$).

Discussion

The primary purpose of this pilot study was to examine the effect of instructing participants to perform 90 min a day of TV commercial stepping. Outcome variables included changes in steps taken during TV viewing, total daily steps, TV viewing time, and breaks in sitting time during TV. This study shows that a small behavior change, like stepping in place during TV commercials (TV commercial stepping) may be one strategy worth pursuing to modify sedentary TV watching. By using the commercial breaks as

their cue to get up and be active, participants increased their TV-related PA, and added more breaks from sitting during TV viewing. On days when participants achieved at least 90 min of TV commercial stepping, they were able to accumulate about 1700 steps per day during TV viewing time alone. The results of a 26-study meta-analysis suggest that pedometer-based PA interventions successfully increase walking levels by about 2000 steps per day [34]. Thus, the novel TV commercial stepping approach may result in a change in steps similar to what is seen in more traditional walking programs. TV commercial stepping led to a significant increase in the number of steps during TV viewing when adherence days were compared with non-adherence days. It should be noted, that the average American takes about 5,117 steps per day [35], while on average the participants in this study were taking about 8370 steps per day during week 1. In our sample, when participants adhered to TV commercial stepping, the extra 1350 steps per day (1700 TV commercial stepping steps – 350 baseline TV-related steps) amounted to a 16% increase from their baseline steps per day. For the average American, the extra 1350 steps per day would amount to a 26% increase in daily steps. Those who had more initial non-TV commercial steps per day may not see as significant an increase in overall steps from engaging in TV commercial stepping. Nonetheless independent of how physically active an individual is, everyone can benefit from breaking up prolonged periods of sitting and adding a few more steps to their day [13,14].

As a group, participants in this short, home-based TV commercial stepping intervention were not as compliant to the protocol as we had hoped. One reason for this finding is that these participants were not in the process of seeking ways to increase PA; so low motivation may have been an issue. Review of the time-sequenced StepWatch

data showed that on average participants engaged in at least 90 min per day of TV commercial stepping 3 days per week. For any PA behavior change to be successful, participants need to be committed to making long-term changes to their PA levels. It is possible that the addition of behavior modification components could enhance this sort of intervention in the future.

These results will be used to inform future interventions involving sedentary overweight adults who watch many hours of TV, but who are seeking a simple and effective method to start to both increase their PA level and decrease their sedentary time. It is important to note that this was only a 2-week intervention. The main focus of this intervention was to evaluate how much PA participants would incorporate into their TV viewing time when given the instructions to step in place through commercial breaks during at least 90 min of TV programming. Regarding future TV commercial stepping interventions, participants could benefit from being given both: a time goal (for the total number of minutes or number of commercial breaks to step through) and a pedometer with a daily step goal based on the anticipated increase in the number of steps per day from baseline due to ≥ 90 min of TV commercial stepping.

Pedometer users who keep a step diary and set step goals for motivation tend to have greater increases in PA than those who do not set goals or self-monitor daily steps [34]. Individuals typically do not change their activities or behaviors when they are simply told to do so [36]. Successfully incorporating a seemingly simple change like TV commercial stepping on a long-term basis may require more motivated individuals interested in increasing their PA levels. Also providing participants with specific goals and potentially the social support of group meetings should help them incorporate this

change more easily. Working with individuals who have a strong desire to make changes in their PA levels, and using common behavior modification techniques such as: 1) goal setting and self-monitoring, 2) stimulus control, 3) problem-solving and pre-planning, 4) cognitive restructuring, and 5) prevention of relapse to shape and help participants incorporate a new behavior (TV commercial stepping) into their lifestyle should result in greater adherence and outcomes from this strategy in the future [37,38].

TV watching is the most prominent leisure-time activity in the U.S. [11]. TV viewing time may compete with time spent in active leisure pursuits (walking, sports, etc.) that have greater energy expenditure demands [39,40]. A significant finding from this study is that TV commercial stepping not only caused a significant increase in TV viewing-related steps, and self-reported breaks from sitting, but it also produced a significant reduction in TV viewing time. The average American reports spending between 2.8 hr/day to 5.9 hr/day sitting watching TV [11,15,24]. In our sample, the self-reported TV viewing time during phase 1 (2.5 hr/day) was slightly below national averages. During the intervention, participants reported watching an average of only ~1.75 hr/day. This may be another reason for the lack of daily adherence to TV commercial stepping. In order to meet the required goal, participants would have to TV commercial walk for 86% of their total TV viewing time. Individuals who watch a greater amount of TV, would have greater flexibility as to when and how they achieved their 90 min of TV commercial stepping, and not have to dedicate all of their TV viewing time to TV commercial stepping. The TV viewing reduction was not something that was anticipated due to this intervention, and it was not clear whether this reduction was an effect resulting from adults not wanting to watch as much TV, because it was now

associated with TV commercial stepping, whether it was simply variability in viewing habits from one week to the next, or whether it was a Hawthorne-like effect where participants modified their TV viewing because it was being evaluated.

TV commercial stepping could be added to the list of many potential strategies to increase PA. This study demonstrates that TV stepping can increase PA levels, but it also has the benefit of disrupting prolonged bouts of sitting time. Simply breaking up extended bouts of sitting time by standing and performing moderate physical activity is associated with positive health outcomes [13,14]. Recently, important public health messages for reducing central obesity and overall metabolic risk have called for strategies that can create a reduction in sedentary time through increasing light-intensity day-to-day activity [9,14]. Another recent task force report [41] advocates that small sustainable behavior changes may be a better long-term approach to help address the obesity epidemic. It has been suggested that the gradual weight gain observed in the majority of the population could be blunted by shifting energy balance by as little as 100 kcal/day [42,43]. The combined increase in PA and subsequent decrease in sedentary TV viewing behavior resulting from TV commercial stepping could help reduce the negative effect TV viewing has on the energy balance equation.

To our knowledge, this the first study to examine the Omron under free-living conditions over a 24-h period. Previous laboratory-based research has shown that the Omron, is a valid and reliable pedometer for speeds ranging from 2.0 to 8.0 mph, across multiple wear positions and in lean, overweight and obese individuals, but that it undercounts steps during some lifestyle-related activities (i.e., climbing stairs, elliptical, ballroom dancing) [28].

In the present study, the Omron was worn in two different locations and was compared to the StepWatch. The underestimation of step counting by the Omron waist and ankle positions can be attributed to several factors. While it is a very accurate device for step counting during continuous walking bouts [28], the device may miss steps taken during intermittent lifestyle activities that are less than 4 seconds in duration due to its 4-second filter. The most common walking bout in free-living adults is 4 steps in a row (accounting for 17% of all bouts) and the second most common bout is 6 steps in a row (accounting for 10% of all bouts) [44]. Due to the 4-second filter, it is likely that the Omron would miss many of these steps taken in short bouts, thus contributing to an underestimation of the total number of steps accumulated. Previously, in a laboratory-based study, TV commercial stepping steps were accurately recorded with the ankle mounted StepWatch and Omron pedometers [26]. Because TV commercial stepping is continuous in nature (~3-6 minute bouts), the Omron pedometer, when worn on the ankle was able to count all of the steps [26]. In this present study, the Omron pedometers counted the same percentage of StepWatch-determined steps on the days when participants TV commercial stepped for at least 90 min of TV viewing time, and on the days when participants did not participate in TV commercial stepping. This would indicate that the Omron pedometer is still effectively capturing TV stepping.

One of the strengths of this study was the use of the StepWatch monitor, a highly accurate step counting device that is not effected by BMI and walking speed [32,44], as a criterion measure for daily steps. The StepWatch mechanism has greater sensitivity for detecting steps than most pedometers, and it counts accurately even in slow walkers and obese individuals. It allowed the quantification of TV commercial stepping, due to its

ability to provide minute-by-minute step activity across 24 hours. Thus this study was able to match up self-reported TV time and TV commercial stepping and isolate those bouts of walking.

A limitation of this study includes its short duration. This 2-week intervention may have not allowed enough time for participants to stabilize their TV commercial stepping behavior, or their TV viewing behaviors. However, the purpose of this short TV commercial stepping intervention was to gather the information to make the changes necessary for a similar, but longer-term physical activity intervention in sedentary overweight adults. While PA was objectively measured, TV viewing time was not objectively measured, nor was there any follow-up about why TV viewing was reduced during phase 2, or how participants reallocated their TV viewing time.

Another potential limitation of this study is that the participants in this study were already more active and watched less TV than most American adults. Prior to starting the study, all participants self-reported watching at least 2 hours per day, or 14 hours per week of TV, and participants were classified as inactive, based on self-reporting not engaging in any structured PA. There was a wide range of StepWatch-determined baseline activity levels ranging from 4593 ('sedentary') to 13,545 ('highly active') steps/day, but as a whole, the group would have been classified as 'somewhat active' (7500-9999 steps/day) [45] based on their phase 1 step counts (~8368 steps/day). These higher than anticipated initial step counts may be the result of volitional activities, elevated occupational activity demands, and/or a reflection of the time of year [45]. Therefore, caution must be used when generalizing these results to the average American who is less active and watches more TV.

In conclusion, TV commercial stepping may be a useful strategy to increase activity levels of adults who find it difficult to exercise daily, but do spend time watching TV. This approach may also cause a reduction in TV viewing behavior. TV commercial stepping may be an appropriate strategy for any one looking for an inexpensive, easy, convenient, low-impact starting point for incorporating regular PA into their lives. The Omron pedometers counted about 40% fewer steps than the StepWatch, which we believe is due to the Omron under counting during free-living conditions. However, data suggest the Omron step counts do accurately reflect the TV commercial stepping that occurred during the intervention, and that the ankle placement was superior to the waist. To our knowledge, this is the first study to measure the effects of TV commercial stepping as a PA intervention in adults. It appears that it is not necessary to reduce TV to reduce sedentary time and increase PA. Changing current TV viewing habits, and making them more active, may be an effective approach to reducing sedentary behaviors, and increasing PA levels in adults. The effectiveness and efficacy of longer-term TV commercial stepping interventions combined with additional behavior modification techniques should be investigated.

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Part V

TV Commercial Stepping: Can America's Top Sedentary Activity
be Made More Active?:

Physical Activity and Leisure-time Study (PALS)

ABSTRACT

Physical inactivity is a major public health problem and a primary contributing factor to the obesity epidemic. While most Americans do not meet the physical activity (PA) guidelines (30 min/day, 5 day/wk), they do report watching several hrs of TV each day, and frequently site “lack of time” as a barrier for engaging in PA. The Physical Activity and Leisure-time Study examines an approach to convert sedentary TV watching into active TV watching time by having adults step in place during commercials (TV commercial stepping). **PURPOSE:** This randomized controlled trial examined the effects of a PA prescription of TV commercial stepping for at least 90 min/day of TV programming, with that of walking at least 30 min/day (30 min walk) on daily step counts, TV viewing, and diet during a 24-wk PA intervention. **METHODS:** 58 sedentary, overweight or obese (mean BMI 33.5 ± 4.8 kg/m²), adults (mean age 52.0 ± 8.6 yr) were randomly assigned to either the TV commercial stepping, or 30 min walk group during a 24-wk behavioral PA intervention. Both groups attended 8 sessions, but received different PA goals. PA, TV watching time, diet, and anthropometric data were collected at 0, 12, and 24 wks. **RESULTS:** These are the 12-wk results of an ongoing 24-wk study. Using intent-to-treat analyses, there were no significant differences in the increase of daily steps between groups. Both groups showed a significant increase ($P < 0.05$) in daily steps from baseline (Omron-determined: 4760 ± 1443 steps/day and StepWatch-determined: 7871 ± 2225 steps/day) to 12 wks (Omron-determined: 7377 ± 2391 steps/day, and StepWatch-determined: $10,710 \pm 3138$ steps/day). Both groups showed a significant decrease ($P < 0.05$) in TV viewing from baseline (4.2 ± 1.8 hr/day) to 12 wks (3.6 ± 2.1 hr/day). Energy intake was significantly higher at baseline than energy intake at 12 wks (2021 ± 585 kcals/day vs. 1714 ± 476 kcals/day, $P < 0.05$). There

were no significant changes ($P > 0.05$) in BMI between or within the two groups over the 12 wks. At baseline and 12 wks there were no significant between group differences in daily steps, TV viewing, energy intake or BMI between the groups. **CONCLUSION:** Instructing people to engage in TV commercial stepping during at least 90 min/day of TV watching results in a change in daily steps roughly equivalent to encouraging people to walk at least 30 min/day. PA can be successfully incorporated into traditionally sedentary TV watching habits and this may be an acceptable alternative to traditional approaches for increasing daily steps in overweight and obese adults. *Key Words:* walking, pedometer, behavior modification

Introduction

Physical activity (PA) is increasingly recognized as an important factor influencing health and disease status. PA reduces the incidence and mortality risks of many chronic diseases, including cardiovascular disease, diabetes, stroke, and various types of cancer including colon and postmenopausal breast cancer [1-5]. According to the PA Guidelines for Americans, developed by the U.S. Department of Health and Human Services (DHHS), healthy adults should accumulate at least 150 min/wk of moderate-intensity, or 75 min/wk of vigorous-intensity aerobic activity, or a combination of the two intensities, in bouts of at least 10 min, ideally spread out over several days a wk [6].

PA has positive health benefits (i.e., decreased all-cause mortality, decreased cardiovascular mortality, improved function and enhanced quality of life) [1,3,5] and it need not be restricted to leisure-time exercise/PA [6]. Unfortunately, a large proportion of the American population is not physically active, [7-10] and the prevalence of adult overweight and obesity has increased to 68% in the United States [11]. One of the most frequently reported barriers to PA is “lack of time” [12,13].

Approximately 25% of the population report being completely sedentary during their leisure time [8]. Watching television (TV) is the most common leisure-time sedentary activity carried out in the home [14]. Currently, Americans spend about three to five hrs/day (almost 38 hrs/wk) watching TV [14-16]. TV watching is potentially linked to obesity in many ways: displacement of PA causing reduced energy expenditure, increased energy intake due to unhealthy snacking during watching, effects of food advertising on food and beverage purchasing, and decreased metabolic rate while watching TV (often time seated) [17-19]. Independent of PA, large amounts of sedentary

behavior, such as sitting while watching TV, for prolonged periods is associated with an increased risk for obesity, cardiovascular disease-related death, and all-cause mortality [15,20-22]. Fortunately, the harmful physiological effects of prolonged sitting can be attenuated by disrupting sedentary time through standing or taking a few steps [23], or by replacing sedentary time with light intensity activity [24]. While the goal of many public health recommendations is to increase participation in moderate-to-vigorous PA [6,7], decreasing sedentary behaviors may be another important public health message worth considering [25,26].

The 2008 PA Guidelines for Americans clearly state that all adults should avoid inactivity [6]. The world's first evidence-based sedentary behavior guidelines were released in 2011 by the Canadian Society for Exercise Physiology [27]. The guidelines stipulate that for health benefits, children (aged 5–11 years) and youth (aged 12–17 years) should minimize the time that they spend being sedentary each day (i.e., limiting recreational screen time to ≤ 2 h per day; and limiting extended sitting time, time spent indoors throughout the day, and sedentary vehicular transport [27].

In light of the numerous mechanisms by which television may promote obesity and inactivity [17-19] and the amount of time adults invest in watching TV [14-16], it is surprising how little data exist on interventions to alter TV viewing in adults [28]. Previous research has focused on turning off or limiting TV viewing time in children [29-31]. In pediatric studies, reducing TV viewing decreased sedentary behaviors and energy intake [30], but did not increase moderate-intensity PA [29]. The results of the first and only study to measure the effects of a TV reduction intervention in adults showed that a forced 50% reduction in TV viewing caused a significant increase in total daily energy

expenditure and a significant decrease in time spent in sedentary activities [32]. However, due to the massive amount of leisure-time Americans devote to watching TV, and their reluctance to permanently give it up, the long-term sustainability of reducing TV is doubtful [33].

In contrast to the above studies [29,30], that have found little success in increasing PA by reducing TV watching, converting sedentary TV viewing time into active viewing time could be an effective method to promote PA in adults who spend a large amount of time watching TV. In 2009, the results of the Video Consumer Mapping Study conducted by Ball State University's Center for Media Design reported that Americans watch 5.9 hr/day of TV and view 72 min/day of commercials [16]. Encouraging a small behavior change, by having individuals step in place during television commercials (TV commercial stepping) is one strategy to reduce sedentary time and increase daily physical activity. No study has examined the efficacy of using this method to combat the negative effects of sedentary TV viewing.

Previously, a laboratory-based study established stepping in place as a moderate intensity activity [34,35]. Stepping in place increased energy expenditure to moderate levels, nearly as high as walking at 3.0 mph. Additionally, steps taken during stepping in place were accurately recorded with pedometers [34,35]. A preliminary outcome evaluation of TV commercial stepping with a small sample, over short period of time suggested that it might be an effective method to increase PA levels [36]. When participants achieved at least 90 min of TV commercial stepping, they accumulated approximately 1700 steps/day during TV viewing time alone [36]. The primary aim of the Physical Activity and Leisure-Time Study (PALS) was to examine the effectiveness

of incorporating PA into a traditionally sedentary leisure time activity (TV viewing), by comparing the effects of two different leisure-time PA prescriptions (TV commercial stepping vs. 30-min walk) on successfully increasing and maintaining PA (measured as steps/day) over a 24 wk period. It was hypothesized that the TV commercial stepping condition would, show an equal increase in PA at 12 and 24 wks as compared to the 30-min walk condition. Neither group was hypothesized to demonstrate changes in TV viewing time, dietary intake, or weight.

Methods

Study design

This parallel-group, randomized controlled trial was designed to compare the effects of two different PA prescriptions on PA, TV viewing time, dietary intake, and weight change during a 24-wk behavioral PA intervention. The trial was conducted from September 2010 through May 2011 at The University of Tennessee, Knoxville, TN. Participants were randomly assigned to one of two PA prescriptions: TV commercial stepping or 30-min walk. The primary outcomes of the study were PA, TV viewing time, dietary intake, and weight at 12 and 24 wks.

Participants

The goal was to recruit 60 overweight and obese participants. Participants had to be 25 to 65 years of age and have a BMI (weight in kilograms divided by height in meters squared) between 25 and 45 kg/m². Inclusion criteria included watching ≥ 14 hrs per wk of TV, the ability to follow instructions and record data, and the ability to walk 1/4 mile without stopping. Participants were excluded if they reported a: history of myocardial infarction, angina, stroke, heart failure, or uncontrolled cardiac arrhythmias; had a resting

blood pressure greater than 180 mm Hg systolic and/or 100 mm Hg diastolic; had other physical or medical limitations for engaging in PA; did not have a television in the home; had baseline PA level exceeding 7,499 steps per day as determined by the Omron pedometer; were currently participating in a program to increase PA; intended to move outside the East Tennessee area within the time frame of the intervention; were pregnant, lactating, less than 6 months post-partum, or planned to become pregnant during the time frame of the intervention; or if they were unwilling to attend group intervention meetings, assessments or to complete an activity diary for the duration of the study.

Participants were recruited and enrolled on a rolling basis from September 2010 through November 2010 by flyers posted in public buildings (see **Appendix C** for the flyer), newspaper advertisements (see **Appendix C** for the newspaper advertisement), and word of mouth seeking adults interested in increasing their PA as well as through mailings to individuals in the Healthy Eating and Activity Laboratory (HEAL) Ineligible Participant Database (see **Appendix C** for the recruitment letter sent to individuals in the database). Participants interested in the investigation were screened by phone to determine initial eligibility. Participants, who met all eligibility criteria, attended orientation, completed the screening and baseline assessment, and signed the written informed consent (see **Appendix C** for the informed consent form), were randomized to a treatment group by the principal investigator using a random number table, stratified by gender. Participants were told about their group assignment at the first intervention meeting. The study was approved by the Institutional Review Board at The University of Tennessee, Knoxville, TN.

PA intervention

The PA intervention lasted 24 wks. Both treatment groups received a standard behavioral intervention for increasing PA and were prescribed a similar volume of exercise; enough to meet PA recommendations (≥ 150 min/wk) [6]. The two groups differed in the way their PA was prescribed [a standard PA prescription (walking briskly, 30 min/day) and a novel approach) intermittent TV commercial stepping for at least 90 min of TV programming daily)]. For both groups, the exercise was home-based.

30-min walk group. One half of the participants were instructed to use “brisk” walking (at least 30 min/day in bouts of at least 10 min) at least 5 days/wk. Participants built up to walking 30 min/day over the first three wks. During this time period duration increased from 10 min/day wk one, to 20 min/day wk two, to 30 min/day for the duration of this study. Participants were permitted to exercise in one long bout (30 min) or divide the exercise into multiple bouts as long as the bout length was 10 min or greater.

TV commercial stepping group. The other participants were instructed to stand and “briskly” step in place, or “briskly” walk continuously around the room/house for the duration of each commercial break during at least 90 min of TV programming on at least 5 days/wk. Rather than exercising continuously for at least 10-min bouts, participants performed multiple (~9 or 10), short (~3-5 min) bouts, conveniently incorporated into their daily TV viewing time. Participants were instructed to increase their TV commercial stepping from 30 min of TV programming/day wk one, to 60 min of TV programming/day wk two, to 90 min of TV programming/day for the duration of this study.

Common Treatment Components

All participants in the 24-wk PALS program were provided with common intervention components to help them to meet their respective PA recommendations. During wk one through 12, participants attended monthly group treatment meetings, and received monthly individual phone call sessions. During wks 12 through 24, the individual monthly phone call treatment sessions continued, and onsite group meetings were supplemented with monthly newsletters. All sessions were led by a single investigator (J.S.). If participants missed a group meeting or phone call, a make-up session was scheduled. Group meetings, individual phone sessions, and newsletters focused on behavioral strategies for modifying exercise behaviors. Strategies used for changing behaviors included goal setting, self-monitoring, stimulus control, pre-planning, problem solving, cognitive restructuring, and relapse prevention.

For self-monitoring PA, participants wore an ankle mounted Omron pedometer, so they were able to track their steps each day. Participants used a daily diary to record daily PA bouts, steps, and TV viewing time. At every in-person visit (monthly group meetings and assessment visits), the PA logs were collected and reviewed for compliance and individualized feedback was provided to help participants reach their goals. Participants were not given instructions concerning diet modification. Pedometers and PA logs were returned at the end of the 24-wk assessment. Participants were compensated \$50.00 for completing the study; they received \$25.00 at the completion of the 12-wk assessment visit and another \$25.00 at the completion of the 24-wk assessment.

Assessment procedures

Individual assessments were completed at baseline, 12 wk and 24 wk by a single investigator who was not blinded to treatment assignment (J.S.). Each assessment visit was identical and included: (1) PA (daily steps) using a pedometer across seven days; (2) self-reported TV watching time; (3) three days of dietary intake (energy and fat intake overall, and while watching TV); (4) anthropometric measurements; and (5) resting heart rate and blood pressure.

Baseline activity levels were determined during the initial recruitment process. Participants first attended the laboratory-based assessment, followed by the 7-day evaluation of PA, TV viewing, and dietary intake. Steps per day were measured for seven consecutive days using the Omron HJ 303 tri-axial accelerometer-based pedometer (Omron Healthcare, Inc. Bannockburn, Illinois), and the StepWatch activity monitor (Orthocare Innovations, Mountlake Terrace, Washington). When considering which pedometer brand and body placement to most accurately record both regular walking, and also the modified gait of stepping in place during TV commercial stepping, the StepWatch activity monitor, and Omron pedometer, both worn on the ankle, were determined the most accurate [36].

The StepWatch is a highly accurate, and expensive research grade device that is not affected by walking speed or BMI [37,38]. Due to its accuracy and its ability to present 24-hrs of time-sequenced data, it has been used as a criterion device to validate other pedometers over a 24-h period [37,39]. The StepWatch allowed the quantification of intervention-specific PA (i.e., TV commercial stepping, and 30-min walk) due to its ability to provide minute-by-minute step activity across 24 hrs. Thus this study was able

to match up self-reported bouts of TV commercial stepping and walking bouts ≥ 10 min and isolate those steps from the rest of the day. One limitation of the StepWatch device is its inability to provide instantaneous feedback (steps/day) to participants because it does not have a digital display. Also, the device requires expensive software to download the recorded information onto a computer [37]. For these reasons the StepWatch, was only used during the three, 7-day assessment time points (0, 12, and 24 wks).

The Omron, is a tri-axial piezoelectric accelerometer-based pedometer that can be oriented in any direction and still validly record steps [40,41]. This allows it to be worn either at the traditional waist-mounted location, or in a pocket or backpack. For this study's purpose, the Omron was worn in an elastic strap around the ankle. Due to the inability of waist-mounted pedometers to accurately record TV commercial stepping steps [35], the decision was made to provide participants an ankle mounted Omron pedometer for the duration of the 24-wk program. Although not as accurate as the StepWatch at capturing all daily steps, it was able to provide participants daily feedback, and reflected the increase in daily steps. It can store up to 7-days of step data, and has a digital display to show daily step counts. In laboratory-based studies, Omron pedometers with this internal mechanism have been found to be valid and reliable for recording step counts at walking and running speeds ranging from 2.0 to 8.0 mph, across multiple body positions and in lean, overweight and obese individuals, when the activity is continuous in nature [35,41-44].

Omron data from the 7-day baseline period was used to screen participants and confirm that they were inactive ($\leq 7,499$ steps/day). The StepWatch was not used to determine eligibility, because it counts considerably more steps per day in comparison

with other pedometers that have been used to determine baseline activity levels [37,39,45,46]. Participants were instructed on proper placement of the pedometers and were instructed not to change their normal activities over this 7-day baseline period. The accuracy of the Omron pedometer was verified prior to the 7-day baseline assessment by having each participant walk 20 steps down a straight hallway [47,48]. This verification was repeated when subjects returned for their 12- and 24-wk assessments.

During the baseline wk (and at 12 and 24 wks) participants were asked to keep a daily activity log and to document the time that the devices were put on and taken off each day, time spent engaged in intervention specific PA (i.e., 90 min of TV commercial stepping, or 30 min of walking), time spent watching TV, and daily steps. Participants were instructed on how to complete daily activity logs, and at the end of the first wk logs were reviewed to confirm that participants also met the TV viewing eligibility criteria ($\geq$ 14 hrs/wk).

Dietary intake was assessed by three-day food record (two weekdays and one weekend day) at baseline, 12, and 24 wks. Participants were asked to record all food and drink consumed throughout the day, and indicate any consumption that occurred specifically while watching TV. Dietary data were analyzed using Nutrition Data System Software (NDS) for Research developed by the Nutrition Coordinating Center, University of Minnesota, Minneapolis, Minnesota.

At 0, 12, and 24 wks, anthropometric measures were obtained at the Applied Physiology Laboratory. Height and weight were measured. Height and weight were measured (in light clothing, without shoes) with a wall-mounted stadiometer and a Tanita bio-electrical impedance analyzer (model BC-418), respectively. Body mass index was

calculated by dividing weight (kg) by height (m) squared. Waist and hip circumferences were measured using a Gulick spring-loaded tape measure. Waist circumference was measured at the narrowest portion of the torso between the iliac crest and inferior rib. Hip measurements were taken at the maximal circumference of the buttocks, above the gluteal fold [49]. Two measurements were taken at each site, and the average of the two measurements was used for data analysis. Resting heart rate and resting blood pressure were measured after 10 min of seated rest with an appropriate sized cuff attached to an automatic sphygmomanometer (Omron HEM-773-E, Omron Healthcare Inc. Vernon Hills Illinois). The average of two heart rate and blood pressure measurements served as the resting values.

Statistical analysis

SPSS version 17.0.0 for Windows (SPSS Inc., Chicago, Illinois) was used for statistical analysis. Descriptive statistics were calculated for all baseline measures. Baseline differences between the 30-min walk and TV commercial stepping groups were examined using independent t-tests or X^2 analysis. A repeated measures ANOVA (with time point as the within-subject variable, and group as the between-subject variable) was used to compare weekly averages of steps per day, weekly averages of TV viewing time, anthropometric variables, and overall energy and dietary fat intake, as well as energy and dietary fat intake consumed while watching TV. The interaction of treatment condition by time was the effect of interest. For significant interactions, pair-wise comparisons of the groups, using Bonferroni corrections, were conducted at each time point to determine when group differences occur. Models were structured such that treatment comparisons were made using the *intention-to-treat* principle. Specifically, missing values were

imputed by generating five random values from a normal distribution that has a mean equal to the baseline value and variance equal to the estimated variance for the value of other participants at the time where the value is missing. This process led to five complete datasets; each of which was analyzed using the ANOVA model, and effects were computed by averaging the appropriate regression coefficient across models.

A secondary data analysis was conducted of subjects who completed measures of PA at 12-wks. Independent sample t-tests were used to compare whether the groups differed in StepWatch wear time, days/wk they met their respective PA goals, intervention-specific moderate-vigorous PA (MVPA), StepWatch-determined total steps and intervention-specific steps on days when the prescriptions were met (≥ 30 -min walking or ≥ 90 -min TV commercial stepping), and when they were not met. For each group, paired sample t-tests was used to compare whether the groups differed in accumulated steps on days when the prescriptions were met and when they were not met.

All data are presented as means $\pm$ s.d. unless otherwise stated. For all statistical analysis, an alpha level of 0.05 was used to show significant differences.

The effect size of selected variables occurring at 12-wks between the two groups was calculated using G Power [50]. Effect sizes were classified as small (0.20), medium (0.50), or large (0.80) [51]. Using group means and standard deviations at the 12-wk assessment effect size was calculated.

Results

The 12-wk results of an ongoing 24-wk study are presented below. Of the 159 interested participants that were reached by telephone, 58 (36%) were identified as eligible and accepted our invitation to participate. A total of 58 individuals (21% male, 79% female, age = 52.0 ± 8.6 yr; BMI = 33.5 ± 4.8 kg/m²; baseline Omron-determined steps = 4760 ± 1443 steps/day) met eligibility criteria and agreed to participate in the study. Five participants in the 30-min walk group (one male, four females), and five in the TV commercial stepping group (five females) did not return for the 12-wk assessment. Participant flow through the study is presented in Figure 3.1. Compared to other participants, the subjects who did not return for the 12-wk assessment visit were significantly younger (44.9 ± 12.0 yr), ($t(56) = 3.09$, $P < 0.05$), had greater BMI (37.4 ± 4.5 kg/m²), ($t(56) = 3.07$, $P < 0.05$), greater hip circumference (130.5 ± 11.1 cm), ($t(56) = 3.50$, $P < 0.05$), greater percent body fat (47.0 ± 6.6 %), ($t(56) = 2.88$, $P < 0.05$), reported less min walking per day (0.90 ± 1.5 min/day), ($t(56) = 2.1$, $P < 0.05$), had lower average daily steps according to the Omron (3042 ± 999 steps/day), ($t(56) = 4.9$, $P < 0.05$), and StepWatch pedometers (6136 ± 2584 steps/day), ($t(56) = 2.9$, $P < 0.05$).

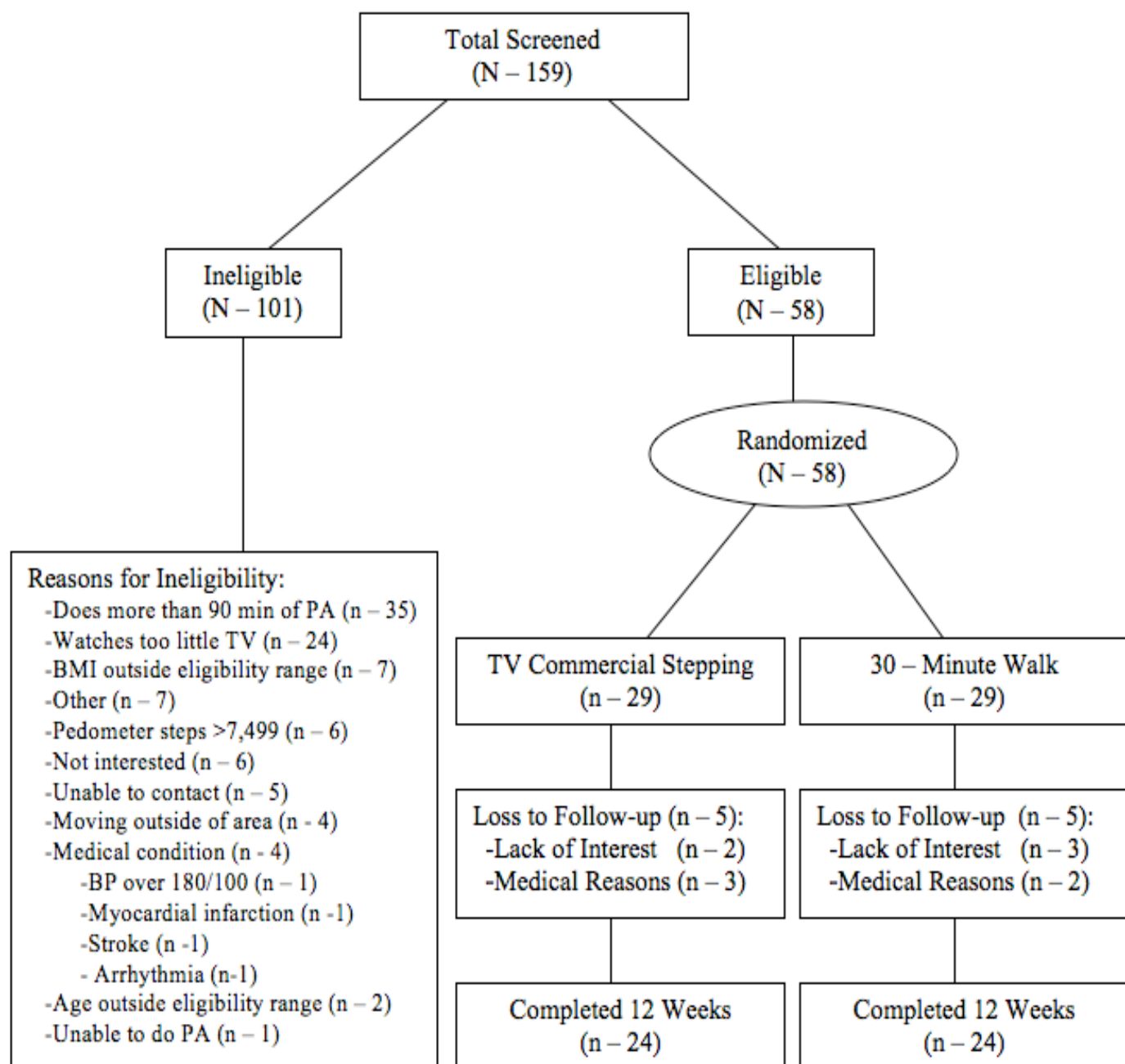


Figure 3.1: Participant Flow

There were no statistically significant differences between the 30-min walk and TV commercial stepping group participants at baseline for demographic, leisure time activity, or diet characteristics (Table 3.1). Of the 48 subjects who completed the 12-week assessment, 46 were white, and two were African American. Participants completed 100% of the sessions (either in the group setting or on a one-on-one basis with the interventionist if they missed the group meeting) and were reachable by phone for all the phone sessions.

Table 3.1 Baseline personal, anthropometric, and leisure-time characteristics of participants

	All participants (N=58)	TV commercial step (N=29)	30-min walk (N=29)
Sex	12M/46F	5M/24F	7M/22F
Age (years)	52.0 ± 8.6	53.8 ± 6.8	50.2 ± 9.8
Height (cm)	167.1 ± 7.9	166.0 ± 8.0	168.2 ± 7.8
Weight (kg)	93.8 ± 16.1	94.3 ± 17.5	93.3 ± 14.9
BMI (kg/m ²)	33.5 ± 4.8	34.2 ± 5.5	32.8 ± 3.9
Percent fat (%)	41.8 ± 6.6	42.4 ± 6.9	41.3 ± 6.3
Waist circum. (cm)	103.8 ± 11.2	105.4 ± 13.6	102.3 ± 8.1
Hip circum. (cm)	120.3 ± 11.1	121.6 ± 12.3	118.9 ± 9.7
Resting HR (bpm)	72 ± 9	74 ± 10	70 ± 8
Resting systolic (mmHg)	125 ± 14	125 ± 15	125 ± 14
Resting diastolic (mmHg)	79 ± 8	79 ± 9	80 ± 8
PA (steps/day Omron)	4760 ± 1443	4611 ± 1553	4909 ± 1335
PA (steps/day SW)	7871 ± 2225	7691 ± 2263	8050 ± 2213
Walking Time (min/day)	4.3 ± 5.8	3.9 ± 6.0	4.6 ± 5.6
TV viewing (hr/day)	4.2 ± 1.8	4.2 ± 1.5	4.1 ± 2.0

Data are mean ± SD. Note. N = number of participants; M = male; F = female; BMI = body mass index; circum. = circumference; HR = heart rate; PA = physical activity; SW = StepWatch

Changes in average Omron-determined steps per day, self-reported intervention-specific PA (TV commercial stepping, or walking), and self-reported TV viewing by group for each wk of the intervention are shown in Figure 3.2 and Table 3.2.

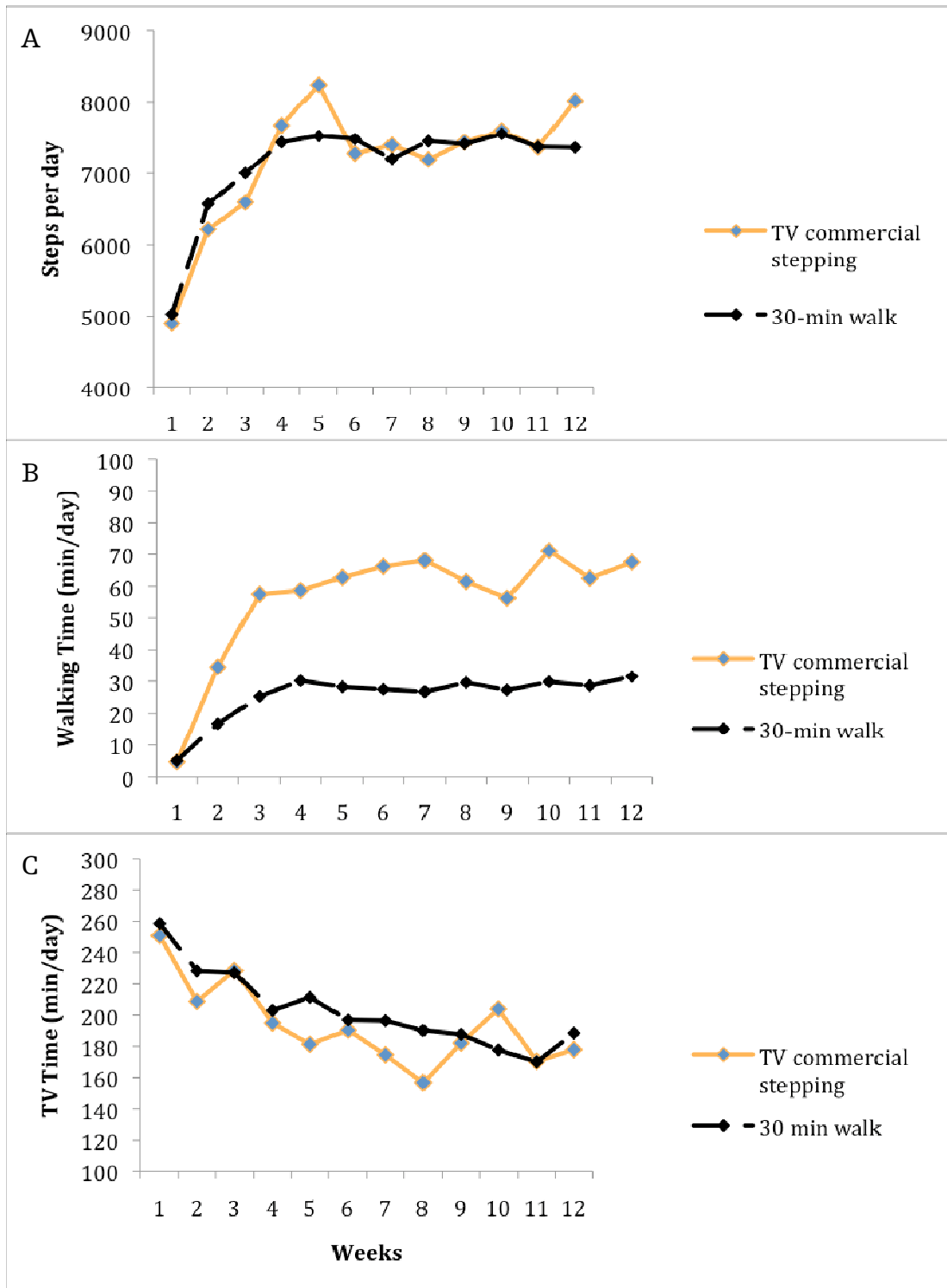
Because the Omron was worn throughout the study, and not just during the baseline and 12-wk time points, these data can provide insight into subjects' activity during all weeks of the study. There were no differences in Omron-determined steps per day at baseline between groups. There was a significant ($F(1, 56) = 103.1, P < 0.05$) main effect of time for Omron-determined steps per day such that Omron-determined steps per day increased over time; baseline Omron-determined steps per day were lower than Omron-determined steps per day at 12 wks (4760 ± 1443 steps/day vs. 7377 ± 2391 steps/day, $P < 0.05$). There was not a significant group by time interaction or main effect of group for Omron-determined steps per day.

There were no differences in TV viewing at baseline between groups. There was a significant ($F(1, 56) = 8.22, p < 0.05$) main effect of time such that TV viewing decreased over time; baseline TV viewing was higher than TV viewing at 12 wks (4.2 ± 1.8 hr/day vs. 3.6 ± 2.1 hr/day, $P < 0.05$). There was not a significant group by time interaction or main effect of group for TV viewing.

There were no differences in StepWatch-determined steps per day at baseline between groups. There was a significant ($F(1, 56) = 106.5, P < 0.05$) main effect of time for StepWatch-determined steps per day such that StepWatch-determined steps per day increased over time (approximately 3000 steps per day); baseline StepWatch-determined steps per day were lower than StepWatch-determined steps per day at 12 wks (7871 ± 2226 steps/day vs. $10,710 \pm 3138$ steps/day, $P < 0.05$). There was not a significant group by time interaction or main effect of group for StepWatch-determined steps per day (Figure 3.3). There was a trivial effect size ($d = 0.0148$) for differences in treatment group at 12 wks for StepWatch-determined steps/day, with both groups accumulating a

similar number of steps/day (TV commercial stepping: $10,734 \pm 3465$ steps/day; 30-min walk: $10,687 \pm 2834$ steps/day).

Figure 3.2: (on next page) Changes in average Omron-determined steps per day (Panel A) and self-reported intervention-specific physical activity (Panel B) and self-reported TV viewing (Panel C) according to intervention group. Note: Each data point represents the mean values for all participants examined at that time. Changes in self-reported TV viewing from 0 to 12 wks differed significantly between the treatment groups ($P < 0.05$).



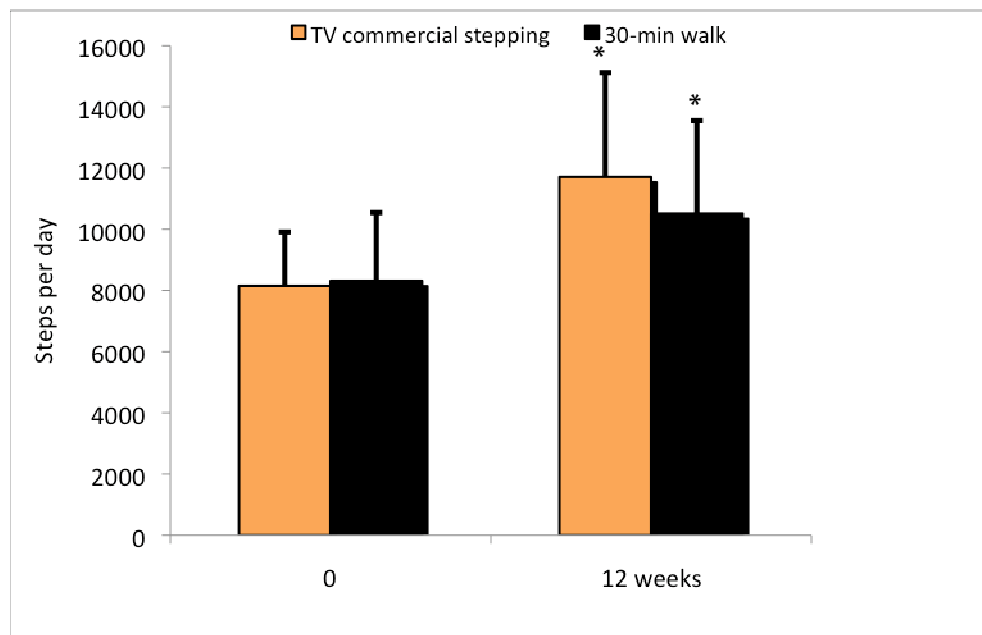


Figure 3.3: Comparison of changes in StepWatch-determined daily step counts between groups. * Significant step difference from baseline.

Although changes in body weight and body composition were not a primary focus of this investigation body composition and blood pressure measures were assessed before and after the intervention (Table 3.2). There were no significant changes ($P > 0.05$) in body weight, BMI, waist-to-hip ratio, percent body fat, or resting heart rate between or within the two groups over the 12 wks.

There were no differences in waist circumference at baseline between groups. There was a significant ($F(1, 56) = 8.22, P < 0.05$) main effect for time on waist circumference. Waist circumference decreased at 12 wks (baseline: 103.8 ± 11.2 cm; 12 wks: 102.3 ± 10.3 cm). There was not a significant group by time interaction or main effect of group for waist circumference.

There were no differences in hip circumference at baseline between groups. There was a significant ($F(1, 56) = 15.17, P < 0.05$) main effect for time on hip circumference. Hip circumference decreased at 12 wks (baseline: 120.2 ± 11.1 cm; 12 wk: 118.6 ± 11.1 cm). There was not a significant group by time interaction or main effect of group for hip circumference.

There were no differences in systolic blood pressure at baseline between groups. There was a significant ($F(1, 56) = 5.34, P < 0.05$) main effect for time on systolic blood pressure. Systolic blood pressure increased at 12 wks (baseline: 125.0 ± 14.2 mmHg; 12 wk: 128.4 ± 14.9 mmHg). There was not a significant group by time interaction or main effect of group for systolic blood pressure.

There were no differences in diastolic blood pressure at baseline between groups. There was a significant ($F(1, 56) = 7.11, P < 0.05$) main effect for time on diastolic blood pressure. Diastolic blood pressure increased at 12 wks (baseline: 79.3 ± 8.3 mmHg; 12 wk: 81.9 ± 9.8 mmHg). There was not a significant group by time interaction or main effect of group for diastolic blood pressure.

Table 3.2 Anthropometric and leisure-time variables measured at baseline and 12 weeks for TV commercial stepping (N=29) and 30-min walk (N=29) participants

Variable	Group	Baseline	12 weeks
Weight (kg)	TV commercial stepping	94.3 ± 17.5	93.9 ± 17.5
	30-min walk	93.3 ± 14.9	93.1 ± 15.1
BMI (kg·m ⁻²)	TV commercial stepping	34.2 ± 5.5	33.9 ± 5.6
	30-min walk	32.8 ± 3.9	32.8 ± 3.9
Percent fat (%)	TV commercial stepping	42.4 ± 6.9	42.8 ± 6.6
	30-min walk	41.3 ± 6.3	41.2 ± 6.5
Waist Circ. (cm) *	TV commercial stepping	105.4 ± 13.6	102.9 ± 12.8
	30-min walk	102.3 ± 8.1	101.6 ± 8.4
Hip Circ. (cm) *	TV commercial stepping	121.6 ± 12.3	119.4 ± 12.8
	30-min walk	118.9 ± 9.7	117.9 ± 9.3
Resting HR (bpm)	TV commercial stepping	74 ± 10	75 ± 11
	30-min walk	70 ± 8	73 ± 10
Resting SBP (mm Hg) *	TV commercial stepping	125 ± 15	131 ± 16
	30-min walk	125 ± 14	126 ± 13
Resting DBP (mm Hg) *	TV commercial stepping	79 ± 9	83 ± 11
	30-min walk	80 ± 8	80 ± 9
PA (steps/day Omron) *	TV commercial stepping	4611 ± 1553	7313 ± 2623
	30-min walk	4909 ± 1335	7442 ± 2180
PA (steps/day SW) *	TV commercial stepping	7691 ± 2263	10734 ± 3465
	30-min walk	8050 ± 2213	10687 ± 2834
Walking Time (% time met goal) *	TV commercial stepping	13.0 ± 20.0	63.0 ± 34.2 ⁺
	30-min walk	15.3 ± 18.7	100.2 ± 52.7
TV viewing (hr/day) *	TV commercial stepping	4.2 ± 1.5	4.0 ± 2.5
	30-min walk	4.1 ± 2.0	3.2 ± 1.7

Data are mean ± SD. Note. BMI = body mass index; circum. = circumference; HR = heart rate; SBP = systolic blood pressure; DBP = diastolic blood pressure; PA = physical activity; SW = StepWatch
 * 12 weeks significantly different from baseline; + significantly different from 30-min walk (P < 0.05).

There was no significant difference in energy intake between groups at baseline. There was a significant ($F(1, 56) = 15.8, P < 0.05$) main effect of time such that energy intake decreased over time; baseline energy intake was higher than energy intake at 12 wks (2021 ± 585 kcals/day vs. 1714 ± 476 kcals/day, $P < 0.05$). There was not a significant group by time interaction or main effect of group for energy intake.

There was no significant difference in percent energy from fat between groups at baseline. There was a significant ($F(1, 56) = 11.2, P < 0.05$) main effect of time for percent energy from fat. Percent energy from fat was higher at baseline compared to 12 wks ($36.5 \pm 12.9\%$ vs. $35.7 \pm 13.1\%$, $P < 0.05$). There was not a significant group by time interaction or main effect of group for percent calories from fat.

There was no significant difference in TV-related energy intake between groups at baseline. There was a significant ($F(1, 56) = 21.6, P < 0.05$) main effect of time revealing that TV-related energy intake decreased over time. Baseline TV-related energy intake was higher than TV-related energy intake at 12 wks (728 ± 432 kcals/day vs. 420 ± 476 kcals/day, $P < 0.05$). There was not a significant group by time interaction or main effect of group for energy intake.

There was no significant difference in TV-related percent energy from fat between groups at baseline. There was a significant ($F(1, 56) = 18.0, P < 0.05$) main effect of time showing that TV-related percent energy from fat decreased over time. Baseline TV-related percent energy from fat was higher than TV-related percent energy from fat at 12 wks ($38.3 \pm 26.0\%$ vs. $36.4 \pm 40.7\%$, $P < 0.05$). There was not a

significant group by time interaction or main effect of group for TV-related percent energy from fat.

The findings reported below are based on the 48 participants (24, 30-min walk; 24, TV commercial stepping) assessed at both baseline and 12 wks. At 12 wks the actual number of steps accumulated during intervention specific PA (TV commercial stepping for the TV commercial stepping group, and walking bouts lasting at least 10 min for the 30-min group) was acquired from the StepWatch. Figures 3.4 and 3.5 show a visual representation of the StepWatch output isolating the intervention-specific steps of a participant in the TV commercial stepping group compared to a participant in the 30-min walk group. At 12 wks there was no significant difference between the TV commercial stepping (2593 ± 1951 steps/day), and the 30-min walk (2756 ± 1543 steps/day), ($t(46) = 0.60$, $P = 0.55$) participants' StepWatch-determined intervention-specific steps (Table 3.3).

Of the 48 participants assessed at 12 wks, participants did not meet their time goals each and every day. Figure 3.6 and Table 3.3 shows a direct comparison between the average number of total steps per day for each group on the days that they met their PA goals (i.e., ≥ 90 -min of TV commercial stepping or ≥ 30 -min walk) and the days they did not. Overall, when goals were met participants had a significantly greater number of steps ($12,501 \pm 3197$ steps/day) compared to when goals were not met (9565 ± 3270 steps/day, $t(39) = 5.68$, $P < 0.05$).

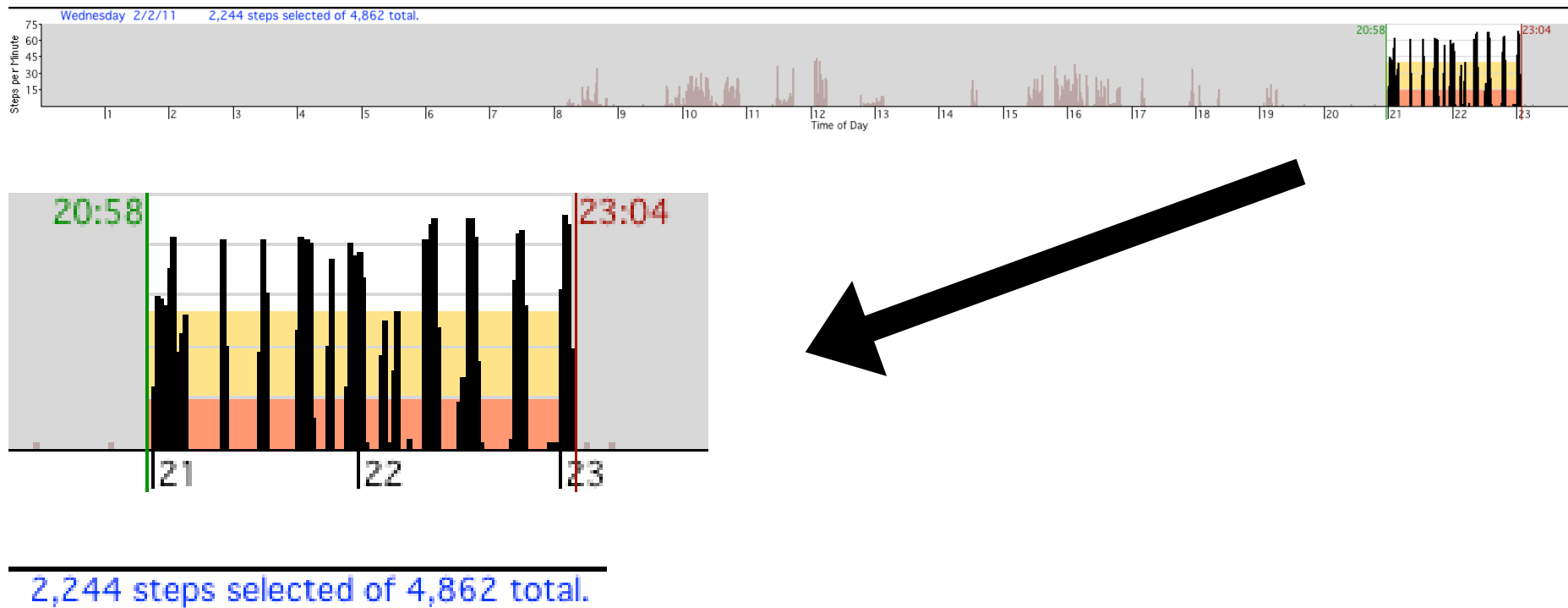


Figure 3.4. StepWatch output isolating TV commercial stepping steps from total daily steps (4488 TV commercial stepping steps in ~120 min of TV viewing time, and 9724 total daily steps). Note: StepWatch values need to be multiplied by two because the device is worn on the ankle and only counts steps on one side of the body.

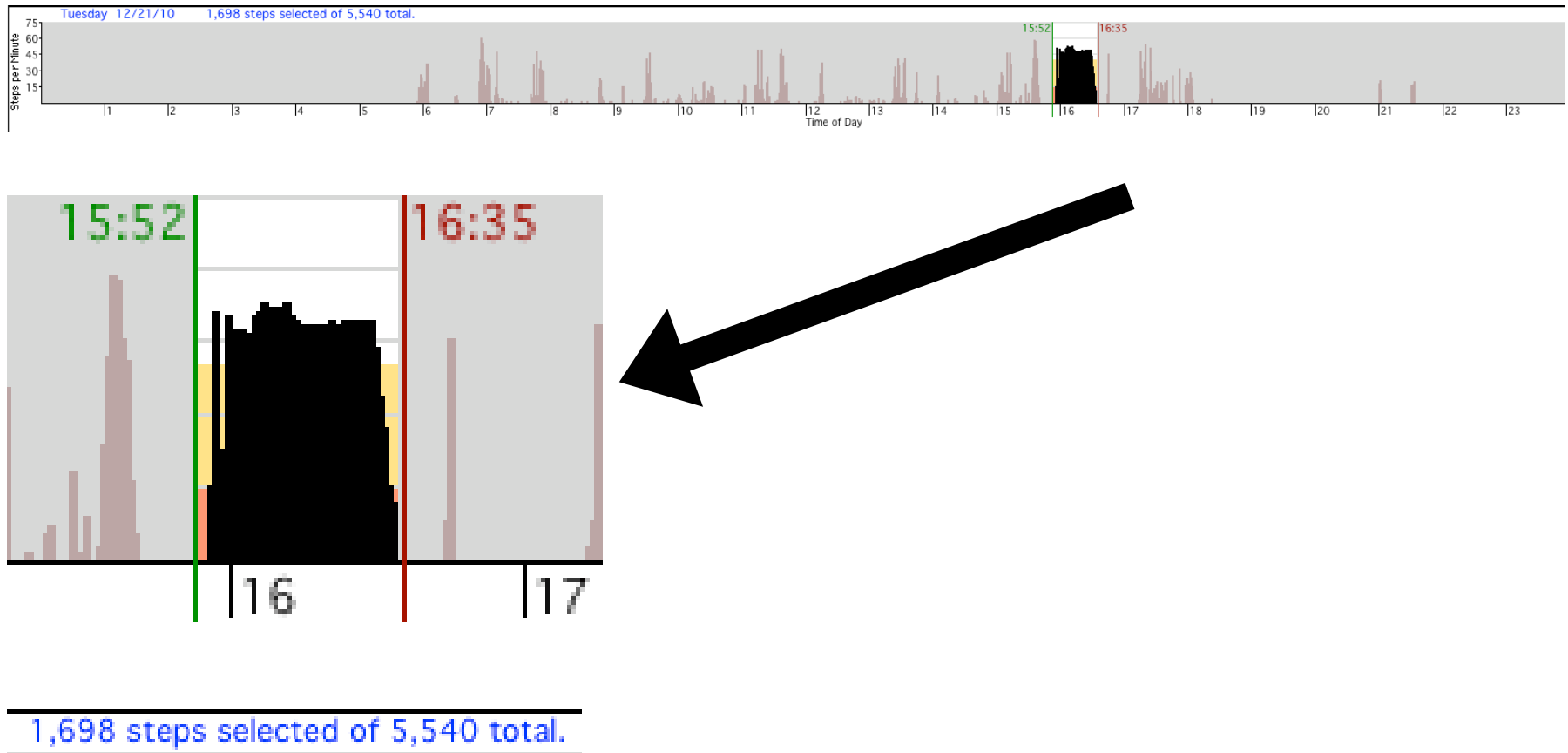


Figure 3.5. StepWatch output isolating 30-min walk steps from total daily steps (3396 30-min walk steps in ~40 min of walking time, and 11,080 total daily steps). Note: StepWatch values need to be multiplied by two because the device is worn on the ankle and only counts steps on one side of the body.

Table 3.3 StepWatch determined variables measured at 12 wks for TV commercial stepping (N=24) and 30-min walk (N=24) participants

Variable	Group	12 wks
StepWatch wear time (hr/day)	TV commercial stepping	14.4 ± 1.1
	30-min walk	14.2 ± 1.4
Days respective PA goals met (days/wk)	TV commercial stepping	4.2 ± 1.9
	30-min walk	4.3 ± 2.1
Intervention-specific MVPA (min/day)	TV commercial stepping	28.4 ± 18.9
	30-min walk	25.9 ± 12.4
Total Steps on days goals met (steps/day)	TV commercial stepping	12,571 ± 3228
	30-min walk	12,275 ± 2961
Total Steps on days goals not met (steps/day)	TV commercial stepping	9635 ± 2722
	30-min walk	9091 ± 3751
Average daily intervention-specific steps (steps/day)	TV commercial stepping	2593 ± 1951
	30-min walk	2756 ± 1543
Intervention-specific steps on days goals met (steps/day)	TV commercial stepping	3861 ± 2047
	30-min walk	4083 ± 1572
Intervention-specific steps on days goals not met (steps/day)	TV commercial stepping	482 ± 604
	30-min walk	1089 ± 2567

Data are mean ± SD. Note. PA = physical activity; MVPA = moderate-vigorous physical activity.

The TV commercial stepping group averaged 12,571 ± 3228 steps/day on the days that they TV commercial stepped for at least 90 min compared to the 30-min walk group who averaged 12,274 ± 2961 steps/day on the days they did walk for a total of at least 30 min ($t(43) = 0.32$, $P = 0.75$).

The TV commercial stepping group averaged 9636 ± 2722 steps/day on the days that they did not TV commercial stepped for at least 90 min compared to the 30-min walk group who averaged 9091 ± 3751 steps/day on the days they did not walk for at least 30 min ($t(41) = 0.55$, $P = 0.59$). At 12 wks there was no difference ($t(46) = 0.22$, $P = 0.83$) in the number of days/wk

treatment groups meet their respective PA goals. The TV commercial stepping group reached their assigned PA goal an average of 4.2 ± 2.0 days/wk and the 30-min group reached their goal an average of 4.3 ± 2.0 days/wk.

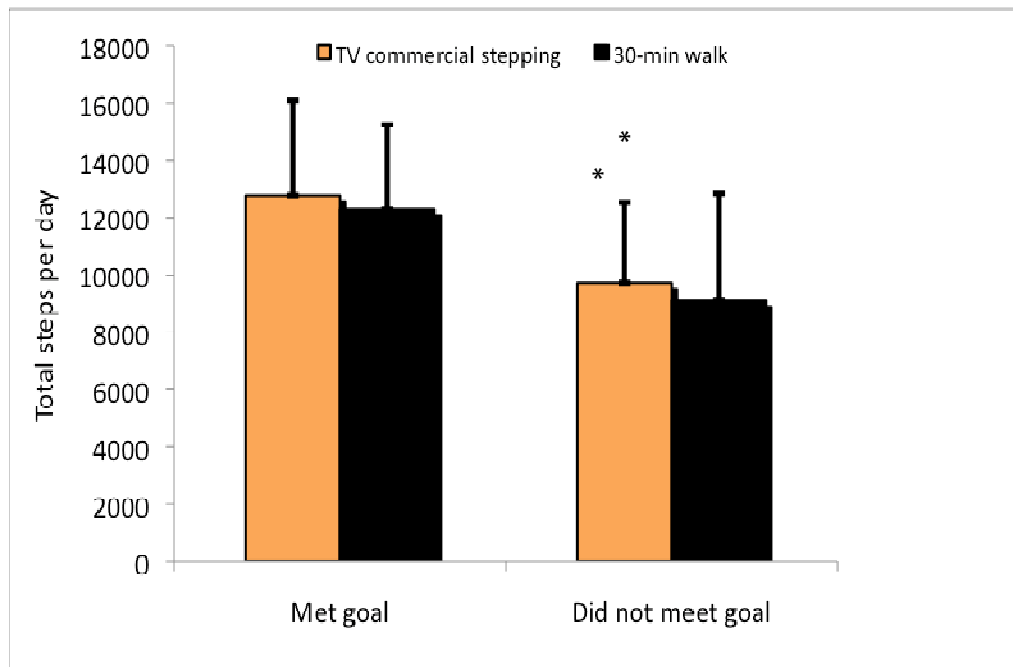


Figure 3.6: Comparison of average StepWatch-determined daily step counts when participants met their PA goals and when they did not. * Significant step difference between the days goals were met and the days goals were not met.

Overall, participants had a significantly greater number of intervention-specific steps when goals were met (4002 ± 1868 steps/day) compared to when goals were not met (815 ± 1912 steps/day) ($t(39) = 7.11$, $P < 0.05$). The TV commercial stepping group averaged 3861 ± 2047 TV commercial stepping steps/day on the days that they TV commercial stepped for at least 90 min compared to the 30-min walk group who averaged $4083 \pm 1572 \geq 10$ min walking bout steps/day on the days they did walk for a total of at least 30 min ($t(43) = 0.41$, $P = 0.68$). The TV commercial stepping group averaged 482 ± 604 TV commercial stepping steps/day on

the days that they did not TV commercial stepped for at least 90 min compared to the 30-min walk group who averaged $1089 \pm 2567 \geq 10$ min walking bout steps/day on the days they did not walk for at least 30 min ($t(41) = 1.08$, $P = 0.29$). Figure 3.7 and Table 3.3 shows a direct comparison between the average number of intervention-specific steps per day for each group on the days that they met their PA goals (i.e., ≥ 90 -min of TV commercial stepping or ≥ 30 -min walk) and the days they did not.

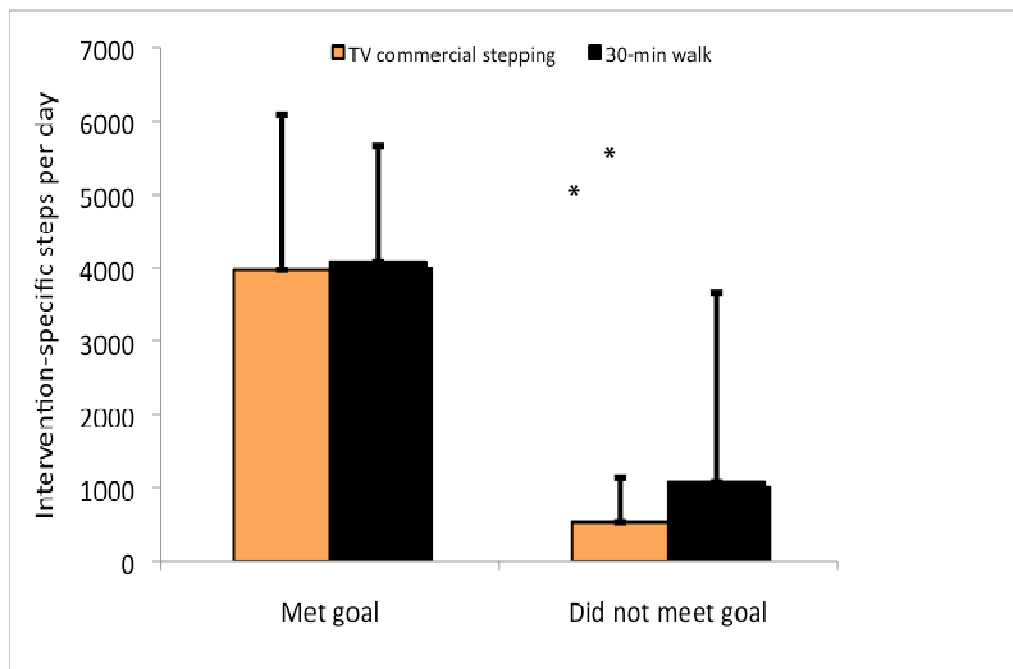


Figure 3.7: Comparison of average StepWatch-determined intervention specific step counts when participants met their PA goals and when they did not. * Significant step difference between meeting and not meeting goals.

The number of min in moderate-vigorous physical activity (MVPA) during intervention specific exercise (TV commercial stepping for the TV commercial stepping group, and walking for the 30-min group) was also acquired from the StepWatch. At 12 wks no significant difference ($t(46) = 0.52$, $P = 0.60$) was found between the groups for number of min per day in MVPA.

The TV commercial stepping group averaged 28 ± 19 min MVPA/day and the 30-min group averaged 26 ± 12 min MVPA/day during intervention-specific exercise (Table 3.3).

Discussion

There are many ways adults can increase their levels of PA in an effort to meet the recommendation of the U.S. Department of Health and Human Services (≥ 150 min/wk) [6]. The PALS program directly compared the ability of a novel method (TV commercial stepping) to increase daily activity levels to a method that has been traditionally prescribed in PA interventions (30 min of walking, in bouts of at least 10 min in duration). This study shows that by using the commercial breaks as their cue to get up and be active, previously sedentary, overweight adults successfully increased their PA levels ($10,734 \pm 3465$ steps/day) as much as those following the PA recommendation to walk at least 30-min/day on most days of the wk ($10,687 \pm 2834$ steps/day).

Many Americans fail to attain that recommended amount of PA [7,8], but they watch more than the recommended hrs of TV [14-16], and cite “lack of time”, as a reason for their physical inactivity [12,13]. This study shows that a small behavior change, like stepping in place during TV commercials could be one strategy to convert sedentary TV viewing into active TV viewing. Overall, TV commercial stepping resulted in about 3000 additional steps/day. On days when participants did at least 90 min of TV commercial stepping the group took an average of 12,571 total steps/day, and they averaged only 9635 steps/day on days when they did not participate in at least 90 min of TV commercial stepping. The actual number of steps accumulated during TV commercial stepping or bouts of walking lasting at least 10 min were determined by matching up the self-reported TV stepping and walking times with the time-sequenced data from the StepWatch. The TV commercial stepping group took an average of 3861 steps/day during TV

viewing on days they commercial stepped for at least 90 min, and they averaged only 482 TV related steps/day on days when they did not participate in TV commercial stepping for at least 90 min. Instructing people to step in place during commercials for least 90 min/day of TV watching resulted in an increase in daily steps roughly equivalent to encouraging people to walk at least 30 min/day. Overall, a 30-min walking resulted in about 2637 additional steps/day. On days when participants adhered to walking a total of 30-min/per day or more, the group took an average of 12,275 steps/day, and they averaged only 9091 steps/day on days when they did not walk for at least 30 min. The actual number of steps accumulated during their walks (e.g., three 10 min bouts, two 15 min bouts, or one bout $\geq$ 30 min) on days when participants adhered to walking at least 30-min/per day was 4083 steps, and they averaged only 1089 walking-specific steps per day on days when they did not walk for at least 30 min (e.g., one 10 min walk only).

Encouraging adults to exercise during their leisure time is one approach to counter the inactivity and obesity epidemics. The PALS program was a pedometer-based physical activity intervention that incorporated commonly used behavior modification techniques such as goal-setting, self-monitoring and feedback, to help participants increase their walking during their leisure-time. Presenting PA recommendations (such as 30 min of continual exercise) to a sedentary individual, without using small, behavioral changes may be overwhelming and decrease the exercise self-efficacy of the individual. The TV commercial stepping approach may be more practical in terms of creating a more attainable level of activity for previously sedentary individuals (i.e., shorter bouts that can be done more frequently) as well as those who has difficulty fitting activity into their daily schedule.

Despite the difference in approaches to increasing PA between the groups, the volume and intensity of exercise for both groups was approximately equal to meeting the goal of 150

min/wk of moderate intensity PA. The TV commercial walking group was specifically instructed to step in place or to walk around the house at a “brisk” intensity; one that would increase their heart rate and breathing rate. The importance of intensity and using the complete duration of each commercial break during 90 min of TV programming was emphasized. Steeves et al. [34] demonstrated that stepping in place at a “brisk” pace is a moderate-intensity activity. The 30-min group was instructed to walk for at least 30 min per day at a “brisk” pace. It was assumed that most of their walking was of moderate intensity, because the normal walking speeds of most healthy adults are classified as moderate-intensity [52,53]. Although the primary purpose of our study was to measure step volume and not exercise intensity, a measure of intensity was provided through the use of the StepWatch device. The StepWatch is programmed to categorize all recorded steps into one of three activity levels: 1) low intensity (0-30 steps per min), 2) moderate intensity (32-80 steps per min), and 3) high intensity (82-150 steps per min) (Michael S. Orendurff, personal communication, April 1, 2010); [54].

Health may be improved by accumulating at least 150 min/wk of moderate-intensity PA [53]. Both PA prescriptions allowed the participants to successfully meet this health-focused goal. The TV commercial stepping group averaged 28 min of MVPA/day (196 min/wk), and the 30-min group averaged 26 min of MVPA/day (182 min/wk) specifically through adhering to their prescribed exercise. The StepWatch output confirms that TV commercial stepping is a moderate intensity activity, and that short bouts of exercise like TV commercial stepping can be as effective as longer-bouts of exercise (30 min walks) for accumulating MVPA.

There was no significant difference between the TV commercial stepping group and the 30-min walking group with regard to daily steps, exercise participation, or weight loss. This study suggests that the results from using the novel strategy of TV commercial walking were

equivalent to those obtained with a standard PA participation of 30 min of daily walking. TV commercial walking can be used as an option for breaking up sedentary time and incorporating exercise into one's lifestyle during TV viewing.

Studies have shown that activity compliance can be enhanced by increasing lifestyle activities, developing an appropriate home-based exercise program, and considering short bouts rather than long bouts of activity for individuals who "can't find the time to exercise" [55-58]. TV commercial stepping adds no extra time to a participant's day because it can be worked into the TV programming already being watched, it can be spontaneous, it can be done with minimal equipment, and is performed in the comfort of an individual's home. In future studies participants could be encouraged to be physically active (i.e., walk on the treadmill, use the elliptical trainer, stepping in place) through an entire 30-min program to obtain their daily-recommended levels of PA.

TV commercial stepping does have several weaknesses. In order for participants to meet the PA goals using commercial break time, they actually have to sit and watch TV, a sedentary behavior. There were days when participants did not watch any TV. On days when participants did not watch TV, they were unable to meet their goals through this strategy, while those in the 30-min walk group had no such requirement or barriers. The reduction in both the 30-min walk and TV commercial stepping groups' TV viewing time may be related to the time they spent walking, or changes in seasons. The TV viewing reduction was not something that was anticipated due to this intervention, and it was not clear whether this reduction was an effect resulting from adults not wanting to watch as much TV, because it either interfered with their 30-min walk, or was now associated with TV commercial stepping, whether it was simply

variability in viewing habits from one wk to the next, or whether it was a Hawthorne-like effect where participants modified their TV viewing because it was being evaluated.

Changes in body weight were not a primary outcome of this investigation. It may be hypothesized that through increasing PA levels participants may experience some weight loss. Over 12 wks, it was estimated that participants in both groups would expend approximately 9000 extra kcals by accumulating at least 30 min of walking/day (~150 kcal), 5 days/wk. It was hypothesized that participants could see ~2.5 lbs (~1.1 kg) of exercise induced weight loss over 12 wks (9000 kcals / 3500 kcals / one lb fat = 2.57 lbs).

Recently, it has been hypothesized that the amount of exercise necessary to promote weight loss may be greater than the amount of PA prescribed in public health recommendations [6,53,57,59-61]. Achieving a minimum of 150 min/wk of exercise throughout our 3-month program did not result in significant weight loss in either group. Many studies have shown that participating in regular PA (i.e., 140-240 min/wk) for up to a year without an energy-restricted diet usually results in only minimal weight loss [62].

This study did not include a dietary restriction component; however, dietary assessment measures were taken by having participants complete 3-day food records at 0 and 12 wks. In the records, participants reported if they were or were not watching TV at every meal or snack bout. These records were analyzed to determine total energy and percent energy from fat. Records were also coded to determine energy and percent energy from fat while watching TV. There was a significant decrease in total and TV-related energy consumption, and percent energy from fat intake in both the TV commercial stepping and the 30-min walk groups. At the 12-wk assessment, participants reported a caloric decrease of approximately 300 kcal per day. If this caloric reduction had been maintained over 12 wks, it was hypothesized that participants could

expect to lose about 7 lbs (3.2 kg) through dietary changes alone. At the 12-wk point there was no significant weight change from baseline in either treatment group. Errors in estimates of dietary intake are common due to the subjective nature of dietary assessment measurement techniques [63]. The changes in energy and fat intake found may have been caused by underreporting and errors in measurement verses actual decreases in energy and fat intake. Considering the lack of focus on dietary changes in this PA intervention, the significant reduction in energy intake was unexpected. Due to the lack of weight loss, it is possible that the changes in self-reported dietary intake are a result of under-reporting. With only three days of dietary data at 0 and 12 wks, it cannot be determined how participants ate throughout the 12-wk period. Other short-term (<12 months) exercise only programs have also demonstrated that PA alone results in minimal weight loss [62].

One of the strengths of this study was the use of the StepWatch monitor, a highly accurate step counting device that is not affected by BMI and walking speed [37,64], as a criterion measure for daily steps. The StepWatch mechanism has greater sensitivity for detecting steps than most pedometers, and it counts accurately even in slow walkers and obese individuals. Raw data from the StepWatch provided min-by-min stepping activity across 24 hrs. This allowed the quantification of steps during TV commercial stepping and during intervention-specific walking bouts in the 30-min group. Matching self-reported TV commercial stepping and walking bouts to the StepWatch data allowed the isolation of stepping bouts and a detailed examination of intervention-specific PA. While PA was objectively measured, TV viewing time was not objectively measured. Since there was no restriction being placed on TV viewing time, an objective measure of this variable was not incorporated into the study design. Obtaining TV viewing time through self-report has been used in other studies [65-68].

Individuals typically do not change their activities or behaviors when they are simply told to do so [69]. Most participants were interested in increasing their PA levels and responded well to the behavioral modification techniques provided to help motivate them. All participants were provided with specific goals and had the social support of monthly group meetings during the first 12 wks to help them increase their PA levels. The common behavior modification techniques used included: 1) goal setting and self-monitoring of progress towards short- and long-term PA goals, 2) stimulus control by making changes to the environment, increasing cues that encourage PA, and reducing cues that promote inactivity, and 3) problem-solving and pre-planning to handle situations that may make it difficult to reach or maintain PA goals to help participants incorporate a new behavior (TV commercial stepping or 30-min walking) into their lifestyle [70,71]. All participants wore the Omron pedometer on the ankle, for the purposes of tracking their PA levels. This viewable pedometer, served as an environmental cue to engage in their prescribed PA, and provided an additional means of reinforcement to adhere to their prescription. Self-monitoring is an important behavioral modification technique for helping participants successfully track and increase their PA levels [72]. Participants may have been encouraged to step or walk more because of the presence of a pedometer that could be checked periodically throughout the day to see how many steps they had accumulated.

To our knowledge, this is the first study to measure the effects of TV commercial stepping as a PA intervention in adults. It appears that it is not necessary to recommend a reduction in TV to make an impact on increasing PA.

In summary, this study highlights that PA can be successfully incorporated into traditionally sedentary TV watching habits. Exercise performed in short bouts during commercial breaks can result in similar increases in PA as exercise performed in traditionally advocated

longer bouts. TV commercial stepping provides another option for effectively incorporating and increasing the PA levels of previously sedentary overweight adults. Independent of increasing PA, it also breaks up prolonged bouts of sedentary TV viewing. Due to the amount of time Americans spend watching TV, TV commercial walking should be considered when developing behavioral intervention strategies for increasing exercise participation, breaking up sedentary time, and potentially for increasing weight maintenance in overweight adults.

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Appendices

Appendix A
Part III
Informed Consent Form and Flyer

INFORMED CONSENT

Walking in place while watching TV: a pilot study

Investigator: Jeremy Steeves, MS.

Address: The University of Tennessee
Department of Exercise, Sport and Leisure Studies
1914 Andy Holt Ave.
Knoxville, TN 37996

Telephone: 865-974-8768

PURPOSE:

The purpose of this 2-part research study is to determine the energy expenditure and feasibility of walking in place during TV commercials. In each part of this study, we will measure the calories you burn and a researcher will count your steps while you perform a series of tasks. Your total time commitment will be approximately 3 hours. You should be fasted and rested prior to each test. Details are below.

EXCLUSION CRITERIA:

If you have problems that limit your ability to walk, or you have serious health problems you should not participate in this study.

PROCEDURES:

Testing will take place in the **Applied Physiology Laboratory at the University of Tennessee HPER building (1914 Andy Holt Ave)**. You will wear 3 small, non-invasive electronic physical activity monitors and be breathing into a mouthpiece during these tests.

Part 1

Before arriving for this part of the testing, you should avoid eating for 10-12 hours and avoid exercising for at least 12 hours. Measurements will be taken of your height, weight, and waist circumference. You will then be asked to perform the following activities (30 minutes resting, and 5 minutes for the other activities) while wearing the three activity monitors, a heart rate monitor, and breathing into a mouthpiece attached to computerized monitors:

Resting while reclined (30 minutes)

Sitting

Standing in place

Walking in place at a comfortable pace

Walking (3.0 mph (normal paced walking) on the treadmill)

Part 2

Before this test you should avoid eating and exercise for at least 6 hours. You will watch 2 hours worth of video recorded television programming with commercials. During this 2 hours you will be breathing through a mouthpiece, as in Part 1. There will be a 15-minute break after the first hour. During one hour of programming you will remain seated during programming, but during the second hour during each commercial break you will stand and walk in place at a comfortable

pace for the duration of each commercial break. During this activity your steps will be monitored by the 3 activity monitors and the investigator will be counting your steps.

RISK AND BENEFITS:

The risks of participating in this study include falling on the treadmill, but the moderate speed (3.0 mph) is considered a normal walking pace so falling is unlikely. The results will expose you to a potential method to combat physical inactivity and help us to better determine the feasibility of implementing this novel physical activity intervention on a larger scale.

CONFIDENTIALITY

The information obtained from these tests will not be released to any person without your consent as it is considered privileged and confidential. The information may be used in research reports or presentations, but your name and other information will not be disclosed.

CONTACT INFORMATION

If you have any questions at any time about the study or the procedures, requirements (or you experience adverse effects as a result of participating in this study), contact the investigator Jeremy Steeves at 865-974-8768. Questions regarding your rights as a participant can be directed to Brenda Lawson of the Research Compliance Services of the Office of Research at (865)-974-3466.

RIGHT TO ASK QUESTIONS AND WITHDRAW

You are free to decide if you want to participate in this study or withdraw from it at any time. Before you sign this form, please ask questions about any aspects of the study that are unclear to you.

Consent

By signing this form, I am indicating that I understand what I will be asked to do in this study and agree to participate in this research study.

Your Signature

Date

Researcher's Signature

Date

The University of Tennessee

TV time and physical activity



- Activities include:
 - Wearing three activity monitors for three weeks
 - Daily logging physical activity/steps
 - 3 visits to The Applied Physiology Laboratory (HPER)

You may be eligible to participate if:

- Currently Healthy
- Between 18-65
- Watch ≥ 2 hours/ day of TV

For more information call (865) 974-5091 or send an email to

jsteeves@utk.edu

TV and Physical activity study (865) 974-5091 jsteeves@utk.edu	TV and Physical activity study (865) 974-5091 jsteeves@utk.edu	TV and Physical activity study (865) 974-5091 jsteeves@utk.edu	TV and Physical activity study (865) 974-5091 jsteeves@utk.edu	TV and Physical activity study (865) 974-5091 jsteeves@utk.edu	TV and Physical activity study (865) 974-5091 jsteeves@utk.edu	TV and Physical activity study (865) 974-5091 jsteeves@utk.edu	TV and Physical activity study (865) 974-5091 jsteeves@utk.edu	TV and Physical activity study (865) 974-5091 jsteeves@utk.edu	TV and Physical activity study (865) 974-5091 jsteeves@utk.edu
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Appendix B
Part IV
Informed Consent Form

INFORMED CONSENT

Walking in place while watching television as an at home exercise intervention

Investigator: Jeremy Steeves, M.S.

Address: The University of Tennessee
Department of Exercise, Sport and Leisure Studies
1914 Andy Holt Ave.
Knoxville, TN 37996
Telephone: 865-974-8768

PURPOSE:

The purpose of this research study is to test the ability of people to work more steps into their day through changing behaviors connected with TV watching at home.

EXCLUSION CRITERIA:

If you exercise regularly, have problems that limit your ability to walk or do not watch at least 2 hours of TV daily you will be excluded from participating in this study.

PROCEDURES:

You will be asked to make three visits to the Applied Physiology Laboratory at the University of Tennessee HPER building (1914 Andy Holt Ave). During lab visit one all procedures will be explained and anthropometric measurements (including height, weight, waist and hip circumferences) will be taken. We will also ask you to wear 3 small devices to measure how much walking you do each day. (The devices weigh only a few ounces and do not interfere with daily activity.) You will wear 2 Omron HJ 303 pedometers; one on the waist, and one on the ankle. The Step watch 3 will be worn on your ankle, on the other side. The devices are to be worn during all waking hours for one day from the time you wake up until the time you remove them to go to bed except while sleeping, swimming, or bathing

In week 1 you will go about your daily habits as normal. During weeks 2 and 3, you will be instructed to modify your sedentary behaviors while watching TV. You will be instructed to stand up and walk in place during each commercial break while watching TV.

Over the next 3 weeks, you will be asked to fill out log books to record your daily steps and TV viewing habits as well as record daily on/off times of the physical activity monitoring devices, which measures how much walking you do over 7 days. Once a week, you will be asked report your daily activities (steps, TV time, TV walking, time devices were put on in the morning and time the devices were removed at night) through an in person meeting at the end of weeks 1 and 3 and via phone or e-mail at the end of week 2. You may discontinue your involvement in this study at any point, but you must return all of the provided equipment.

RISK AND BENEFITS:

The risks of this study are minimal and are no greater than normal activities of daily living. There is no known risk to wearing activity monitors. There may be no direct benefits to you during this study. The results of this study help us to better determine the feasibility of implementing this novel non-exercise physical activity intervention on a larger scale.

CONFIDENTIALITY

The information obtained from these tests will not be released to any person without your consent as it is considered privileged and confidential. The data collected may be used in research reports or presentations, but your name and other information will not be disclosed.

CONTACT INFORMATION

If you have any questions at any time about the study or the procedures, requirements (or you experience adverse effects as a result of participating in this study), contact the investigator Jeremy Steeves at 865-974-8768. Questions regarding your rights as a participant can be directed to Brenda Lawson of the Research Compliance Services of the Office of Research at (865)-974-3466.

RIGHT TO ASK QUESTIONS AND WITHDRAW

You are free to decide if you want to participate in this study or withdraw from it at any time. Before you sign this form, please ask questions about any aspects of the study that are unclear to you.

Consent

By signing this form, I am indicating that I understand what I will be asked to do in this study and agree to participate in this research study.

Your Signature

Date

Researcher's Signature

Date

Appendix C
Part V
Informed Consent Forms, Recruitment Letter, Flyer,
and Newspaper Advertisement

INFORMED CONSENT FORM

Physical Activity and Leisure-time Study (PALS)

Investigator: Jeremy Steeves, M.S.

Address: The University of Tennessee
Department of Exercise, Sport and Leisure Studies
1914 Andy Holt Ave.
Knoxville, TN 37996

Telephone: 865-974-5091

PURPOSE:

You are invited to participate in a research study. The purpose of this study is to determine the effectiveness of the exercise prescription of walking at least 30-minutes daily, with bouts lasting at least 10 minutes. If you give your consent, you will be asked to perform the testing below. This testing will take approximately one hour. You will complete a health history questionnaire to determine your health status. Body fat, waist and hip measurements, and blood pressure will be determined in the Applied Physiology Laboratory in the HPER building on the UT campus. You will be asked to report to the lab following an overnight fast having abstained from both food and exercise the morning of the test.

EXCLUSION CRITERIA:

If you report a history or symptoms of heart problems; have a resting blood pressure greater than 180 mm Hg systolic and/or 100 mm Hg diastolic; report any other physical or medical limitations for engaging in PA; report no television in your home or watch < 14 hours per week of TV with commercials; are currently participating in a program to increase PA; or have an internal defibrillator or pacemaker you will be excluded from participating in this study.

PROCEDURES:

The testing will take place in the Applied Physiology Laboratory at the University of Tennessee HPER building (1914 Andy Holt Ave., room 317). On the first day, you will fill out a health history questionnaire, and we will measure your height, weight, waist and hip circumference, resting heart rate and blood pressure. Body fat percentage will be determined by measuring electrical currents in your body while standing on a device similar to a bathroom scale. The initial testing will take no more than 1 hour; and these tests will be repeated 3 and 6 months after the start of the study. At the three assessment time points (0, 3, and 6 months) the StepWatch-3, which will be used as the criterion is to be worn around your other ankle for 7 days. We will assess your dietary intake using a three-day food record (2 weekdays and 1 weekend day) at 0, 3 and 6 months. You will be asked to record all food and drink consumed, and indicate eating that occurs while watching TV.

Your normal weekly walking will be measured for one week following the lab tests. You will wear one step counting device around each ankle in order to count how many steps you take each day. You will be asked to fill out diaries, recording your daily steps and TV viewing habits over 7 days. You will return to the lab 7 days after the lab tests in order for us to gather information from your pedometer and review your physical activity and TV diaries. We do not want you to change your activity or TV viewing habits during this time. At the end of this 1-week period, we will determine whether you fit the activity profile to be included in this study. If you do not, you will still be given all of the health information we have collected.

Physical Activity Prescription

During this study, we will ask you to walk at least 30-minutes daily. These minutes can be taken in bouts of 10 minutes or more. This study will last for 6 months, and we ask that you wear your pedometer and complete your diaries each day. During months 1-3, you will report to the lab with the researcher once per month to review your diaries and to address any questions or comments you may have. Midway between each month's lab visit, the researcher will call you. At the end of 3 months, you will return to the lab and the researchers will measure your height, weight, waist and hip measures, body fat, and blood pressure. Also at this assessment time point the StepWatch-3, is to be worn around the other ankle for 7 days. During months 4-6, you will continue with the exercise recommendation of walking for at least 30-minutes daily, with bouts lasting at least 10 minutes. You will also continue to record your daily steps, physical activity and TV viewing habits each day. We will provide you with a postage paid envelope for you to send your daily log sheets to the lab each week. You will receive one monthly phone call and newsletter that includes information describing the health benefits of walking, and motivational tips during months 4-6. You will return to the lab at the end of the 6-month study for follow-up tests which will be the same as previous tests. Again at this assessment time point the StepWatch-3, is to be worn around the other ankle for 7 days. You may discontinue your involvement in this study at any point, but you must return the pedometer.

RISK AND BENEFITS:

The risks of walking 30 minutes per day are considered minimal for healthy adults. In comparison to the risks, the potential health benefits associated with this study are significant. Increased physical activity has the potential to substantially improve your health. Previous studies have shown walking to be important in controlling weight and blood pressure, so you may experience these benefits. However, if you experience any abnormal feelings while walking such as chest pain or severe breathlessness you should contact your physician immediately.

Because the body fat test could potentially impact those with a pacemaker or implanted defibrillator, you should not participate in this study if you have one of these devices. There are no known risks to the other laboratory tests and surveys you will complete. All testing will be performed free of charge. This information will be explained to you by the researchers. You may find this information useful in your personal wellness.

CONFIDENTIALITY

The information obtained from these tests will not be released to any person without your consent as it is considered privileged and confidential. The data collected may be used in research reports or presentations, but your name and other information will not be disclosed.

COMPENSATION

Compensation for completing the study will be \$50. You will receive \$25 at the completion of the 3-month assessment visit and another \$25 at the completion of the 6-month assessment. Full payment will be received only if you complete the final 6-month assessment. Payment will be received by check within 6-8 weeks of completing all testing.

CONTACT INFORMATION

If you have any questions at any time about the study or the procedures, requirements (or you experience adverse effects as a result of participating in this study), contact the investigator Jeremy Steeves at 865-974-5091. Questions regarding your rights as a participant can be directed to Brenda Lawson of the Research Compliance Services of the Office of Research at (865)-974-3466.

RIGHT TO ASK QUESTIONS AND WITHDRAW

You are free to decide if you want to participate in this study or withdraw from it at any time.

Before you sign this form, please ask questions about any aspects of the study that are unclear to you.

Consent

By signing this form, I am indicating that I understand what I will be asked to do in this study and agree to participate in this research study.

Your Signature

Date

Researcher's Signature

Date

INFORMED CONSENT FORM

Physical Activity and Leisure-time Study (PALS)

Investigator: Jeremy Steeves, M.S.

Address: The University of Tennessee
Department of Exercise, Sport and Leisure Studies
1914 Andy Holt Ave.
Knoxville, TN 37996

Telephone: 865-974-5091

PURPOSE:

You are invited to participate in a research study. The purpose of this study is to determine the effectiveness of a novel exercise program of intermittent TV commercial walking (1.5 h of TV time per day). You will be encouraged to walk in place whenever a commercial comes on the television (minimum of 1.5 hours of television viewing with commercials a day). If you give your consent, you will be asked to perform the testing below. This testing will take approximately one hour. You will complete a health history questionnaire to determine your health status. Body fat, waist and hip measurements and blood pressure will be determined in the Applied Physiology Laboratory in the HPER building on the UT campus. You will be asked to report to the lab following an overnight fast having abstained from both food and exercise the morning of the test.

EXCLUSION CRITERIA:

If you report a history or symptoms of heart problems; have a resting blood pressure greater than 180 mm Hg systolic and/or 100 mm Hg diastolic; report any other physical or medical limitations for engaging in PA; report no television in your home or watch < 14 hours per week of TV with commercials; are currently participating in a program to increase PA; or have an internal defibrillator or pacemaker you will be excluded from participating in this study.

PROCEDURES:

The testing will take place in the Applied Physiology Laboratory at the University of Tennessee HPER building (1914 Andy Holt Ave., room 317). On the first day, you will fill out a health history questionnaire, and we will measure your height, weight, waist and hip circumference, resting heart rate and blood pressure. Body fat percentage will be determined by measuring electrical currents in your body while standing on a device similar to a bathroom scale. The initial testing will take no more than 1 hour; and these tests will be repeated 3 and 6 months after the start of the study. At the three assessment time points (0, 3, and 6 months) the StepWatch-3, which will be used as the criterion is to be worn around your other ankle for 7 days. We will assess your dietary intake using a three-day food record (2 weekdays and 1 weekend day) at 0, 3 and 6 months. You will be asked to record all food and drink consumed, and indicate eating that occurs while watching TV.

Your normal weekly walking will be measured for one week following the lab tests. You will wear one step counting device around each ankle in order to count how many steps you take each day. You will be asked to fill out diaries, recording your daily steps and TV viewing habits over 7 days. You will return to the lab 7 days after the lab tests in order for us to gather information from your pedometer and review your physical activity and TV diaries. We do not want you to change your activity or TV viewing habits during this time. At the end of this 1-week period, we will determine whether you fit the activity profile to be included in this study. If you do not, you will still be given all of the health information we have collected.

Physical Activity Prescription

During this study, we will ask you to participate in at least 1.5 hours of television commercial walking per day. This involves walking for the duration of each commercial break over the course of 1.5 hours of TV viewing. This study will last for 6 months, and we ask that you wear your pedometer and complete your diaries each day. During months 1-3, you will report to the lab with the researcher once per month to review your diaries and to address any questions or comments you may have. Midway between each month's lab visit, the researcher will call you. At the end of 3 months, you will return to the lab and the researchers will measure your height, weight, waist and hip measures, body fat, and blood pressure. Also at this assessment time point the StepWatch-3, is to be worn around the other ankle for 7 days. During months 4-6, you will continue with the exercise recommendation of walking for at least 1.5 hours of television commercial walking per day. You will also continue to record your daily steps, physical activity and TV viewing habits each day. We will provide you with a postage paid envelope for you to send your daily log sheets to the lab each week. You will receive one monthly phone call and newsletter that includes information describing the health benefits of walking, and motivational tips during months 4-6. You will return to the lab at the end of the 6-month study for follow-up tests which will be the same as previous tests. Again at this assessment time point the StepWatch-3, is to be worn around the other ankle for 7 days. You may discontinue your involvement in this study at any point, but you must return the pedometer.

RISK AND BENEFITS:

The risks of walking in place during all commercials for 1.5 hours daily are considered minimal for healthy adults. In comparison to the risks, the potential health benefits associated with this study are significant. Increased physical activity has the potential to substantially improve your health. Previous studies have shown walking to be important in controlling weight and blood pressure, so you may experience these benefits. However, if you experience any abnormal feelings while walking such as chest pain or severe breathlessness you should contact your physician immediately. Because the body fat test could potentially impact those with a pacemaker or implanted defibrillator, you should not participate in this study if you have one of these devices. There are no known risks to the other laboratory tests and surveys you will complete. All testing will be performed free of charge. This information will be explained to you by the researchers. You may find this information useful in your personal wellness.

CONFIDENTIALITY

The information obtained from these tests will not be released to any person without your consent as it is considered privileged and confidential. The data collected may be used in research reports or presentations, but your name and other information will not be disclosed.

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Compensation for completing the study will be \$50. You will receive \$25 at the completion of the 3-month assessment visit and another \$25 at the completion of the 6-month assessment. Full payment will be received only if you complete the final 6-month assessment. Payment will be received by check within 6-8 weeks of completing all testing.

CONTACT INFORMATION

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RIGHT TO ASK QUESTIONS AND WITHDRAW

You are free to decide if you want to participate in this study or withdraw from it at any time.

Before you sign this form, please ask questions about any aspects of the study that are unclear to you.

Consent

By signing this form, I am indicating that I understand what I will be asked to do in this study and agree to participate in this research study.

Your Signature

Date

Researcher's Signature

Date

September 7, 2010

Dear _____:

In the past, you have expressed interest in participating in a weight loss program at The Healthy Eating and Activity Laboratory (HEAL) at the University of Tennessee, Knoxville. We are excited to inform you about a new physical activity program that we are starting. This new program is being conducted in the Applied Physiology Laboratory and is called the Physical Activity and Leisure-time Study (**PALS**). This new program focuses on increasing physical activity in sedentary adults. This program provides 6 months of treatment and involves examining the influence of different leisure-time physical activity prescriptions on physical activity, television viewing, dietary intake, and weight loss in sedentary adults. The program involves 3, 20-40 minute individual counseling sessions, and 3 assessment sessions at the Applied Physiology Laboratory on the University of Tennessee campus. We anticipate the program will start at the end of September and all aspects of the treatment are provided at no cost to you.

If you are interested in getting more information about this study or participating in it, please call us at (865) 974-5091 and say that you are calling about **PALS**. We are looking forward to hearing from you and helping you meet your healthy lifestyle goals!

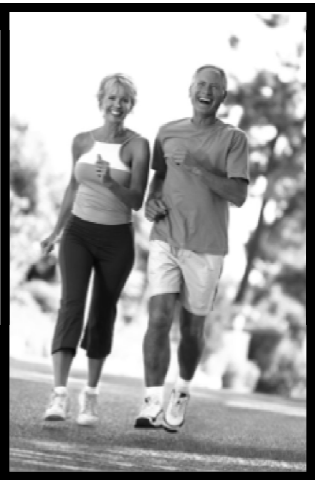
Sincerely,

Jeremy Steeves

Jeremy Steeves, MS
Dept. of Kinesiology, Recreation, and Sport Studies
Applied Physiology Laboratory
Healthy Eating and Activity Laboratory
University of Tennessee, Knoxville

Do you watch too much TV and want to be more active?

If you are between the ages of 35 and 65 and 20 to 75 pounds over your ideal weight, you may be eligible to take part in a physical activity program. The program is provided free of charge to participants. You will learn about effective ways to increase your physical activity during your leisure-time and how to maintain a healthy lifestyle.



If interested, please call the **Applied Physiology Lab** to see if you qualify for the **Physical Activity and Leisure-time Study (PALS)**.

Phone: 856-974-5091

Physical Activity and Leisure-time Study (PALS) (865) 974-5091	Physical Activity and Leisure-time Study (PALS) (865) 974-5091	Physical Activity and Leisure-time Study (PALS) (865) 974-5091	Physical Activity and Leisure-time Study (PALS) (865) 974-5091	Physical Activity and Leisure-time Study (PALS) (865) 974-5091	Physical Activity and Leisure-time Study (PALS) (865) 974-5091	Physical Activity and Leisure-time Study (PALS) (865) 974-5091	Physical Activity and Leisure-time Study (PALS) (865) 974-5091	Physical Activity and Leisure-time Study (PALS) (865) 974-5091	Physical Activity and Leisure-time Study (PALS) (865) 974-5091
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Do you watch too much TV and want to be
MORE ACTIVE?



If you are between the ages of 35 and 65 and 20 to 75 pounds over your ideal weight, you may be eligible to take part in a physical activity program. The program is provided free of charge to participants. You will learn about effective ways to increase your physical activity during your leisure-time and how to maintain a healthy lifestyle.

**Call the University of Tennessee,
Applied Physiology Lab at
(865) 974-5091 to see if you qualify
for the Physical Activity and
Leisure-time Study (PALS).**



Appendix D
Part V
Health History Questionnaire

HEALTH HISTORY QUESTIONNAIRE

NAME _____ DATE _____

DATE OF BIRTH _____

ADDRESS _____

PHONE NUMBERS (HOME) _____ (WORK) _____

e-mail address: _____

When is the best time to contact you? _____

Whom should we notify in case of emergency?

Name _____

Address _____

Phone # _____

Please answer the following questions. This information will only be used for research purposes and will not be made public. Please answer the following questions based on physical exercise in which you regularly engage. **This should not include daily work activities such as walking from one office to another.**

1. Do you regularly engage in exercise? Yes/No If yes, please describe.

2. On average, how many times per week do you engage in exercise training?

0 _____ 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____

3. On average, how long do you exercise each time?

0-19 minutes _____ 20-40 minutes _____ more than 40 minutes _____

4. How long have you been exercising at this level?

Less than 6 months _____

6 – 12 months _____

1 – 2 years _____

3 or more years _____

5. Can you walk 1/4 continuous mile without pain or discomfort? _____

6. Have you ever been told by a doctor to avoid exercise? _____ If yes, please explain:

MEDICAL HISTORY

Past History: Have you ever been diagnosed with the following conditions? Please check the appropriate column.

	Yes	No	Don't Know
Heart Murmur	()	()	()
High Blood Pressure	()	()	()
Any heart problem	()	()	()
Lung Disease	()	()	()
Seizures	()	()	()
Irregular heart beat	()	()	()
Bronchitis	()	()	()
Diabetes	()	()	()
Asthma	()	()	()
Orthopedic problems	()	()	()

Present Symptom Review:

Have you recently had any of the following symptoms? Please check if so.

Chest Pain	()	Shortness of Breath	()
Heart palpitations	()	Leg or ankle swelling	()
Low blood sugar	()	Difficulty walking	()
Feeling faint or dizzy	()	Weakness in arm	()
Leg numbness	()	Significant emotional problem	()
Do you smoke? Yes/No		If yes, how many per day? _____	

Are you currently trying to lose weight (through diet, exercise, and/or medication)? Yes/No

Are you taking any medications? Yes/No

If yes, please

list: _____

On average, how many alcoholic drinks do you consume per week? _____

I have been given the opportunity to ask questions about any of the above items that were unclear, and I have answered all questions completely and truthfully to the best of my knowledge.

SIGNATURE _____ DATE _____

Appendix E
Part V
Physical Activity Questionnaires

Self-Report Physical Activity Scale

Instructions for Respondents

How physically active are you on an average weekday? In the physical activity scale you see some examples of different levels of physical activity. Try to assess how much time you spend on each level on an average weekday. Start with level A and continue downward. If you normally sleep 7 h, you should mark the 7-h box of level A. If you watch TV for an hour and a half, you should mark the 30-min box and the 1-h box of level B. If you are not active on all activity levels, you should leave levels unmarked. Please note that the total number of minutes and hours should amount to 24 = an average weekday and night. You may find the column on the right helpful when adding the minutes and hours together.

Examples	Minutes	Hours	Time:
A  Sleep, rest	☐ 15 ☐ 30 ☐ 45	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10	
B  Sitting quietly, watching television, listening to music or reading	☐ 15 ☐ 30 ☐ 45	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10	
C  Working at a computer or desk, sitting in a meeting, eating	☐ 15 ☐ 30 ☐ 45	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10	
D  Standing, washing dishes or cooking, driving a car or truck	☐ 15 ☐ 30 ☐ 45	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10	
E  Light cleaning, sweeping floors, food shopping with grocery cart, slow dancing or walking downstairs	☐ 15 ☐ 30 ☐ 45	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10	
F  Bicycling to work or for pleasure, brisk walking, painting or plastering	☐ 15 ☐ 30 ☐ 45	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10	
G  Gardening, carrying, loading or stacking wood, carrying light object upstairs	☐ 15 ☐ 30 ☐ 45	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10	
H  Aerobics, health club exercise, chopping wood or shoveling snow	☐ 15 ☐ 30 ☐ 45	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10	
I  More effort than level H: Running, racing on bicycle, playing soccer, handball or tennis	☐ 15 ☐ 30 ☐ 45	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10	

Self-Report Leisure-time Activity Scale

Instructions for Respondents

What activities do you engage in during your leisure-time on an average weekday and weekend day? Try to assess how much time (hours: minutes) you spent in leisure and sports-related activities on the average weekday and weekend day last week. If walking is your only form of participating in sports, exercise, and recreation, and you normally walk for 30 minutes, you should mark the 30 minutes beside that activity. If you watch TV for an hour and a half, you should mark 1: 30 beside that activity. If you do not engage in all activity categories, you should leave those activity categories unmarked. Please use the bottom row to sum up the total number of minutes and hours spent in all leisure and sports activities for an average weekday and an average weekend day in the last week by adding all the above columns (1-7) together.

Leisure & sports activities	Weekdays		Weekend days	
	hours	minutes	hours	minutes
1. Participating in sports, exercise, and recreation				
2. Watching TV				
3. Socializing and communicating				
4. Reading				
5. Relaxing/ thinking				
6. Playing games and computer use for leisure				
7. Other leisure and sports activities, including travel (1)				
8. Total, all leisure and sports activities				

1 Includes other leisure and sports activities, not elsewhere classified, and travel related to leisure and sports activities.

Barriers to Being Active Quiz

Directions: Listed below are reasons that people give to describe why they do not get as much physical activity as they think they should. Please read each statement and indicate how likely you are to say each of the following statements:

<u>How likely are you to say?</u>	Very Likely	Somewhat Likely	Somewhat Unlikely	Very Unlikely
1. My day is so busy now, I just don't think I can make the time to include physical activity in my regular schedule.				
2. None of my family members or friends like to do anything active, so I don't have a chance to exercise.				
3. I'm just too tired after work to get any exercise.				
4. I've been thinking about getting more exercise, but I just can't seem to get started.				
5. I'm getting older, so exercise can be risky.				
6. I don't get enough exercise because I have never learned the skills from any sport.				
7. I don't have access to jogging trails, swimming pools, bike paths, etc.				
8. Physical activity takes too much time away from other commitments-time, work, family, etc.				
9. I'm embarrassed about how I will look when I exercise with others.				
10. I don't get enough sleep as it is. I just couldn't get up early or stay up late to get some exercise.				
11. It's easier for me to find excuses not to exercise than to go out and do something.				
12. I know of too many people who have hurt themselves by overdoing it with exercise.				
13. I really can't see learning a new sport at my age.				
14. It's just too expensive. You have to take a class or join a club or buy the right equipment.				
15. My free times during the day are too short to include exercise.				
16. My usual social activities with family and friends do not include physical activity.				
17. I'm too tired during the week and I need the weekend to catch up on my rest.				
18. I want to get more exercise, but I just can't seem to make myself stick to anything.				
19. I'm afraid I might injure myself or have a heart attack.				
20. I'm not good enough at any physical activity to make it fun.				
21. If we had exercise facilities and showers at work, then I would be more likely to exercise.				

TV Environment

- 1) How many TV sets do you have in your home? _____
- 2) How many TV sets are in your children's bedroom(s) (if you have no children, please write 0 TVs)? _____
- 3) Do you have a TV set in your bedroom? Yes No
- 4) In the table below, please write in the number of TVs, as well as a description of the room the TVs are in are in each room of your home.

Example:

<u>Number of TVs</u>	<u>Room in house</u>
1	Family Room

<u>Number of TVs</u>	<u>Room in house</u>

5) Of the above listed TVs, which TV do you watch the most (please write the name of the room in which the TV is located)? _____

6) For the TV that you most watch, how many channels are available to watch?

7) For the TV that you most watch, does it have TiVo? Yes No

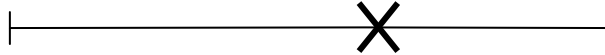
8) If you answered yes to #7, do you use TiVo? Yes No

Pleasantness Visual Analogue Leisure-time Activities

On the blank lines provided, please draw a vertical line or an 'X' to indicate the pleasantness of the following items:

EXAMPLE:

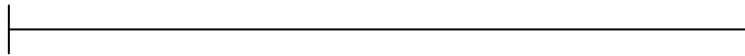
Vanilla Ice Cream



Very unpleasant

Very pleasant

TV watching



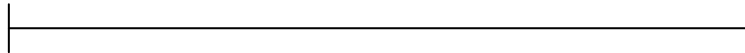
Very unpleasant

Very pleasant

Office Use
Only:

Score:

Physical activity



Very unpleasant

Very pleasant

Office Use
Only:

Score:

Barriers Specific Exercise (Walking) Self-Efficacy Scale

The following items reflect situations that are listed as common reasons for preventing individuals from participating in exercise (walking) sessions or, in some cases, dropping out. Using the scales below please indicate how confident you are that you could exercise (walk) in the event that any of the following circumstances were to occur.

Please indicate the degree to which you are confident that you could exercise (walk) in the event that any of the following circumstances were to occur by circling the appropriate %. Select the response that most closely matches your own, remembering that there are no right or wrong answers

For example, in question #1 if you have complete confidence that you could exercise (walk) even if “the weather was very bad,” you would circle 100%. If, however, you had no confidence at all that you could exercise (walk), if you failed to make or continue making progress (that is, confidence you would not exercise (walk)), you would circle 0%.

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Not at all					Moderately					Highly
Confident					Confident					Confident

I believe that I could exercise regularly (walk daily for at least 30 minutes) for the next 3 months if:

1. The weather was very bad (hot, humid, rainy, cold).

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

2. I was bored by the program or activity.

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

3. I was on vacation.

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

4. I was not interested in the activity.

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

5. I felt pain or discomfort when exercising (walking).

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

6. I had to exercise (walk) alone.

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

7. It was not fun or enjoyable.

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

8. It became difficult to get to the exercise (walking) location.
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
9. I didn't like the particular activity program that I was involved in.
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
10. My schedule conflicted with my exercise (walking) session.
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
11. I felt self-conscious about my appearance when I exercised (walked).
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
12. An instructor does not offer me any encouragement.
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
13. I was under personal stress of some kind.
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** and **moderate** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal.

PART 1: JOB-RELATED PHYSICAL ACTIVITY

The first section is about your work. This includes paid jobs, farming, volunteer work, course work, and any other unpaid work that you did outside your home. Do not include unpaid work you might do around your home, like housework, yard work, general maintenance, and caring for your family. These are asked in Part 3.

1. Do you currently have a job or do any unpaid work outside your home?

☐

Yes

☐

No



Skip to PART 2: TRANSPORTATION

The next questions are about all the physical activity you did in the **last 7 days** as part of your paid or unpaid work. This does not include traveling to and from work.

2. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, heavy construction, or climbing up stairs **as part of your work**? Think about only those physical activities that you did for at least 10 minutes at a time.

_____ **days per week**

☐

No vigorous job-related physical activity



Skip to question 4

3. How much time did you usually spend on one of those days doing **vigorous** physical activities as part of your work?

_____ **hours per day**

_____ **minutes per day**

4. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads **as part of your work**? Please do not include walking.

_____ **days per week**

☐

No moderate job-related physical activity



Skip to question 6

5. How much time did you usually spend on one of those days doing **moderate** physical activities as part of your work?

_____ **hours per day**

_____ **minutes per day**

6. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **as part of your work**? Please do not count any walking you did to travel to or from work

_____ **days per week**

☐

No job-related walking



Skip to PART 2: TRANSPORTATION

7. How much time did you usually spend on one of those days **walking** as part of your work?

_____ **hours per day**

_____ **minutes per day**

PART 2: TRANSPORTATION PHYSICAL ACTIVITY

These questions are about how you traveled from place to place, including to places like work, stores, movies, and so on.

8. During the **last 7 days**, on how many days did you **travel in a motor vehicle** like a train, bus, car, or tram?

_____ **days per week**

☐

No traveling in a motor vehicle



Skip to question 10

9. How much time did you usually spend on one of those days **traveling** in a train, bus, car, tram, or other kind of motor vehicle?

_____ **hours per day**

_____ **minutes per day**

Now think only about the **bicycling** and **walking** you might have done to travel to and from work, to do errands, or to go from place to place.

10. During the **last 7 days**, on how many days did you **bicycle** for at least 10 minutes at a time to go **from place to place**?

_____ **days per week**

☐

No bicycling from place to place



Skip to question 12

11. How much time did you usually spend on one of those days to **bicycle** from place to place?

_____ **hours per day**
_____ **minutes per day**

12. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time to go **from place to place**?

_____ **days per week**

☐

No walking from place to place



***Skip to PART 3: HOUSEWORK,
HOUSE MAINTENANCE, AND
CARING FOR FAMILY***

13. How much time did you usually spend on one of those days **walking** from place to place?

_____ **hours per day**
_____ **minutes per day**

PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY

This section is about some of the physical activities you might have done in the **last 7 days** in and around your home, like housework, gardening, yard work, general maintenance work, and caring for your family.

14. Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, chopping wood, shoveling snow, or digging **in the garden or yard**?

_____ **days per week**

☐

No vigorous activity in garden or yard



Skip to question 16

15. How much time did you usually spend on one of those days doing **vigorous** physical activities in the garden or yard?

_____ **hours per day**
_____ **minutes per day**

16. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, sweeping, washing windows, and raking **in the garden or yard**?

_____ **days per week**

☐

No moderate activity in garden or yard



Skip to question 18

_____ **hours per day**
_____ **minutes per day**

18. Once again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, washing windows, scrubbing floors and sweeping **inside your home**?

_____ **days per week**

☐

No moderate activity inside home



*Skip to PART 4: RECREATION,
SPORT AND LEISURE-TIME
PHYSICAL ACTIVITY*

19. How much time did you usually spend on one of those days doing **moderate** physical activities inside your home?

_____ **hours per day**
_____ **minutes per day**

PART 4: RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVITY

This section is about all the physical activities that you did in the **last 7 days** solely for recreation, sport, exercise or leisure. Please do not include any activities you have already mentioned.

20. Not counting any walking you have already mentioned, during the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **in your leisure time**?

_____ **days per week**

☐

No walking in leisure time



Skip to question 22

21. How much time did you usually spend on one of those days **walking** in your leisure time?

_____ **hours per day**
_____ **minutes per day**

22. Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous** physical activities like aerobics, running, fast bicycling, or fast swimming **in your leisure time**?

_____ **days per week**

☐

No vigorous activity in leisure time



Skip to question 24

23. How much time did you usually spend on one of those days doing **vigorous** physical activities in your leisure time?

_____ **hours per day**
_____ **minutes per day**

24. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like bicycling at a regular pace, swimming at a regular pace, and doubles tennis **in your leisure time**?

_____ **days per week**

☐

No moderate activity in leisure time



Skip to PART 5: TIME SPENT SITTING

25. How much time did you usually spend on one of those days doing **moderate** physical activities in your leisure time?

_____ **hours per day**
_____ **minutes per day**

PART 5: TIME SPENT SITTING

The last questions are about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.

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

_____ **hours per day**
_____ **minutes per day**

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

_____ **hours per day**
_____ **minutes per day**

This is the end of the questionnaire, thank you for participating.

Appendix F
Three-Day Dietary Record

****3 DAYS IN A ROW. 2 WEEKDAYS, AND 1 WEEKEND DAY****

PALS Food Record Instructions

Please record all of the foods and beverages you consume for the three days as indicated on the attached PALS Food Records. Record only one day per form and use the back if additional space is needed. For each item, including snacks, note the meal (breakfast, lunch, dinner, or snack), time the meal began, a description of the food and drink, amount consumed and whether or not you watched television during the meal or snack. The food and drink description should be very detailed including items added such as sugar, sauces, and condiments and note brand names when possible. For mixed foods such as sandwiches and salads, list the components separately. Estimate the amount of each item as closely as possible, using the provided estimation aids as needed. Most participants find it easier to record consumption throughout the day. Please review the sample food record below for additional guidance.

PALS Food Record

		Office Use Only
Date: 3/4/08		Reference #:
Day: Tuesday		Assessment #:

Meal (B, L, D, S)	Time (am/pm)	Description of Food and Drink	Amount Consumed	Watched TV? (yes or no)
B	7:30 a	Kellogg's corn flakes	1 cup	No
		Milk – 1%	½ cup	
		banana	1 med	
		coffee	12 fl oz	
		sugar	2 tsp	
L	12:00 p	Turkey sandwich		
		White bread	2 slices	
		Turkey luncheon meat	2 oz	
		American cheese	1 slice	
		Mayonnaise – regular	2 Tbsp	
		Lettuce - iceberg	1 leaf	
		Lay's regular potato chips	1 oz	
		Diet Coke	16 fl oz	
		Oreo cookies	3	
S	3:15 p	apple	1 large	No
D	7:00 p	Spaghetti pasta	1 cup	Yes
		Meat sauce	½ cup	
		Sweetened iced tea w/ ice	20 fl oz	

Appendix G
Part V
Supplemental Results

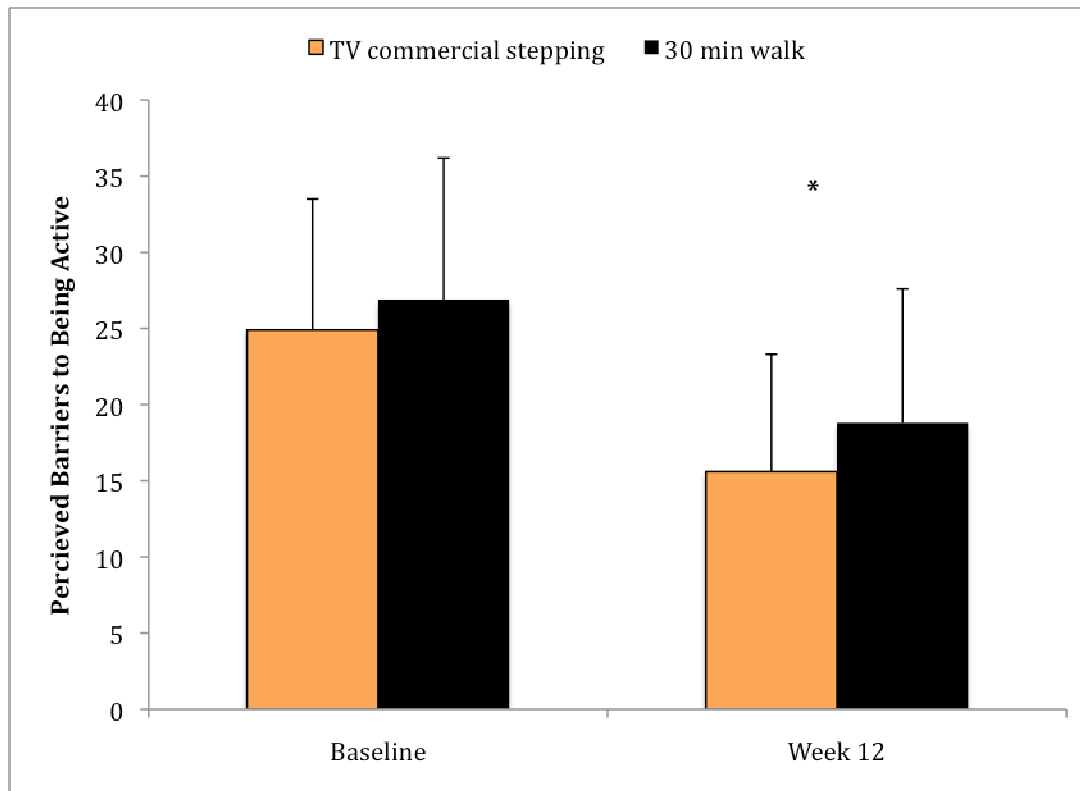


Figure 4.1: Overall perceived barriers to exercise scores. * Significantly different from baseline.

Repeated measures ANOVA revealed no significant group by time interaction and no group effect for barriers to being physically active between 0 and 12 weeks.

Paired sample t-tests were used to assess changes within groups over the course of the intervention found that there was a significant decrease in perceived barriers to exercise between baseline and week 12 in both groups ($P < 0.05$).

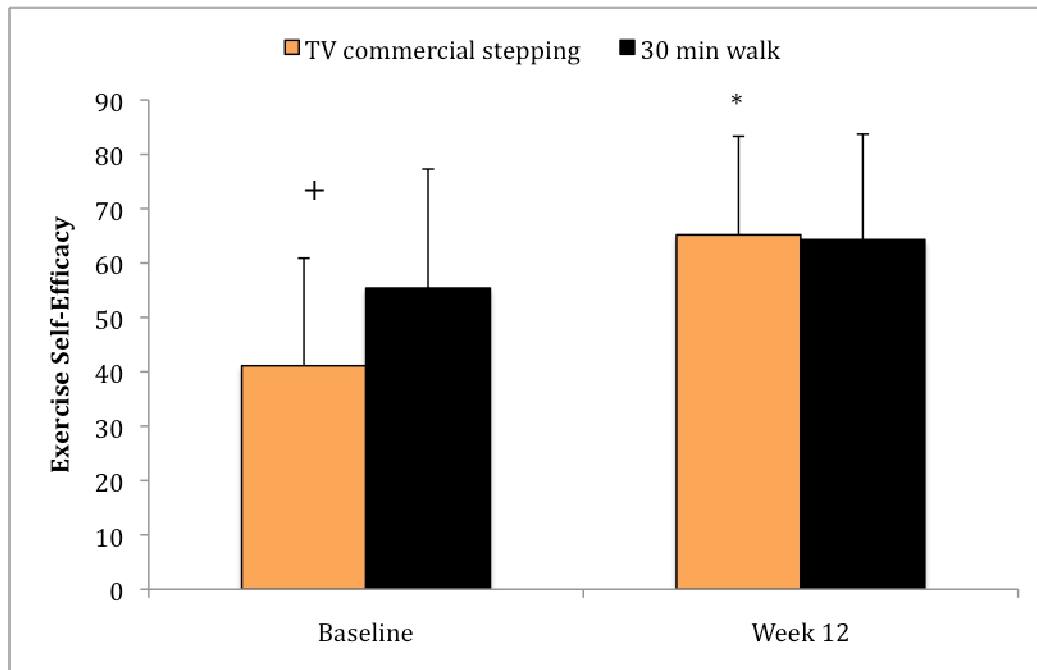


Figure 4.2: Overall exercise self-efficacy scores. * Significantly different from baseline. + Significantly different from 30 min walk group.

Repeated measures ANOVA revealed a significant group by time interaction ($P=0.03$), and a time effect ($P<0.01$) but no group effect ($P=0.17$) for exercise self-efficacy between weeks 0 and 12.

Independent sample t-test found a significant difference in exercise self-efficacy between the groups at base ($P=0.033$), but no difference in exercise self-efficacy between the groups at 12 weeks ($P=0.86$).

Paired sample t-tests were used to assess changes within groups over the course of the intervention. Exercise self-efficacy significantly increased ($P=<0.05$) between baseline and week 12 for the TV commercial stepping group, but did not change significantly for the 30 minute walking group ($P=0.65$).

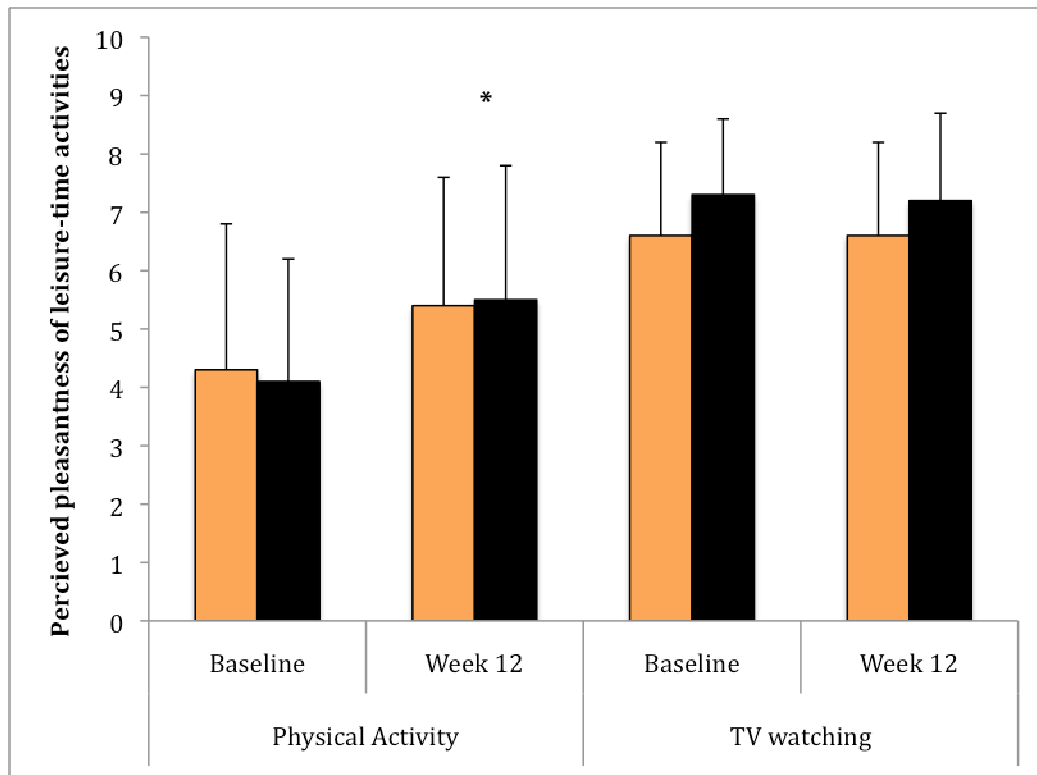


Figure 4.3: Perceived pleasantness of leisure-time activities. * Significantly different from baseline.

Repeated measures ANOVA revealed no significant group by time interaction and no group effect for perceived pleasantness of physically activity or TV watching between 0 and 12 weeks.

Paired sample t-tests were used to assess changes within groups over the course of the intervention found that there was a significant increase in perceived of physical activity between baseline and week 12 in both groups ($P < 0.05$), and no change in perceived pleasantness of TV watching.

VITA

Jeremy Steeves was born in Moncton, New Brunswick, Canada on May 24th 1983. He completed a Bachelors of Science Degree in Human Kinetics at St. Francis Xavier University (Antigonish, Nova Scotia, Canada) in 2005. After a few short-lived runs as a professional football player in the Canadian Football League, Jeremy returned to academia to obtain a Masters of Science degree in Biomechanics from the University of Tennessee in the Department of Kinesiology, Recreation, and Sport Studies. Jeremy continued at the University of Tennessee to pursue a Doctor of Philosophy degree in Exercise Science with a concentration in Exercise Physiology. While working on his degree, Jeremy received a dissertation grant from the American College of Sports Medicine Foundation and the University of Tennessee's ESPN Fellowship award. He has accepted a position as a post-doctoral research fellow in the Cancer Prevention Fellowship Program at the National Cancer Institute in Bethesda, Maryland.