Web-Based Physical Activity Intervention for College-Aged Women

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Abstract

This study compared the effectiveness of a web-based physical activity intervention to two control conditions in terms of increasing walking behavior in college-aged women. Women (N=112) from a public university in the southwest were randomly assigned to intervention or control groups. The 4-week intervention featured an experimental, repeated measures design that used the internet to deliver interactive activities. Control group participants were asked not to change their activity. Walking behavior was assessed by using pedometers to record step counts daily. Data were analyzed using repeated-measures analysis of variance (RM-ANOVA). Women who received the intervention increased their mean steps/day by 38.8% while women who did not receive the intervention increased their mean steps/day by only 2.1% [F (1) = 2.61, p=.001]. A web-based physical activity intervention promoted the short-term adoption of routine walking in college women.

Key words: *Physical Activity, Females, Pedometer*

Introduction

Physically Inactive Lifestyles

According to research, sedentary persons engage in less than 30 minutes of moderate intensity physical activity (PA) per day.[1] A sustained sedentary lifestyle increases risk for several conditions including heart disease, hypertension, obesity, and type 2 diabetes[2] and it may also contribute to early mortality.[3] Indeed, poor diet and physically inactive lifestyles are the second highest cause of mortality.[4] The good news is that sedentary lifestyles are modifiable. The Centers for Disease Control and Prevention (CDC) recommend that persons participate in PA at least 30 minutes on most, if not all, days of the week.[3] It is clear that decreasing risk for mortality can occur when individuals increase their daily activities to a level such that they are meeting standard PA recommendations and making PA a fundamental component of their lifestyle.[5]

College-aged women are at risk for developing sedentary lifestyles in the transition years between college and career. Unfortunately, very few intervention studies have addressed the sedentary lifestyle of college-aged women. Health promotion professionals are in a good position to promote PA through college-supported wellness centers. Development of effective health promotion interventions to prevent sedentary lifestyles in college-aged women is a challenge for health promotion professionals.

College-aged Women and Physical Activity

The sedentary lifestyle of females is striking. When women enter college, they become significantly less physically active than when they were in high school.[6] Up to 67% of college-aged women are insufficiently physically active.[7] Proposed reasons for their lack of PA include: (a) lack of time or motivation,[8] (b) lack of enjoyment,[9] (c) lack of purpose (compared to other life tasks),[10] (d) a desire to spend time with family members who have needs, (e) and other household demands.[9,10] If women do not develop behavioral skills to increase PA during college, it is unlikely they will adopt a physically active lifestyle after entering the workplace.[7]

Interventions Designed to Increase Physical Activity

Throughout the years, researchers have designed interventions to increase PA. Unfortunately, few PA interventions have targeted college-aged women. Interventions that promote walking to increase PA are appealing because walking is the most popular PA for women.[10] Interventions that used walking to increase PA increased physical fitness,[11] decreased blood pressure,[11,12] and increased glucose tolerance.[12] Research suggests that women who walk more, as measured by pedometers, have less body fat.[13]

Pedometers are an efficient, valid and reliable method of measuring walking behavior.[14] Pedometers display "steps taken" on the front of the device and thereby, can motivate participants to walk. Pedometer step count indices have been established that identify sedentary (<5000 steps/d), inactive (5000-7499 steps/d), somewhat active (7500-9999 steps/d), and very active (≥ 10,000 steps/d) behavior in adults.[15] Studies that used pedometers and daily activity logs as part of an intervention found that participants significantly increased the amount of walking they did.[16,17]

Home-based intervention programs have been successful in increasing PA levels among adults.[18] Social Cognitive Theory[19] was used as a framework in the intervention to develop behavioral capacity that include self-efficacy, outcome expectations, and reinforcements.[18]

In addition, recent research demonstrates that the combination of media-based and face-to-face interventions show promise in increasing PA behavior.[20] Web-based interventions were successful in increasing PA in adults at their workplace[21] but were not successful at increasing PA in adults with disabilities[22] or diabetes.[23] Interventions that were web-based have shown to be effective in increasing knowledge about PA and the use of self-regulation skills in college students[24] but were not successful at increasing PA when compared to a print-based intervention in adolescent females.[25] A few studies found that participants' use of the website decreased over time.[23,26] Many of these studies did not address the effect of the intervention on PA level.

WebCT is an electronic learning system used in higher education.[27] WebCT provides an internet communication platform for instructors to create interactive learning experiences, assess student performance, and distribute course materials such as syllabi, assignments, and content. Web-based courses are equivalent to conventional courses in knowledge transfer[28] and students consider these courses a valuable alternative to conventional courses.[27] Colleges and universities generally offer numerous courses through this system; therefore, using a theoretically based intervention program delivered through WebCT is a practical option for promoting PA in this group.

Given that 9.4 million young adults are enrolled in colleges and universities[7] and that PA can be increased by developing interventions with typically sedentary populations, studies are needed to determine if web-based PA interventions can facilitate the adoption of walking in college-aged women. This study compared the effectiveness of a web-based physical activity intervention to a control condition in terms of increasing walking behavior in college-aged women. The 4-week intervention used the internet to: (a) deliver interactive activities designed to improve behavioral capabilities, self-efficacy, and outcome expectancies, and (b) increase reinforcement of self-regulated walking. The hypothesis of this study was that college-aged women using a pedometer and receiving a 4-week web-based PA intervention have significantly greater mean pedometer steps than college-aged women not receiving the intervention.

Methods

Participants

Desired sample size was calculated for a repeated-measures design using the following data: (a) the average correlation between the measures, or the mean steps per day at each time, (0.50) (b) the number of times the participant was being measured (5 times), and (c) the desired effect size (medium, .35).[29] A sample of 75 participants (25 in each group) was deemed necessary for a power of 80% and a significance level of .05.

This study was approved by the university's Institutional Review Board. Inclusion criteria were female students aged 18 to 34, who were not regularly or systematically physically active, and were comfortable using computer technologies as determined by researcher-developed questions. Examples of questions used to determine eligibility are "How many days of the week are you usually physically active for at least 30 minutes?" and "How confident do you feel using a computer?" Participants also had to be able to walk unassisted, follow directions, and have the time and desire to participate. Women were excluded if they were athletes at the university or majors in physical education or dance. Recruiting techniques included using newspaper ads, posters, and researcher visits to classes on the college campus. Potential study participants were asked by the first author to participate in the study. If participants met inclusion criteria, the study was explained and informed consent was obtained.

Although 210 students met the eligibility criteria for the sample, 121 students agreed to participate in the study (58% participation rate). No significant differences in age, educational background, or baseline PA were found between participants in the intervention and control groups.

Instrumentation

Pedometers (YAMAX, SW 200), which are spring loaded devices worn on the waistband, were used to assess ambulatory activity (i.e., steps/day). Pedometers are easy for participants to use and provide low cost valid and reliable data for assessing changes in walking behavior in college women.[31] Prior to the start of data collection, pedometers were calibrated for reliability by having participants walk 50 steps while concurrently counting.[32] Pedometers that did not record steps accurately were repositioned and another 50 steps were taken and counted; those pedometers that still did not measure with 3% of the 50 steps (49-51 steps) were replaced with another pedometer until adequate reliability could be obtained.

All participants wore a sealed pedometer for seven consecutive days to record baseline activity and daily steps for the 4-week intervention or control period. Steps/day were averaged by week (e.g., baseline, week 1, week 2, and so on).[31] Data collection began in August of 2005 and ended in October of 2005.

Intervention

An experimental repeated measures design was used to compare the effectiveness of a web-based PA intervention to two control conditions in terms of increasing walking behavior in college-aged women. After baseline activity was obtained, participants were randomly assigned into a sealed pedometer control group (n=30, wore sealed pedometers, no feedback on steps taken, no intervention), an unsealed pedometer control group (n=30, wore unsealed pedometers, recorded steps taken only, no intervention), or an intervention group (n=61, wore pedometers, set goals, recorded steps taken, web-based intervention). The two control groups were used to determine whether there is a motivational effect to be more physically active because of being able to view pedometer steps per day (unsealed pedometer control group) compared to not being able to view pedometer steps per day (sealed pedometer control group) regardless of the receipt of information on physical activity.

Participants in the control groups were not given instruction to increase physical activity or access to the intervention. They were asked not to change their PA level but rather to follow their present daily routine. Their steps/day reflected normal fluctuations throughout the entire intervention period. The sealed pedometer control group met with the first author weekly to record their steps and reset their pedometer. Their steps/day were added together and divided by 7 to obtain mean steps/day over the five weeks examined for this study. Participants in the unsealed pedometer control group recorded steps per day and the time their pedometer was worn daily for the four-week period. Data sheets used to record steps/day were collected at the end of the intervention period.

After baseline, ambulatory activity level was obtained as previously described. Participants in the intervention group were told their baseline mean steps and shown how to set goals for walking for the first week of the intervention. They participated in a web-based intervention where they learned about lifestyle PA, set step goals, wore a pedometer to monitor the attainment of their step goal, and recorded daily steps taken. This procedure was repeated each week throughout the 4-week intervention. The length of the intervention was chosen because interventions of moderately intense physical activity, delivered through mediated methods with shorter lengths (4 to 6 weeks) had higher effect sizes than longer interventions delivered through other mediums.[29] Participants were encouraged to access the WebCT site daily and view the different modules within the program to help develop their walking program. Messages to encourage visiting the site were emailed to the intervention participants each week.

Nine modules, based on the Social Cognitive Theory, were created for the intervention. A summary of the application of specific components of the Social Cognitive Theory to the intervention is presented in Figure 1. The first three modules contained information about lifestyle physical activity, the benefits of physical activity and safety issues. Participants learned how to integrate walking into their daily routine and stretching and safety tips for walkers were presented. These three modules addressed behavioral capability aspects of Social Cognitive Theory.

Participants were given pedometers at the beginning of the intervention; through face-to-face interaction and reinforcement on WebCT, they were instructed on how to wear and use the pedometer to record steps taken. The module, "Using a Pedometer," reinforced the verbal and written instructions on pedometer use given at the beginning of the study. The module "Monitoring Your Progress," instructed participants to set goals and monitor whether or not their goals were met. The WebCT module stressed that goals should be set to increase the amount of PA (walking) done by the participants. Personalized step goals were used to decrease the risk of failing to meet goals. For example, rather than set a goal of walking 10,000 steps/day, which some participants may not be able to meet, this module encouraged participants to write goals that initially increased their daily steps from 1000 to 3000 over their baseline steps. These modules addressed the self-regulation component of the Social Cognitive Theory.

The process of identifying and overcoming barriers to walking was reinforced because barriers cause many participants to stop their PA. Therefore, several modules were developed to increase participant awareness of barriers to PA. "Barrier Identification" contained information about the identification of barriers to PA and strategies to overcome these barriers. "Choices and Strategies" presented participants with choices and strategies to increase the amount of walking they do in their daily routine. "Strategies to Deal with Barriers" contained information on decreasing barriers to PA. Modules on identifying and overcoming barriers and making PA choices were developed to enhance self-efficacy, as described in the Social Cognitive Theory.

Links to maps and a state-supported PA site were incorporated into the WebCT site. Individuals were given feedback on performance attainment through personal e-mails and incentives given for the submission of goal statements and recording sheets (for steps/day) each week. These links and the individualized feedback were developed to reinforce the behavior, as described in the Social Cognitive Theory. The modules in the intervention were pilot tested with seven women who were associated with or students of the university. Minor changes in format were made based on their evaluation.

Data Analysis

To assess the efficacy of this intervention in terms of increasing walking behavior, pedometers were used to compare walking (steps/day) between college-aged women in the intervention group and control groups. Data consisted of mean steps/day as measured by pedometers collected at five different times to attain PA level. SPSS (version 12.0) was used to analyze the data. Statistical treatment of data was by repeated measures analysis of variance (RM-ANOVA). Effect

size (η^2) was calculated to assess the magnitude of the intervention effect. Stevens suggests that 0.14, 0.35, and 0.57 are small, medium and large effect sizes (respectively) for RM-ANOVA-based analyses.[30]

Results

Participants

The final sample was comprised of 112 students: 53 in the intervention group, 29 in the sealed pedometer control group and 30 in the unsealed pedometer control group. Nine of the original 121 participants failed to complete the study (93% completion rate). When demographic and baseline data from the dropouts were compared to data from those participants who finished the study, dropouts were not significantly different from participants who completed except in baseline PA level. At baseline, dropouts had greater mean steps/day (9,756) than participants who finished the study (7,674).

The majority of participants were majors in the colleges of Science (29%) and Humanities (25%). Freshman accounted for 55% of the sample. Eighty-five participants (76%) were single, 24 participants (21%) were married, and 3 participants (3%) were divorced. Sample characteristics are presented in Table 1.

Treatment of Missing Data

Twenty-six cases (3%) of pedometer steps were missing as evidenced by gaps in the recording sheets within the intervention and unsealed pedometer control groups. No data were missing in the sealed pedometer group. In deciding how to treat missing data, the first author examined steps on individual recording sheets and noticed that they were not highly variable (e.g., they were within 500 steps/day) by day of the week. Therefore, missing data for the pedometer steps were replaced by taking a mean of the steps taken by the participant on the same day of the week as the missing datum. Steps/day were checked for normality and skewness and data met the assumptions of RM-ANOVA, including multicollinearity, linearity, and outliers.

Evaluation of Control Group Differences

A 2 (group: sealed, unsealed) x 5 (time: baseline, weeks 1, 2, 3, 4) RM-ANOVA was conducted to evaluate the effect of knowing and recording steps on walking behavior (steps/day). Since the only significant difference in steps between the two control groups was during time 5 (week 4) [t (57) =2.56, p=.01], data were collapsed into one control group and a RM-ANOVA between the intervention group and combined control groups was performed to determine if there was a group by time interaction effect. Figure 2 shows the mean pedometer steps plotted over time for the sealed and unsealed pedometer control groups.

Evaluation of Intervention and Control Group Differences

A 2 (group: intervention, control) x 5 (time: baseline, weeks 1, 2, 3, 4) RM-ANOVA was conducted to evaluate the effect of the intervention, regardless of step count exposure, on level of PA. The dependent variable was mean pedometer steps and the independent variable was group assignment. The assumptions of sphericity and homogeneity of variance were not met; therefore, the group by time interaction effect was tested using both the multivariate criterion of Wilk's λ and the univariate criterion of Greenhouse Geiser.[33]

Significant differences were found in mean pedometer steps during weeks 1, 2, 3, and 4 between women in the control and the intervention groups, Wilk's λ =.785, F(4,107)=7.33, p=.001; F(2.8)=13.8, p=.001. The effect sizes (□ for the group by time interaction were considered small [□=.11 (univariate) to .22 (multivariate)]. This finding indicates that the group by time interaction effect of the sample explains 11-22% of the variance in PA behavior.

A significant linear pattern was exhibited for the group (intervention, combined control group) by time (baseline, time 1, 2, 3, 4) interaction [F (1) =26.1, p=.001]. The intervention group increased their mean steps by 38.8% overall, while the combined control group increased its mean steps by only 2.1%.

When analyzed separately, the sealed pedometer control group decreased its steps/day by 13.7% over the 4 weeks. The unsealed pedometer control group increased its steps/day by 10.4% over the 4 weeks. A paired t-test indicated that for the participants in the unsealed pedometer control group, the mean pedometer steps at time 2 (M=8,896), were significantly greater than the mean pedometer steps at time 1 (M=7,812) [t (29) =2.5, p=.017]. In subsequent weeks, participants in the unsealed pedometer group maintained their steps near the level established at

time 2 but did not continue to increase step counts (steps/day) significantly over time.

The intervention group participants consistently increased their steps/day each week of the study. The greatest increase occurred from baseline (time 1) to week 1 (time 2) (18.7%); however, the intervention group continued to increase steps/day significantly throughout the study period. Fourteen participants (23%) met their step goals for three of the four weeks of the intervention. Ten participants (2%) met their step goals for all 4 weeks of the intervention. Four participants (8%) in the intervention group decreased their mean steps/day taken by 1.8% to 8.6%. Figure 3 shows the steps/day means plotted by group over time.

The participants in the intervention and unsealed pedometer control groups took fewer mean steps on Tuesdays. Daily variations of steps/day are unknown for participants in the sealed pedometer control group, as they did not collect steps taken daily.

Characteristics of Participants who Increased their Steps/Day

A series of analyses of variance tests were conducted to evaluate the characteristics of participants for whom the intervention worked. Post hoc tests revealed that the intervention was most successful for older students aged 26 to 34 y [$F(1, 52)=4.56$, $p=.04$], who were living alone in a house or apartment [$F(3, 53)=3.91$, $p=.01$], and who were enrolled for 16 or more credit hours [$F(2, 53)=4.09$, $p=.02$]. Other demographic factors or receiving academic credit did not affect whether or not participants increased their PA behavior.

Learning outcomes were not measured with each module but rather Web-CT tracks interactions with the program. This study found that most of the women (86.7%) logged into the intervention on the Web-CT and 42 out of 53 (70%) of these women gained access and viewed the instructional modules. However, less than half of the women (42%) communicated with the program director, and a little less than one-fourth of the women (18.3%) viewed the information from all of the tutorials. Moreover, 10 of the women (16.7%) never viewed the instructive components of the intervention. Those women who accessed the intervention but did not communicate or view the tutorials were probably online to submit their goals and weekly steps.

Discussion

The purpose of this study was to compare the effectiveness of a web-based physical activity intervention to two control conditions in terms of increasing walking behavior in college-aged women. The primary finding of this study was that the web-based intervention facilitated a 38% increase in steps/day whereas the control group increased their PA by only 2.1% steps/day. A second finding was that the PA (steps/day) continued to increase through the duration of the study (4 weeks). This finding suggests that the duration of the intervention could be extended to discover how many more weeks of an intervention should be developed before no further increases in PA is expected. The findings of this study document the effectiveness of a theory-based, web-mediated intervention on increasing walking behavior in college-aged women; however, further research to determine if goal-setting and the use of pedometers alone are effective in producing behavior change is needed. Prior research has shown that PA interventions that are based on theory or use objective measures of PA increase PA in women.[11,12,17,34]

The third important finding was that between the two control groups (sealed vs. unsealed), the effect of revealing pedometer steps/day was statistically insignificant until the 4th week of the intervention. Studies showing the motivational effects of pedometers are scarce. One study found that motivational effects of pedometers lessen over time.[35] The current study found that pedometer steps increased in the unsealed pedometer control group during the 4th week. This finding suggests that in some persons, it may take at least 4 weeks before the knowledge of the number of steps/day begins to affect PA. Since pedometer steps increased significantly in the intervention group and continued through week 4, this finding suggests that the intervention rather than motivational effects of seeing pedometer steps led to the behavior change.

While we reported several novel findings, this study is not without limitations. First, the participants were mostly Caucasian volunteers. Thus, study results should not be generalized to other samples. Future studies should be planned with more diverse samples. Second, this study did not measure the learning that occurred by viewing the modules as an outcome. Future studies should be planned to determine in increasing one's knowledge about physical activity affects behavior. This type of study could help explain if the WebCT promotes behavior change by

increasing one's knowledge or providing reinforcement for goal-setting. Third, difficulties with WebCT may have affected internet access for some of the students. For example, a WebCT quiz was developed to ask the student about their weekly goal, the times they wore the pedometer, and the number of steps taken each day. Many students panicked the first time they entered the quiz area even though they were informed that the quiz was not graded and used only as a means to submit their data. A fourth limitation is that the intervention was only four weeks long. Intervention studies of longer duration should be planned to determine whether the intervention effects help maintain behavior. Another limitation is that we used a no-treatment control group, which may have resulted in the Hawthorne Effect. The Hawthorne Effect occurs when an individual's behavior changes because they know they are being observed. In future studies, an attention control group that logs into an information-only Web-CT program but not the intervention program would reduce this effect.

Despite these limitations, our study is among the first to investigate the use of web-based interventions for promoting PA in college-aged women.[22,23,25,26] Recommendations for future research include investigating which theoretical constructs of a behavior change theory mediate behavior change. For example, behavior change from this intervention may have been linked to self-regulation and the use of the pedometer and setting goals. Further studies should compare the effect on physical activity between interventions that are web-based or pedometers and goal setting. Additionally, using alternative methods of submitting goals and steps should be explored. Flexibility with submitting web-based forms would improve compliance and lessen the problem of missing data. Additionally, future studies should (a) use a pedometer with a timer to obtain intensity of PA or (b) combine classroom sessions with WebCT to compare the efficacy of entirely online courses to that of hybrid courses that meet online and face-to-face. Lastly, incentives tied to completion of classroom assignments and submission of goals and recording sheets in paper form may increase participants' motivation and compliance.

This is the first study conducted to examine whether or not a web-based intervention can increase PA in college-aged women. This study used an objective measure, the pedometer, to measure PA (rather than rely on self-report methods). This study provides evidence that a web-based PA intervention was successful in increasing the PA level in college-aged women. In this study, the use of pedometers, along with goal setting, increased women's PA level. Findings of this study provide a quantitative basis for future work in PA interventions.

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Table 1. Characteristics of the Sample

	Intervention Group (n=53)	Unsealed Pedometer Group (n=30)	Sealed Pedometer Group (n=29)	Difference between groups significance
Age (*M*±*SD*)	20.6 (2.6)	20.5 (3.2)	20.6 (4.0)	0.99
Baseline Steps/day (*M*±*SD*)	7717 (1797)	7812 (2760)	7457 (2814)	0.88
Body Mass Index (kg/m^2)	25.3(6.2)	24.7(5.5)	25.9(6.9)	0.76
	n (%)	n (%)	n (%)	
Living Arrangements				0.41
With parents	7 (13)	0 (0)	4 (14)	
Home/apartment (alone)	2 (4)	0 (0)	1 (3)	
Home/apartment (with others)	30 (57)	19 (63)	15 (52)	
Dormitory	14 (26)	11 (37)	9 (31)	
Employment				0.18
Not employed	25 (47)	15 (50)	21 (72)	
Employed part-time	21 (40)	13 (43)	7 (24)	
Employed full-time	7 (13)	2 (7)	1 (3)	

F-test for continuous variables, Pearson's chi-square test for categorical variables

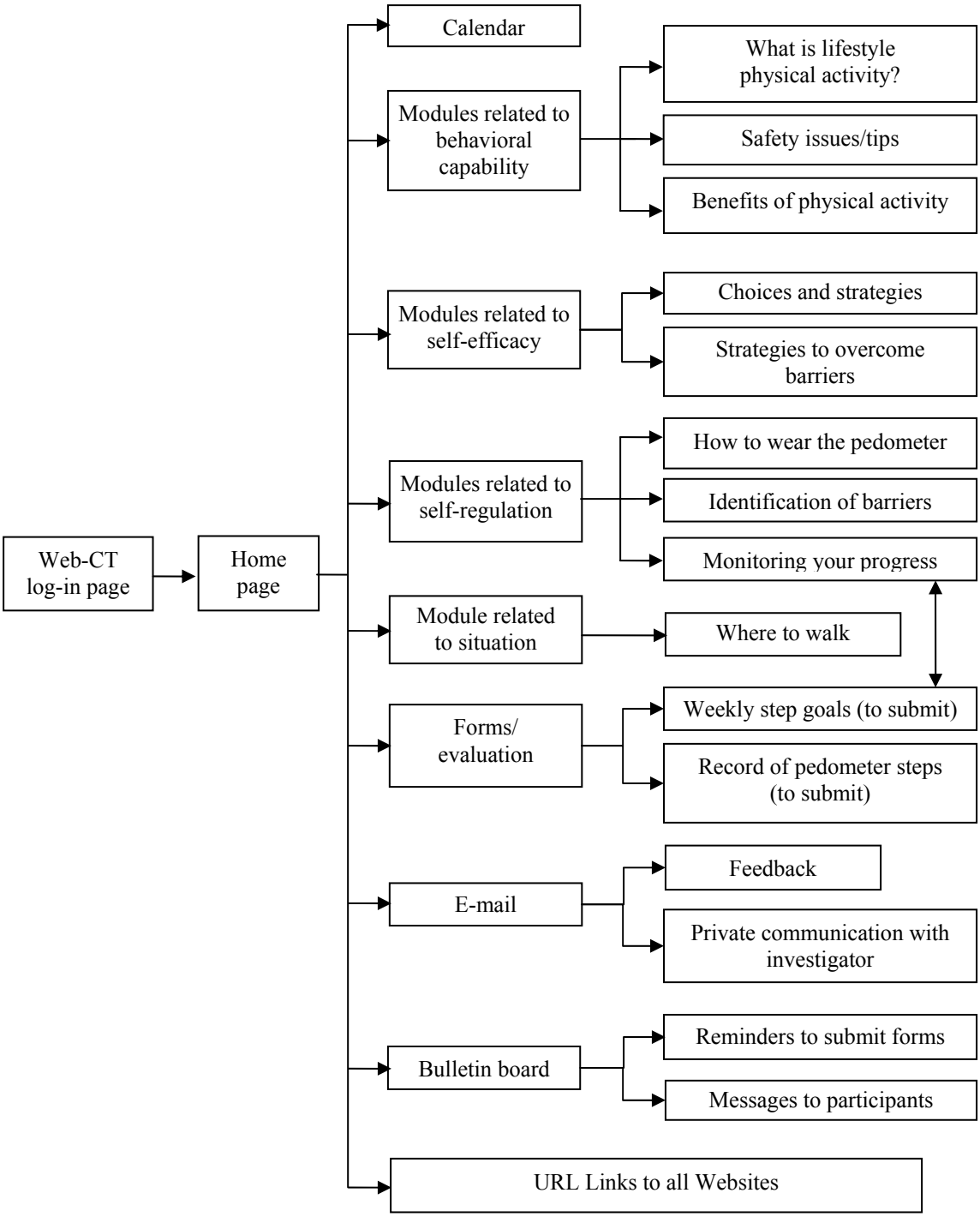

Figure 1. WebCT Intervention

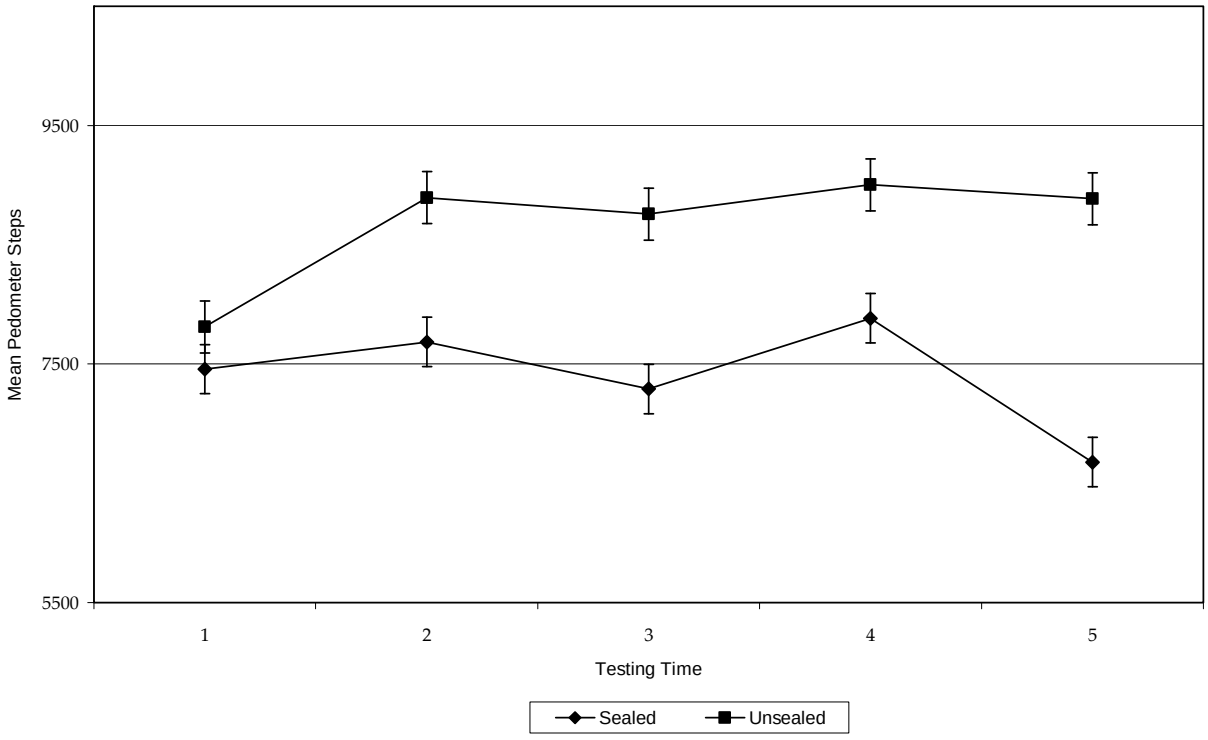

Figure 2 Means plot of pedometer steps for sealed pedometer and unsealed pedometer control groups.

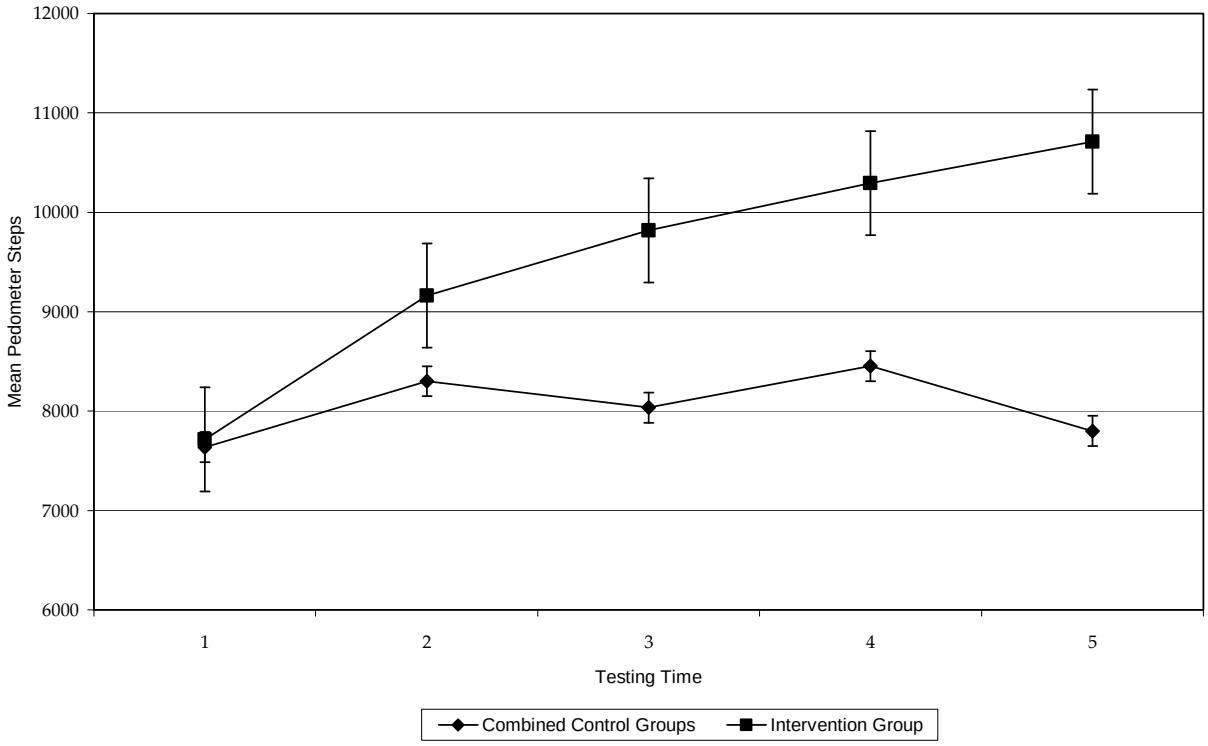

Figure 3 Means plot of steps by intervention

and combined control groups over time