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Is Knowing Enough? Increasing Physical Activity by Wearing a Pedometer

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ABSTRACT

Objective: Physical inactivity is a health concern in the United States with nearly 70% of the population getting inadequate amounts of exercise. We set out to determine if wearing a pedometer could significantly increase awareness and amount of physical activity among female employees at a large health care setting.

Methods: Employees purchased a pedometer, completed a survey, and were encouraged to walk 10,000 steps daily. Eight weeks later, they completed a follow-up survey.

Results: Initially, 510 employees initially participated. Results from 400 women are reported. Setting daily step goals, keeping a log of steps walked, and wearing the pedometer all the time were the indicators most likely to predict significant improvements in level of awareness and amount of physical activity, self-efficacy, and other physical improvements (increased energy, ill less often, and weight loss). A majority (71%) indicated they would continue to wear the pedometer after the study ended.

Conclusions: Wearing a pedometer is a simple, non-invasive way for women to increase awareness of daily activity and does lead to increased physical activity. Maximum results in improved activity and improvement in health occurred in women who were most compliant with the intervention.

INTRODUCTION

The prevalence of overweight adults is increasing dramatically in the United States. Results from the Behavior Risk Factor Surveillance System (BRFSS) suggest that obesity prevalence increased by more than 57% among adults between 1991 and 1999 (body mass index [BMI] of 30.0 kg/m^2 or greater.)[1,2] Excess weight occurs when a person consumes more calories from food than he or she expends through physical activity. Data from the BRFSS in 1998 showed that 27% of US adults did not engage in any physical activity, 28% were not regularly active in the previous week, and 80% of adults exercise less than 30 minutes per day for 5 days a week.[3] Bonheur and Young showed that women are, on average, more sedentary throughout their lives than men.[4]

Many factors influence a woman's physical activity level. Some factors are biological in nature (e.g. genetic, neural, metabolic, and sensory influences),[5] others are psychosocial (e.g. perceived benefits to exercise, self-efficacy, goal setting, and social support),[6] while still others are environmental (e.g. access to facilities, safe environments, and optimal weather conditions). In addition, several host factors, such as age, race, income, and education, may affect physical activity in women.[6]

In 1999, the Cooper Institute for Aerobics Research conducted a 24-month study comparing the effects of "lifestyle activity" to "structured exercise" on 235 healthy sedentary men and women.[7] Subjects randomized to the lifestyle activity group were asked to accumulate 30 minutes of moderate-intensity physical activity on most days. Activities could include those activities that people could fit into their everyday routine such as walking, biking, playing tennis, or golf. Those randomized to structured exercise received a traditional prescription for exercise, including a membership at a health club with a set routine based on the individuals' preferences for exercise. At the end of the 24 months, researchers concluded that lifestyle activity was as effective at improving physical activity, fitness, and cardiovascular risk as a structured traditional exercise program. The researchers also found compliance to be slightly better for those in the lifestyle activity group. They approximated an extra 1000 kcal/week or about 150 kcal/day is necessary to achieve a significant improvement in cardiovascular risk. This recommendation fits well with the Surgeon General's report that encourages people to get at least 30 minutes of activity most days.[8]

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A pedometer is a non-invasive tool that allows for instant feedback regarding a person's activity level. It measures vertical accelerations of the body and captures a variety of activities that enhance the concept of "lifestyle activity." Research has concluded that approximately 10,000 steps is equivalent to an extra 150 kcal/day, and thus becomes the recommendation for most adults.[9] The accuracy of a step counter or pedometer to measure energy expenditure has been criticized.[10-12] Nelson et al[10] compared 4 different activity monitors to an assessment of indirect calorimetry. At all walking speeds, either the pedometer over-counted or under-counted calories expended. New technology has improved the quality of pedometers, as well as making them more affordable ($20-$25 per unit). Welk and colleagues[13] conducted a study using the Digi-Walker (Yamax Inc., Tokyo, Japan), comparing the number of steps needed to complete a mile on a treadmill and track at various speeds and found no significant difference in the number of steps by surface type.

The most significant benefit to wearing a pedometer may not be its ability to monitor the actual amount of activity in any given day, but rather to provide immediate feedback for participants, serving as a behavior modification tool. Sequeira et al[14] suggest that the pedometer can be worn without major inconvenience, requires little effort on the participant's part, and is compatible with most daily activities, making it a practical and socially acceptable measure of physical activity in large free-living populations.

We describe below a research study called the "Monitoring Your Physical Activity Level" (MY-PAL) project. This project investigated the impact a pedometer worn for 8 weeks had on female health care workers. We examined changes in physical activity, awareness of one's level of physical activity, self-efficacy and physical activity, and what impact keeping a step log and goal setting had as possible mechanisms for increased effectiveness of the pedometer.

METHODS

Employees at a health care organization in a 3-state area were recruited to participate in this 8-week research project conducted in the summer of 2000. The health care organization employs over 5100 people in a 19-county service area with 25 remote clinics, in addition to a major central clinic and hospital. Participants purchased a pedometer for $20 (Yamax SW200; Walk4Life, Plainfield, Ill) and completed a baseline survey. They were instructed to walk 10,000 steps each day and strongly encouraged but not mandated to keep a log of their progress. Participants were instructed on how to wear the pedometer. At the end of the 8 weeks, they completed a follow-up survey and returned it along with their step log. Upon receipt of the follow-up survey, participants were reimbursed $10.

The research study had Institutional Review Board approval and completion of the surveys assumed consent. Participation was voluntary. Those not completing the final survey did not receive the reimbursement. Data was entered into a database and analyzed using the SAS statistical software.[15] Analysis of variance, chi-squares, and *z* scores were calculated to test changes over time. All *P* values <0.05 were considered significant.

Pre- and post-surveys asked about participants' awareness of their current level of activity, the number of times per week they exercised, and the frequency of short bouts of activity to "fit exercise in" per week. We also asked participants about perceived improvements in such areas as their energy level, mood, stress, endurance, weight loss, and how their clothes fit. Participants were asked to rate their self-efficacy regarding exercise. Self-efficacy measures one's belief in her ability to become physically active even in the presence of barriers to physical activity or alternative activities. For this study, the self-efficacy scale developed by Marcus et al[16] was used. This scale asked participants to rate their level of confidence that they could exercise in situations such as when they are too tired, in a bad mood, or when the weather is bad. The Marcus scale uses a 7-point Likert scale ranging from 1 ("not at all confident") to 7 ("very confident") and total scores range from a low of 5 to a high of 35 points.

RESULTS

Overall, 510 employees initially participated (473 women, 37 men.) For this paper, the analysis was restricted to the 400 (85%) women that completed all parts of the study. The mean age of the women participants was 42.01 years (8.92 year standard deviation). Age was not related to any of the outcomes or mediating variables in our analysis (all *P* values >0.05).

At baseline, 40% of the women (n=160) rated themselves as sedentary (i.e. they engaged in 30 minutes of physical activity less than 3 times per week). After the 8-week study, only 27% of the women were sedentary. Those women who were sedentary at baseline were much more likely to have a significant change in the number of days they exercised per week compared to active women (+1.51 days vs. –0.03 days, $P<0.0001$) and in the number of days they were able to fit in short bouts of activity (+1.2 days vs. +0.45 days, $P=0.0023$).

We examined three different intervention variables (goal setting, keeping a step log, and wearing the pedometer all of the time) to determine if there were any characteristics that could distinguish those participants who were more successful. Fifty-six percent of the women reported setting a daily step goal. At baseline, the women who were more active were slightly more likely to set goals. Participants who set daily step goals had significant improvements in self-efficacy, were more likely to be aware of the level of exercise needed to benefit their health at follow-up, and more likely to increase the awareness of their own level of activity. Additionally, these women were more likely to increase the number of days they exercised from pre- to post-study. Finally, the women who set daily step goals said they had increased energy, improved muscle tone, lost weight, clothes fit better, and had less stress than those who did not set goals (Table 1).

During the study, 250 women (63%) kept a log of their physical activity during the study. Those keeping a log were more likely to also set daily step goals, and their goals were more aggressive (i.e. greater than the recommended 10,000 steps per day). Log keepers reported having more days per week in which they engaged in short periods of exercise or physical activity both at baseline and at follow-up than those who did not keep a log. The change in level of activity was not significantly different for those keeping a log or not keeping a log, however. Women who kept logs said that wearing the pedometer made them more aware of their daily amount of physical activity and they were more likely to see a positive change in their self-efficacy (Table 2).

Participants were asked if they wore the pedometer all of the time, some of the time, or none of the time during the 8-week study. Women who reported wearing the pedometer all of the time (43%, n=173) were compared to the rest of the participants. They were more likely to have kept a log, set daily step goals, and to have set goals that were more aggressive. Women wearing the pedometer all of the time were more likely to say their awareness of their own level of activity was increased and to say that wearing the pedometer had made them more active. These participants were more likely to have seen a greater improvement in their self-efficacy. Additionally, they were more likely to say that their clothes fit better and that they were somewhat likely to be less ill at the end of the study. Finally, the women wearing the pedometers all of the time were more likely to meet the 10,000 steps per day goal and more likely to walk 10,000 steps on more days during the study than those not wearing the pedometer all of the time (Table 3).

Table 1. Impact of Goal Setting on Improvements Reported by Participants

Improvement	Set Goal (n=222)	No Goal (n=177)	*P* value
Sedentary at follow-up (%)	19.2	36.4	0.0001
More aware of level of activity needed to benefit health (%)	88.7	76.8	0.0013
More energy (%)	63.5	49.2	0.0056
Weight loss (%)	56.3	40.7	0.0019
Clothes fit better (%)	41.9	31.1	0.0262
Less stress (%)	43.7	33.3	0.0351
More active (%)	45.5	23.9	0.0001
Change in number of days per week exercise (>20 min/ vigorous) (mean)	0.8	0.3	0.0078
Increase in self-efficacy (change from pre- to post) (mean)	2.2	0.3	0.0052
% of total steps met (mean)	78.3	59.7	0.0005
% of days met goal (mean)	47.0	26.7	0.0001

Table 2. Impact of Keeping a Log on Improvements Reported by Participants

Improvement	Kept Log (n=250)	No Log (n=150)	*P* value
Set goal (%)	60.0	48.3	0.0231
Set goal greater than 10,000 steps/day (%)	50.0	24.7	0.0001
More aware of own level of activity (%)	83.6	71.2	0.0045
Increase in self-efficacy (change from pre- to post) (mean)	1.8	0.6	0.0588

Table 3. Impact of Wearing the Pedometer All of the Time on Improvements Reported by Participants

Improvement	Wore All the Time (n=173)	Wore Less than All the Time (n=227)	*P* value
Kept log (%)	80.4	48.9	0.0001
Set goal (%)	64.0	49.3	0.0036
Set goal greater than 10,000 steps/day (%)	50.9	32.6	0.0011
Clothes fit better (%)	44.5	31.3	0.0066
Less ill (%)	8.7	4.0	0.0496
More aware of own level of activity (%)	86.1	73.9	0.0031
More active (%)	44.2	29.7	0.0027
Increase in self-efficacy (change from pre to post) (mean)	2.5	0.5	0.0023
% of total steps met (mean)	84.7	59.7	0.0001
% of days met goal (mean)	47.3	28.3	0.0001

Table 4. Impact of Compliance (Set Goal, Kept Log and Wore Pedometer All of the Time) on Improvements Reported by Participants

Improvement	Compliant (n=92)	Not Compliant (n=308)	*P* value
Improved muscle tone (%)	39.1	27.0	0.0249
Weight loss (%)	58.7	46.4	0.0389
Clothes fit better (%)	51.1	32.8	0.0014
More aware of own level of activity (%)	85.9	77.1	0.0702
More active (%)	53.3	30.7	0.0001
Increase in self-efficacy (change from pre- to post) (mean)	2.6	0.9	0.0376

Table 5. Impact of Planning to Continue Wearing a Pedometer After the Study on Improvements Reported by Participants

Improvement	Plan to Wear (n=282)	No Plan to Wear (n=116)	*P* value
Set goal (%)	62.4	38.8	0.0001
Set goal greater than 10,000 steps/day (%)	44.7	30.2	0.0004
More aware of level of activity needed to benefit health (%)	86.7	75.0	0.0044
More aware of own activity level (%)	84.0	67.2	0.0002
More energy (%)	62.8	44.8	0.0010
Improved endurance (%)	45.7	31.0	0.0068
Weight loss (%)	55.0	36.2	0.0007
Less ill (%)	7.5	1.7	0.0262
Less stress (%)	43.3	29.3	0.0096
More active (%)	44.3	14.8	0.0001
Increase in self-efficacy (change from pre- to post-study) (mean)	2.1	-0.5	0.0005
% of total steps met (mean)	73.8	58.2	0.0090

After analyzing each of the 3 intervention variables (setting a goal, keeping a log, wearing the pedometer all of the time) separately, we combined them to create a compliance indicator and analyzed its impact on participants' outcomes. "Compliant" participants (n=92, 23%) were slightly more likely to say that wearing the pedometer made them more aware of their daily amount of physical activity and more likely to be more active than those who were not compliant. These women had a greater positive change in self-efficacy than those who were not compliant. Finally, the compliant women reported losing more weight, increasing their muscle tone, and having their clothes fit better (Table 4).

The last question we asked participants was whether they planned to wear the pedometer for at least the next 6 months after the study. Two hundred eighty-two women (71%) reported they planned to continue to wear the pedometer, and they were also more likely to show improvement in self-efficacy. Additionally, they were more likely to be aware of the level of activity needed to benefit their health at follow-up and more likely to be aware of their own level of activity than those who were no longer planning to wear the pedometer. The women planning to wear the pedometer after the study benefited in the following outcomes: energy, endurance, weight loss, less illness, and less stress (Table 5).

DISCUSSION

The MY-PAL study was designed to investigate whether wearing a pedometer could increase a woman's knowledge of her level of physical activity and increase her participation in exercise. The study also looked at the woman's perceived health benefits attributed to her increased exercise level. Participants were encouraged to walk 10,000 steps per day. Additionally, women were encouraged to set daily step goals, to keep a log of their activity, and to wear the pedometer all of the time for the 8-week study.

Changing one's pattern of exercise is not easy. In fact, it is expected that between 40% and 65% of individuals beginning a new exercise program will drop out within 3 to 6 months.[16-17] There are a number of psychosocial factors that can influence the behavioral change process. We looked specifically at 3 psychosocial factors (goal setting, keeping a log, and wearing the pedometer all of the time).

Goal setting involves establishing realistic and attainable steps for performing the desired behavior.[19] Women who set goals in the MY-PAL study were significantly more likely to be aware of their own levels of activity, and more aware of the level of activity needed to benefit their health. Not only did they say they were more active, the change in number of days per week they exercised from pre- to post-study increased significantly. They met the 10,000-steps per day goal more often and were more likely to exceed the 10,000 steps. Significant improvements in energy level, weight loss, stress reduction, and the way clothes fit were reported in those who set goals. It has been proposed that goal setting successfully directs attention and action, mobilizes energy expenditure, prolongs maintenance of effort, and motivates people to develop self-regulation strategies for success.[20-21]

Keeping a log promotes accountability for the participant. The log serves as a prompt or reminder and provides feedback of the progress made for the exerciser. Prompting and feedback have been shown to be effective in increasing and maintaining physical activity as well as other health behaviors.[22] This study showed that women who kept a log were more aware of their own level of physical activity and more likely to set aggressive goals.

At the onset of this study, the participants were instructed to wear the pedometer for the entire 8-week period. Wearing the pedometer, we hypothesized, would serve as a reminder and encourage the participants to increase their activity level. We found that women who wore the pedometer all of the time saw improvements in the way their clothes fit and were less ill. Additionally, they were more likely to set aggressive goals. Participants wearing the pedometer all of the time were more aware of their activity level, became more active, met the 10,000-step per day goal more often, and were more likely to walk more than 10,000 steps per day.

Self-efficacy is a mediator of behavioral change. Mediators can be defined as "intervening causal variables that are necessary to complete a cause-effect pathway between intervention and physical activity."[23] Our study showed that those participants setting goals, keeping a log, or wearing the pedometer all of the time had significant improvement in their self-efficacy to exercise. The study also showed that women meeting the compliance criteria (set goal and kept log and wore pedometer all the time) also saw significant improvements in self-efficacy. Wearing a pedometer and realizing that it is possible to exercise in situations previously not thought possible may enhance a woman's self-efficacy, which in turn may lead to an increased level of physical activity.

We felt the most compelling indicator of value for the participant was if they indicated they planned to wear the pedometer beyond the study's completion. We were encouraged that over 70% of the women indicated they planned to continue to wear the pedometer. These women were more likely to report significant physical improvements (more energy and endurance, less illness and stress, and weight loss) and improvements in self-efficacy. Given the high dropout rate of most exercise programs, one of the greatest strengths to wearing a pedometer may be its longevity.

This study has a number of weaknesses. The lack of a control group is a limitation; however, our study was designed to see if wearing a pedometer could be a tool used to increase physical activity. We felt it necessary to determine if a pedometer could be useful and cost-effective before designing a study requiring the use of more invasive and costly measures (e.g. BMI calculation, cholesterol testing, etc.). Future research should be designed to examine the specific physiological and psychological effects the use of a pedometer may have on a person's physical activity level.

A second weakness is that the self-reported nature of outcomes does not allow us to know the pedometer's true impact on weight loss or ultimately on lower risks for chronic illness. The short duration is also limiting, since 8 weeks may not be sufficient to see health results. Further studies should explore the impact of wearing a pedometer for longer. The study results presented here were limited to women. The impact of a pedometer for males was thus not determined from this study. Only a small number of males participated, reflective of the make-up of the health care workforce.

Despite the limitations, we believe the study was successful. We were able to reach 10% of our workforce. Given the remote locations and the "around-the-clock" nature of the health care organization, we feel this is significant. The study was also low in cost and non-invasive. Additionally, 71% of the participants indicated that they would be wearing the pedometer for at least 6 months after the study. Given that past studies have shown a 3- to 6-month dropout rate of 40% to 65% for individuals beginning a new exercise program, we feel walking may prove to be more effective in promoting physical activity than other forms of exercise. Further research is needed to explore this possibility, and the MY-PAL study should be expanded to include other groups such as children, older adults, and those persons who are severely obese.

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