Pedometers: a strategy to promote increased physical activity among college students

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ABSTRACT

Inactive lifestyle behaviors are predominant in society, especially among the adult population. This study examined the issue of inactivity among college students. A pedometer was used as an intervention strategy, to increase awareness of, and motivate college students to achieve the minimum recommended amount of daily physical activity. A convenience sample of college participants ($N = 49$) wore a pedometer for a three week period to assess and identify current daily physical activity level, exclusive of structured exercise. Accumulated steps were examined to determine if college students met the minimum recommended amount of daily physical activity. A survey instrument examined perception and rational toward physical activity, personal estimation of activity level, and indicators of sedentary behavior or physical activity. Results show significant differences in steps from baseline to conclusion. Significant differences were detected in participant estimation of activity level and in the activity indicators from pre- to post- test. Pedometers increased awareness of physical activity among college students and would be a useful intervention strategy in the college and university setting.
Keywords: Pedometers, Promote, Increased, Physical, Activity

INTRODUCTION

The adult population in today's society is largely inactive, with a rapid decline occurring during the college years. College and university physical education programs are an excellent venue to promote and inspire healthy behavioral changes. In light of the increasing obesity epidemic and physically inactive lifestyle in the United States, and in particular among college students, strategies are continually pursued in an effort to promote increased activity. Researchers have used self-report techniques, direct observation, heart rate monitors, and accelerometers to measure physical activity (Dale, Welk, & Matthews, 2002). A simple counting device called a pedometer is another method growing in popularity. By counting the number of steps accumulated in a day, both sedentary behaviors and indicators of insufficient activity can be identified. The use of a pedometer not only motivates, but also promotes an increase in the amount of daily activity a person performs (Behrens, Hawkins, & Dinger, 2005; Van Wormer, 2004). In addition, pedometers have been found to be a reliable instrument for measuring walking-type movements (Bassett, 2000). With its ease of use, low cost, and low participant burden, consideration should be given for implementing a pedometer within and outside of the college and university physical education settings to promote increases in daily physical activity. The focus of this paper was to examine the issue of inactivity among college students using a pedometer as an intervention tool to increase awareness of and motivate college students to achieve the minimum recommended amount of daily physical activity.

Issues Pertaining to Inactivity among College Students

Inactivity is a critically important issue in today's society. Strategies are continually sought in an effort to produce changes from unhealthy behaviors. Clear documentation exists pertaining to the risks associated with a sedentary lifestyle, along with the benefits derived from physical activity. Yet, more than half of the adult population in the United States do not meet the minimum activity guidelines necessary for good health and lowered disease risk (Haskell, et al., 2007; Pate, et al., 1995). In addition, approximately one-quarter of the population is identified as living a sedentary lifestyle, with no substantial activity (Pate, et al., 1995; Tudor-Locke & Myers, 2001). In large part, the prevalence of obesity is directly related to this issue of inactivity (Tudor-Locke, 2002).

Patterns of activity among college students reflect those of the population as a whole. After examining eight national surveys pertaining to physical activity, Stephens, Jacobs, and White (1985) reported, a significant decline occurs in an individual's level of physical activity as they age. In particular, a rapid decrease in activity occurs among those in the age group between adolescence and early adulthood. This represents the typical age of most college students. Research showed a substantial number of college students do not meet the minimum recommendations for physical activity and instead are leading highly sedentary lifestyles (Behrens & Dinger, 2003; Pinto, 1995). For these individuals, work, academic demands, travel times, family obligations, and their recently discovered independence interfere with their decision to make healthy choices regarding activity and diet.

The College and University Physical Education Council (CUPEC) in conjunction with the National Association of Sport and Physical Education (NASPE) emphasize the importance of physical education and the teaching of activity in the college and university setting. A 2006 statistics by the American College Health Association (ACHA) indicated thirty-five percent of

all college students were classified as either overweight or obese. Forty-six percent believed they needed to lose weight, and of these, only one-third had ever received any information regarding healthy diets and the importance of physical activity through their college programs (NASPE, 2007). Therefore, college physical activity programs should provide the vehicle for students to continue to engage in different activity opportunities, acquire skills needed to succeed in self-directed activity and overcome the variety of barriers. In addition, it should help students build confidence in their ability to be physically active when starting a career and family, highlight, nurture a participant's intrinsic reasons for physical activity, and sustain activity throughout their life.

Recommended Minimum Daily Activity Guidelines

Walking is a very familiar and accessible type of physical activity that people participate in on a regular basis (Tudor-Locke, Bassett, Swartz, et al., 2004). Most people walk during recreational activities, transportation, occupational tasks, and activities of daily living (Bassett, et al., 2000). However, for a large percentage of the population, the amount of physical activity performed throughout the day falls short of reaching the minimum recommended guidelines for either health or fitness. Thus, simply performing the basic activities of daily living is not sufficient to meet the minimum recommendations, improve health, and reduce the risk of chronic disease and premature death (Choi, Pak, Choi, & Choi, 2007). Adults should accumulate 30 minutes or more of moderate to intensity physical activity on most days of the week (Pate, et al, 1995) with a goal of walking 10,000 steps per day (Behrens, et al., 2005; Choi, et al., 2007; Hultquist, Albright, & Thompson, 2005; Le Masurier, Sidman, & Corbin, 2003).

Methods Used to Monitor Daily Activities

Walking or daily activity levels have been measured using direct and indirect methods including questionnaires or self-report forms and accelerometers. Accelerometers are highly technological and expensive (Bassett, et al., 2000; Tudor-Locke & Myers, 2001). Questionnaires or self-report forms rely heavily on participants' recollection of the activity and interpretation of the question (Dale, et al., 2002). Recently, researchers have switched to pedometers to measure walking-type motion because pedometers are easy to use and less expensive (Haines, et al., 2007; Tudor-Locke & Myers, 2001). In addition, it can directly and quantitatively measure the amount of movement performed by counting the number of steps taken throughout a given time period, typically each day (Behrens & Dinger, 2003; Behrens, et al., 2005; Tudor-Locke, 2002). Furthermore, pedometers can be used to detect those with sedentary tendencies, provide an incentive to move, be physically active (Behrens, et al., 2005; Hultquist, et al., 2005; Le Masurier & Tudor-Locke, 2003; Van Wormer, 2004), and can realistically be used with large groups of people (Tudor-Locke & Meyers, 2001).

The purpose of this study was to examine the issue of inactivity among college students. As an intervention strategy, a pedometer would be a tool used to increase awareness of and motivate college students to achieve the minimum recommended amount of daily physical activity. In addition, this research study focused on assessing and identifying the current amount of daily physical activity of college students as measured in steps per day, of selected college students. Measured physical activity was exclusive of any planned or structured exercise sessions. Daily step totals were used to determine if these particular college participants achieved

the minimum recommended amount of physical activity for improved health, weight maintenance or weight loss. It was hypothesized that implementing a pedometer to measure daily activity would promote and further an increase in daily activity in order for college students to meet, or even exceed, the minimum recommended amount of daily physical activity.

METHOD

Participants

A single group convenience sample of undergraduate college students (N = 50) enrolled in classes at a two-year community college were recruited for participation in this study. Participants included both males (n = 12) and females (n = 38). Of the 50 participants who began the study, 49 completed the research by wearing the pedometer for the three-week period and provided both step and survey data. One female participant failed to fully complete the pre-survey or return any step data, and she was dropped from the study. None of her information was used in any analysis of results. Age of participants ranged from 18 – 41 years (M = 21.43, SD = 5.32), with most (88%) ranging in age from 18-25 years. No age restriction was placed on the college participants; however, only six participants (12%) in the total sample were above the age of 25, providing a group typically the age of most college students. Although participants were attending a two-year school, freshmen (n = 15), sophomores (n = 20), juniors (n = 9), and seniors (n = 5) at the undergraduate level represented the sample. The sample included Hispanic (n = 17), White/Non-Hispanic (n = 15), Asian (n = 11), Black/African American Non-Hispanic (n = 1), Filipino (n = 3), and American Indian/Alaskan Native (n = 1). In addition, one participant was listed an unknown/non-respondent concerning ethnicity. This sample was a fair representation of the specific college's demographic make-up. Participants were of varying activity levels, since the convenience sample was recruited from a variety of physical education fitness activity and theory classes. However, current involvement in exercise was neither a requirement nor an exclusionary factor for participation in this study.

Dependent Measures

Reliability studies found significant differences between various brands of pedometers. Four brands, however, were identified after exhibiting accuracy with consistent results in each study (Schneider, et al., 2004; Tudor-Locke & Myers, 2001). The Yamax Digiwalker (Yamax Corporation, Tokyo, Japan) is the most consistently accurate pedometer, and is highly recommended for collecting research data (Bassett, 2000; Behrens & Dinger, 2003; Le Masurier & Tudor-Locke, 2003).

Yamax Digiwalker

The Yamax Digiwalker SW-200 pedometer (New Lifestyles Inc., Lees Summit, MO, USA) was selected for use in this study. This specific model counts only steps, therefore no adjustment for stride length on the pedometer was necessary. Behrens, et al (2005) and Bassett (2000) have noted this particular brand and model is one of the most accurate in the measurement of daily step totals and highly recommended for collecting research data. Among the various brands tested, this pedometer has shown the greatest degree of accuracy (± 1%) for

counting steps in both controlled laboratory settings (Crouter, Schneider, Karabulut, & Bassett, 2003; Schneider, Crouter, Lukajic, & Bassett, 2003; Le Masurier & Tudor-Locke, 2003; Swartz, Bassett, Moore, Thompson, & Strath, 2003) and in free-living conditions (Schneider, Crouter, & Bassett, 2004). The Digiwalker, however, uses a coil spring, instead of a hairspring, attached to the suspended lever arm in the internal mechanism, which results in greater durability, reliability and accuracy of step counting (Bassett & Strath, 2002). Every time the hip moves up and down during normal walking motion, the internal mechanism also moves, which in turn causes the pedometer to record a step (Schneider, Crouter, & Bassett; Bassett & Strath).

Certain conditions including walking at slower pace than typical of a normal walking gait will cause the Digiwalker to undercount steps (Le Masurier & Tudor-Locke, 2003). Such slow speeds are found among elderly and obese individuals. Schneider, Crouter, and Bassett (2000) report the Digiwalker SW-200 to be an accurate step assessment device for individuals ranging from normal weight to slightly obese. All participants in this current study would be classified within this weight range. Other known pedometer error may occur if the pedometer is not correctly placed in a vertical position. Participants were given instructions and practiced correct placement of the pedometer at the initial orientation session. Reminders were provided with the written instructions and in e-mail correspondence.

Survey Instrument

An activity survey (see appendix A) was administered at baseline. The survey asked questions pertaining to participants' perception of physical activity, self-estimation of the amount of activity each participant performed per day, rationale for being active, and rating of personal activity level. Demographic information included gender, age, ethnicity, and college standing. A four-point Likert scale (strongly agree = 1 to strongly disagree = 4) was used for questions one through seven. Similarly, a four point rating scale (not at all = 1 to almost always = 4) was used for question eight (a through i) and question nine (a through d). For questions 10 and 11, participants were to recall the number of days per week spent doing thirty minutes of moderate intensity physical activity and the number of days per week spent in structured exercise programs within the past week. Question 12 asked subjects to rate their perception of personal activity level on a four point rating scale ranging from inactive/sedentary (1) to highly active (4).

At the conclusion of the study period, the activity survey was re-administered largely to determine if after wearing the pedometer, any change occurred in the participant's responses. The post-survey, however, excluded demographic information since this information would not change in the three-week study timeframe. In addition, since participants logged step data and marked days exercise was performed on the activity log, it was not necessary to ask pre-survey questions ten and eleven for recall of activity.

An activity-recording log (see appendix B) was created for participants to record step data and mark any additional exercise activity performed outside of wearing the pedometer. For week one, while the pedometer was sealed, participants simply marked any exercise they performed during the week. At the end of the first week, the pedometer was unsealed and total weekly steps were recorded at the top of the log by the researcher. This provided a baseline assessment of average daily steps for each participant. For weeks two and three, participants used the activity log to record steps taken on a daily basis and again marked any exercise performed during the week. Logs were submitted to the researchers at the end of each week.

Procedures

Prior to the onset of the study and any data collection, approval was received from the Institutional Review Board (IRB). Participants were recruited from undergraduate classes at a two-year junior college in southern California. The convenience sampling was chosen due to time limitations and researcher accessibility to participants. The opportunity to be a participant in the research study was announced in several physical education fitness activity and theory classes on campus. At that time, the researchers provided an overview of the research design, along with its purpose. Those interested in participating attended an orientation session to sign an informed consent and to receive specific instructions pertaining to the study and on how to use the pedometer. Each participant read and signed an informed consent in agreement to voluntarily participate in the study. The pre-research activity survey was administered and completed by each participant. Participants were given specific verbal instructions pertaining to the study, a pedometer, and an activity-recording sheet. Additionally, written instructions were attached to the activity logs with the researchers contact information. Each participant was randomly given a numbered pedometer. In order to maintain participant confidentiality, all data for the participant corresponded to the pedometer number. Participants, however, did provide either a phone number, e-mail address or both, on the signed informed consent for contact purposes. Once a week, participants were sent a brief e-mail reminder to continue wearing the pedometer and to provide the date and time of participants next meeting with the researchers for data collection. Midway through the study, an e-mail about ten simple suggestions for increasing daily activity in everyday living was sent to each participant. Examples included taking the stairs, instead of the elevator or escalator, take the dog for a walk, walking inside instead of using a drive-thru window, parking in a lot farther from the store or mall, walking around while talking on a cell phone, and walking through every aisle of the grocery store at least once.

This research design poses similarity to that of Bassett, Cureton, and Ainsworth (2000), which measured only physical activity outside of structured exercise. Similar instructions were provided to the participants, as they were to wear the pedometer for all waking hours, except when participating in structured exercise or when in the water. To determine baseline activity, participants wore a sealed pedometer for the period of seven days. A minimum of three days is considered to offer reliable information for determining average daily steps, as long as Sunday is included as one of the three days (Tudor-Locke, Burkett, & Reis, et al., 2004). Sunday has typically been shown to elicit the least amount of activity; therefore, Sunday is one of the days included in this baseline assessment for the calculation of average daily steps. During this period, participants were instructed not to purposefully increase their amount of daily physical activity, but rather to simply perform their normal, everyday activities.

Participants returned for a single meeting following the baseline period for the researchers to unseal the pedometer to record initial steps taken per day. Participants were informed they would be wearing an unsealed pedometer for the next two weeks, whereby they would be able to monitor their activity by seeing recorded steps on the pedometer. Briefly discussed were the minimum recommended guidelines for physical activity, and the goal of accumulating 10,000 steps per day. For subsequent data collection, participants were instructed to open the pedometer each morning upon waking and reset it to zero. They were reminded to attach the pedometer on their waistband, at the midline of the right thigh, keeping it in a vertical position against the body. The pedometer was once again to be worn throughout the day for all daily activities until the participant retired to bed at night. Participant would only remove the

pedometer when showering, bathing or swimming, or during any structured exercise activity, such as an aerobic class, running on a treadmill, a mile walk, working out in the gym, soccer class, a pick-up game of basketball, and the like. Upon removal of the pedometer at night, each participant was instructed to open the pedometer and record the total number of steps taken that day on the activity log provided. At the end of each week, the researchers met briefly with participants to collect step count data, the activity log, address any questions or concerns, and to remind participants of instructions pertaining to the data collection. These procedures were repeated in both weeks two and three, for a total of three weeks of data collection. At the conclusion of the study, participants met with the researcher one final time to return the pedometer, the week three-activity log, and to complete the post-research survey.

RESULTS

Survey Instrument Analysis

Participants completed a survey instrument before the research period started and again at its conclusion. Demographic information was collected and used in statistical analyses. The survey included questions pertaining to the participant's perception of physical activity, self-estimation of frequency of daily activity and exercise, personal activity level, and rationale for performing activity. In addition, participants were asked to choose frequency of performing activity or inactivity common to daily living. Separate four-point Likert scales were used to assign numerical value to responses. Each survey item was analyzed separately and items were grouped into categories, according to similarities for analysis.

Analysis of pre- and post-responses to the 19 matched survey items were calculated using a Paired-Sample T-Test. Results for 17 of the matched survey items showed no significant difference in response from pre - to post-survey. Two survey items had participants rate their likelihood of taking a walk and for doing gardening or yard work during spare time. Results showed a statistical significant difference between pre- and post-test responses for these two questions, t (48) = -2.07; t (48) = -2.25, respectively, both $p < .05$. Response at post-survey suggested a greater tendency for performing these activities during spare time. Although statistically significant differences were not found between the other matched survey items, slight differences in the mean were noted from pre- to post- survey. An example was found in participant's response for finding ways to be active during leisure time. Although not a statistically significant difference, pre- to post survey results (71.4%, 75.5%, respectively) show a greater number of participants agreed or strongly agreed as a response. Thirteen of the survey items were further grouped into two categories, allowing participants to choose responses indicative of active or sedentary behaviors in daily living. A Paired-Sample T-Test resulted in a significant difference from pre- to post-survey for activity indicators, t (49) = -2.46, p = .018. No statistical significant difference was found for the items indicative of sedentary behaviors, p = > .05. Findings may suggest increased awareness for increasing daily activity after wearing the pedometer.

Prior to the research study, less than half of participants (38.7%) reported having ever worn a pedometer to measure activity. At the conclusion of the three-week period, most participants (73.5%) either agreed (42.9%) or strongly agreed (30.6%) that wearing a pedometer made them more attentive to their daily physical activity.

Participants were asked to recall physical activity and exercise performed over the previous seven days. Responses were focused on the frequency of participation in moderate intensity physical activity, along with the frequency of participation in structured exercise programs. Responses indicated 35 (71.4%) participants performed moderate intensity physical activity either two to three days of the week (40.8%) or four to six days of the week (30.6%). Five respondents (10.2%) reported performing moderate intensity physical activity on only one day of the week, while 8 (16.3%) participants report moderate activity over all seven days. One participant (2%) recalled no moderate intensity physical activity over the previous seven days. In addition, 34 (69.4%) participants indicated current participation in a structured exercise program either two to three days per week (49%) or four to six days per week (20.4%). Three respondents (6.1%) performed structured exercise only one day of the previous week, while one (2%) participated in structured exercise all seven days. Eleven participants (22.4%) reported no participation in a structured exercise program.

It was not the intent of this study to examine steps taken during exercise programs or to analyze the intensity, duration, or frequency of exercise performed in relation to steps taken in daily living. It was only of interest to the researchers to discover the number of participants who engaged in structured exercise programs in conjunction with physical activity performed in daily living activities. To that end, steps measured were exclusive of time spent performing structured exercise and the pedometer was not worn by participants during any engaged in this type of activity. However, participants were asked to mark each day exercise was performed during the three week period on the activity log provided. Frequency calculations revealed during week one, week two, and week three, the majority of participants (61.3%, 44.9%, and 51%, respectively) engaged in some form of structured exercise program two to six days of the week. Approximately one-quarter of participants were not engaged in any exercise program during the three-week period (see Figure 1).

Pedometer Data Analysis

Frequency analysis of the pre-research survey instrument revealed over half of the participants either agreed (38.8%), or strongly agreed (20.4%) they were meeting the minimum recommended amount of daily physical activity. To investigate whether participants met the minimum recommended number of daily steps, 10,000 per day, One-Sample T-tests were calculated using pedometer data collected at baseline with a sealed pedometer and for the subsequent weeks with an unsealed pedometer.

Results of the One-Sample T-tests showed highly statistical significant difference for week 1, t (48) = -12.60, (M = 5,585, SD = 2,452); week 2, t (48) = 9.30, (M = 6,586. SD = 2,571); and week 3, t (48) = -8.08, (M = 7,124, SD = 2,490); all $p < .05$. Overall, participants showed improvement in steps taken over the three-week period, but they failed to meet the 10,000 steps per day minimum recommendation as a group. Interestingly, the post-research survey instrument revealed most participants still agreed (40.8%) or strongly agreed (14.3%) they met the minimum recommended amount of physical activity.

To further investigate differences between weeks, a Repeated Measures 1 x 3 Analysis of Variance (ANOVA) was calculated on the total sample for treatment effect. A statistical significant difference was found within subjects, F (1, 2) =10.58, $p < .05$. A pairwise comparisons, using a Bonferroni adjustment ($\alpha = .05/3 = .017$) revealed a statistically significant differences between week one and week two, and between week one and week three. During

these two periods, participants showed the greatest improvement in steps taken. A simple calculation revealed average daily steps improved 15.19% between weeks 1 and 2, 7.6% between weeks two and three, and 21.6% between weeks one and three.

In order to investigate if differences in performance between males and females existed during weeks 1, 2, and 3, an Independent Sample T-Test was calculated. Results of the analysis showed a statistical significant difference between males and females only for week 3, $t(47) = 2.69$, $p < .05$. During this third week men outperformed their female counterparts, taking more steps on average per day (see Figure 2). No statistical difference was found between males and females for week 1 and week 2 performances, $p > .05$ (see Table 1 for data).

Additionally, separate One-Way ANOVAs were calculated to investigate if differences existed between participant's ethnicity, college standing, or age on their week one, two, and three performances. Results of each ANOVA analysis yielded no statistically significant difference between the participant's ethnicity, college standing, or age to weekly performance, all $p > .05$. Therefore, participants in this study, regardless of ethnicity, college standing, and age, did not show a difference in performance.

To further explore the differences in steps taken between weeks, and for interactions between and within participants, a 2 x 3 (gender x time) mixed factor Repeated Measures ANOVA was calculated. Results showed time by gender interaction was statistically significant, $F(1, 2) = 3.69$, $p < .05$. To investigate further where gender differences occurred, separate 1 x 3 Repeated Measures ANOVA (male x time; female x time) were calculated. Within subject effects showed a significant difference for males, $F(2) = 7.80$, $p < .05$ and for females, $F(2) = 5.43$, $p < .05$. Pairwise comparisons, using a Bonferroni adjustment ($\alpha = .05/3 = .017$), showed statistically a significant difference occurred for males between weeks one and three ($p = .018$) and between weeks two and three ($p = .003$). The only statistically significant difference for females occurred between weeks one and three ($p = .012$). Although each gender increased the number of steps taken through all weeks, no statistically significant difference occurred between weeks one and two for either males or females, nor between week two and week three for females.

An examination for any significant differences in steps taken between days within week two and in week three was investigated (see Figure 3). Two, separate 2 x 7 (gender x time) Repeated Measures ANOVA calculations resulted in no gender interaction for number of steps taken between any day either in week two, $F(1, 6) = .346$, $p > .05$, or in week three, $F(1, 6) = .215$, $p > .05$. However, a 1 x 7 Repeated Measures ANOVA found significant between-day differences only during week two, $F(6) = 4.82$, $p < .05$. No significant differences were found between any day during week three, $F(6) = 1.83$, $p > .05$. Although number of steps varied from day to day, pairwise comparisons, adjusted with Bonferroni ($\alpha = .05/7 = .007$), found statistically significant differences between Tuesday and Thursday ($p = .017$), between Thursday and Friday ($p = .011$), and between Tuesday and Sunday ($p = .001$) during week two (see Table 2). All participants of this study regularly attended classes on Tuesdays and Thursdays. However, during week two, Thursday was a holiday, which may account for a difference in the number of steps. Other studies have found fewer steps are typically taken on Sunday, as compared to other days of the week (Tudor-Locke, et al., 2004).

We also examined daily step averages for any same day differences between weeks two and three (Monday/Monday, Tuesday/Tuesday, and so forth). A 2 x 2 Repeated Measures ANOVA (gender x day/day) revealed no gender interaction, all $p > .05$. Seven, separate 1 x 2 Repeated Measures ANOVA were analyzed against the total sample. A Bonferroni adjustment (α

= .05/2 = .025) was used for pairwise comparisons. Significant differences were found between Mondays, $F(2) = 5.60$ and between Thursdays, $F(1) = 14.69$, both $p < .05$ (see Table 2). In both instances, a significant increase in steps occurred during week three as compared to the same day in week two.

Tudor-Locke and Basset (2004) proposed activity level indices relative to average daily steps. Using their indices as a guide, each participant was assigned a rating based on their average daily steps for each week (see Figure 4). The survey instrument asked participants to estimate personal activity level prior to wearing the pedometer and again at the conclusion of the research study. Participant's estimation of personal activity level was correlated with their assigned indices rating at baseline (week one) and at the conclusion of the study (week three). A Bivariate Correlation resulted in no statistical significance at baseline. Similarly, a Paired-Sample T-test analyzed the differences between participant's estimation of activity and assigned indices. Results showed a statistically significant difference between the two at both baseline and at the end of the third week, $t(48) = 7.36$; $t(49) = 3.44$, respectively, both $p < .05$. At the conclusion of the study, however, the two variables showed a statistically significant correlation, $r(49) = .405$, $p < .01$. Although not considered a strong association, it can be predicted that participants were able to give a more accurate assessment of personal activity level after wearing a pedometer to track daily steps.

Data variables were created to calculate how accurately participants estimated personal activity level in accordance with the indices rating. Results showed prior to wearing the pedometer, a majority of participants (69.4%) overestimated activity level in a comparison between actual number of steps taken and activity indices. Approximately one-quarter of participants (26.5%) estimated with a good degree of accuracy. At the conclusion of the study, however, a reduced number of participants overestimated activity level (49%) while an increased number of participants had a more accurate estimation (44.9%) (see Figure 5).

DISCUSSION AND CONCLUSION

Sedentary, inactive lifestyle behaviors are predominant in today's society, especially among the adult population. Physical inactivity is a prevailing component linked to both poor health and obesity, and as a result, chronic diseases and the cost of healthcare in the United States have continued to rise. Increased rates of inactivity and obesity in today's society have been well reported by major health organizations.

Ambulatory movement, in other words, a walking motion is commonly associated and utilized in everyday activities. Research has established a minimum amount of movement must be performed in order to be healthy; performing less than the guidelines increases the risk for developing chronic disease due to poor health or premature death. Current recommendations state a minimum of 30 minutes of moderate intensity activity on most days of the week will meet these guidelines (Pate et al., 1995). Recently, wearing a pedometer has become a popular method of measuring the amount of movement, or activity, performed in a day. As stated earlier, the pedometer measures movement by counting the number of steps accumulated over a day, a week, or other established period. The goal of accumulating 10,000 steps per day is a popular guideline by which minimum activity levels for good health can be achieved. Le Masurier, et al. (2003) note this 10,000 step marker is really a goal, established to help increase activity. However, the minimum steps needed to meet activity guidelines may vary between different population groups, such as children, young adults, older adults, or at-risk individuals (Tudor-

Locke & Myers, 2001). In addition, a young, healthy population of college students should be expected to accumulate between 7,000 and 13,000 steps per day. For most college students, this range falls within the 10,000 step per day goal.

Bassett, et al. (2000), along with Tudor-Locke, et al., (2002) found adults (*M* age = 40 and 69, respectively) took an average of 6000 steps per day simply through activities of daily living, exclusive of structured exercise, sports or recreation programs. Findings in this current study were similar. At baseline, the participants took an average of 5,585 steps per day. Although total steps accumulated over the three week period increased on average per week (*M* = 6528, 7124 respectively), the number of steps taken was still significantly different from the 10,000 steps per day goal and failed to meet the minimum recommended guidelines.

According to the proposed indices for activity (Tudor-Locke & Bassett, 2004), the average daily steps for the three weeks, classify the group of participant as 'low active'. In fact, more than one-half of the participants overestimated their level of activity at the start of the research study; most believing they are more active than results show. Many students assume they get enough daily activity simply around campus. Others believe simply taking one exercise activity class a minimum of two times per week will give them a sufficient amount of activity, and will offset less physical activity performed in everyday living. This is shown in the survey responses. On both the pre- and post-survey, participants (59.2%, 55.1%, respectively) believed they were meeting the minimum recommended amount of daily physical activity. Exercise, however, should not be a substitute for acquiring sufficient movement through daily living. Although more than one-half of the participants in this study do engage in some form of structured exercise program a minimum of two times per week, one-quarter of the participants did not engage in any form of exercise.

Although students did not achieve the minimum recommended goal of 10,000 steps per day, as stated previously total steps accumulated did increase over the three-week period. Statistical examination detected the differences in steps between participants, weeks, and individual days. Statistical significant differences were found between and within genders. Each gender increased their average daily steps above baseline totals. Men on average took more steps each week than women, however, during week one and during week two, there was no statistical difference between the men and women in terms of improvement. Only a modest increase in average daily steps was detected within and between genders between baseline and week two. A significant difference was observed between the number of steps men and women took during week three. Although both groups still averaged more steps than in either week one or in week two, men outperformed the women in week three, in terms of total steps accumulated. In fact, men made significant improvement in their average daily steps between weeks two and three, and between weeks one and three. On the other hand, women only made significant improvement in their average daily steps from baseline to the end of week three. Although women took more steps during week three than during week two, the increase was modest at best. Other studies (Behrens & Dinger, 2003 have found that men typically take more steps on average than women do.

Individual variations in daily routines may have accounted for the fluctuation of steps taken between days of the week. The convenience sample used in this study attended classes on both Tuesday and Thursday. How many participants also attended classes on other days of the week was unknown. Academic, work, and time demands may also play a significant role in the daily step fluctuation between individuals who participated in the study. Several significant between day differences were discovered in the analysis of results. During only week two,

significant differences in steps occurred between Tuesday and Thursday, between Thursday and Friday, and between Tuesday and Sunday. Tuesday and Friday had significantly more steps recorded than Thursday or Sunday. As stated previously, all participating in this research study attended classes on campus on Tuesday and Thursday. The variance between Tuesday and Thursday in steps taken was largely due to the Thanksgiving holiday. Although it may have been a limitation to the study, a holiday does not necessarily have to be a significant factor for activity performed in daily living. This may also have been the case between Thursday and Friday. Other researchers have documented that on Sunday fewer steps are taken than on any other day of the week. An examination of same day between weeks showed significant differences in steps between Mondays and between Thursdays. Week three Monday and week three Thursday resulted in a significant increase in steps when compared with the same day in week two. Thursday differences again were in all probability due to the holiday. Two participants did not provide step counts for the Monday in week two, which may account for part of the variation. Since the weeks of the study spanned Tuesday through Monday (in other words, Tuesday was the start day for each week), the Monday in week two followed the Thanksgiving holiday, which may have also influence the difference in steps.

After wearing a pedometer, slightly less than one-half of the participants still overestimated their activity level; again believing they were meeting the minimum guidelines. While a substantial number of participants still overestimated their activity level, the number of participants who were able to estimate their level of activity more accurately almost doubled. Findings of this study may suggest increased awareness for increasing daily activity after wearing the pedometer. In fact, a substantial number of participants (73.5%) responded that wearing the pedometer made them more attentive to their physical activity. Awareness of a problem, in this case sedentary tendencies, is a key step for changing a behavior. A conclusion can be inferred that wearing the pedometer increased awareness of the participant's current level of activity. By offering immediate feedback, students could gauge how much activity they had performed relative to the 10,000 steps per day goal.

Time constraints for the researchers allowed for only three weeks of data collection, which was an insufficient amount of time for substantial changes to occur in the participant's perceptions or rational for performing physical activity. Behavioral change is a process, which takes time. Habits are generally not formed until a behavior is repeated sufficiently. However, survey responses overwhelmingly indicated participants would do physical activity to improve their look and health. While improved looks are generally a primary motivation for college students to exercise, doing so to obtain or maintain good health is just as, if not more important. This is an extremely important message for physical educators to bring to college students. Participants in this study, who were currently enrolled in physical education classes, seem to have a high level of understanding for this point, as shown by their responses. Understanding the importance of increasing activity for better health, and not just looks, is a key step for behavioral change.

As seen in the results, most survey responses did not significantly change within the three-week research period. Interestingly, the significant differences were found in questions indicative of activity behaviors. After the three-week period, more participants agreed they were more likely to take a walk, or do gardening and yard work in their spare time, both indicators for increased daily activity. In fact, a significant difference in responses from pre- to post-survey also occurred among total question grouped as activity indicators. Questions grouped together which indicated more sedentary behavior did not significantly change. An interesting observation

made by the researchers, although not significant, was in the Mean average from pre- to post-survey responses, which revealed small changes in a move away from indicators of sedentary behavior and the move toward increased activity. These results again seem to indicate an increased awareness by the participant for the need to include physical activity more into their daily lives. Whether or not this indication of increased activity would be sustained over a longer period could be a question for future research. A study design that would span over a period of months might be more likely to determine if the pedometer was influential in replacing sedentary behavior with activity.

Sparling and Snow (2002) examined physical activity patterns among a group of college graduates. Their findings indicated the activity level of a college senior is maintained at either the same level or a greater level post-graduation. This finding emphasizes the importance of physical education curriculum to intervene and promote healthy behaviors. Similarly, a study by LaVine and Ray (2006) found when college physical education majors focused on physical activity by wearing a pedometer and setting goals, they became motivated, acquired and maintained a more physically active lifestyle. Physical education offers the optimal venue for teaching college students the benefits of living a healthy lifestyle, which includes implementing movement into the everyday activities of living. Through the process of teaching, physical educators should employ various strategies that encourage activity and healthy living. The pedometer is a simple, cost-effective, and valuable tool, which can be easily implemented into any physical education curriculum. The pedometer can be effective for measuring activity, while providing immediate and useful feedback to the students.

This study focused on issues of inactivity among college students. An attempt was made to determine if the pedometer would be useful intervention strategy to increase awareness of personal activity level. In addition, current activity level was measured to determine if college students met the minimum recommended amount of daily physical activity associated with daily living, exclusive of participation in structured exercise programs. Further, an attempt was made to discover if the pedometer would encourage and motivate college students to increase their average daily steps with the goal of meeting the minimum recommended 10,000 steps per day. The results of this study seem to indicate the intervention strategy of using a pedometer to measure physical activity is useful in the college setting. Although the minimum recommended amount of physical activity was not achieved, participants did increase their average daily steps each week, moving them closer to the minimum recommendations. In addition, survey responses seem to indicate an increased awareness toward activity and possible changes from sedentary behaviors and tendencies. The pedometer provided useful feedback to the college students giving them the tools that more accurately assess their current activity level. Even if the goal of 10,000 steps is not achieved, seeing improvements can be a powerful motivator, which in turn can influence positive behavior changes. In addition, goals can be set to increase weekly steps in increments until the goal of 10,000 steps or more is achieved. The same progression principles used in exercise programs to achieve results could also be applied to increasing everyday activity.

Future Areas of Research and Consideration

Further examination of the physical activity patterns among various population, including college students should be continued. This current study used a small, single group sample of college students; all enrolled in physical education classes. Results of the study may not be

generalized to a larger college student population. The short time frame of the research period limited the scope of the study. Future study designs should incorporate a longer period for college student to wear the pedometer. While results from this study were generally favorable, a longer research time frame and a larger random sample may be a better indicator of the activity patterns of college students, and also indicate behavioral changes that have taken place and been subsequently maintained. Since the pedometer does not measure intensity of movement, research investigating a relationship between step counts and intensity is warranted. For example, when step counts increase, does exertion or intensity also increase?

Activity, along with being active, has an impact on the health of all individuals, including college students. It is not enough to simply participate in exercise programs, and maintain a relatively sedentary lifestyle otherwise. Lifestyle behaviors are an important part of healthy living. Incorporating a device, such as a pedometer is a strategy that can increase awareness and lead to behavioral change. Physical education has the optimum setting to inform and guide college students to increased activity, better health, and longevity.

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Figure 1.
Survey Recall of Moderate Intensity Activity and Structured Exercise, and Additional Exercise Performed by Number of Days per Week

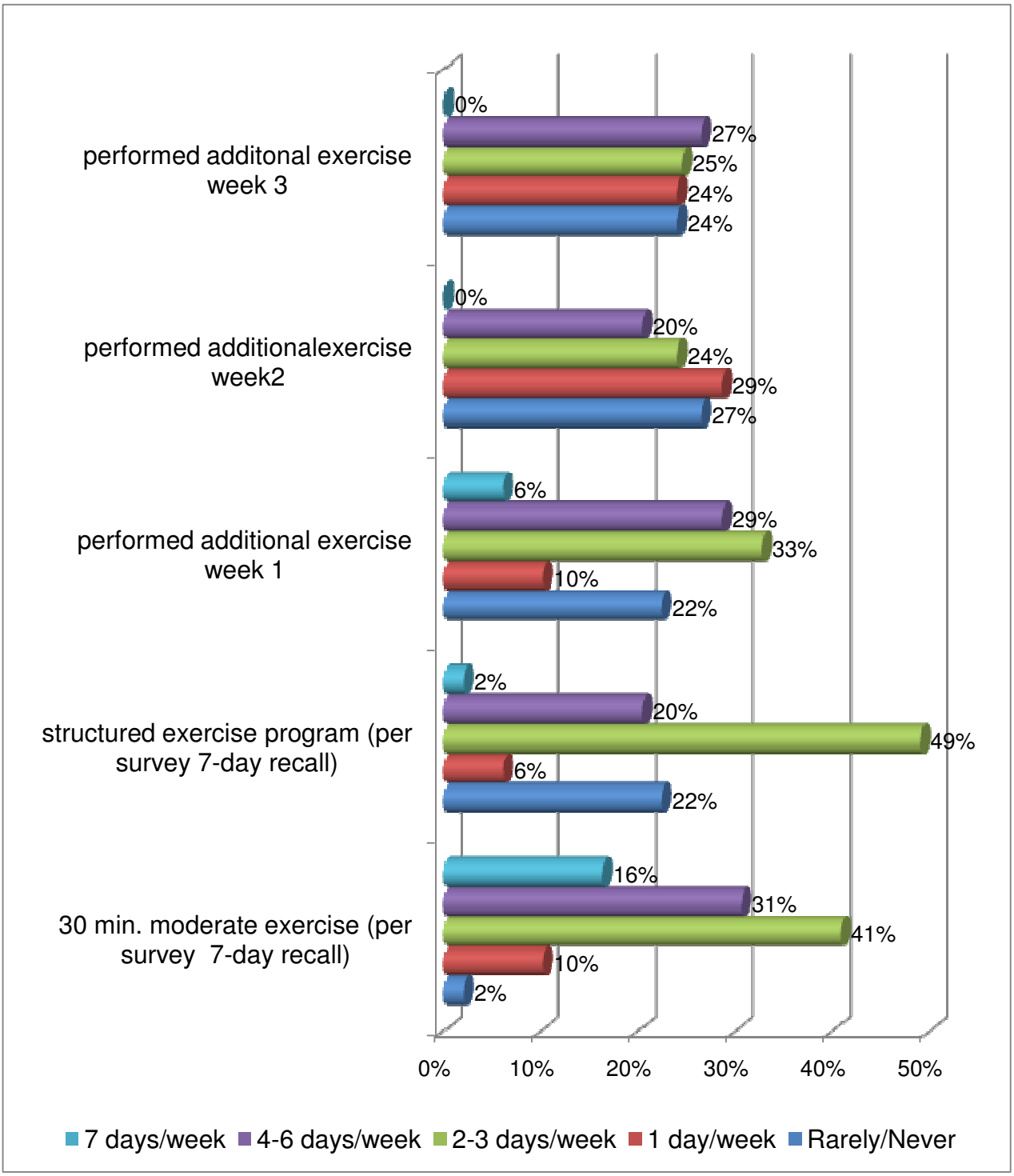
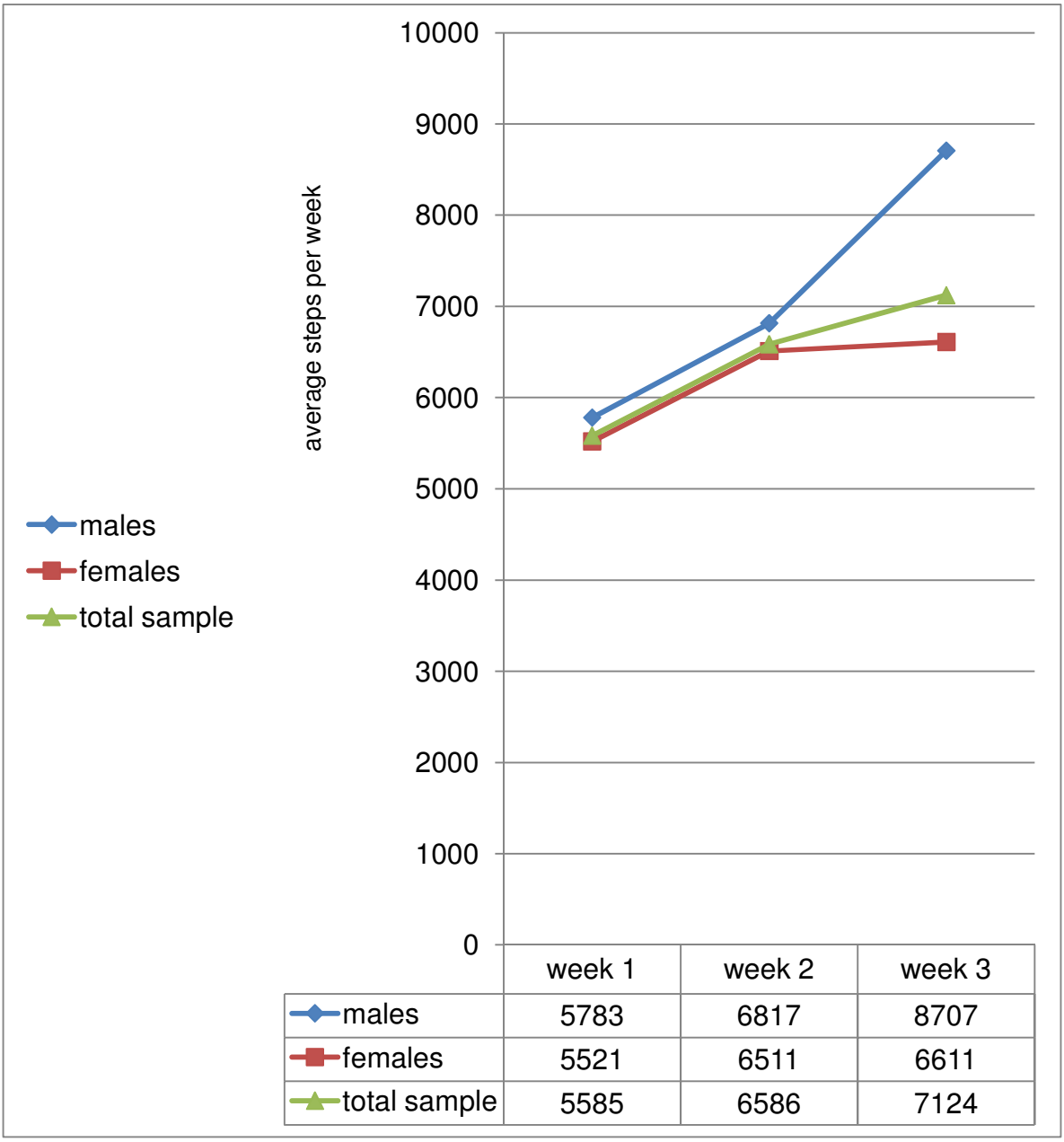


Figure 2.
Average Daily Steps per Week by Gender and Total Participants



	week 1	week 2	week 3
males	5783	6817	8707
females	5521	6511	6611
total sample	5585	6586	7124

Figure 3.
Average Steps per Day of the Week by Gender and Total Participants

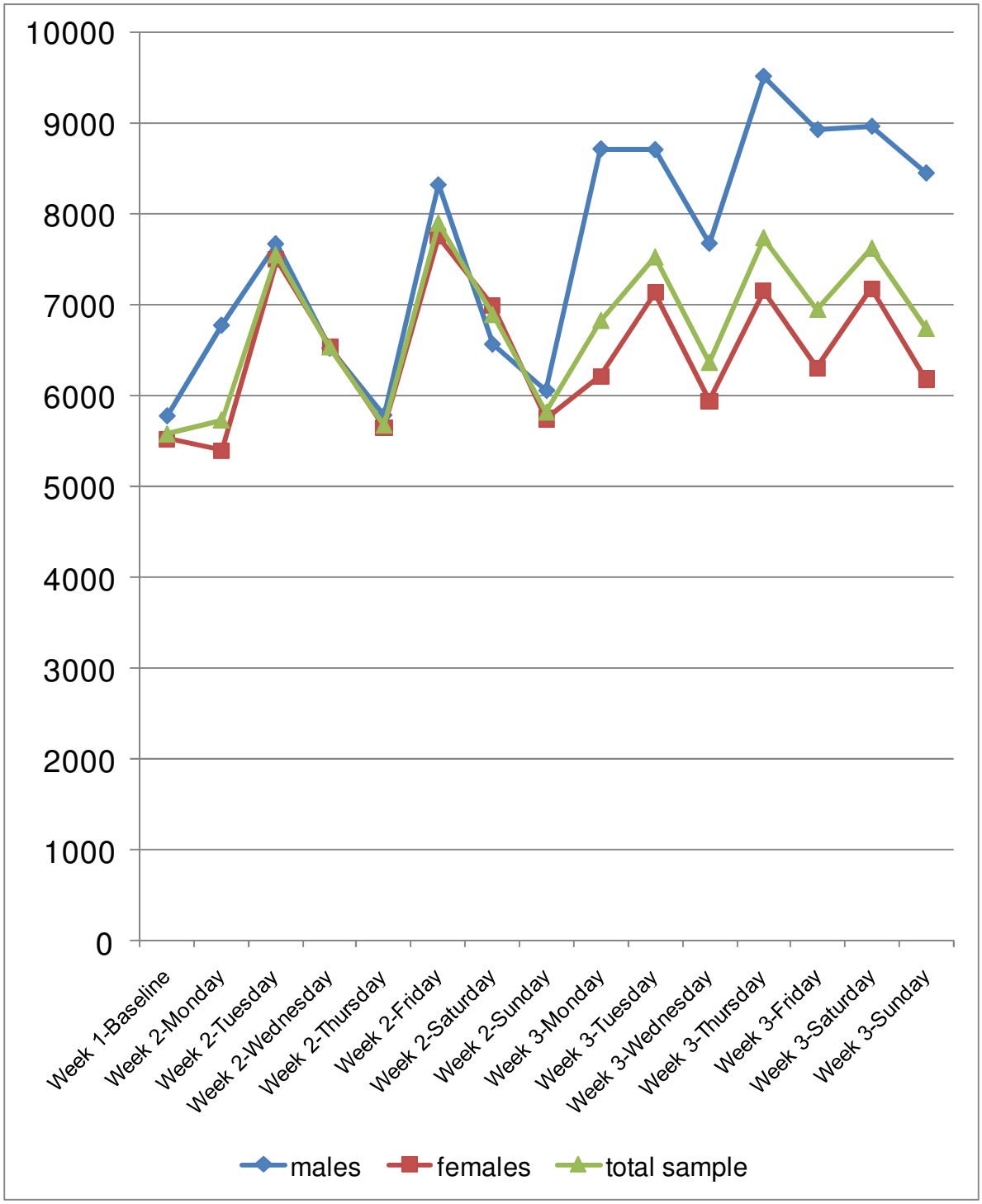
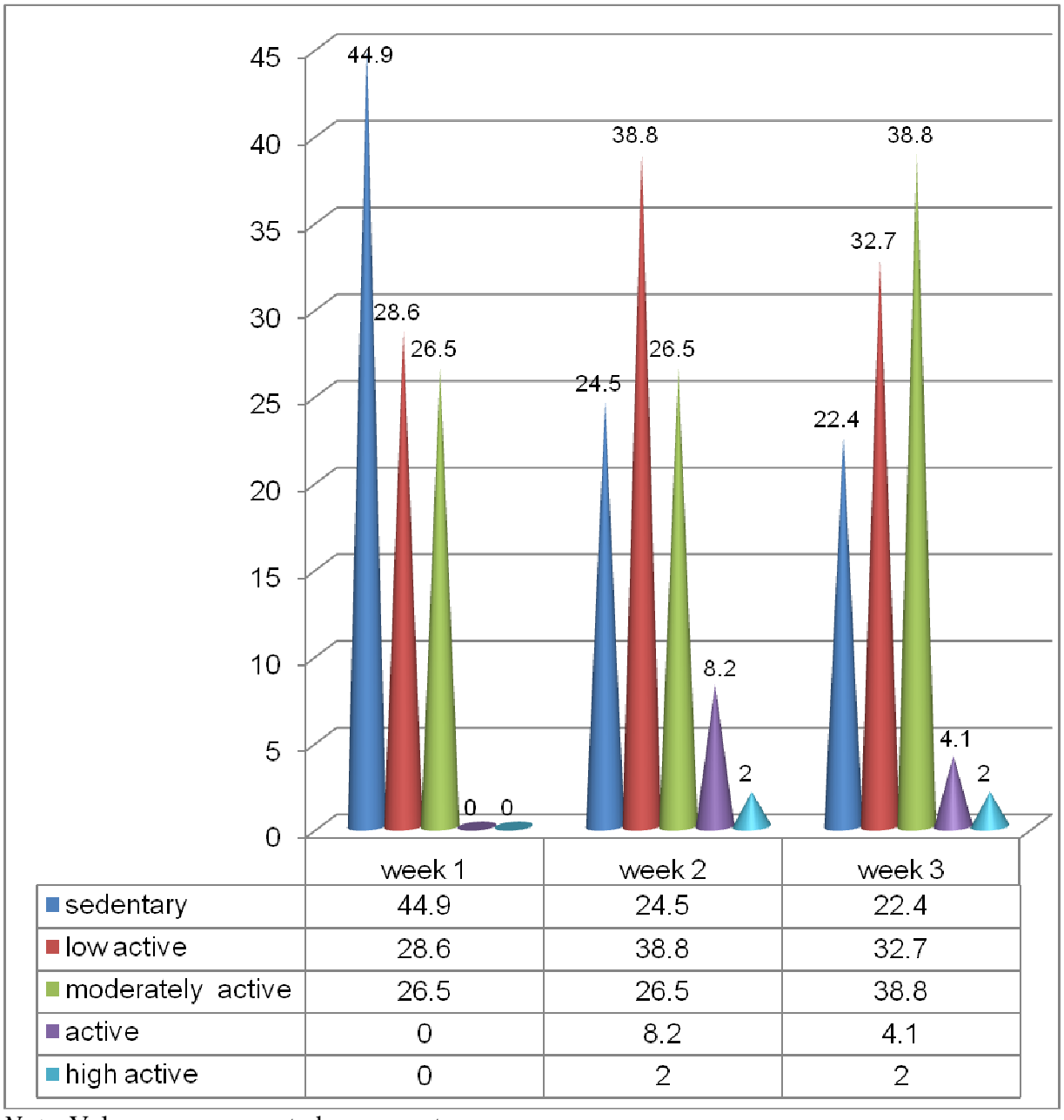


Figure 4.
Participant Activity Level According to Indices Rating by Week



	week 1	week 2	week 3
sedentary	44.9	24.5	22.4
low active	28.6	38.8	32.7
moderately active	26.5	26.5	38.8
active	0	8.2	4.1
high active	0	2	2

Note. Values are represented as percentages.

Figure 5.
Participant Accuracy in Estimation of Activity Level Compared to Indices Rating

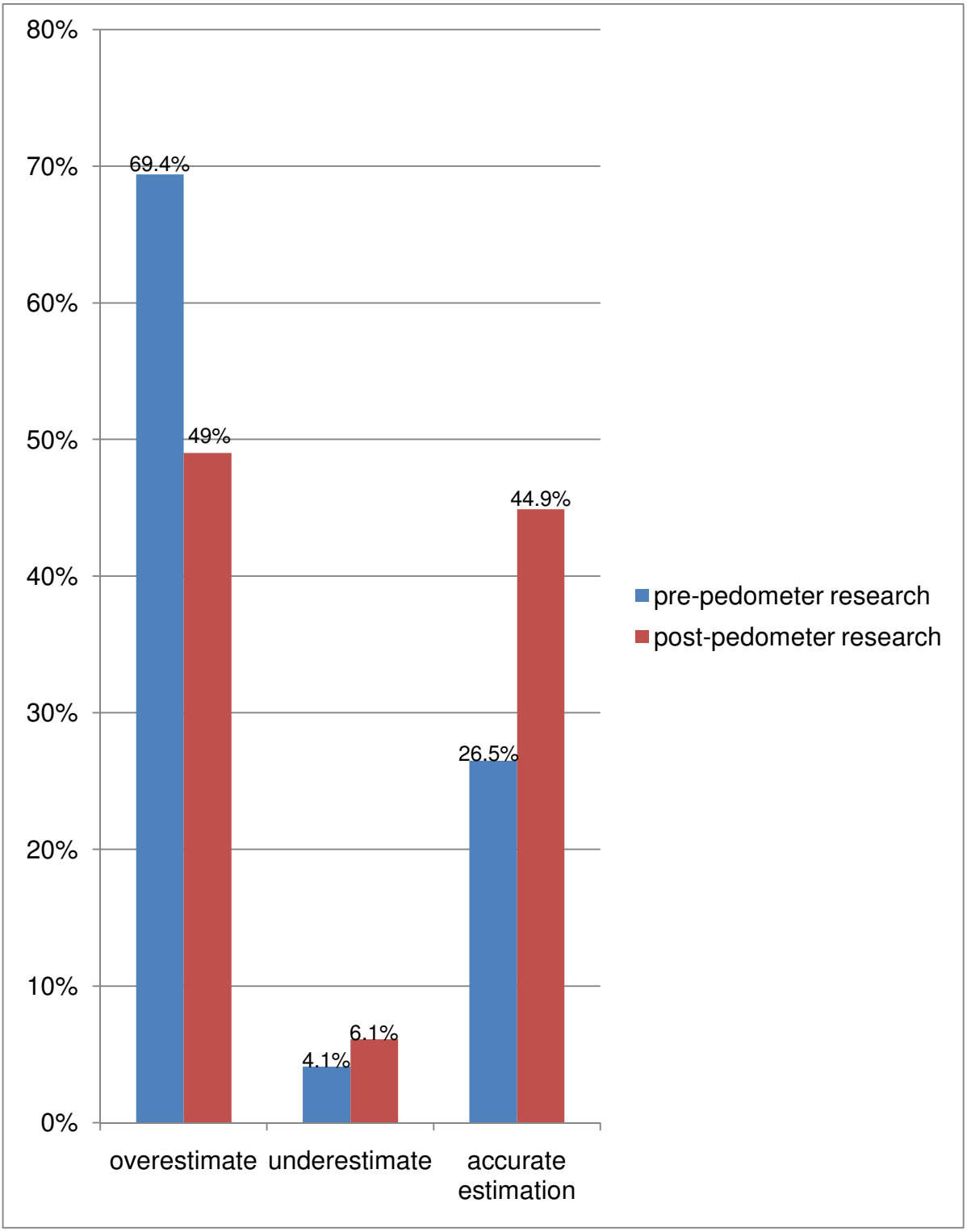


Table 1.
Means and Standard Deviations of Steps per Day Performances for Week 1, 2, and 3 by Gender

Gender		Week 1	Week 2	Week 3
Female	M	5,521	6,511	6,611*
	SD	2,473	2,540	2,182
	N	37	37	37
Male	M	5,783	6,817	8,707*
	SD	2,481	2,766	2,805
	N	12	12	12

* $p < .05$.

Table 2.
Means and Standard Deviations of Steps per Day Performances by Day of Week

	M	SD
Week 2		
Monday	5,737≠	4,009
Tuesday	7,544*++	3,318
Wednesday	6,537	3,508
Thursday	5,682*##»	3,566
Friday	7,888##	4,692
Saturday	6,889	3,470
Sunday	5,824++	3,024
Week 3		
Monday	6,827≠	3,190
Tuesday	7,519	2,700
Wednesday	6,268	3,243
Thursday	7,730»	2,592
Friday	6,947	4,092
Saturday	7,614	4,561
Sunday	6,739	3,771

Note. Symbols represent significant differences found between days. *Tuesday and Thursday; ++Tuesday and Sunday; ##Thursday and Friday; ≠Monday and Monday; »Thursday and Thursday; all $p < .05$

Appendix A
Survey Instrument

Instruction: Please circle or fill in the following information.

Male Female

Age: _____

College standing: Freshman Sophomore Junior Senior

Ethnicity: Hispanic White (Non-Hispanic)

Asian Black/African American (Non-Hispanic)

Filipino Other Non-White

Pacific Islander American Indian/Alaskan Native

Unknown/Non-Respondent

Instruction: Rate questions one through seven using the following scale. (Circle your response)

SD=Strongly Disagree D=Disagree A=Agree SA = Strongly Agree

1.	I meet the minimum recommended amount of daily physical activity.	SD	D	A	SA
2.	I would do more physical activity to improve how I look.	SD	D	A	SA
3.	I would do more physical activity to improve my health.	SD	D	A	SA
4.	I enjoy doing physical activity.	SD	D	A	SA
5.	I like to be physically active.	SD	D	A	SA
6.	I try to find ways to be active during my leisure time	SD	D	A	SA
7.	I have worn a pedometer to measure activity prior to participating in this study.	SD	D	A	SA

Instruction: Rate questions eight and nine using the following scale. (Circle your response.)

Not at all = 1 Minimal/Somewhat = 2 Moderately = 3 Almost always = 4

8. During my spare time, I am likely to:

a. Participate in high intensity/vigorous activities or sports (i.e., aerobic class, cycling, running, etc.)	1	2	3	4
b. Participate in moderate intensity activities or sports (golf, bowling)	1	2	3	4
c. Take a walk	1	2	3	4
d. Garden or do yard work	1	2	3	4
e. Perform household chores (cleaning, dusting, vacuuming)	1	2	3	4
f. Read a book or study	1	2	3	4
g. Sit and watch television	1	2	3	4
h. Work on the computer	1	2	3	4
i. Sleep	1	2	3	4

9. When given a choice, I will

a. Walk or cycle instead of drive	1	2	3	4
b. Take the elevator or escalator instead of the stairs	1	2	3	4
c. Use a TV or stereo remote control instead of manually changing the channels	1	2	3	4
d. Search for the closest parking spot to my destination	1	2	3	4

Instruction: For questions ten and eleven, circle the response that best applies to you within the last 7 days.

10. I currently perform moderate intensity activity for at least 30 minutes (walking, housecleaning, gardening, etc)

7 days/week 4-6 days/week 2-3 days/week 1 day/week Rarely/Never

11. I currently participate in a structured exercise program (i.e., aerobics, running, cycling, yoga, weight training)

7 days/week 4-6 days/week 2-3 days/week 1 day/week Rarely/Never

Instruction: For question twelve, circle the response to best describe your current level of physical activity.

12. In terms of my overall lifestyle, I consider myself

Highly Active Moderately Active Low Active Inactive/Sedentary

Appendix B
Activity Recording Log
Week 1 – Baseline Assessment (Sealed Pedometer)

Pedometer #							
Week 1:	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Additional Exercise Activities: (circle one)	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No
List Exercise activity:							
Exercise Time (in minutes)							

Week 2:	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Daily Step Total:							
Additional Exercise Activities: (circle one)	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No
List Exercise activity:							
Exercise Time (in minutes)							

Week 3:	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Daily Step Total:							
Additional Exercise Activities: (circle one)	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No
List Exercise activity:							
Exercise Time (in minutes)							