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ORIGINAL PAPER

E-technology and Pedometer Walking Program to Increase Physical Activity at Work

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Abstract This study examined the application of the transtheoretical model (TTM) as a means to increase physical activity at the worksite through the introduction of a 10-week pedometer walking program combined with internet-based motivational messages. Participants ($N = 206$) were employees of two worksites who completed a health history questionnaire and assessment based on the TTM. There were significant improvements in the number of steps per week, level of physical activity, movement through stage of change and other health related indicators ($p < 0.05$). The worksite pedometer walking program and e-technology may be effective interventions in improving the lifestyle of employees who might be at risk for developing chronic diseases. *Editors' Strategic Implications:* Because walking is an inexpensive, easy, and convenient form of physical activity for many adults, implementation of this type of workplace program—with the important element of increasing individuals' awareness of risks—could be an effective approach to reduce cardiovascular risk factors and manage overweight and obesity in sedentary adults. Future research should compare this simple model with more individualized (but often more expensive) programs.

Keywords Physical activity · Stage of change · Worksite · Pedometer

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Introduction

The Impact of Obesity and Overweight

Over the past 20 years, obesity among adults has risen significantly in industrialized countries such as the United States (Levin et al. 2003; U.S. Department of Health and Human Services [USDHHS], 2005). This trend persuaded the Centers for Disease Control and Prevention (CDC) to declare obesity an epidemic in 1999. According to the 2005 Behavioral Risk Factor Surveillance System, 36.7% or 109 million of U.S. adults 18 years and older are overweight, and 24.4% or 72 million of U.S. adults 18 years and older are obese (CDC 2006). The impact of overweight and obesity is widespread and has consequences ranging from medical to economic. Medically, overweight and obese individuals are at increased risk for many diseases and health conditions, including premature deaths (Hahn et al. 1990), asthma, breathing problems, osteoarthritis, dyslipidemia (CDC 2006), hypertension (USDHHS 1996), type 2 diabetes (Ransdell et al. 2004; USDHHS 1996), coronary heart disease and stroke (Barengo et al. 2004; Garrett et al. 2004; Hahn et al. 1990), complication of pregnancy, menstrual irregularities, hirsutism or presence of excess body hair, stress incontinence, increased surgical risk (CDC 2006), psychological disorders (Prodaniuk et al. 2004), gallbladder disease, sleep apnea and respiratory problems, and some cancers such as endometrial, kidney, esophageal, breast, and colon (CDC 2006). In addition, 23% of all-cause mortality or over 300,000 deaths a year is attributed to overweight and obesity (Barengo et al. 2004; Garrett et al. 2004; Hahn et al. 1990; Popovic 2001).

In 2000, the total cost of overweight and obesity was estimated to be \$117 billion, and it was projected to increase to \$127 billion in 2004 (CDC 2005a; USDHHS 2002). This cost is associated with increased health care expenses, absenteeism, lost productivity, restricted activity, sick days and other indirect medical costs (USDHHS 2002). Obese individuals spend approximately 36% more than the general population on health services and 77% more on medications (Strum 2002; USDHHS 2002).

As a result of the aforementioned consequences, there is an urgent need to understand the factors that contribute to weight gain in order to implement appropriate interventions to minimize the epidemic. Body weight is the result of genetics, metabolism, behavior, environment, culture and socioeconomic status (CDC 2005b). However, studies have shown that the present epidemic is more a result of an imbalance between the amount of food consumed and the amount of energy expended (Levin et al. 2003; USDHHS 2002; CDC 2005b). In the last two decades, the amount of calories consumed by adults has increased while their physical activity patterns have either decreased or remained the same (Atlantis et al. 2006; CDC 2006; USDHHS 2002).

Furthermore, behavior and environment play a major role in overweight and obesity (CDC 2005b). A changing environment has broadened food options and eating habits (CDC 2005b). Pre-packaged foods, fast food restaurants, and soft drinks are more accessible at the worksite. Consuming excessive foods from these sources may contribute to excessive calorie intake (CDC 2005b). Also, the trend of "supersizing" meals and snacks results in the consumption of larger portion sizes, which significantly increase calorie consumption. If the extra calories consumed are not burned off, weight gain will most likely occur. In addition, technology has created time and labor saving products such as cars, elevators, computers, dishwashers, and televisions. These conveniences of modern living have reduced the overall daily amount of energy expended (CDC 2005b).

Benefits of Physical Activity

Moderate physical activity such as 30 min of brisk walking on most, if not all, days of the week, has been shown to reduce cardiovascular diseases and overall mortality in adults (Barengo et al. 2004; Brown et al. 2003; CDC 2005b; Chan et al. 2003; Iwane et al. 2000; Prodaniuk et al. 2004; Sacco et al. 1998). Other health benefits of regular physical activity include reduced risk of developing diabetes (Hirsch 2002; Kirk et al. 2004), reduced risk of premature death from cardiovascular disease (Barengo et al. 2004; Sacco et al. 1998), decrease in blood pressure in those who have high blood pressure (Tudor-Locke et al. 2002), reduced high blood pressure, colon and breast cancer, increase ability to maintain a healthy weight (NCDPHP 2006b; Trost et al. 2002; USDHHS 1996), reduce disease-related symptoms in many diseases, such as osteoarthritis, asthma and chronic obstructive pulmonary disorder (Kujala 2004), improve flexibility and physical fitness (Eriksen et al. 2002; Ransdell et al. 2004), improve aerobic fitness (Atlantis et al. 2006), reduce feelings of depression and anxiety (Garrett et al. 2004; USDHHS 2002;), and improve quality of life (Brown et al. 2003). In spite of the well documented benefits of physical activity, 51.3% of the U.S. adult population is not meeting the American College of Sports Medicine (ACSM) recommended 30+ min of moderate physical activity five or more days per week or 20 min of vigorous physical activity three or more days per week (Gordon-Larsen et al. 2004).

Effect of E-technology on Health Education

The application of e-technology to raise patient's compliance and education has been studied recently due to increased access to internet and availability of technology at worksites and households. In an online education program for cancer patients, the results indicated that those who received internet based education and information were more competent to deal with relevant disease oriented information (Gustafson et al. 2001). Studies have also indicated that patients who use the internet to look for health information ask more specific questions related to their health when they are seen by their health care professionals (Gerber and Eiser 2001). Application of e-technology with worksite health promotion interventions may increase employees' awareness of risk related to their unhealthy behavior and encourage them to take more steps to change that behavior.

In addition, some studies have shown that e-mail messages can motivate people to increase their physical activity level. In a weight loss study of individuals at risk of type 2 diabetes, where participants were assigned to either a basic internet group or a behavioral counseling via e-mail group, the authors found that participants who were receiving behavioral counseling via e-mails lost more weight, had higher reduction in waist circumference and blood glucose levels, and higher energy expenditures than the basic internet group (Tate et al. 2003).

Behavioral Interventions to Promote Activity

Most of the ten leading causes of premature death in the U.S. are in some way linked to lifestyle behaviors that may either contribute to disease development or exacerbate existing health problems (Levin et al. 2003). Studies have shown that behavior modification interventions such as nutrition counseling and increasing physical activity have been successful in helping people lose weight (Kirk et al. 2004), decrease their blood pressure (CDC 2005b), and heart rate (Eriksen et al. 2002; Ransdell et al. 2004) and reduce cholesterol level (Rached-Amrouche et al. 2007). However, despite the numerous benefits of physical activity, most Americans still live a sedentary lifestyle.

Behavioral interventions have focused on increasing self-monitoring, goal setting, or self-efficacy (Lowther et al. 2007). Enhancing self beliefs and motivating people to be physically active has been shown to boost intention to exercise and maintain the adopted behavior for long time (Marcus et al. 1992). The transtheoretical model (TTM) was first described by Prochaska and DiClemente (1983) as a proposed mechanism for smoking cessation. The TTM attempts to explain *how* rather than *why* behavior change occurs. It offers explicit suggestions for how people can be helped to change their behavior (Adams and White 2003). The TTM states that there are five distinct stages involved in long-term behavior change during which ten different processes of change may be used (Dunn et al. 1997). The five stages are precontemplation—not ready to change, contemplation—thinking about changing in the next six months, preparation—thinking about change in the next 30 days, action—have been practicing the new behavior for the past 30 days but less than 6 months, and maintenance—have been practicing the new behavior for the past six months (Prochaska and DiClemente 1983). In addition, the stages are no longer considered to be linear; rather, they are components of a cyclical process that varies for each individual. Although the TTM was originally developed to explain smoking cessation behavior (Prochaska and DiClemente 1983), the model has broader applications. Its usefulness in addressing physical inactivity has been confirmed (Marshall and Biddle 2001; Sorensen 2004). In a study on cardiac patient in rehabilitation, using the stage of exercise behavior change, found that 59.7% of the participants involved in the physical activity rehabilitation program progressed in stage (Kocourek and Reid 2006). Also, Griffin-Blake and DeJoy (2006), in their worksite physical activity intervention program, found that the stage of change model was effective in moving participants to higher levels of motivational readiness for regular physical activity.

Worksite Interventions

In an effort to reach a greater proportion of the population, the worksite has been identified as a key setting to promote physical activity due in part to the fact that an intervention can occur at a venue where individuals spend a significant amount of time on a consistent basis (Prodaniuk et al. 2004). The workplace is defined as a setting where work is done such as a factory, office, etc. In this article, workplace and worksite are used interchangeably. Worksites employ 65% of the population aged $\geq$16 years, which makes them ideal settings to implement strategies for reducing the prevalence and burden of overweight and obesity (NCCDPHP 2006a; Partnership for Prevention 2001; Prodaniuk et al. 2004). Worksites allow access to employees in a controlled environment through existing channels of communication and social support networks (Prodaniuk et al. 2004). Opportunities for environmental and policy change to foster healthy dietary practices and increase activity are readily available (Atlantis et al. 2006; Levin et al. 2003; Sacco et al. 1998; Wyatt et al. 2005). For example, worksites can provide easier access to stairwells that employees can use to increase physical activity. Also, management can adopt policies that provide employees with exercise breaks during working hours (Levin et al. 2003). The incentive for ongoing support of weight loss and maintenance and other health promoting activities at the worksite is substantial because support for such programs may likely translate into cost savings for employers (Partnership for Prevention 2001). Worksite health promotion programs have been shown to increase productivity, decrease absenteeism, decrease health care costs, improve focus at work, improve physical strength, improve employee morale, reduce employee health risks, and increase job satisfaction (Partnership for Prevention 2001; Chan et al. 2004).

Walking is a common form of physical activity for Americans and some success has been achieved in increasing walking in small-scale studies using electronic pedometers (Iwane et al. 2000; Wyatt et al. 2005; Tudor-Locke et al. 2002). The pedometer is an inexpensive, simple electronic device that measures ambulatory (walking) activity (Wyatt et al. 2005). It provides an easy way both to quantify amount of physical activity performed and to provide a clear and measurable goal for physical activity (Chan et al. 2003; Wyatt et al. 2005). The pedometer-based program was originally designed for sedentary and obese individuals with type-2 diabetes (Iwane et al. 2000). In the diabetic population, the intervention increased daily physical activity and had positive effects on the health of the population. The intervention has been repeated in several community-based studies and similar results were found (Chan et al. 2003; Chan et al. 2004; Ransdell et al. 2004; Hirsch 2002; Iwane et al. 2000; Marshall and Biddle 2001; Tudor-Locke et al. 2002;Wyatt et al. 2005).

However, there are few documented studies on the effectiveness of pedometer walking programs at the worksite. Individuals holding relatively sedentary jobs may be at greater risk of becoming obese due to energy imbalance. Energy imbalance is an increasing problem at worksites, with energy intake (calories) not corresponding to energy expenditure (physical activity). Type of work is a major contributor to the problem i.e. office work as opposed to assembly line. Other worksite factors such as inflexible work hours, hourly or salary, and access to unhealthy food and unhealthy snacks also contribute to this imbalance. Physical inactivity at the worksite (decreased energy expenditure) and consumption and availability of abundant unhealthy food (increased energy intake) lead to a positive energy balance, which will eventually result in weight gain.

Maintaining or decreasing energy balance could play an important role in the prevention of overweight and obesity and related disorders such as hypertension, diabetes, hypercholesterolemia, cardiovascular diseases, and some types of cancer (Brown et al. 2003; Partnership for Prevention 2001). Occupational activity has an impact on total daily activity and sedentary employees do not compensate for occupational inactivity by increasing physical activity during leisure-time (Chan et al. 2004). The purpose of the present study was to determine if the use of pedometer-based walking programs in combination with website and email motivational messages could motivate sedentary employees to increase their physical activity at work as well as improve their lifestyle behavior as measured through TTM.

Methods

Procedure

This study used a pre/post measure design, which used participants as their own controls. All participants signed an informed consent form approved by the University's Institutional Review Board. Measurements were conducted pre and post 10-week walking program, and participants submitted weekly walking logs, which recorded number of steps taken per day by using their pedometer, as well as minutes walked per day.

Participants

Participants were recruited from employees of two large state agencies with 1100 employees, where most jobs were sedentary. Participants were recruited through mass emails, newsletters, and posters at the worksites. Participants were excluded if they had any medical problems that would preclude them from participating in moderate physical activity. Two hundred and six participants registered for the program. Fifty percent of the participants were 45 years or older, putting them at higher risk for chronic disease. Of the participants 80% were female, 59% were white and majority was overweight with BMI of 27.3 $\pm$ 0.47 (Mean $\pm$ SD). Of the 206 participants, 56% completed the entire 10-week program. The attrition rate was most dramatic after week 7, a period that coincided with the Thanksgiving and Christmas holidays.

The physical characteristics of the participants are depicted in Table 1.

Walking Program

The progressive walking program lasted for 10 weeks. Participants were allowed to choose their own walking speed and increase their speed and time walked based on

Table 1 Demographics of the sample

	$N = 206$
Gender	
Male	18.2%
Female	81.8%
Race/ethnicity	
Black	19.8%
Asian	5.3%
White	58.9%
Hispanic	12.6%
Age group	
<25	2.0%
25–35	18.1%
36–45	28.6%
46–55	37.7%
56–65	13.6%
Anthropometrics	
Weight	166.6 ± 3.44
Height	65.3 ± 0.27
BMI	27.3 ± 0.47
SBP	118.1 ± 1.18
DBP	72.8 ± 0.76

level of comfort. Each day participants put on pedometers upon arriving at work, prior to getting out of their cars. Almost all of the participants drove to work or used public transportation. They then recorded the number of steps taken and minutes walked before they left work each day on individualized walking logs distributed to each participant before the study. To increase motivation, participants were encouraged to develop teams, and each team chose a team leader. The team leader was responsible for collecting the walking logs and delivering the logs to the investigators on a weekly basis.

E-technologies

Weekly motivational emails were sent to participants and was posted on the website encouraging them to continue their walking as well as instructing them on how to set goals and overcome barriers. It was postulated that since participation in the walking program was voluntary, there should be no, or minimal number, of participants in pre-contemplation. Therefore, motivational messages were not tailored to an individual's stage but more generally, focused on consciousness rising, dramatic relief, environmental re-evaluation, self re-evaluation, social liberation, self-liberation and stimulus control based on behavioral change construct of TTM model to move individuals through stages (Marcus et al. 1992). In addition, the participants were encouraged to visit the program's website. The website contained information about the program, the weekly logs, the monthly calendar of events, and the guides for team leaders and participants. Maps of worksite walking routes were provided to the participants via the website. The routes were color coded so that there was a distinct color for each route and a distance associated with that route. For example, if participants followed the blue line, they would know that it was a two-mile walk. There were also monthly newsletters and information about healthy living seminars conducted at the worksite available on the website.

Measures

At both pre- and post walking program, all participants completed a health history questionnaire, as well as a stage of behavior change questionnaire based on Procheska's transtheoretical model for physical activity, smoking, dietary habits and stress management. The health history questionnaire also contained questions about participants' lifestyles such as level of physical activity, eating habits, stress level, smoking habits, as well as motivation to participate. The investigators took measurements of weight, height and blood pressure, and BMI was calculated from body weight and height. The independent variables were age, height, weight, race, and health status.

Physical Activity

Numbers of steps taken were compared on weekly basis. Baseline steps per week was defined as the steps taken in week one and plateau was defined as the week the participants took the highest number of steps per week. Physical activity was measured as both a subjective and an objective outcome. The subjective outcome was measured as the self-reported physical activity level of the participants. The objective outcome was measured as the number of days participants participate in regular, mild, moderate and vigorous physical activities according to ACSM classification (ACSM and CDC 2006) as well as the number of steps walked per week. Regular physical activity was defined as any activity that causes an increase in heart rate. Mild physical activity was defined as activities that require little energy such as archery, fishing, bowling, horseshoes, golf with cart, easy walking, gardening, or mild yoga. Moderate physical activity was defined as activities that cause small to moderate increases in breathing or heart rate such as brisk walking, slow bicycling, easy swimming, and dancing. Vigorous physical activity was defined as activities that cause large increases in breathing or heart rate such as running, aerobics, heavy yard work, fast bicycling, and fast swimming.

Stage of Change

Stage of change was defined as 'precontemplation'—does not exercise/eat healthy diet/manage stress now and does not intend to start in the next 6 months, 'contemplation'—does not exercise/eat healthy diet/manage stress regularly but intends to start exercising in the next 6 months, 'preparation'—does not exercise/eat healthy diet/manage stress regularly but intends to start exercising in the next 30 days, 'action'—has been exercising/eating healthy diet/managing stress for less than 6 months, 'maintenance'—has been exercising/eating healthy diet/managing stress regularly for more than 6 months.

Statistical Analysis

Stratification of Variables

Body Mass Index was classified according to the CDC guidelines, i.e., normal weight or BMI less than 25 kg/m^2 and overweight/obese or BMI 25 or more kg/m^2 (CDC 2007). Blood pressure was classified according to the American Heart Association guidelines, i.e., normal BP was defined as systolic blood pressure less than 120 and diastolic blood pressure less than 80; hypertensive BP was defined as SBP is $\geq$120 and DBP is $\geq$80 (American Heart Association 2007). Also, self reported physical activity level was classified as not active and active. 'Not active' means that the subject was not involved in any physical activity during the week and 'active' means that the subject participated in physical activity at least once a week.

Descriptive analyses were performed for all data. Percentages are reported for categorical variables and mean $\pm$ SE for continuous variables. Wilcoxon sum test was used to analyze categorical variables and paired sample t-tests were used to analyze continuous variables that were normally distributed. The mean steps per day were calculated by dividing the mean steps per week by 5. The average steps per week, for the 10-week was computed by taking the mean of the steps per week for all participants who completed the walking program. Chi-Square analysis was used to determine the movement in stage of change, physical activity levels and change in self-reported data. ANOVA analysis was used to determine the changes within groups. All of the analyses were performed using SPSS 14.0 for Windows. Significant levels were set at $p \leq 0.05$.

Results

Weekly Logs

Baseline steps per week was defined as the steps taken in week one and plateau was defined as the week the participants took the highest number of steps per week. Analysis of weekly logs showed that there was a significant increase in the number of steps per week for weeks 2, 3, 4, 5, 6 and 8 in comparison to baseline ($p < 0.001$ for weeks 2, 3, 4, 6 and 8; $p = 0.029$ for week 5). There was a significant drop in the number of steps taken in week 7 compared to the other weeks, perhaps due to the Thanksgiving holiday. The group reached a plateau in week 8; however, 10% of the participants did not reach a plateau by the time the program ended. The average

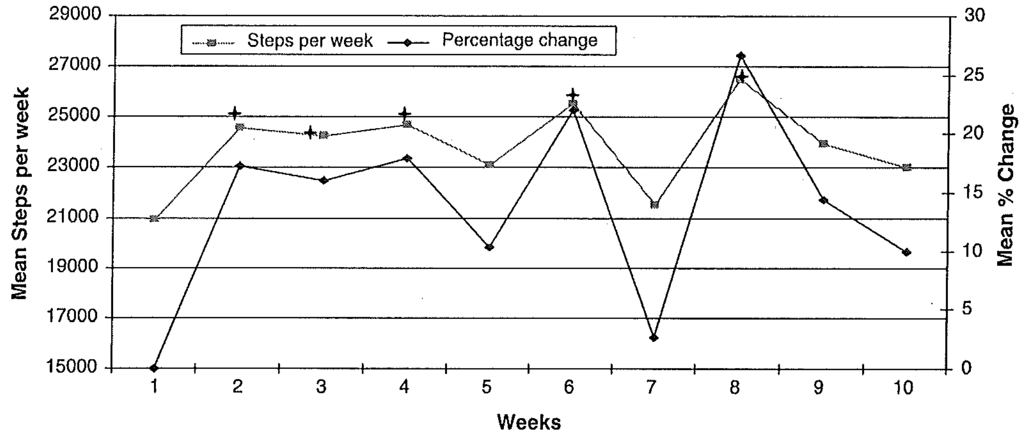

Fig. 1 Average steps per week for the overall sample. Mean % change is the percentage increase in steps between n-week and baseline. * $p < 0.05$

steps per person per week were 23,803 ± 1,720 steps. The average steps per day during the working hours at baseline were 4,185 ± 174 steps. At plateau, the average steps per day during the working hours were 5,300 ± 356 steps, resulting in an increase of 27% (Fig. 1).

Self-reported Physical Activity Scale

There was a significant increase in the physical activity reported by the participants ($p = 0.044$). With respect to self-reported physical activity level, there was a significant increase in the percentage of participants who reported that they were active at post assessment. More than one-third or 40% of the participants who reported themselves as 'not active' moved to 'active'. Overall, there was a 33% increase in the number of participants who reported being active at post assessment. There was a significant increase in the number of participants meeting the ACSM recommendation for mild, moderate, and regular physical activity.

Self-reported Physical Activity and Steps Taken

The participants who reported being regularly physically active or active three times per week and moderately physically active or active four times a week walked, on average, more steps per day than participants who were not involved in moderate physical activity for at least three to four times per week ($p < 0.05$) (Figs. 2 and 3).

Stage of Change

Baseline stage of exercise behavior change did not affect the amount of steps taken at baseline, plateau and 10-week average (Fig. 4). There was no significant

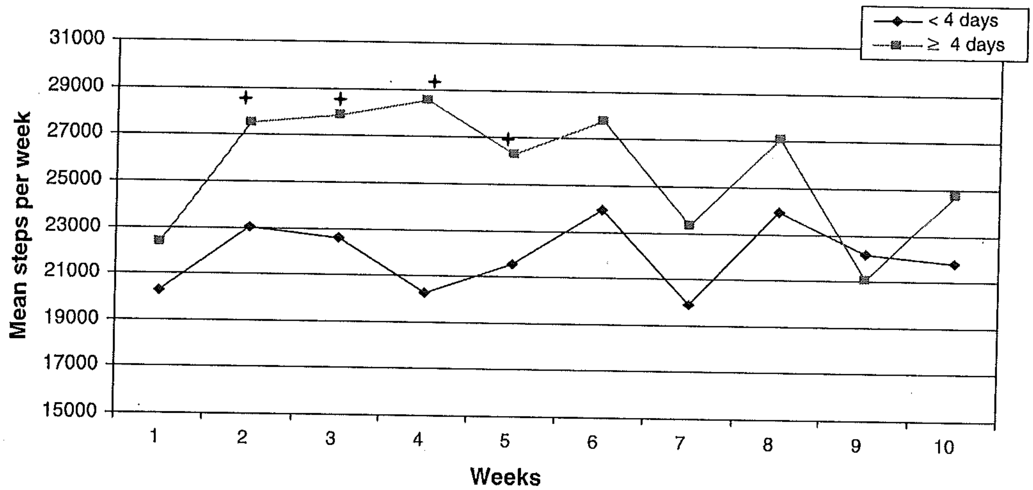

Fig. 2 Mean steps per week by participation in moderate physical activity. * $p < 0.05$

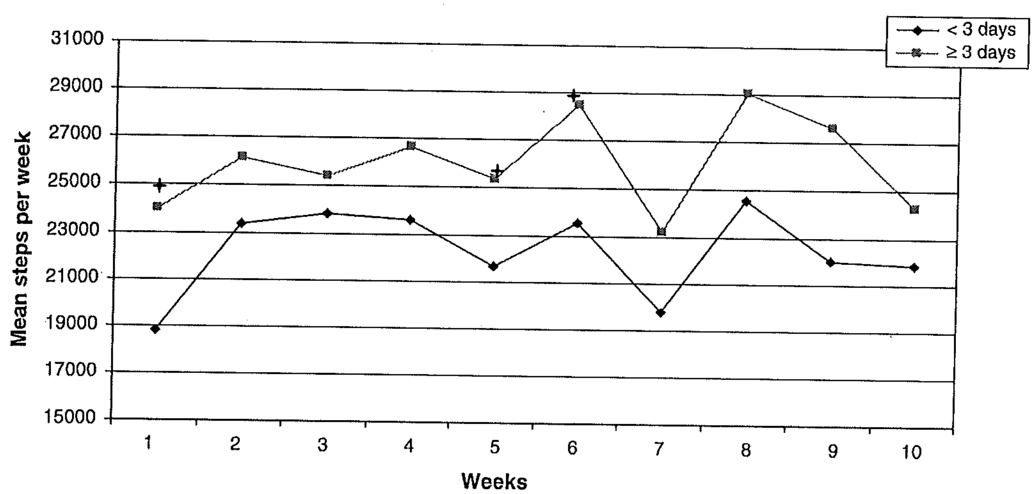

Fig. 3 Mean steps per week by participation in regular physical activity. * $p \leq 0.05$

difference in the amount of steps taken each week by participants at each stage of change i.e. precontemplation was not significantly different from preparation and so on. There was a significant movement in stage of change for physical activity (PA), dietary habits (DH), and stress management (SM). For PA, one third of the participants in the preparation or action stages moved at least one stage forward, i.e., those in preparation stage moved to action or maintenance and those in action moved to maintenance. There was a 20% increase in the number of participants who were in the maintenance stage at post assessment. For DH, one third of the participants in the preparation or action stages moved at least one stage forward. For SM, 100% of participants who were at the precontemplation stage moved at least one stage forward. More than half (53%) of the participants in the preparation stage moved at least one stage forward, and one third of those in action stage moved to the maintenance stage. There was a 25% increase in the number of people in the maintenance stage at post assessment.

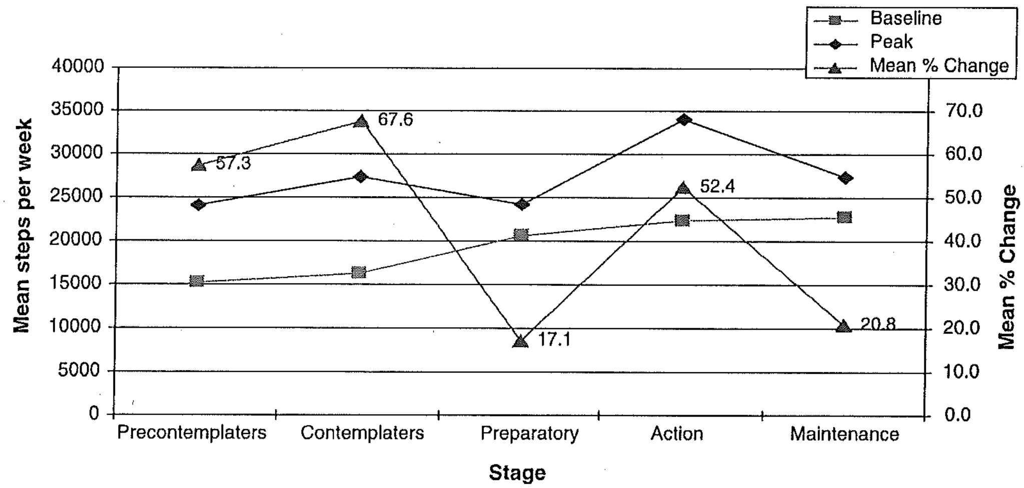

Fig. 4 Mean steps per week for baseline and plateau by stage of change. The mean % change is the percent increase in steps per week from baseline to plateau. The increase in steps between baseline and plateau was significant at all stages ($p < 0.05$) except for preparation

Blood Pressure, BMI and Body Weight

T-test analysis showed that there was a significant reduction in systolic blood pressure ($p = 0.011$). Forty percent of the participants who were considered hypertensive at pre-assessment became normotensive at post-assessment.

There was no significant difference in body weight, but 33% of the participants lost at least 0.5% of their body weight and another 23% maintained their weight (Fig. 5). Furthermore, body weight, BMI and BP did not affect the number of steps taken per week (Figs. 6, 7).

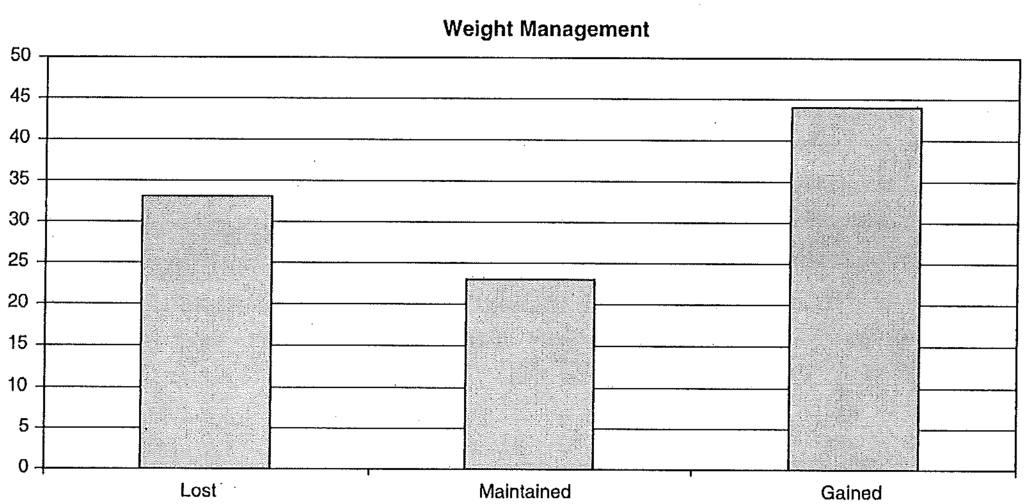

Fig. 5 Percentage of participants, who lost, maintained and gained weight during the program. About 56% of the participants maintained or lost weight after the program

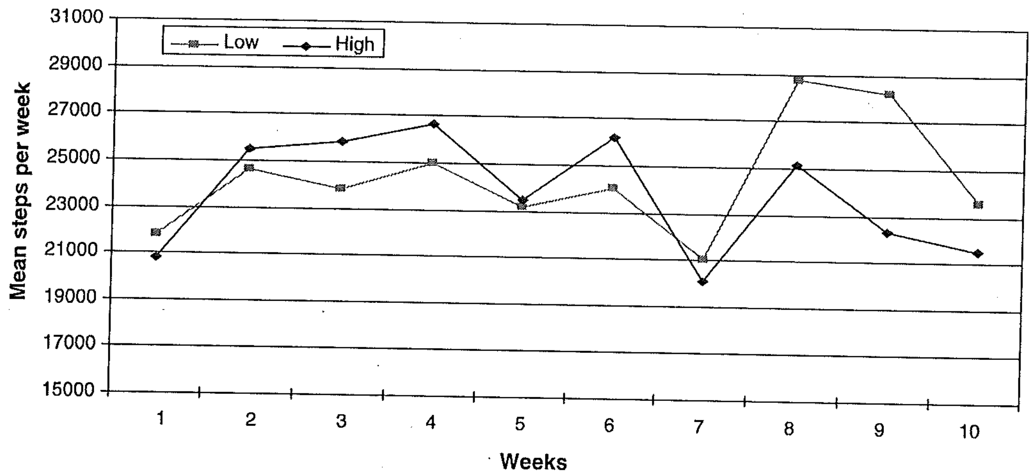

Fig. 6 Mean steps per week stratified by blood pressure. *High* (blood pressure) are participants with SBP >120 and/or DBP >80. *Low* (blood pressure) is SBP <120 and/or DBP <120, No significant difference in mean steps per week for both groups

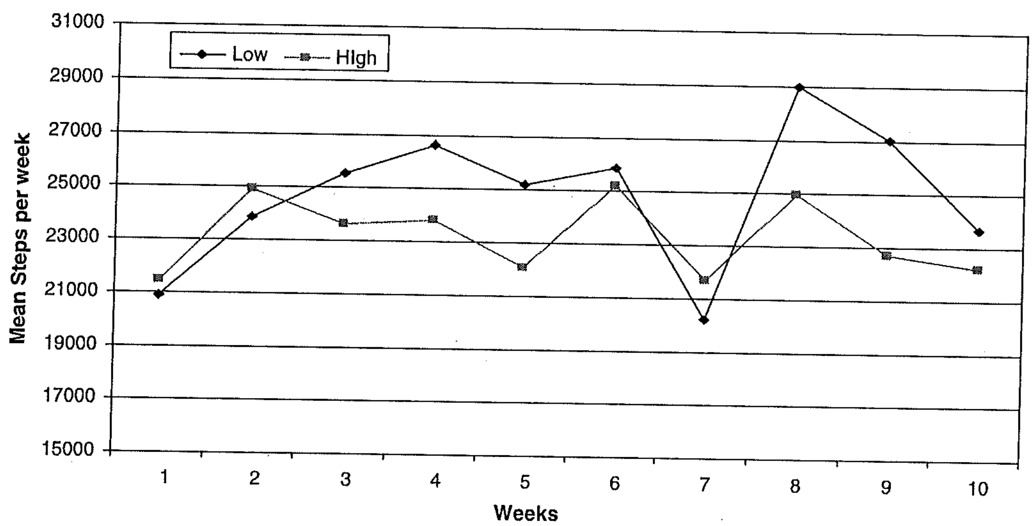

Fig. 7 Mean steps per week stratified by BMI. Low (BMI) is <25 kg/m2 and High (BMI) is ≥25 kg/m2. No significant difference in steps per week for both groups

Discussion

This study was designed to increase the level of physical activity of workers during their working hours and motivate them to increase the number of steps walked using a pedometer. Employees were encouraged to use every opportunity to walk for example taking stairs, parking their cars further away from the building, or using their break times to walk. In the 10-week period, the 206 participants took a cumulative 38,922,980 steps. Assuming that the participants walked at a pace of 2 miles per 30 min or 4,000 steps, this is equivalent to 1,459,591 calorie expenditure (CDC and ACSM Guidelines). On average, each participant burned 177 calories per day. The mean calories burned at baseline were 156.9 and 198.8 at plateau. This shows that a pedometer walking program may be effective at increasing physical activity in sedentary employees and may be effective at helping them maintain or lose weight. Although this study did not control for participants' food intake, the increases in the number of steps may help overweight and sedentary participant maintain or lose weight. Dietary intervention in combination with physical activity may have even more effect in helping participants lose weight (Alnasir and Masuadi 2006). It could also be assumed that the program was effective at helping hypertensive participants reduce their blood pressure. Through the use of pedometers, employees were able to track and increase the number of steps they took per day over the 10-week period. On average, the employees walked almost 5,000 steps per day during their eight hour workday, which is half of the recommended 10,000 steps per day (Iwane et al. 2000).

Most adults spend half of their waking hours at work. Therefore, a worksite pedometer-based walking program may be an excellent intervention to help working adults achieves energy balance, i.e., maintain or lose weight by increasing their physical activity. Stovitz et al. (2005) found that participants who were given pedometers walked more than the control group. It appears that the pedometer served as a cue to encourage walkers to increase their steps and consequently their physical activity level.

The non-significant increases in the number of steps for weeks 7–10 were due to Thanksgiving and Christmas Holidays. As a result of the shortened week, the average steps per week for week seven were less than those of the other weeks and almost the same as baseline. However, this did not impact the average steps per day taken by each participant. The average step per day for week 7 was comparable to the other weeks, which could mean that participants walked more to compensate for the days they were out of the office.

Some participants walked more than 8,000 steps per day within the same eight hours, which could mean that they walked at a faster pace, or they approximately doubled their steps per day. In the long term, this faster pace could translate into muscle gain. In this study, we did not measure the percentage of body fat, but for future research, this could be a way to confirm the findings. The relationship between physical activity and BMI is contradictory in different studies. Some studies reported that there is a direct association between physical inactivity and BMI (Cooper et al. 2000; Fogelholm and Kukkonen-Harjula 2000; Stunkard and Wadden 2003), those with higher BMI are mostly inactive. In contrast some other studies reported that there is no association between baseline BMI and subsequent physical activity level (Fogelholm et al. 2000; Sallis et al. 1992a; Sallis et al. 1992b).

In our study, we did not find any differences in the number of steps taken between those with high and low BMI; the average number of steps for those with high BMI was very similar to that of those with normal BMI. However, it should be noted that some of the participants experienced significant weight loss by the end of the intervention. In a study by Iwane et al. (2000) a pedometer-based walking program was shown to help participants lose weight. Similar findings were found in this study; one-third of the participants lost weight and another one-quarter maintained their weight (Fig. 5). This could be correlated with the thirty-three percent who moved from 'not active' to 'active' as well as moved from the 'preparatory' to the 'action' stage. In addition, the increase in the number of participants meeting the recommendation for mild and moderate physical activity could also have contributed to this weight loss. Although we did not control for dietary intake of the participants in this study, it is possible that as a result of participation in the walking program, participants also changed other negative behaviors, such as unhealthy eating, as indicated by significant movement through stage of change for eating habits.

This worksite walking intervention also proved effective in helping participants with high blood pressure to decrease their blood pressure. This result is not surprising as walking is known to be a relaxing activity. Participants probably decreased their stress level by taking time out of their busy schedule to exercise outside while chatting with co-workers and enjoying pleasant scenery. Over time, this could help to lower blood pressure. Additional factors that could have contributed to the increase in physical activity, reduction in blood pressure, and body weight include prompts to take the stairs instead of the elevators and the presence of teammates, who could provide motivation and support. Of 206 participants, only 56% completed the entire 10- week program. The drop out occurred mostly during the holiday season. This attrition was likely due to holiday-related obligations that diverted some of the participants' interest and attention away from the PA intervention, and due to the shorter holiday work week.

Interestingly, the stage of change or the level of physical activity pre-intervention did not predict the number of steps taken during the intervention. That is, the participants who were active took more steps than those who were not active; the difference was not significant at baseline, mean and plateau. For health promotion professionals, this finding may be considered noteworthy because it demonstrates that a worksite pedometer-based walking program can be an effective way to increase the physical activity of all people regardless of their pre-intervention stage of change designation and level of physical activity.

Allowing participants access to a website appeared to be a cost effective means to further increase their awareness of their physical activity level and their health risk. Every month, over 500 visits occurred from these worksites to the website, which means that participants were accessing information posted on the website. Participants could go to the website to find motivational messages as well as send and receive program-related e-mail. The application of e-technology has been shown to increase patient's education and compliance to mange chronic disease. It has shown to increase patients' awareness of their risk factor to be an educated customer when dealing with their disease and discussing it with their physicians (Gerber and Eiser 2001; Gustafson et al. 2001).

In addition to its impact on physical activity, it is likely that this intervention helped participants to better manage stress. Evidence to support this assertion is based on the fact that 100% of the participants in the 'precontemplation' stage for stress management pre-intervention moved up *at least* one stage post-intervention.

In conclusion, this worksite pedometer-based walking program was associated with a decreased risk for cardiovascular disease and obesity. Since walking is an inexpensive, relatively easy and convenient form of physical activity, implementation of this type of program at work could be an effective approach to reduce cardiovascular risk factors and manage overweight and obesity in sedentary adults. The program was effective in increasing individuals' awareness of risks associated with physical inactivity and motivating them to make additional health-related changes. Another noteworthy observation was that post-intervention there continued to be a significant movement toward a healthier lifestyle for all behaviors as assessed by the TTM Model.

One major concern regarding this type of intervention is the impact of attrition on program outcome. Researchers and planners are interested in discovering how to reduce this factor and increase retention. In this study, we attempted to address this concern by incorporating the 'buddy system; a strategy that has been shown to increase retention by motivating individuals to become accountable to someone other than themselves while attempting to initiate and sustain a health-related activity (in this case, a walking regimen). Motivational e-mails were also used to encourage participants to establish and meet goals. We monitor the access to the motivational messages by tracking the number of hits by the employees to the website, especially to the motivational page of the website. We did not track the email motivational messages due to confidentiality.

In this study we showed that a very simple intervention of providing employees with pedometer, using the website to motivate them and incorporate social support network at work is a simple, low cost intervention which could address the obesity epidemic, sedentary lifestyle, and associated health care costs.

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