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Assessment of physical activity in college students by pedometer and questionnaire

Tonia K. Gay

University of Tennessee

To the Graduate Council:

I am submitting herewith a thesis written by Tonia K. Gay entitled "Assessment of physical activity in college students by pedometer and questionnaire." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Human Performance and Sport Studies.

David R. Bassett Jr., Major Professor

We have read this thesis and recommend its acceptance:

Dixie L. Thompson, Edward T. Howley

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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Assessment of Physical Activity in College Students by Pedometer and Questionnaire

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Tonia K. Gay
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Dedication

To my mother, Linda Gay, for her continuous support and understanding, and my grandmother, Imogene Buckner, for her infinite wisdom and encouragement. Thank you both for your love and patience. I love you!

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Abstract

The purpose of this study was to determine the average number of steps accumulated per day in students attending a private, 4-year college. Specifically, the study sought to determine (a) percentage of those students who met the 10,000 steps per day recommendation, (b) whether a difference exists between men and women, and (c) the effects of on- or off-campus residence. Additionally, measurements of physical activity from the Behavioral Risk Factor Surveillance Survey or System (BRFSS) and the pedometer were compared. A total of 79 men (n=40) and women (n=39) ages 18-32 years old participated in this study. Participants completed a physical activity questionnaire (BRFSS), and wore a pedometer (Yamax SW200 electronic pedometer) seven consecutive days except while showering or sleeping. Participants also completed a pedometer log concurrently in which they recorded steps per day and the types of activities they engaged in and the duration of those activities. The average number of steps for men was 9,914 and for women was 7,840 (p=0.013). There was no difference in average number of steps between those who lived on-campus and those who lived off-campus. The BRFSS classified 58% of the students as having met the current physical activity recommendation (150-minutes per week), 29% as insufficiently active, and 13% as inactive. However, only 28% of the students met the Japanese recommendation of accumulating 10,000 steps per day. In conclusion, a greater proportion of college students were classified as physically active on the BRFSS questionnaire, as compared to the pedometer. This indicates that 10,000 steps per day recommendation was more difficult to meet. In part, this is due to the fact that pedometers fail to capture some common activities in college students (e.g. - swimming, bicycling, and weightlifting).

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Chapter I

Introduction

Current American College of Sports and Medicine (ACSM) and Centers for Disease Control and Prevention (CDC) guidelines for physical activity recommend that every American adult accumulate at least 30 minutes of moderate activity on most, if not all, days of the week (17). However, according to the CDC, more than 60% of adults do not achieve recommended amounts of physical activity, and 25% are inactive (i.e. they perform no leisure time physical activity) (17). Further, the CDC also states that inactivity increases with age and is more common in women than men, in lower income households, and in those with less education (17). In 2000, data obtained using the Behavioral Risk Factor Surveillance Survey or System (BRFSS) showed that 77% of the residents of Tennessee ages 18-24 reported participating in physical activities, whereas 79% of this population nationwide reported participating in physical activities. However, for adults 18 years or older, inactivity in Tennessee in 2000 (25%) was higher than the national average (21%) (7).

Although 7.1 million of adults ages 18 to 24 year olds attend a college or university, little is known about their physical activity habits. Most knowledge concerning this subject has been obtained through questionnaires (18,23,24). The 1995 National College Health Risk Behavior Survey found that 38% of college students reported vigorous exercise for at least 20 minutes on at least three days one week prior to the survey. Vigorous activity was describes as "activity that made you sweat and breathe hard."

Almost 20% reported walking or bicycling (moderate activity) at least 30 minutes for five days one week prior to the survey. Overall, more men than women reported participating in vigorous activity, and moderate activity participation did not vary between gender or age group (9). Regarding on- versus off-campus residence, Brevard and Ricketts showed there was no significant difference in energy expenditure, mode of exercise, and activity level patterns between students living on- or off- campus (6).

Even though subjective data is valuable, objective physical activity data is more desirable. Pedometers have been shown to accurately count steps in many populations (12,20,27). Since walking is one the most common forms of exercise in the United States (ranking ahead of calisthenics, cycling, jogging, weightlifting, swimming, dancing, tennis, basketball, football, and softball) (8), it is logical to use a pedometer to record steps taken per day in college students. Further, regular use of a pedometer may also make people more conscious of their daily activity so they can maintain or improve current activity levels. This would be very important in this age group since Haberman et al. and Pinto et al. agreed that physical activity habits adopted during college continue through adulthood (11,19).

Many studies have been conducted to determine the amount of physical activity college students perform, mainly through the use of questionnaires (1,6,9,18,23,24). However, little research has been conducted using pedometers, especially in college students. A Japanese researcher has proposed a goal of attaining at least 10,000 steps per day as a recommendation for good health and cardiovascular disease prevention. Accumulating 10,000 steps per day would seem to be roughly consistent with the American College of Sports Medicine and Centers for Disease Control exercise recommendation of thirty-minutes of accumulated moderate exercise on most, if not all, days of the week (17). Walking two miles meets CDC/ACSM physical activity recommendation, and one mile is approximately 2,000 steps. Those who are sedentary accumulate, on average, 6,000 steps per day so accumulating these extra 4,000 steps is not impossible and would satisfy both physical activity recommendations. Therefore, the primary purpose of this study was to determine the average number of steps per day taken by students attending a four-year, private college. In addition, the study sought to (a) determine the percentage of those students who met current recommendations of 10,000 steps per day; (b) determine if there was a difference between men and women in amount of accumulated steps; and (c) determine if the residence (on-campus or off-campus) of the students made an impact on accumulated steps. The study also compared the objective data obtained from the pedometer to the subjective data obtained from the questionnaire (BRFSS).

Chapter II

Review of Literature

Walking is a part of everyday life and is also one of the most common forms of physical activity that is performed during exercise and recreational activities (6,8,12,27). Pedometers have proved to be an important tool in measuring daily ambulatory activity especially when used as a step counter (12,20,27). Therefore, it is logical to use a pedometer to measure steps taken per day to objectively assess physical activity accumulated throughout the day in college students.

Validity of Pedometer in Measuring Distance/Counting Steps

Pedometers, though relatively new to many people, have been in use in research for more than thirty years. Originally, pedometers were mechanical, involving the displacement of a lever arm and registering a count through a series of gears. In a 1977 study, Saris and Binkhorst tested the use of pedometers and actometers in measuring daily activity (21). The reliability of both the pedometer and actometer was tested by mounting them on a carriage connected by a drive shaft with a crank rotating at different speeds. They discovered a great difference in the rotation speed at which different pedometers started counting. A subsequent adjustment of spring tension was made to insure that all pedometers began counting at the same speed. Saris and Binkhorst also tested both devices by having subjects walk and run at different speeds on a treadmill. They found the pedometer to be unreliable in recording the number of steps at extremely slow velocities and at higher velocities, such as fast walking and running. They observed that the pedometer underestimated the number of steps at a slow walking pace (1km/hr), concluding that the impulses were too small to trigger a count. At a fast walking pace, the pedometer over-estimated the number of steps. With running, they found the pedometer steps remained constant while energy expenditure increased at higher speeds, probably due to an increase in stride length with running. With regards to location of the pedometer, Saris and Binkhorst found the waist pedometer to be more accurate than the ankle pedometer, with no difference between the pedometers on the right and left sides of the waist (21).

Another study in 1980 found similar results (28). This study tested the accuracy of the pedometer in walking and running. Washburn, Chin, and Montoye had subjects complete one-mile walks on a treadmill at various speeds, on a 400-meter track, and along a one-mile jogging path. Differences were observed in the treadmill trials both at different speeds and between different subjects. In agreement with Saris and Binkhorst, this study also found that pedometers incorrectly recorded the number of steps at speeds higher or lower than 3.0 mph. They indicated the need to calibrate pedometers at different speeds or make a stride adjustment if the pedometer has one. A significant finding in this study was that of inter-subject variation, indicating that a subject's body weight and gait influenced pedometer accuracy. Based on this result, the authors recommended that further studies should use brands of pedometers able to be adjusted for stride length and take body weight into account. Washburn, Chin, and Montoye also observed that pedometers worn at the waist were more accurate than those worn at the ankle, which agreed with the earlier Saris and Binkhorst study (21, 28).

More recently, the older mechanical versions of the pedometer have been replaced with electronic models, and many manufacturers have begun to produce their own versions of pedometers. Bassett et al. tested the accuracy of five brands of waist-mounted, electronic pedometers for measuring distance walked (4). In addition to testing the accuracy for distance measurements, this study focused on variations among different brands. The five models tested included the Freestyle Pacer 789, Eddie Bauer Compustep II, L.L. Bean Pedometer, Yamax Digiwalker DW-500, and the Accusplit Fitness Walker. This three-part study first tested pedometer accuracy on a sidewalk course of a measured distance. In a second part of the study, subjects walked on a cushioned 400m track to determine the effect of walking surface on pedometer accuracy. A third part of the study had subjects walking on a treadmill at various speeds to test the effect of walking speed on accuracy. The study found significant difference in distance walked between pedometers, with the Yamax, Pacer, and Accusplit models being significantly more accurate. For those pedometers that displayed number of steps, there was no statistical difference in the percent of actual steps recorded. The Yamax model had the smallest between-subject standard deviation. This study agreed with the two previously discussed in finding no difference in pedometers worn on the right or left side of the body. The second phase of the study found no significant effect of walking surface on distance recorded. In the last part of the study, the Yamax pedometer was found to be more accurate at slow to moderate speeds (2.0-3.0 mph) than the Eddie Bauer or Pacer models, while all three models were similarly accurate at faster speeds (4.0 mph). This study also found variability from two pedometers of the same model for the Pacer and Accusplit models. This showed intra-model variability still exists with the newer electronic pedometers as with the mechanical models. Only the Yamax model was very consistent between units. The authors concluded that overall, the newer electronic pedometers have a greater absolute accuracy than the older, mechanical ones (4).

A more recent study investigated the validity of pedometers and accelerometers to assess physical activity in a field study on different activities that included walking. Hendelman et al. evaluated the accuracy of step counting in numerous activities including walking in the field, golf, and indoor and outdoor household chores using two accelerometers and the Yamax SW-701 pedometer (14). The findings support the previous studies in this area; the Yamax underestimated the number of steps at lower speed, but estimation improved at higher speeds. The authors pointed out that the lowest walking speed tested was much slower than the subjects' normal walking speeds so that this inaccuracy would not be cause for concern in studies conducted in the field (14).

Measuring Energy (kcal) Expenditure

There are a variety of methods that can be used to estimate energy expenditure and physical activity. An older and more traditional method is the use of questionnaires and self-reporting of daily activity. Along with the pedometer, accelerometers can be used to obtain activity counts and a temporal record of physical activity patterns. Energy expenditure can also be measured using a portable metabolic system that measures oxygen uptake (VO_2). Yet another method for determining energy expenditure is the doubly labeled water method. The latter two methods are considered most accurate and are used to validate the other methods mentioned.

Validity of Pedometer in Measuring Energy Expenditure

In addition to providing a count of steps taken and distance traveled, many pedometer models also estimate energy expenditure in kcals. A group of Japanese researchers evaluated the correlation of pedometer readings with energy expenditure in a group of factory workers (15). The subjects consisted of two types: clerical workers and assembly workers. Pedometer readings from a single day of free-living were analyzed and compared to energy expenditure determined from simultaneously recorded 24-hour heart rate. The pedometer readings were significantly correlated, r=0.83, with the calculated net energy cost, and the correlation improved once the net energy cost per kg body weight was considered. The study evaluated different phases of activity during commuting, work, and time at home. The results showed that the best reflection of net energy cost by pedometer readings was during commuting followed by a moderate correlation during work. The time spent commuting involved mostly walking and thus the pedometer readings are highly correlated with energy expended. Time spent at home involves the least amount of walking and more sedentary activity, therefore, there was no statistically significant correlation when subjects were at home. While at work, the study compared the results of the clerical workers with that of the assembly workers and found that the pedometer data of the clerical workers were better correlated with the net energy costs. This was explained in the different types of jobs and the types of activities involved. Clerical workers had sedentary jobs with walking as the main cause of energy expenditure. The assembly workers were moving about at a slow pace and a good deal of energy expenditure came from upper body movements, which the pedometer would not detect. Advantages of the pedometer, pointed out by the authors, are its low cost, light-weight, and strong correlation to energy expended during ambulatory activity (15).

Another recent study was conducted by Bassett et al. (3) to test the validity of four motion sensors in measuring moderate intensity activity (3). This study evaluated three accelerometers and the Yamax SW-701 pedometer during several different tasks including yard work, housework, occupation, family care, conditioning, and recreation. The readings from the motion sensors were compared to data collected from a portable indirect calorimetry system (Cosmed K4b^2, Rome, Italy) that each subject wore during activity bouts. The Yamax SW-701 model had accuracy similar to that of the Yamax DW-500 model used in a previous study (4). The participant's body weight and an assumed stride length was entered into the pedometer. The results of this study showed that most of the motion sensors underestimate the energy cost of everyday activities. The Yamax SW-701 pedometer overestimated the energy cost of walking within speeds of 2.91-3.73 mph (3). The SW-701 was found to underestimate energy expenditure in most other activities (3). This is in agreement with the previous Kashiwazaki study in that pedometers underestimate energy expenditure in activities that involve slower speeds of walking or no walking and use of upper body for carriage and weight-bearing activity (15).

Validity of Questionnaires in Measuring Energy Expenditure

Several studies tested the accuracy of questionnaires in estimating daily physical activity (5, 16, 22, 29). A recent study by Weston, Petosa, and Pate found that the previous day physical activity recall (PDPAR) questionnaire yielded energy expenditure estimates that were highly correlated with those of pedometer and accelerometer data, r=0.88 (29). Leenders et al. (16) found that energy expenditure data obtained from the Physical Activity Recall (PAR) questionnaire were highly correlated with data obtained using the doubly labeled water method, r=0.91 (16). Contrary to these findings, Bassett, Cureton, and Ainsworth found that a different questionnaire, the College Alumnus Questionnaire (CAQ), significantly underestimated daily walking distance and consequently energy expenditure estimates as compared to the Yamax SW-701 pedometer (5). The energy expenditure of walking computed from CAQ data was lower by 1050 kcal/wk than data from the pedometer (5).

Double-Labeled Water vs. Pedometer, Questionnaire, and Accelerometer

Leenders et al. (16) compared energy expenditure estimates from a seven-day Physical Activity Recall questionnaire (PAR), along with pedometer and two accelerometer estimates, to values obtained using the doubly labeled water method of measuring energy expenditure (16). In regards to the estimates of physical activity and energy expenditure, the PAR was highly correlated with the doubly labeled water method, r=0.91. However, the data from the pedometer (Yamax DW-500) were found to significantly underestimate energy expenditure as compared with the doubly labeled water method by 59%, as was the case with the two accelerometers tested, 35% for the Tritrac and 59% for the CSA.

Oxygen Consumption vs. Pedometer and Accelerometers in Measuring Energy Expenditure

Two studies used pedometers and accelerometers to estimate activity and energy expenditure as compared with oxygen consumption data estimates (4, 14). Both studies evaluated the Yamax SW-701 pedometer, the CSA accelerometer, and the Tritrac accelerometer for validity in measuring moderate intensity activity in the field. The Bassett et al. (4) study also evaluated an additional accelerometer, the Caltrac. Both studies evaluated a range of activities from walking to golf to housework and yard work, and measured energy expenditure using a portable metabolic system. Both studies (4,14) found that all types of motion sensors underestimate energy expenditure in most types of activity. This is most likely due to the inability of the sensors to detect upper body and isometric work. Leenders et al. (16) also tested both pedometers and accelerometers for accuracy in measuring physical activity. Leenders found that while accelerometers were somewhat more accurate than pedometers, all types of these motion sensors underestimated net energy cost in most activities tested. This led to the suggestion that the validity and usefulness of motion sensors is dependent upon the type of activity evaluated. Accelerometers provide an advantage over pedometers in their ability to store data and in some cases, provide temporal information to establish and verify bouts of moderate to vigorous activity. However, accelerometers are far more expensive and are less practical in studies or situations involving large numbers of subjects (16).

Freedson and Miller reviewed the characteristics of the motion sensors mentioned above in assessment of physical activity (10). Their findings repeat those of the studies mentioned above in the advantages and limitations of pedometers and accelerometers. They indicate an additional advantage in the usefulness of pedometers as motivational tools in intervention studies. Goals in steps per day could be set according to the recommendations for daily physical activity. This is an area for further research to establish correlation of number of steps with an adequate amount of daily activity so that appropriate physical activity goals are set. This would allow subjects to self-monitor their progress and attainment of their goals (10).

The studies discussed here point to inaccuracy in the ability of pedometers and accelerometers to accurately assess energy expenditure. For pedometers, it is partly due to their mechanics and design. Pedometers record data based on number of vertical accelerations recorded or number of steps. Bassett et al. found that the Yamax SW-701 pedometer overestimated energy expenditure in both slow and brisk walking (3). In addition, pedometers do not take into account upper body movement, which would underestimate energy expenditure. These drawbacks would limit the usefulness of pedometers in measuring energy expenditure. However, as pointed out in discussion of the Kashiwazaki study, the pedometer readings were correlated with energy expenditure in workers with sedentary occupations, where walking is the main activity (15). This could prove very useful for those individuals with more sedentary occupations, which encompasses much of the population.

Pedometers are useful in measuring walking activity but underestimate energy expenditure in most activities (3, 4). Bassett, Cureton, and Ainsworth concluded that perhaps pedometers could prove useful to measure walking data in conjunction with recall questionnaires to more accurately assess energy expenditure and prescribe physical activity programs (5).

Overall, pedometers provide a low cost method of assessing physical activity in cases where walking is the main activity. As mentioned earlier, walking is one of the most popular forms of activity and is the main component of daily activity for those with sedentary or desk jobs (15). Since those types of jobs are prevalent in our society, the pedometer could prove extremely useful in estimating daily ambulatory activity, especially when combined with questionnaire protocols. Pedometers seem to be the best tool available for use in assessing physical activity in large studies or health promotion programs involving walking as the main component because of its objectivity. Rowland and Tudor-Locke also mention that using raw step data obtained from pedometers (i.e. total steps per day) is an accurate descriptor of ambulatory activity and may be more useful and meaningful than using pedometer calculated distance or energy expenditure (20, 27). Rowland further suggests that the pedometer is the most appropriate tool to assess progression of physical activity from childhood to adulthood. Also, since there is a lack of data on steps per day in college students, a pedometer would be a useful objective tool to gather ambulatory activity information in this population.

Current Physical Activity Recommendations

Regular physical activity has shown to improve health by decreasing the risk for heart disease, reducing the risk of hypertension, decreasing blood pressure in those with hypertension, decreasing insulin resistance in those with type 2 diabetes, decreasing depression and anxiety, helping build and maintain healthy bones, muscles, and joints, and promoting psychological well-being (17).

Current American College of Sports and Medicine (ACSM) and Centers for Disease Control and Prevention (CDC) guidelines for physical activity recommend that every American adult accumulate at least 30 minutes of moderate activity on most if not all days of the week (17). An alternative proposal by Hatano recommends obtaining 10,000 steps per day to maintain good health (12). Walking two miles meets CDC/ACSM physical activity recommendations, and one mile is approximately 2,000 steps. Those who are sedentary accumulate, on average, 6,000 steps per day so accumulating these extra 4,000 steps is not impossible and would satisfy both physical activity recommendations. Also, estimated caloric expenditure for 10,000 steps is between 300 and 400 kilocalories depending on body size and walking speed. This is double the minimum recommended energy expenditure set forth by the U.S. Surgeon General of 150 kcal per day (12, 16, 26).

According to the CDC, more than 60% of adults do not achieve recommended amounts of physical activity, and 25% are not active at all. Further, the CDC also states that inactivity increases with age and is more common in women than men, in lower income households, and among those with less education (17). In 2000, data collected from the BRFSS showed that 77% of the residents of Tennessee age 18-24 reported participating in physical activities, and for adults 18 years of age and older 70% of the men and 65% of the females reported participating in physical activities. Inactivity in Tennessee in 2000 was about 4% higher than the national average, 25% and 21% respectively. Physical inactivity was also higher in men (30%) and women (35.1%) in Tennessee than the national averages for gender, 24% for men and 29% for women (7).

Age and Gender Differences in Steps Accumulated Per Day

A review article by Tudor-Locke and Myer (27) found that 8-10 year old children accumulate 12,000-16,000 steps per day. Apparently healthy young adults accumulate between 7,000-13,000 steps per day and healthy older adults accumulate between 6,000-8,500 steps per day. Individuals with disabilities and chronic diseases accumulate between 3,500 and 5,500 steps per day. All walking values were estimated to be lower in women than in men in every age group (27).

Sequeria et al. (23) conducted a study involving 493 Swiss men (n=265) and women (n=228) age 25 to 74 to evaluate pedometer use in epidemiological research on physical activity. Each subject wore the pedometer for seven consecutive days and recorded daily results on a form provided by researchers. Participants also completed a daily physical activity questionnaire concerning occupation and leisure time physical activity. Average number of steps taken per day by men in the 25-34 year old age group was 11,900 for men and 9,300 for women. In the oldest age group, 65-74, men accumulated 6,700 steps per day, and women accumulated 7,300 steps. Researchers noted that as leisure time physical activity became more demanding, the number of steps per day increased for both sexes. However, when physical activity was limited for any reason, fewer steps were taken. Overall, steps decreased with age from 11,900 to 6,700 in men and from 9,300 to 7,300 in women between the two extreme age groups, 25-34 and 65-74. During the 65-74 year old age group, women began averaging more steps than men (23).

In another study by Hatano (12), 500 Japanese men and women wore a pedometer for one week and recorded the number of steps taken per day. The average number of steps taken per day in the 30-39 year old age group was 8,240 for men and 7,233 for women. In those who were 70 years or older, steps per day values were 4,652 for men and 3,930 for women. However, in those who were older, Hatano suggested 6,000 steps per day as an appropriate physical activity goal (12).

Both of the above studies used similar methods in that the study was conducted under free-living conditions, subjects wore the pedometer for seven consecutive days, and subjects self-recorded data from the pedometers. Even though the age groups were not exactly the same, Hatano's subjects seemed to have lower step counts overall compared to Sequeria's subjects (12, 23). In Sequeria's study, on average, men maintained the 10,000 steps per day recommendation from the 25-34 year old age group through the 45-54 year old age group. However, the overall sample of women did not average 10,000 steps per day during any age group, but were very close in the 25 to 34 and 35 to 44 year old age groups, 9,300 and 9,800 average steps per day, respectively. In this cross-sectional study, men had a greater age-related decline than women from youngest to the oldest age groups; men decreased 5,200 steps and women decreased 2,000 steps (23). However, the decline in average steps per day was not as drastic as in Hatano's study, men decreased 3,588 steps and women decreased 3,303 steps (12).

Intervention Studies

In addition to being used as a step counter in free-living conditions, pedometers have also been used in intervention studies. Tudor-Locke (25) studied nine obese and sedentary men (n=3) and women (n=6) with Type II diabetes who averaged 53 years of age and had an average BMI of 32.9 kg/m^2. Subjects used a pedometer and a physical activity log concurrently for three days (Thursday, Friday, and Saturday) for four weeks. The walking intervention was based on individual goals for increasing walking and activity. Participants attended weekly group meetings and had individual practice with goal setting and self-monitoring. Activity log data obtained at baseline did not show a significant difference, but average steps taken per day increased from 6,342 $\pm$ 2,244 (4,617-8,068) at baseline to 10,115 $\pm$ 3,407 (7,497-12,735) steps per day after intervention (25).

Another study by Wilde et al. (30) assessed 32 women between ages of 30 and 50 who were school secretaries. Participants completed the Par-Q, responded to two questions from NHANES II (1997), and kept a daily log of activities, which recorded activities not typical of their daily routine. The pedometer was worn on four consecutive weekdays, and 30-minutes of walking was incorporated into their routine two of the four days. Walks were unsupervised and participants chose the time of day when the walks took place. Researchers found significant differences between walk (average 10,030 steps per day) and non-walk days (average 7,220 steps per day) (31). Therefore by increasing physical activity by 30 minutes, steps per day increased to around 10,000 steps per day in these women (30).

Both studies prove that adding walking activity to everyday activity increased the total steps taken per day (25, 30). However the study by Tudor-Locke did not state an average time that the subjects walked (25). This would have been beneficial to compare the 10,000 steps per day recommendation and the ACSM and CDC recommendation.

Activity Patterns in Male and Female College Students

Although 7.1 million 18 to 24 year olds attend a college or university, little is known about their physical activity habits. Most knowledge concerning this subject is obtained through questionnaires (1,6,9,11,18,19). The 1995 National College Health Risk Behavior Survey found that 37.6% of college students reported vigorous exercise for at least 20 minutes per day, on at least three days one week prior to the survey. Vigorous activity was described as "activity that made you sweat and breathe hard." Almost 20% reported walking or bicycling (moderate activity) for at least 30 minutes per day, for five days per week prior to the survey. Overall, more men than women reported participating in vigorous activity, and moderate activity participation did not vary between genders (9).

Pierce et al. (18) surveyed 115 male and 143 female students entering college. Variables included were maximal oxygen consumption (estimated from Astrand cycling protocol), body composition (skin-fold techniques), muscle endurance (sit-up protocol), muscle strength (bench-press protocol), and joint flexibility (upper and lower body). All subjects were members of a comprehensive wellness course required of all students at the University of Richmond. Average age of men and women was about 18, and average body weight was 74 kilograms for men and 60 kilograms for women. In terms of aerobic capacity, women were average (39 ml/kg/min) and men were below average (41.6 ml/kg/min). Women had average body composition (20.1%), excellent muscle strength (20.2 repetitions), average muscle endurance (38 repetitions), and average joint flexibility for upper and lower body. Men had a good body composition (10.9%), excellent muscle strength (10.9 repetitions), average muscle endurance (47.7 repetitions), and average joint flexibility for both upper and lower body. Patterns of physical activity was classified as aerobic, recreational, or weight training. Subjects were considered participants for each activity if they engaged in the activity two times per week. Researchers determined that females were more likely to participate in aerobic activity than males (78% vs. 34%), but men participated in weight training more than females (35% vs. 18%). Men also participated in recreational activities more than women (28% vs. 12%) (18). One interesting aspect of this paper was that no student reported being sedentary. Therefore, this may not be a good representation of the entire population.

Another study conducted by Haberman et al. (11) assessed 302 college students' diet and exercise behaviors. The study took place the last two weeks of March at the University of Pittsburgh. Researchers used the Survey of Selected Nutritional Health Practices of College Students to gather data. Thirty-nine percent of the students reported that they exercised three or more time per week, and 12.3% reported not exercising at all. They reported no differences between men and women regarding frequency of exercise. Even though the average age of participants was not reported, researchers referred to subjects as youths and stated there was a need for higher standards for exercise participation given the decline with age and that people continue habits from college into adulthood (11).

Pinto et al. (19) also used a questionnaire to assess changes in college students' exercise participation from their first year to their second year. The questionnaire assessed moderate to vigorous activity patterns for the seven previous days prior to receiving the questionnaire. Questionnaires were sent in February of 1995 and 1996. Three hundred thirty-two students responded to the initial assessment. The average age of the students was 18.6 years of age, mean BMI was 21.7 kg/m^2, and 60% were women. Two hundred and forty-two students from the initial assessment responded to the second, and average BMI was 21.8 and 61% were women. Authors also noted that 27% of the original respondents were athletes, and 28% were athletes at the second assessment. There were no significant differences between subjects at the initial and second assessment. Researchers found no significant differences in reported average number of minutes spent on either vigorous or moderate exercise between 1995 and 1996. Vigorous activity in 1995 was 182 minutes per week and in 1996 it was 175.7 minutes per week.

Moderate activity in 1995 was 97.1 minutes per week and in 1996 it was 104 minutes per week. These moderate and vigorous intensity activity findings are in disagreement with the findings of Telama and Yang, who stated that self-reported intensity of activity increased with age (24). Fifty-eight percent of the students were active in 1995, and 64% were active in 1996. These findings were higher than those found in the 1995 National College Health Risk Behavior Survey. Only 42% of 18 to 24 year old participated in vigorous activity, which was defined as "activity that made you sweat and breathe hard" for at least 20-minutes three times in the week prior to the survey. Also, only 20% participated in moderate activity for at least 30-minutes five times in the week prior to the survey (9). This discrepancy may be due to the latter survey encompassing a greater age range. Researchers stated that they may have over reported regular exercisers. They also suggested that motion monitors should be worn in the future to more accurately measure activity. Pinto et al. (19) agreed with Haberman et al. (11) that the transition from college to the work force was associated with a decrease in activity (11,19).

Residence of College Students and Physical Activity

Brevard and Ricketts (6) conducted a study to determine how residence (on- or off-campus) affected physical activity and dietary intake of college students. One hundred and four college students (30 men and 84 women) in a nutrition class at James Madison University participated in the study. A total of 55 students lived off campus. The lifestyle questionnaire contained questions on mode, intensity, and frequency of exercise. Weekly energy expenditure was classified into six groups and mode of exercise was classified as aerobic, anaerobic, combination of anaerobic and aerobic, or no exercise. There were no significant differences in energy expenditure, mode of exercise, and activity-level patterns between students living on- or off- campus. Twenty-nine percent of the students living on campus and 28% of students living off campus led a sedentary lifestyle (6). Studies concerning the residence of the student in regards to physical activity are scarce. However, Pinto et al. (19) stated that those who live off campus may find it beneficial and economical to walk or bike to class, therefore finding moderate intensity activity more feasible than vigorous activity (19).

Conclusion

In summary, pedometers provide a low cost method of assessing physical activity in cases were walking is the main activity (5). As mentioned earlier, walking is one of the most popular forms of activity and is the main component of daily activity for those with sedentary or desk jobs (9, 12, 27). The pedometer could prove extremely useful in estimating daily activity, especially when combined with questionnaire protocols (5). A recent article by Healey discussed future possibilities in electronic monitoring of physical activity, including wearable computers and computer chips embedded in clothing as a method of collecting physical activity data (13). However, given the expense of these methods, pedometers seem the best tool available for use in assessing physical activity in large studies or health promotion programs in which walking is the main component. It may also be the best tool for assessing progression of physical activity from childhood to adulthood (20).

Most information regarding physical activity in college students has been obtained through questionnaires (1,6,9,11,18,19). Pedometers would yield objective data not affected by recall bias. Pedometers have been used in studies to determine average steps per day in many populations, but not specifically in the college population (12, 15, 20, 23, 25, 27, 30). Physical activity in college students has been collected mainly through the use of questionnaires (1, 6, 9, 11, 18, 19), which may be affected by recall bias or wording that is confusing to the participant (5).

In regards to the current study, the Yamax SW200 digital pedometer will be used. Results from the pedometer will determine accumulated steps per day in college students and percentage of college students who meet the 10,000 steps per day recommendation set forth by Hatano. A questionnaire will also be used to assess physical activity in college students. The Behavioral Risk Factor Surveillance Survey (BRFSS) was designed by the Centers for Disease Control and Prevention to determine public health issues and at-risk populations for those issues. One component of the survey collects information regarding exercise behaviors. Some trade-offs exist with both methods. Questionnaires are subject to recall error and lack objectivity, although some have been proven reliable in providing energy expenditure estimates. Questionnaire wording has also been suggested as a source of error in activity estimation (5). The results will provide objective information regarding ambulatory activity in college age student, and how it is affected by gender and residence (on-or off-campus).

Chapter III

Methods

After approval from the University of Tennessee's Institutional Review Board and Carson-Newman College's Human Subjects Review Board, ninety-two volunteers 18 years of age or older from Carson-Newman College (CNC) in either First Aid and Safety or Wellness courses were invited to participate in this study. These are general education courses required of all students. Students who were unable to walk or who have contraindications to exercising were excluded from participation. Before participating in the study, all subjects read and signed an informed consent form approved by the institutional review boards (IRB's) (Appendix A).

During a designated class period, the following information was obtained: age, gender, year in school, residence (on- or off-campus), method of commuting to school if living off campus, and their phone number for completion of a physical activity telephone survey. Weight and height for each subject was measured by the researcher and included on the general information sheet (Appendix B).

Participants were then instructed on how to use a pedometer. The pedometer was to be worn for seven consecutive days and a log was to be completed concurrently (Appendix D). The log sheet included information such as time the pedometer was put on, time the pedometer was taken off, steps taken that day, the date, activities participated in that day, and the duration of those activities. Each person was asked to position the step counter on the waistband of shorts/pants/skirt, in the mid-line of the thigh. The participants were instructed not to change their level of exercise habits during the study. Two days before the study began, the participants were instructed to begin wearing the pedometer to allow the student to become familiar with its operation. Participants were given the following instructions:

- Wear the pedometer at all times for an entire day seven consecutive days, except while showering or sleeping.
- Do not change your physical activity.
- Upon waking each morning, place the pedometer on clothing, record time of day it was put on, and wear it all day, except when sleeping and showering.
- Just before you go to bed each night, please remove the pedometer, fill in the pedometer log sheet, and then re-zero the pedometer for next day use.
- Repeat the procedure until seven consecutive days are finished.
- At the end of seven days, I will return to CNC to gather all pedometers and pedometer log sheets.

The physical activity survey (BRFSS) was completed by phone on the day before students began documenting their accumulated steps (7) (Appendix C). It was originally developed in 1984 by the Centers for Disease Control and Prevention to determine public health issues and at-risk populations for those issues. The particular version used was the 2001 revision. One component of the survey collects information regarding exercise behaviors, especially walking behavior (7). Based on answers from this questionnaire participants were classified as inactive, insufficiently active, or met recommendation. Those in the met recommendation category had to either participate in vigorous intensity activity three or more days per week for at least 20 minutes and/or participate in moderate intensity activity five or more days per week for at least 30 minutes. Those in the insufficiently active category reported participating in activity, but were not considered to be sufficiently active in either vigorous intensity or moderate intensity activities. Those in the inactive category reported no physical activity.

Statistical Analysis

Statistical analysis was performed using SPSS 11.0 software (Knoxville, TN) and was based on 79 complete sets of data (40 males, 39 females) from the original ninety-two participants. Thirteen sets of data were either not returned or returned with more than two days of pedometer data missing. Data are presented as means ± standard deviation. Independent t-tests were used to determine statistical significance between men and women for age, height, weight, body mass index, and average steps taken per day. An independent t-test was also used to determine statistical significance in steps taken per day between those who lived on-campus and those who lived off-campus. For all statistical analyses, significance was accepted at $P<0.05$. A chi-square was used for comparison of physical assessment tools, the pedometer and BRFSS.

Chapter IV

Results

Table 1 contains demographic characteristics of subjects. Average age was 20 ± 3 years. Average body mass index (kg/m^2) was 25 ± 6. Average height and weight for males was 181 ± 7 cm and 86 ± 18 kg respectively. Average height and weight for females was165 ± 8 cm and 68 ±20 kg respectively. Average steps per day measured over one week were 8890 ± 3766 with males taking significantly more steps than females, 9914 ± 4564 and 7840 ± 2345, respectively (p=0.013). Figure 1 shows the frequency distribution of average steps taken per day, in which the assumption of normal distribution was not grossly violated. Table 2 shows that only 28% of the students met the 10,000-step recommendation. Table 3 contains steps per day based on residence. Those who lived off-campus averaged 8484 ± 5184 and those who lived on-campus averaged 9078 ± 2931 steps per day; there was no significant difference (p=0.5180). Also, in Figure 2, there was a significant difference of steps taken per day with Sunday being significantly lower than the weekdays (p=0.001).

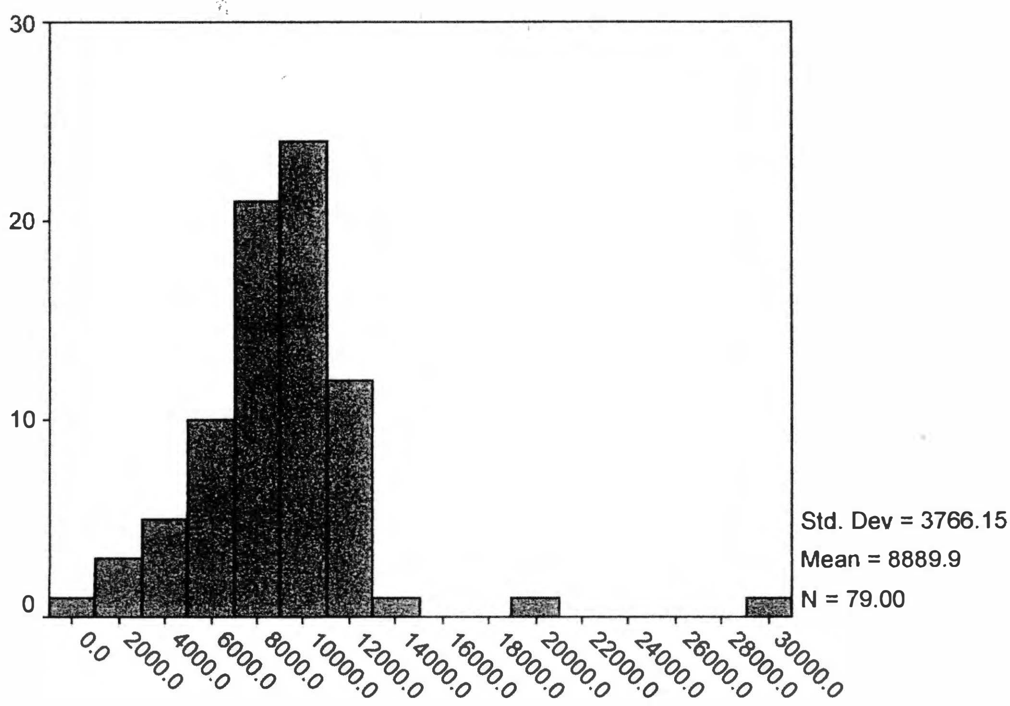
Table 4 shows that the BRFSS classified 58% of the participants as meeting current physical activity recommendations, 29% as being insufficiently active, and 13% as inactive. In Table 5 the pedometer and questionnaire were compared, chi-square results showed that the assessment tools had a weak agreement (57%). Thirty-five percent failed to meet both criteria for physical activity and 22% met both criteria. However for those who met the 10,000-step recommendation, 77% were classified as having met recommendation on the BRFSS. Figure 3 shows the average number of steps

Table 1.

Subject Characteristics

	Gender	Mean	Std. Deviation	p-value
Age	Male	20	1.4	.150
	Female	21	3.3	
Total		20	2.5	
Weight	Male	86	17.8	.001
	Female	68	19.9	
Total		78	20.8	
Height	Male	181	7.0	.001
	Female	165	7.6	
Total		173	11.0	
BMI	Male	26.0	5.0	.3640
	Female	25	7.0	
Total		25	6.0	
Avg. Steps	Male	9914	4564	.0130
	Female	7840	2344	
Total		8890	3766	

Significance accepted at p<0.05



Average Steps Taken

Figure 1. Frequency of Average Steps Taken

Table 2.

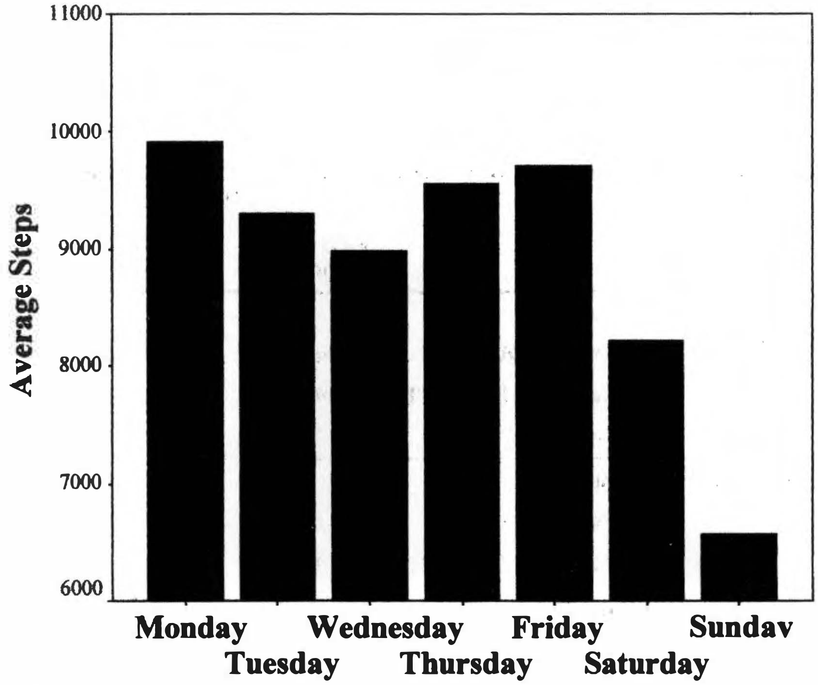
Percentage of Steps <10,000/day and Steps >10,000/day

	Frequency	Percent
Fewer than 10000 steps	57	72.2
10000 steps or more	22	27.8
Total	79	100.0

Table 3.

Average Steps per Day by Residence

	Residence	N	Mean	Std. Deviation	p-value
AVGSTEPS	off	25	8484	5184	.5180
	on	54	9078	2930	



Steps taken per day on Sunday were significantly lower ($p=0.001$) than those taken on weekdays.

Figure 2. Average Steps Taken per Day of the Week

Table 4.

Questionnaire (BRFSS)

	Frequency	Percent
Inactive	10	12.7
Insufficiently active	23	29.1
Met Recommendation	46	58.2
Total	79	100.0

Table 5.

Chi-Square

			STEPCRIT		
			Fewer than 10,000	10,000 steps or more	Total
QUES	Did not meet recommendation	Count	28	5	33
		% within QUES	84.8%	15.2%	100.0%
		% within STEPCRIT	49.1%	22.7%	41.8%
		% of Total	35.4%	6.3%	41.8%
	Met recommendation	Count	29	17	46
		% within QUES	63.0%	37.0%	100.0%
		% within STEPCRIT	50.9%	77.3%	58.2%
		% of Total	36.7%	21.5%	58.2%
Total		Count	57	22	79
		% within QUES2	72.2%	27.8%	100.0%
		% within STEPCRIT	100.0%	100.0%	100.0%
		% of Total	72.2%	27.8%	100.0%

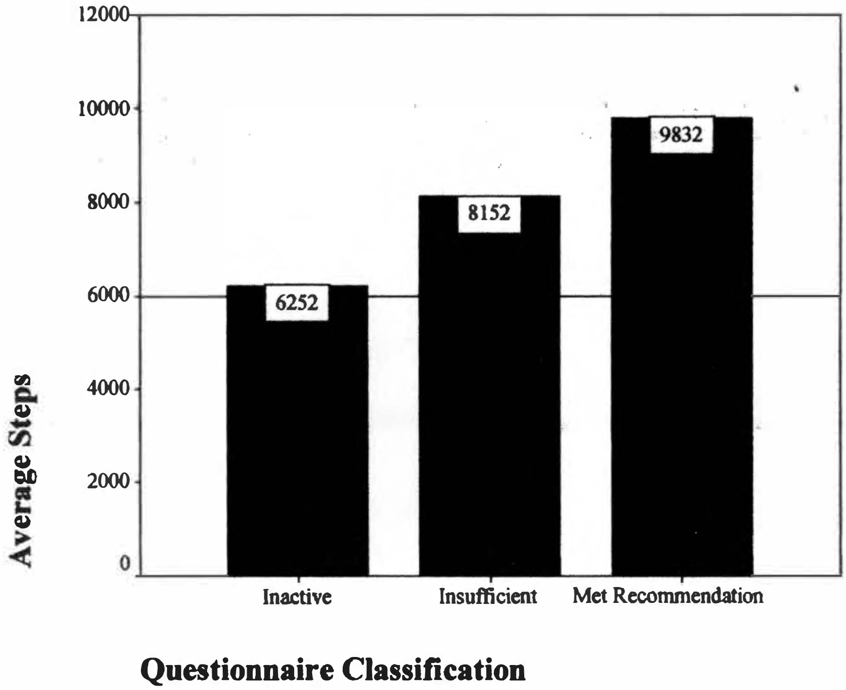


Figure 3. Average Steps Taken in Questionnaire Classifications

taken in each questionnaire category (inactive, insufficient, or meet recommendations). Those in the inactive category averaged the least steps (6,252); those in the insufficient category averaged 8,152; and those in the met recommendation category averaged the most (9,832). Table 6 also shows the range of steps taken per day in each category.

Table 6.

Average Steps Taken in Questionnaire Classifications

Questionnaire		N	Range	Minimum	Maximum	Mean	Std. Deviation
Inactive	AVGSTEPS	10	9611	754	10365	6252	2983
Insufficient	AVGSTEPS	23	9262	2418	11680	8152	2281
Met Recommendation	AVGSTEPS	46	27680	1477	29157	9832	4187

Chapter V

Discussion

Based on Hatano's (12) recommendation the results of this study, indicate that college students are insufficiently active. Pedometer results showed that only 28% of the subjects met the 10,000-step recommendation. Tudor-Locke states that healthy young adults usually accumulate between 7,000 and 13,000 steps per day (27). The average steps for both men and women in the current study (9,914 and 7,840 steps respectively) fell into this range. Pedometer studies regarding college students are lacking, therefore comparison of this population is difficult. However, a study conducted by Sequeria et al. found that men in an age group of 25 to 34 year olds accumulated an average of 11,900 steps per day, and women in the same age group accumulated an average of 9,300 steps per day (23). These findings are well above those found in this sample of college students.

The results of this study based on the Behavioral Risk Factor Surveillance Survey (BRFSS) found that 58% of college students met the physical activity recommendation set forth by the ACSM and CDC (12), 29% were insufficiently active, and 13% were inactive. Those who were classified as inactive accumulated an average of 6,252 steps per day; those who were classified as insufficiently active accumulated an average of 8,152 steps per day; and those who met recommendation accumulated an average of 9,832 steps per day. Those who were inactive were only taking 6,252 steps per day, which suggests that about 6,000 steps per day is typical of individuals who do not participate in planned, structured physical activity.

Based on the 10,000-step per day recommendation, only 28% of the population proved to be active. Chi-square results demonstrated that the assessment tools had a weak agreement (57%). However, on a positive note, 77% of those who met the 10,000-step recommendation were classified as physically active on the BRFSS questionnaire.

Traditionally, data concerning physical activity in college students has been obtained through the use of questionnaires, even though they are subject to recall bias and, to some extent, ambiguous wording (6,7,9,11,19). One questionnaire, the Behavioral Risk Factor Surveillance Survey (BRFSS), provided evidence that in 2000, 77% of Tennessee residents age 18-24 were active, whereas 79% of this population nationwide reported participating in physical activities (7). The results of this current research showed that 13% of this population was inactive, 29% were insufficiently active, and 58% met the ACSM and CDC recommendation. The subjects in this current study appear to be less active than the national and state-wide averages.

The 1995 National College Health Risk Behavior Survey found that 38% of college students reported vigorous exercise for at least 20 minutes on at least three days one week prior to the survey. Vigorous activity was described as "activity that made you sweat and breathe hard." Almost 20% reported walking or bicycling (moderate activity) at least 30 minutes for five days one week prior to the survey. Overall, more men than women reported participating in vigorous activity, and moderate activity participation did not vary between gender or age group (8). These findings are comparable to the findings of this current research, which found that 58% of college students met the physical activity recommendation set forth by the ACSM and CDC (12).

Pinto et al. (19) used a questionnaire to assess changes in college students' exercise participation from their first year to their second year. Questionnaires were completed in February of 1995 and 1996. The questionnaire assessed moderate to vigorous activity patterns for the seven previous days prior to receiving the questionnaire. Fifty-eight percent of the students were active in 1995, and 64% were active in 1996. These findings were higher than those found in the 1995 National College Health Risk Behavior Survey. It showed only 42% of 18 to 24 year olds participated in vigorous activity, which was defined as "activity that made you sweat and breathe hard" for at least 20-minutes three times in the week prior to the survey. Also, only 20% participated in moderate activity for at least 30-minutes five times in the week prior to the survey (9). However, this discrepancy may be due to the latter survey encompassing a greater age range. The values found by Pinto et al. are also higher than the current research, which found 58% of the population to met current physical activity recommendation and 16% were inactive (19).

Brevard and Ricketts (6) also used a questionnaire to determine how residence (on- or off-campus) affected physical activity and dietary intake of college students conducted a study. One hundred and four college students (30 men and 84 women) in a nutrition class at James Madison University participated in the study. A lifestyle questionnaire was used to gather information concerning mode, intensity, and frequency of exercise. Weekly energy expenditure was classified into six groups and mode of exercise was classified as aerobic, anaerobic, combination of anaerobic and aerobic, or no exercise.

Results showed there were no significant differences in energy expenditure, mode of exercise, and activity-level patterns between students living on- or off- campus (6). Based on pedometry, the present study also found no significant difference in activity level between students living on- or off- campus.

Taken together, all of these questionnaire-based studies found a higher percentage of people to be sufficiently active than the pedometer used in the present study. Some underestimation of activity does exist when using a pedometer because it does not capture activity such as swimming, weight training, and bicycling. For those who fell short of the 10,000-step recommendation (72%), thirty-eight percent of them reported participating in the activities aforementioned. Another reason that most of the subjects did not attain the 10,000 steps per day mark could be that they were not performing a sufficient amount of walking in the course of their daily activities. This points out a major difference between the pedometer-based recommendation and the CDC/ACSM physical activity recommendation (30 min/day, 5 days/week). The former is intended to account for ALL activities performed throughout the day, while the latter is generally accumulated through purposeful bouts of extended activity. From what I observed, most college students are performing leisure-time sports/recreation several times per week, but they are not doing as much of some other types of activity (occupational tasks, household chore, gardening, and transportation).

Even though most college students are not obtaining enough ambulatory activity to meet the 10,000-step per day recommendation, the majority are accumulating enough physical activity to be considered active by the BRFSS. All healthy people in this population should be able to engage in enough physical activity to be classified as sufficiently active by the ACSM and CDC, especially walking activities. This would be desirable considering physical activity declines with age and that the transition from college to the work force has been associated with a decrease in activity (11,19).

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Appendices

Appendix A

Informed Consent

Informed Consent Form

TITLE OF THE STUDY: Assessment of Physical Activity in College Students by Pedometer and Questionnaire

Investigator: Tonia Gay
Faculty Advisor: Dr. David R. Bassett, Jr.

Address: Dept. of Health, Safety, and Exercise Science
HPER Building
University of Tennessee, Knoxville
1914 Andy Holt Ave.
Knoxville, TN 37996-2700

Phone: (865) 974-8766

Purpose

You are invited to take part in a research study. The purpose of the study is threefold: to determine the average number of steps per day taken by college students; to determine if there is a difference in steps taken between men and women; and also to determine if the residence (on or off-campus) impacts steps taken per day.

Procedures

You will be asked to complete a telephone physical activity survey and a general information sheet, which requests information on your age, height, weight, gender, year in school, residence (on- or off-campus), telephone number, and how you commute to campus if you live off-campus.

Instruction on how to use a pedometer will also be given. You will then be asked to wear the pedometer for the entire day for seven consecutive days except in the shower and while sleeping. During those seven days, you will complete a pedometer log sheet that will record your walking activity for that day, as well as document the activities that you participate in throughout that day. Each night, after recording the number of steps you have taken, you will re-set the pedometer to zero. At the end of seven days, I will return to collect the step counter and pedometer log sheet from you.

Benefits of Participation

Benefits to the participant include knowledge of their current activity level. This study will provide scientists and the general public with quantitative information regarding activity in college students.

Risks of Participation

The risks of participation are no greater than those experienced during your normal daily activities.

Right to Ask Questions and/or Withdraw from This Study

Any questions about the procedures used in the study are encouraged. If you have any concerns or questions, please ask us for further explanation or call (865) 974-8766. If you have any questions about your rights as a subject you may contact the University of Tennessee Institutional Review Board at (865) 974-3466. As a volunteer in this study you have the right to withdraw at any time.

Confidentiality

Only Dr. David R. Bassett, Jr. and Tonia K. Gay will have access to any of the information collected during this research project. All information collected will be kept in a locked file cabinet in the Applied Physiology lab. The final results of this research may be published, but your name will not be used.

Authorization

By signing this informed consent form, I am indicating that I have read and understood this document and have received a copy of it for my personal records. I have been given the opportunity to ask any questions I may have. By signing this form I indicate that I agree to serve as a participant in this research study.

__________________________ ________________

Participants signature Date

__________________________ ________________

Investigator signature Date

Appendix B

General Information

Sheet

GENERAL INFORMATION

Code Name: ____________________________

Age: ______ **Gender:** ________

Height: __________ **Weight:** _________ **BMI:** __________

Year in School: ____________________

Residence (on-campus or off-campus): __________________________

How do you commute to campus: _____________________________
(i.e. car, bike, walk, etc.)

Phone Number: ______________________________

Appendix C

Behavioral Risk Factor Surveillance Survey

PHYSICAL ACTIVITY QUESTIONS

Physical Activity and Health Branch, Division of Nutrition and Physical Activity
March 27, 2000

Ask only of those who are employed; if not employed, skip to question 2

1. When you are at work, which of the following best describes what you do?

   Would you say: **Please Read**

If respondent has Multiple jobs, Include all jobs	a. Mostly sitting or standing	1
	b. Mostly walking	2
	Or	
	c. Mostly heavy labor or physically demanding work	3
Do not read These responses	Don't know/Not sure	7
	Refused	9

2. In a usual week, do you walk for at least 10 minutes at a time [if employed, **insert: while at work,**] for recreation, exercise, to get to and from places, or for any other reason?

a. Yes	___
b. No **Go to Q. 5**	8
Don't know/Not sure **Go to Q. 5**	7
Refused **Go to Q. 5**	9

3. How many days per week do you walk for at least 10 minutes at a time?

a. Days per week ____

Don't know/Not sure 7

Refused 9

4. On days when you walk for at least 10 minutes at a time, how much total time do you spend walking?

Hours and minutes per day	___:	___	___
Don't know/Not sure	7	7	7
Refused	9	9	9

5. In a usual week, do you do any activities designed to increase muscle strength or tone, such as lifting weights, pull-ups, push-ups, or sit-ups?

a. Yes ____

b. No **Go to Q. 7** 8

Don't know/Not sure **Go to Q. 7** 7

Refused **Go to Q. 7** 9

6. How many days per week do you do these activities?

a. Days per week ____

Don't know/Not sure 7

Refused 9

There are three categories of physical activity – light, moderate and vigorous. I will be asking you about your moderate and vigorous activities, even if you have included them in your previous answers. With moderate activities you have some increases in breathing and heart rate. With vigorous activity you have large increases in breathing and heart rate. Now thinking about the physical that you do when you are not working, please tell me...

7. In a usual week, do you do moderate activities for at least 10 minutes at a time, such as brisk walking, bicycling, vacuuming, gardening, or anything else that causes some increase in breathing or heart rate?

a. Yes	___
b. No **Go to Q. 10**	8
Don't know/Not sure **Go to Q. 10**	7
Refused **Go to Q. 10**	9

8. How many days per week do you do moderate activities?

a. Days per week	___
Don't know/Not sure	7
Refused	9

9. On days when you do moderate activities for at least 10 minutes at a time, how much total time do you spend doing these activities?

Hours and minutes per day	___:	___	___
Don't know/Not sure	7	7	7
Refused	9	9	9

10. In a usual week, do you do vigorous activities for at least 10 minutes at a time, such as running, aerobics, heavy yard work, or anything else that causes large increases in breathing or heart rate?

a. Yes	___
b. No **Quit**	8
Don't know/Not sure **Quit**	7
Refused **Quit**	9

11. How many days per week do you do these vigorous activities?

Days per week	___
Refused	9

12. On days when you do vigorous activities for at least 10 minutes at a time, how much total time do you spend doing these activities?

Hours and minutes per day	___:	___	___
Don't know/Not sure	7	7	7
Refused	9	9	9

Appendix D

Pedometer Log

Code Name

	Day of the Week	Time On	Time Off	Steps Taken Per Day	Physical Activities Participated In Each Day
Day 1					
Day 2					
Day 3					
Day 4					
Day 5					
Day 6					
Day 7					

Examples of physcial activity include: walking, jogging, sports (be specific), bicycling, swimming, gardening, cleaning house, doing laundry, washing car, etc. Also, please record duration of each activity.

Vita

Tonia K. Gay was born in Athens, Tennessee on February 15, 1977. She was raised in Etowah, Tennessee where she graduated from McMinn Central High School in May 1995. Her college career began at Carson-Newman College in Jefferson City, Tennessee in August 1995. She received a Bachelor of Arts degree in Biology and a Bachelor of Science degree in Athletic Training in May 2000. In August 2001, her academic focus shifted from biology to exercise science at the University of Tennessee, Knoxville. In December 2002, she received her Master of Science degree in Human Performance and Sports Studies.