8-2004

Pedometer-Determined Physical Activity and Health Variables in African-American Women (40-62 years of age)

Lyndsey Michelle Hornbuckle
University of Tennessee, Knoxville

To the Graduate Council:

I am submitting herewith a thesis written by Lyndsey Michelle Hornbuckle entitled "Pedometer-Determined Physical Activity and Health Variables in African-American Women (40-62 years of age)." 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 Exercise Science.

David R. Bassett Jr., Major Professor

We have read this thesis and recommend its acceptance:

Dixie L. Thompson, Camille O'Bryant

Accepted for the Council:
Dixie L. Thompson

Vice Provost and Dean of the Graduate School

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

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Pedometer-Determined Physical Activity and Health Variables in African-American Women (40-62 years of age)

A Thesis

Presented for the

Master of Science Degree

The University of Tennessee, Knoxville

Lyndsey Michelle Hornbuckle

August 2004

DEDICATION

This thesis is dedicated to my parents, Michael and Leigh Ann Hornbuckle, and my brother Michael Hornbuckle, II. I will never be able to express how much your unconditional love and support means to me. You have shaped me into the person that I am and believed in me when I did not believe in myself. I would not be where I am today without you guys. I love you all!

ACKNOWLEDGEMENTS

The author wishes to thank the following people for their assistance and guidance throughout the various stages of this project.

My advisor, Dr. David R. Bassett, Jr.: Thank you so much for all the time and effort you put into this study from start to finish. Even at your busiest moments, you were always willing to stop and patiently help me with any question I had along the way. I really appreciate your positive nature and truly had a great time working with you. Your constant enthusiasm kept me going!

Dr. Dixie L. Thompson and Dr. Camille O'Bryant: Thank you for taking the time to serve as members of my committee and provide your individual expertise. Your input was a most appreciated asset to this project.

Olivera Lukajic, M.S.: You have helped me from the very beginning in making the transition into the field of Exercise Physiology, and you have no idea how much that means to me. These past two years would not have gone as smoothly without you. I appreciate your friendship both inside and outside the classroom.

Scott E. Crouter, M.S.: Thanks for your willingness to help out with the "little things" and offer advice throughout this process.

Cary Springer: Thank you for all your help with the statistical analyses used in this study. I definitely would have been lost without you.

Finally, special thanks to all of the women who volunteered to participate in this study. This thesis would not have been possible without you.

ABSTRACT

The purpose of this study was to evaluate the relationship between pedometer-determined physical activity, measured in steps per day, and several health variables in middle-aged, African-American women. Height, weight, waist circumference, hip circumference, and % body fat were measured in 69 African-American females (mean age 51.4 $\pm$ 5.4 years). Subjects wore a pedometer for 7 consecutive days after their laboratory visit and average steps/day were compared to each health variable. For statistical analyses, subjects were categorized into 3 different groups based on their physical activity level. The categories were < 5,000 steps/day, 5,000 – 7,499 steps/day, and $\geq$ 7,500 steps/day. A one-way analysis of variance (ANOVA) was performed to examine the health variables among the three groups. Partial correlation coefficients controlling for age were calculated for steps/day and BMI, % body fat, waist and hip circumferences, and WHR. Significance was set at P< 0.05 for all tests.

This is the first study to investigate the relationships between steps/day and % body fat in middle-aged, African- American females. Significant differences were found among the least active and most active groups for age (P=0.013), average steps/day (P< 0.001), body weight (P=0.003), BMI (P=0.005), % body fat (P< 0.001), waist circumference (P=0.004), and hip circumference (P=0.043). When a partial correlation controlling for age was used to compare steps/day to body composition variables, negative correlations still existed for each variable. These correlations were significant for BMI (P< 0.001), % body fat (P< 0.001), waist circumference (P=0.002), and hip circumference (P=0.015). These results show that women who accumulated more steps/day had significantly lower body fat percentages, BMI values, waist circumferences, and hip circumferences.

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INTRODUCTION

The prevalence of obesity is rapidly increasing in the United States, and has reached epidemic proportions in recent decades. Data from the 1999-2000 National Health and Nutrition Examination Survey (NHANES) shows that 30.9% of the United States population is obese, defined as a body mass index (BMI) of $\geq$ 30 kg/m^2. In addition, 64.5% of the population is overweight or obese, with a BMI $\geq$ 25 kg/m^2 (12, 22). Although these values are disturbing on their own, even more alarming is the rate at which the increase has occurred.

From 1960 to 1980, rates of overweight and obesity in the United States remained relatively stable among adults ages 20 to 74 years. During this time period, there were only modest increases, as overweight status went from 44.8% to 47.4% and obesity rose from 13.3% to 15.1%. However, since 1980 significant increases have been seen for both sexes and various ethnic groups. According to the NHANES III data collected from1988-1994, overweight Americans accounted for 56.0% of the population and obesity increased to 23.3%. Another increase was observed in the 1999-2000 NHANES data, where 64.5% of Americans were shown to be overweight and 30.9% classified as obese (12).

These statistics also depict that African-American women, in comparison to women of other ethnic and racial backgrounds, have considerably higher BMI values and are likely to have higher body fat percentages. In fact, the most recent statistics from the NHANES survey mentioned above show that 78.0% of non-Hispanic black females in the U.S. are overweight and 50.8% are obese (12), with 15.1% being classified as extremely obese with a BMI $\geq$ 40 kg/m^2 (22). These rates are far greater than those for the next highest racial or ethnic group.

Genetic and behavioral factors play a role in body weight and body composition in humans. Although there may be a number of contributing variables for each that will vary from individual to individual, the ultimate determinant of body weight and composition is caloric balance. Since the kilocalorie is a unit of energy, caloric balance may also be referred to as energy balance. Caloric or energy balance is the difference between caloric intake and caloric expenditure. Caloric intake includes food ingested, while caloric expenditure includes energy used through resting metabolic rate, physical activity, and the thermic effect of food. When more energy is expended than consumed, weight loss occurs as this illustrates a negative energy balance. The opposite is true for a positive energy balance (24). Although the majority of one's energy expenditure comes from resting metabolic rate, physical activity is an integral factor in energy balance and the regulation of body weight. The fact that this component may be easily controlled and adjusted has significance for weight maintenance and control.

In recent years, there has been an increasing amount of interest in objective measurements of physical activity, as opposed to that quantified by subjective surveys and questionnaires. Questionnaires present limitations in that they rely heavily on the subjects' ability to recall all physical activity. This is less of a challenge when reporting planned, structured bouts of exercise, but becomes more difficult when attempting to evaluate light- to moderate-intensity routine activities that occur continuously throughout the day (39). Pedometers provide an objective measurement of physical activity in steps/day. They allow monitoring of leisure-time and occupational physical activity, as well as that used in everyday transportation. In addition to being inexpensive and noninvasive, numerous studies have shown that pedometers, especially specific brands, provide a valid and accurate measure of ambulatory activity (7, 16, 44, 45). Pedometers also most accurately measure walking activity, when compared to other forms of physical activity such as bicycling, swimming, or weight training. This is another advantage of pedometer use, as studies have shown that walking is the most prevalent form of physical activity among U.S. adults (19, 46).

A study by DiPietro et al. (19) showed that walking was the most popular form of activity in females between the ages of 40 and 54 years. Walking was also the only activity that increased in prevalence among both sexes and across all age groups as age increased. Most other forms of physical activity, especially those of higher intensities, decreased with age. Simpson et al. (46) found that 40.4% of women reported walking as one of their two most frequent forms of leisure-time physical activity (LTPA) and that the prevalence of walking was two to three times higher than the next most frequently chosen form of activity. Crespo et al. (15) also found that walking ranked first in age-adjusted prevalence among women with 49% choosing this as their most prevalent form of LTPA. It also ranked first among each investigated racial and ethnic groups of females including non-Hispanic blacks at 43%, non-Hispanic whites at 52%, and Mexican Americans at 34%.

African-American females are currently an understudied population in regards to physical activity as it compares to BMI and body composition. This is ironic since they are the precise population in which overweight and obesity are most prevalent. A number of previous studies using physical activity questionnaires or surveys, have shown that African-American women are the population most likely to be classified as sedentary, meaning they acquire very small amounts of LTPA, if any at all (2, 3, 15, 23, 29, 37, 55). These study findings have been consistent over a span of several years.

Currently, only a few studies have reported on pedometer-assessed physical activity in African-American women (51, 56) and no studies have examined the relationship between steps/day and % body fat, specifically in this population. The results of these studies are consistent with questionnaire studies, in that they show African-American females as one of the most sedentary groups when compared to other races and ethnicities. In a recent investigation on a sample of 55 African-American women between the ages of 25 and 55 years (56), Whitt et al. concluded that few participants met the activity level recommended for health benefits. The recommendations, as specified by the Centers for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM), included participation in at least moderate intensity activity for $\geq$ 30 minutes, at least 5 days/week. More specifically, the guidelines suggest that the activity pattern lasting $\geq$ 30 minutes should be achieved in one continuous bout, or accumulated in shorter bouts of at least 8-10 minutes. Activity was measured objectively for 4 days via the Actigraph activity monitor (Manufacturing Technology Incorporated, Shalimar, FL) and an Accusplit Eagle 170 pedometer (Accusplit Inc., San Jose, CA), both worn on the waistband. These devices provided a direct measurement of accelerations of the body and steps taken each day. The investigators concluded that the subjects were not obtaining the recommended amount of physical activity, primarily due to the fact that they performed exercise bouts too few times per week. The subjects accrued 31.9 $\pm$ 18.0 min/day, but on only 3.1 $\pm$ 2.4 days/week. It was also discovered that participants with a BMI < 25 kg/m^2 accumulated more physical activity each day, compared to those with a BMI of 25.0-29.9 kg/m^2 or $\geq$ 30 kg/m^2.

Another current study by Tudor-Locke et al. (51), included 109 apparently healthy adults. The sample included eight African-American males, 23 African-American females, 33 Caucasian men, and 45 Caucasian females. Ambulatory activity was measured in steps/day via a pedometer worn for 21 consecutive days and body composition was measured by bioelectrical impedance. It was shown that the participants categorized as highly active ($\geq$ 9357 steps/day) had the lowest BMI values and body fat percentages. This inverse relationship was also consistent in the moderately active (5268-9356 steps/day) and low activity ($\leq$ 5267 steps/day) categories, where BMI and body fat percentages both increased linearly as steps/day decreased. Although the difference was not significant, a separation of the sample by race and gender showed that African-American women averaged the fewest number of mean steps/day at 6198. This was 17% fewer steps than white females who averaged 7494 steps/day, 19% less than black males who accumulated a mean of 7654 steps/day, and 22% less than white males who averaged 7948 steps/day. As one might expect, African-American women were also the population with the highest mean values for BMI and body fat percentage.

A recent study by Thompson et al. (49) showed a significant inverse correlation between average steps/day and BMI, percent body fat, waist circumference, hip circumference, and waist-to-hip ratio. Subjects included 80 Caucasian females between the ages of 40 and 66 years. Anthropometric measurements included height, weight, waist and hip circumferences, and percent body fat. Body composition was measured using the Bod Pod®. Participants were instructed to monitor their physical activity using a Yamax Digi-Walker pedometer and asked to record the total number of steps/day. The subjects were distributed into 3 activity categories, including inactive (< 6,000 steps/day), somewhat active (6,000 – 9,999 steps/day), and regularly active (≥ 10,000 steps/day). When comparing the 3 groups, there was a linear increase in BMI, percent body fat, waist circumference, hip circumference, and waist-to-hip ratio with a decrease in physical activity. It was also discovered that those classified as regularly active had a BMI within the recommended range for optimal health, as this was not seen in either of the other two categories that were less active.

The study by Thompson et al. (49) was the first to specifically examine the relationship between steps/day and body composition in middle-aged women. After reviewing the existing literature and considering the lack of research on African-American women in this area of study, it was determined that a study similar to Thompson's was warranted in this group.

Purpose

The purpose of the present study is to evaluate the relationship between pedometer-determined physical activity, measured in steps per day, and several health variables in healthy, middle-aged, African-American women. Health variables included body composition, BMI calculated from measured height and weight, and waist and hip circumferences.

Hypotheses

African-American women who accumulate higher pedometer scores (steps/day averaged across 7 days) will have:

1. Lower % body fat
2. Lower BMI
3. Lower waist-to-hip ratio

CHAPTER 2

REVIEW OF LITERATURE

Physical Inactivity Among African-American Females

As rates of overweight and obesity continue to climb in the United States, it has become an important issue to identify the causes of this rapid increase in an attempt to control the epidemic in future generations. Table 1 provides a clear illustration of exactly how quickly these percentages have increased in recent years (12). As stated earlier, African-American women are the sub-group most affected by this trend in the U.S., making them that much more vulnerable to obesity and its related co-morbidities including hypertension, diabetes, stroke, and coronary heart disease.

Table 1: Percentages of overweight and obesity trends for U.S. adults, ages 20-74 Years.

	Overweight			Obese		
	1960-1980^	1988-1994	1999-2000	1960-1980^	1988-1994	1999-2000
All	44.8 - 47.4	56.0	64.5	13.3 - 15.1	23.3	30.9
Men	49.5 - 52.9	61.0	67.0	10.7 - 12.8	20.6	27.7
Women	40.2 - 42.0	51.2	62.0	15.7 - 17.1	26.0	34.0
Non-Hispanic, White	38.7 *	47.2	57.5	15.4 *	23.3	30.6
Mexican American	61.7 *	69.6	71.8	26.6 *	36.1	40.1
Non-Hispanic, Black	62.6 *	68.5	78.0	31.0 *	39.1	50.8

Adapted from data provided by the Centers for Disease Control and Prevention (12).

^ Includes data from NHES I (1960-1962), NHANES I (1970-1974), and NHANES II (1976-1980).

* Percentages from NHANES II (1976-1980) only.

It is suspected that physical inactivity, especially during leisure time, may be a major contributor to the increased prevalence of overweight and obesity among black females. Washburn et al. (55) evaluated data collected in 1984 and 1985 from the Behavioral Risk Factor Surveillance System (BRFSS) survey created by the Centers for Disease Control (CDC). Data was collected via telephone interviews for 431 black and 1574 white individuals, with a mean age of 45 years, selected by random-digit dialing. While the age distribution among blacks and whites was comparable, other factors differed greatly. Blacks had higher percentages of unemployment, low income, low education levels, and unemployment when compared to whites. Blacks were also less likely than whites to be married. Although the entire sample had low levels of leisure time energy expenditure, black women had the highest prevalence of "no leisure time physical activity" at 36%. This was compared to white women at 30%, black men at 32%, and white men at 26.9%. The black women were less likely to report participation in LTPA than white women, even after adjustments for BMI, age, and income.

In a different study, Ford et al. (23) looked at physical activity behaviors among populations of lower and higher socioeconomic status (SES) in males and females. This study showed that women of lower SES were the least active group compared to high SES females and males of either status. The high SES women were the most active group, acquiring significantly more time each week in job-related, household, and leisure-time physical activity. These data also illustrate a racial difference in physical activity as 94.8% of the 172 women classified as low SES were black, and 99.5% of the 208 high SES women were white. Data were collected by telephone interviews using an expansion of the BRFSS Questionnaire. The sample included residents of a suburban and an inner-city section of Pittsburgh.

An investigation of 1,784 black adults, ages 25 to 50 years, in Pitt County, North Carolina showed again that the majority of African-American women were classified as sedentary. Physical activity was assessed using a modification of the Lipid Research Clinics' study questions on physical activity, collected in 1988. Subjects who reported participating in work or exercise strenuous enough to sweat for $\geq$ 20 minutes, three times/week, were categorized as active. Those who reported engaging in activity less vigorously, less often, or not at all were deemed sedentary. The sample of 655 males and 1,086 females showed that 285 (44%) and 711 (65%) were classified as sedentary, respectively (3).

A study by Macera et al. (37) found that African-American women had the highest percentages of participants reporting "no LTPA" and the lowest percentages of participants who were classified as moderately active or active. Telephone interviews were conducted on a random sample of 3121 adults in two South Carolina communities. Personal interviews were conducted for those without telephones. This sample included 969 white men, 1409 white women, 205 African-American men, and 538 African-American women. The survey inquired about LTPA during the past month, and details concerning the type, frequency, and duration of the activity. LTPA was then divided into three categories for those reporting no LTPA (low), activity that was not aerobic or aerobic activity < 3 times/week (moderate), or aerobic activity $\geq$ 3 times/week (high). Results showed the 62% of black women reported no LTPA, a figure 16% higher than the next highest population. In addition, 33% of black women were moderately active and only 5% were active, figures that were 10% and 6% lower than the next lowest population in those categories, respectively. A similar investigation by Heath et al. (29), using the same South Carolina population and methods as mentioned above (37), examined 480 black and 1337 white women. Here, it was determined that 45% of the black females obtained no LTPA, a significant difference when compared to the 22% of white females who acquired no LTPA. This study also reported that 61% of the black women had a BMI > 27.3, classifying them as overweight, while this was true for only 34% of the white women.

Ainsworth et al. (2) examined physical activity in 65 African-American and 76 Native American women, 40 years of age or older, with a mean age of 54.6 $\pm$

10.1 and 50.9 $\pm$ 9.0 years, respectively. These subjects were enrolled in the Cross-Cultural Activity Participation Study (CAPS) completed in South Carolina. Each subject completed a detailed physical activity record every other month for three consecutive 4-day periods. Individual activities were grouped into activity types as listed in the Compendium of Physical Activities, then separated into intensity groups using the CDC-ACSM recommendations for light (< 3 MET), moderate (3-6 MET), and vigorous activity (> 6 MET). Results were evaluated to determine if the 1993 CDC and ACSM recommendation for U.S. adults was achieved, stating that all U.S. adults should accumulate $\geq$ 30 minutes of moderate-intensity physical activity on most, if not all, days of the week. Participants having met the moderate physical activity recommendation were those who accumulated at least 30 minutes/day of moderate intensity activities on at least 3 of the 4 days. It was concluded that more Native Americans than African-Americans met the recommendation at each of the three rounds, with respective values of 70% and 59% in round 1, 75% and 46% in round 2, and 72% and 35% in round 3. Only 15% of African-American women met the goal during all 3 rounds, compared to the 46% of Native American women who met the recommendation during all three rounds.

Studies have also shown that the prevalence of obesity and physical inactivity is lower among African-American girls than other races in the United States, indicating that the pattern begins early (34, 43). Similar to the adult population in recent decades, National Health Examination Survey (NHES) and NHANES data shows a three-fold increase in the pediatric overweight population in the U.S. between the years 1963 to 2000 (43). The prevalence of overweight was especially high in Hispanic boys and African-American girls. Table 2 illustrates that at 2-5 years of age, the percentage of overweight African-American girls was fairly close to the percentage of overweight white and Hispanic girls. However, African-American girls pull further away from other ethnic groups as their age increases.

Table 2: Percentages of overweight prevalence in female children by race/ethnicity.

	2 – 5 years	6 – 11 years	12 - 19 years
Non-Hispanic, White	11.5	11.6	12.4
Mexican American	9.2	19.6	19.4
Non-Hispanic, Black	11.2	22.2	26.6

Adapted from Ritchie et al. (2003). Data source, Ogden et al. (2002).

A prospective study by Kimm et al. (34) showed that African-American girls have a steeper decline in physical activity throughout adolescence than white girls. Subjects included 1213 black girls and 1166 white girls enrolled in the National Heart, Lung, and Blood Institute Growth and Health Study who were followed annually for 10 years, beginning at age 9 or 10 and ending at 18 or 19 years of age. The Habitual Activity Questionnaire (HAQ) was administered to assess the subjects' physical activity over the previous year, not including the activities performed during physical education classes at school. The HAQ was administered in years 1, 3, 5, 7, 8, 9 and 10 of the investigation and HAQ scores were calculated by multiplying the estimated metabolic equivalent (MET) for each activity by the weekly frequency and the fraction of the year during which the activities were performed. Scores were expressed in MET-times/week. Although there were no significant differences in the types of activities selected by the two sub-groups, racial differences in the amount of physical activity obtained became more evident with age. Results showed a considerable decrease in both groups from year 1 to year 10 of the investigation, as the white girls went from 30.8 to 11.0 MET-times/week and the black girls decreased from 27.3 to 0 MET-times/week. This was a 64% decline in physical activity for the white girls and a startling 100% decline in the black girls ($p < 0.001$). In fact, the data were only analyzed through the first 8 years of the study, when the median HAQ scores had already fallen to zero in the black girls. Black girls also had significantly higher BMI values in each year of the study.

Pedometers

Pedometers provide an objective means of measuring ambulatory activity. They are capable of capturing various types of occupational, transportation, household, and leisure-time physical activities. These devices record a step each time a spring-suspended, horizontal pendulum arm is moved up and down, which opens and closes an electrical circuit (6). This process is initiated by vertical accelerations of the waist that occur during walking or running (6, 9). The newer electronic pedometers have proven to be much more reliable than the older, mechanical pedometers which were considered unacceptable for research purposes (6). General guidelines state that the best site for the pedometer is on the waistband in the midline of the thigh (9), although each individual should be tested for the best specific placement to produce the most accurate reading.

Unlike a controlled laboratory experiment, it is difficult to determine the accuracy of a pedometer under free-living conditions, as there is no true "gold standard" (44). However, the Yamax Digi-Walker SW-200 has been consistently shown to be accurate in controlled laboratory settings (16,45) and is frequently used in applied research (50). The Yamax was even utilized as the criterion pedometer in a 2004 study by Schneider et al. that compared 13 different models of pedometers (44). In this investigation, 10 male and 10 female subjects wore the criterion device, the Yamax SW-200, on the left side of the body and a comparison model on the right side. Subjects wore the pedometers for 24 hours, except when showering or sleeping, and each was tested over a 13-day period. In order to provide a more representative sample, five devices from each model were tested among the 20 participants. The order of testing was randomized for each subject.

It was discovered that five of the models did not differ significantly from the criterion. These included the Yamax Digi-Walker SW-200, Kenz Lifecorder, New-Lifestyles NL-2000, Yamax Digi-Walker SW-701, and Sportline 330. The Yamax SW-200 was compared with another Yamax SW-200 on opposite sides of the body to test for right and left side differences. The five models that significantly underestimated steps were the Freestyle Pacer Pro, Accusplit Alliance 1510, Yamax Skeletone EM-180, Colorado on the Move, and Sportline 345. Finally, there were three brands that significantly overestimated steps including the Walk4Life LS 2525, Omron HJ-105, and Oregon Scientific PE316CA. As much as a 45% difference from the criterion was discovered when evaluating the different models in comparison to the criterion (44). This clearly demonstrates that different brands of pedometers will yield different step values, making brand choice a significant factor in the validity of data when used in a research setting. Choosing a reliable brand of pedometer is also important for an individual simply using it to track daily walking. For the present study, the Yamax Digi-Walker SW-200 was used for monitoring free-living physical activity.

While pedometers have become an accepted means for monitoring physical activity in the research setting, they may also serve as motivational tools for the general public. Pedometers provide an inexpensive, non-invasive means of constant and immediate feedback as to how much activity one obtains throughout the day (6). Therefore, pedometers are extremely useful in intervention studies and they are becoming increasingly popular in health promotion settings, such as walking programs with a goal of accumulating a specific number of steps each day.

Body Composition Methods

Body composition refers to the percentage of body weight that is fat versus fat-free tissue. The determination of body composition an important factor in overall health assessment and for determining risk of chronic diseases such as hyperlipidemia, type 2 diabetes, hypertension, cardiovascular disease, and some cancers. Total body density, in mass per unit volume, may be used to estimate body composition. The measurement of body density allows for the calculation of relative percentages of fat and fat-free body mass (24).

Hydrostatic weighing is usually considered a "gold standard" for assessing body composition. This method is based on Archimedes' principle, which states that a body immersed in water will become buoyant due to a counterforce equal to the weight of the water displaced. After accounting for residual volume in the lungs and correcting for the density of the water, body volume may be calculated using the loss of weight in water. Some key disadvantages to the underwater weighing method are the necessity of expensive lab equipment and the overall time-consuming, complicated nature of the procedure (24). This method may also be uncomfortable for some subjects, as the submersion of the entire body and head underwater, combined with maximal exhaling of the air in the lungs, may cause extreme anxiety. This is an especially difficult procedure in special populations such as children, elderly, disabled, and obese participants (40). These factors have prompted the need for a more practical means of assessing body composition that is less obtrusive, yet just as reliable.

The Bod Pod® Body Composition System (Life Measurement Instruments, Concord, CA), is an alternative method of determining body composition that seems to overcome some of the limitations of hydrostatic weighing and has proven valid and reliable results (17, 40). The Bod Pod® is a single structure that contains a dual-chambered plethysmograph. A fiberglass seat separates the structure into two chambers. The front chamber, where the subject enters and exits from, is used for testing. The rear chamber, used as reference, contains the instrumentation including the air circulation system, valves, electronics, and pressure transducers (17).

Before testing, the electronic scale and chambers are calibrated according to the manufacturer's guidelines. The subject enters the front chamber and remains there in a seated position for a body volume measurement. While being tested, the subject is asked to relax and breathe normally. At the completion of the measurement, the door is opened, then a second test is performed. If the first two measurements disagree by more than 150 mL, then a third test is conducted for consistency. The mean of the two measurements that agree within 150 mL is the measurement that is used in the calculations (17).

In a 1995 evaluation of the validity and reliability of the Bod Pod®, McCrory tested a variety of adult subjects measuring this method against hydrostatic weighing (40). Validity was assessed using 68 participants containing 42 males and 26 females. A subsample of 16 subjects, 7 males and 9 females, who had prior experience in hydrostatic weighing, were used in the reliability testing. All tests for each subject were conducted within a 2-hour period on a single day. Findings revealed that the Bod Pod® is a highly valid and reliable method for determining % body fat in adults. No significant differences were shown for either gender or both genders combined when % body fat values from the Bod Pod® (% FAT_{BP}) and hydrostatic weighing (% FAT_{HW}) were compared. In fact, the mean difference between the two methods was -0.3% in all subjects. The reliability assessment also showed no significant difference between the first and second trials for either % FAT_{BP} or % FAT_{HW}, where the between-trial standard deviation values were 0.4% for the Bod Pod® and 0.5% for hydrostatic weighing.

When assessing body composition in a specific race or ethnic group, race-specific body composition models that account for differences in fat-free mass density should be used. The Siri equation (47), used to calculate % body fat from measured body density, is programmed into the Bod Pod® system. Although this equation is one of the most commonly used in body fat estimation, it can produce systematic prediction error when applied to a population whose fat-free body density varies from the assumed value used to develop this equation, 1.10 g/cc (30).

Ortiz et al. (41) conducted a study to determine if black and white females who were matched for age, height, weight, and menstrual status differed in the proportion of body weight contributed by bone mineral mass and skeletal muscle mass. The secondary purpose of their research was to evaluate the validity of body composition measurement techniques in black women. Underwater weighing and total body potassium (TBK) counting were the two methods of body composition measurement being challenged. Twenty-eight black females were included in the investigation and matched with 28 white female control subjects who had no significant differences in age, height, weight, and BMI. The mean age of the sample was 44.2 years for the blacks and 43.6 years in the whites, and mean BMIs for each were 23.9 and 23.6, respectively. A total body dual-photon absorptiometry (DPA) scanner was used to measure total body and regional bone-mineral, as well as appendicular skeletal muscle mass. The DPA instrument's software separated the body into six different regions, including both upper and lower appendages. Soft tissue was divided into fat and lean compartments using the ratio of soft-tissue attenuations (R_{ST}) at the scanner's two energy levels. As hypothesized, age-matched black and white females have significant differences in body composition. Black females had significantly greater values for bone mineral and skeletal muscle in the upper, lower, and combined extremities than the white females. Bone lengths in the upper and lower extremities were also significantly greater in blacks, by approximately 2 cm. Both the density of fat-free mass and the potassium content of fat-free mass were higher in the black women, implying that error exists when traditional under-water weighing and TBK are used to estimate % body fat in blacks. Total fat-free mass was greater in blacks due to the greater fraction of high-density bone mineral. The average potassium concentration of total lean tissue was higher in the black subjects because a high fraction of skeletal muscle weight is potassium-rich cell mass compared to the remaining visceral tissue. Potassium was also greater in black females when compared to whites due to larger appendicular skeletal muscle mass. It was concluded that the density of fat-free mass in black women was 1.106 g/cc, not consistent with the assumed 1.10 g/cc of the Siri equation. The two-compartment model Siri equation will underestimate the average relative body fat of black women by 2% and black men by 3% (30).

The findings above (41) emphasize the importance of using the appropriate race-specific prediction equations when estimating body composition among populations of a particular race or ethnicity. This will help account for any variance in bone density and bone mineral content among specific populations, in turn decreasing the margin of error (30). The following equation is appropriate for the calculation of % body fat in black females, ages 24-79 years (41):

$$\% \text{ Body Fat} = (4.85 / D_b) - 4.39$$

where D_b is body density and % body fat is obtained by multiplying the calculated value by 100.

Few studies exist comparing % body fat among ethnic groups. A study previously cited by Tudor-Locke et al. (51), compared pedometer-assessed ambulatory activity and body composition variables in African-American and Caucasian males and females. Body composition was measured by bioelectrical impedance. Results showed no significant difference in % body fat among races in either males or females. Another investigation by Wang et al. (54) compared BMI and % body fat among a sample of 254 Puerto Ricans, 280 blacks, 523 whites, and 267 Asians residing in the New York City area. BMI was calculated from measured weight and height, while total % body fat was measured via DPA after an overnight fast. There were no significant differences in age distribution among any of the eight subgroups of the sample. Mean BMI values for both genders ranked from highest to lowest showed Puerto Ricans, blacks, whites, and Asians, with significant differences between each group. In females, Puerto Ricans had the highest mean % body fat at 40.2%. This was a significant difference from black women who followed at 38.2%, and the Asian and white women who had averages of 31.9% and 30.8%, respectively. The Asians and white females did not significantly differ from each other for % body fat. Males had similar % body fat results with Puerto Ricans having the highest value at 24.8%. This was significantly greater than blacks and Asians at 22.0% and 21.3%, respectively, however these two groups did not significantly differ from each other. White men did show a significant difference from all the groups at 19.6% body fat.

Waist-to-Hip Ratio

It is been established that an individual's pattern of body fat distribution is a significant predictor of obesity-related diseases. Intra-abdominal fat has been linked to an increased risk of chronic diseases such as type 2 diabetes, hypertension, cardiovascular disease, and premature death (24, 32, 33). Therefore, excess fat in the abdomen, out of proportion with total body fat, is positively correlated with health risk (20, 27). This makes the measurement of body fat distribution an important factor in assessing disease risk.

Waist-to-hip ratio (WHR) has traditionally been used to determine body fat distribution pattern. This is the circumference of the waist at the narrowest part of the torso, divided by the circumference of the hips at the maximum extension of the buttocks or hips (24). Standards for risk vary with age and gender. The ACSM standards for women ages 40-49, 50-59, and 60-69 state that WHR values > 0.80, > 0.82, or > 0.84, respectively, place this population at high or very high risk, depending on how high the individual's value reaches (27). As android-type obesity is the main concern, waist circumference alone is also an indicator of health risk. A high waist circumference can increase risk even if an individual is of normal weight (24). Sex-specific cutoffs exist to identify an increase in relative risk for the development of risk factors associated with obesity. These cutoffs, > 102 cm (> 40 in.) for men and > 88 cm (> 35 in.) for women, are valid in most adults with a BMI values 25-34.9 kg/m^2, but lose predictive power in individuals with a BMI > 35 kg/m^2 because these people will most likely exceed the cutoffs (20, 24, 27).

Although studies have shown a relationship between intra-abdominal adipose tissue and cardiovascular disease in Caucasian men and women (32, 33), there have been some different findings among populations of African-Americans. A recent study by Hunter et al. (31) was the first to use whole body magnetic resonance imaging to measure fat distribution in a sample of African-American women. Subjects included 26 healthy, pre-menopausal females who were active duty members in the Army. Visceral fat was identified as all the fat within the abdominal wall between the xiphoid and pubis. Leg fat included adipose tissue between the pubis and lateral malleolus, while trunk fat included all remaining fat between the shoulder and the pubis. Partial correlations were used to compare the independent relationship of trunk, leg, and visceral fat to CVD risk factors. A positive correlation was discovered between trunk fat and VLDL cholesterol, serum insulin levels, and diastolic blood pressure. There was a negative correlation between leg fat and these same variables. Visceral fat was independently related to triglycerides only. The results indicated that visceral fat may be less atherogenic in African-American women than in Caucasian men and women.

African-American women distribute a smaller proportion of their body fat as intra-abdominal adipose tissue (IAAT) (4, 14). One study by Conway et al. (14) examined 8 black and 10 white obese women (BMI > 30 kg/m^2) participating in a weight-loss study in the Bethesda, MD area. Data were collected at three points during the 6-month weight-loss treatment. At baseline, there were no significant differences between the blacks and whites in mean age, height, weight, BMI, waist and hip circumference, WHR, % body fat, or education. A computed tomography (CT) scanner was used to measure each subject, while lying in a supine position, using a lateral view of the lower lumbar spine. Measurements were taken at the L2-L3 and L4-L5 levels of the lumbar spine. The area (cm^2) for visceral adipose tissue (VAT), subcutaneous adipose tissue (SAT), and total adipose tissue (TAT) were calculated after the images were analyzed using software available with the CT scanner. Results showed that all three adipose areas decreased in a similar fashion in both races with weight loss. Black females had significantly less VAT at all three stages of the dietary treatment in the L2-L3 area. There was no significant racial difference in SAT and TAT in this section though. In the L4-L5 area, blacks again had less VAT, however this difference was not significant. There was also no significant difference between SAT and TAT among the two groups in the L4-L5 area.

A different investigation by Albu et al. (4) showed again that black women had less VAT when compared to white women. This sample included 25 non-Hispanic white and 25 non-Hispanic black females ranging in age from 26-49. All subjects were generally healthy, nondiabetics, taking no prescription medication and weight stable for the previous 6 months. Visceral adipose tissue (VAT) and subcutaneous adipose tissue (SCAT) were measured in most participants by magnetic resonance imaging while lying in a supine position. Four subjects were measured via CT scans due to claustrophobia and/or weight in excess of 295 pounds. Measurements were taken at the midwaist point, identified as the midpoint between the last rib and the iliac crest. For most subjects, this was also the L2-L3 level of the spine. The two groups of women were closely matched by age, body fat, fat free mass, BMI, and waist circumference. Hip circumference was significantly lower in the black women, accounting for a significantly higher WHR among this group. After adjusting for total body fat mass, results showed that black women had significantly less VAT and lower VAT/SCAT compared to the white women at any given WHR. In both groups, waist circumference was significantly correlated to VAT and SCAT.

In a recent study, Lovejoy et al. (36) compared fat distribution and health risk factors in middle-aged white and black women. This investigation did not show as clearly that VAT was less in African-Americans, however it did show that VAT is the strongest predictor of metabolic and cardiovascular risk factors in both racial groups. Subjects included 103 white and 55 African-American females $\geq$ 43 years of age from the Baton Rouge, LA area. Exclusion criteria included those not having regular menstrual cycles, taking regular medication or hormones, and having abnormal results on physical examination or laboratory tests. Body composition was measured by DXA, and abdominal fat distribution was determined using a computed tomography scan at the level of interspace between the fourth and fifth lumbar vertebrae. Total abdominal adipose tissue

(TAT) was divided into four categories including visceral (VAT), subcutaneous (SAT), deep subcutaneous (DSAT), and superficial subcutaneous (SSAT). After adjustments were made for age and total body fat, results showed that SAT and SSAT were significantly higher in African-Americans, with only a slight and nonsignificant trend for this population to have less VAT than their white counterparts. There were no significant racial differences in TAT or DSAT. Multiple regression analysis showed that VAT was the strongest independent predictor of total cholesterol, HDL cholesterol, LDL cholesterol, fasting blood glucose, and fasting insulin concentrations in African-Americans. VAT was also the strongest predictors of most of these factors in whites, with the exception fasting glucose. These results suggest that VAT is generally a good predictor of health risk in both populations.

Hypertension

Hypertension is a principal risk factor for several life-threatening conditions including angina, stroke, congestive heart failure, myocardial infarction, and renal failure (48). In fact, cardiovascular disease risk doubles for each increment of 20/10 mmHg, beginning at 115/75 mmHg (13). Steep increases in the prevalence of hypertension become apparent as one ages (24). Men are affected more by this condition than women until age 55, when women tend to have higher blood pressure than men (1). When compared to whites, African-Americans are also extremely vulnerable to hypertension, placing them at higher risk of development of the disease states mentioned above (48). The prevalence of hypertension in blacks in the United States is among the highest in the world. The NHANES II (1976-1980) and NHANES IV (1999-2000) data illustrate that both Non-Hispanic black males and females have had marked decreases in the prevalence of hypertension since 1980. Still, the hypertension prevalence in black females is 41.0%, down from 51.1%, and the males show a 38.0% prevalence, down from 50.7% (1). Not only are blacks more likely to develop high blood pressure, but it usually develops at an earlier age, is often more severe, and will more likely to lead to mortality at an earlier stage of life (25).

Although the underlying causes for racial differences in hypertension are not fully known, several factors are believed to contribute to this condition. Endocrine factors have been suggested as one cause of increased hypertension among African-Americans. Sodium sensitivity, or the impaired ability to excrete sodium, is one suggested theory, as blacks seem to respond to shifts in sodium balance more often than whites (21). There is theory that blacks possess a sodium-sparing mechanism, enabling them to minimize sodium deficits, but in turn leading to higher levels blood pressure (28). Essential hypertension is also closely linked to non-insulin-dependent diabetes, which is a CVD risk factor in itself, caused by insulin resistance and hyperinsulinemia (21). Another factor that is believed to play a role in high blood pressure in blacks is autonomic function. This theory suggests that there may be racial differences in sympathetic nervous system activity in hypertension, including plasma catecholamine and plasma renin activity (42). However, there is actually little evidence that increased autonomic reactivity predicts or causes the subsequent onset of hypertension in humans (5). It has also been suggested that renal physiology may contribute to hypertension in African-Americans. A previous study by Frohlich et al. (26) found that renal vascular resistance was significantly greater and renal blood flow was significantly lower in black subjects when compared to whites. These differences were most prominent in black males. Psychosocial factors are also a consideration. This may include anger suppression, or lack of anger coping mechanisms, in dealing with the historical treatment by majority populations. Chronic stressors such as low SES, lower status occupations, residential crowding, substandard housing, and lower social status have also been previously suggested as contributing factors to high prevalences of hypertension in the black community (5).

Further, it has been hypothesized that a lack of physical activity in the African-American population may be another contributing factor to the high prevalence of hypertension. Bassett et al. (8) showed that increased amounts of participation in LTPA was related to a lower prevalence of hypertension, but racial/ethnic background seems to be a stronger predictor of hypertension at any physical activity level. This investigation examined data from the NHANES III, administered 1988 to 1994, in order to evaluate ethnic differences in the prevalence of hypertension. Individuals having any hypertension-related diseases that could restrict their physical activity level were excluded from the sample. The final sample consisted of a total of 14,899 participants including 6,436 non-Hispanic whites, 4,244 non-Hispanic blacks, and 4,219 Mexican Americans. Physical activity was assessed by trained, certified investigators measured resting blood pressure by the auscultatory method using standard techniques. Hypertension was identified by a systolic blood pressure $\geq$ 140 mmHg, a diastolic blood pressure $\geq$ 90 mmHg, or an individual currently taking antihypertensive medication. Mexican Americans and non-Hispanic blacks had a higher prevalence of no LTPA when compared to non-Hispanic whites. The corresponding percentage of no LTPA for each group was 36.6%, 32.0%, and 18.0%, respectively. Age-adjusted prevalence of hypertension as it related to physical activity was also considered among the three ethnic groups. This analysis proved that the blacks in this sample had a higher prevalence of hypertension than the whites and Mexican Americans at every level of LTPA, ranging from zero to five bouts per week. The overall age-adjusted hypertension prevalences among the groups were 30.8% in non-Hispanic blacks, 21.4% in Mexican Americans, and 20.7% in non-Hispanic whites.

Summary

Overall, the literature to date consistently indicates that African-American women have low levels of LTPA and high prevalences of obesity, placing them at greater risk for obesity-related chronic diseases. This makes the comparison of physical activity and body composition variables a valuable research topic in this currently understudied population. Pedometers are desirable in this type of research as they provide an objective measurement of all types of physical activity including occupational, transportational, household, and leisure-time physical activities. Pedometers are a convenient, inexpensive means to provide immediate feedback on physical activity levels, making them effective motivational tools as well.

CHAPTER 3

MANUSCRIPT

Abstract

Purpose: The purpose of the present study was to evaluate the relationship between pedometer-determined physical activity, measured in steps per day, and several health variables in middle-aged, African-American women.

Methods: Height, weight, waist circumference, hip circumference, and % body fat were measured in 69 African-American females (mean age 51.4 $\pm$ 5.4 years). Subjects wore a pedometer for 7 consecutive days after their laboratory visit and average steps/day were compared to each health variable. For statistical analyses, subjects were categorized into 3 different groups based on their physical activity level. The categories were < 5,000 steps/day, 5,000 – 7,499 steps/day, and $\geq$ 7,500 steps/day. A one-way analysis of variance (ANOVA) was performed to examine the health variables among the three groups. Partial correlation coefficients controlling for age were calculated for steps/day and BMI, % body fat, BMI, waist and hip circumferences, and WHR. Significance was set at $P < 0.05$ for all tests.

Results: There were significant differences among the least active and most active groups for age (P=0.013), average steps/day ($P < 0.001$), body weight (P=0.003), BMI (P=0.005), % body fat ($P < 0.001$), waist circumference (P=0.004), and hip circumference (P=0.043). When a partial correlation controlling for age was used to compare steps/day to body composition variables, negative correlations still existed for each variable. These correlations were significant for BMI ($P < 0.001$), % body fat ($P < 0.001$), waist circumference (P=0.002), and hip circumference (P=0.015).

Conclusions: Results indicated that middle-aged, African-American women who accumulated more steps/day had significantly lower body fat percentages, BMI values, waist circumferences, and hip circumferences.

Key Words: BODY COMPOSITION, BMI, WALKING, AMBULATION, ETHNIC GROUP

Introduction

The prevalence of obesity is rapidly increasing in the United States, and has reached epidemic proportions in recent decades. Data from the 1999-2000 National Health and Nutrition Examination Survey (NHANES) show that 30.9% of the United States population is obese, defined as a body mass index (BMI) of $\geq$ 30 kg/m^2. In addition, 64.5% of the population is overweight or obese, with a BMI $\geq$ 25 kg/m^2 (22). Although these values are disturbing on their own, even more alarming is the rate at which the increase has occurred. Flegal et al. (22) indicate that between the NHANES III (1988-1994) and the 1999-2000 NHANES, the age-adjusted prevalence of obesity increased 7.6 percentage points, from 22.9 to 30.5%, respectively.

These statistics also reveal that African-American women, compared to women of other ethnic and racial backgrounds, have considerably higher BMI values and likely higher body fat percentages. In fact, the most recent statistics from the NHANES survey mentioned above show that 78.0% of non-Hispanic black females in the U.S. are overweight and 50.8% are obese (12), with 15.1% being classified as extremely obese with a BMI $\geq$ 40 kg/m^2 (22). These rates are far greater than those for the next highest racial or ethnic group. Since African-American women are the sub-group most affected by obesity, they are much more vulnerable to its related co-morbidities including hypertension, diabetes, stroke, and coronary heart disease.

Pedometer-assessed physical activity provides an objective measurement of activity in steps/day. Pedometers are also an inexpensive, noninvasive means to monitor ambulation including leisure-time and occupational physical activity, as well as that used in everyday transportation. Questionnaires have limitations in that they rely heavily on the subject's ability to recall all physical activity. This is less of a challenge when reporting planned, structured bouts of exercise, but becomes more difficult when attempting to evaluate light- to moderate-intensity routine activities that occur continuously throughout the day (39). Numerous studies have shown that specific pedometer brands provide a valid and accurate measure of ambulatory activity (7, 16, 44, 45). While pedometers are highly accurate for measuring walking activity, they do not capture other forms of LTPA such as bicycling, swimming, or weight training. However, studies have shown that walking is the most prevalent form of LTPA among all U.S. adults, and is especially popular among middle-aged and older women (19, 46).

African-American females are currently an understudied population in regards to physical activity and its relationship to BMI and body composition. This is ironic since they are the precise population in which overweight and obesity are most prevalent. A number of previous studies using physical activity questionnaires or surveys have shown that African-American women are the population most likely to be classified as sedentary, defined as no LTPA (2, 3, 15, 23, 29, 37, 55). These study findings have been consistent over a span of several years.

Currently, only a few studies have reported on pedometer-assessed physical activity in African-American women (51, 56) and no studies have examined the relationship between steps per day and % body fat, specifically in this population. The results of the pedometer studies are consistent with questionnaire studies, in that they show African-American females as one of the most sedentary groups when compared to other races and ethnicities. Whitt et al. (56) examined 55 African-American women and found a negative association between daily steps and BMI. Tudor-Locke et al. (51) found that African-American females took fewer steps/day and had more body fat than any other population examined including white females and black and white males. A recent study by Thompson et al. (49) was the first to specifically examine the relationship between steps/day and % body fat in middle-aged Caucasian women. They found a strong inverse correlation between steps/day and both BMI and body fat.

After reviewing the existing literature and considering the lack of research on African-American women in this area of study, it was determined that a study similar to that of Thompson et al. (49) was warranted in this group. The purpose of the present study is to evaluate the relationship between pedometer-determined physical activity, measured in steps per day, and several health variables in healthy, middle-aged, African-American women. Health variables will include body composition, BMI calculated from measured height and weight, and waist and hip circumferences. It is hypothesized that African-American women who accumulate higher pedometer scores (steps/day averaged across 7 days) will have lower body fat percentages, lower BMI values, and lower waist-to-hip ratios.

Methods

Subjects

Sixty-nine self-identified African-American females between the ages of 40 and 62 years volunteered to participate in this study. All subjects were healthy, non-smokers with no physical illnesses or disabilities that might limit ambulation or daily physical activity. Prior to participation, each subject was required to review and sign an informed consent form approved by the University of Tennessee Institutional Review Board (Appendix A) that stated the nature of the study and its potential risks. They also completed a health history questionnaire (Appendix B) to provide written confirmation that they were non-smoking individuals with no ambulatory physical activity limitations. The investigator then administered the 2002 version of the Behavioral Risk Factor Surveillance System (BRFSS) survey (Appendix C) to each participant (11). All procedures were reviewed and approved by the IRB at the University of Tennessee, Knoxville.

Behavioral Risk Factor Surveillance System (BRFSS) Survey

The BRFSS is traditionally a random-digit dialed telephone survey that inquires about various health risk factors. The survey is carried out by the state public health departments and the Centers for Disease Control and Prevention. Prevalence data from the BRFSS is utilized by state governments to aid in health policy decisions and to help create public health programs. The survey is administered to noninstitutionalized adults, 18 years or older.

The portions of the 2002 BRFSS survey used in the current study were Section 3: Exercise, Module 4: Physical Activity, and Module 12: Weight Control (11). The survey was administered verbally by the investigator during each participant's laboratory visit, using the exact prompts given. Subjects were instructed to answer the questions as accurately and honestly as possible. The physical activity and exercise portions of the survey were scored by categorizing each participant as having acquired no LTPA, an insufficient amount, or having met the CDC/ACSM recommendation. In scoring the weight control portion, subjects were categorized as presently making an effort to lose weight, trying to maintain their current weight, or neither.

Anthropometric Measurements and Body Composition

Waist and hip circumferences were measured using a Gulick fiberglass measuring tape with tension handle (Creative Health Products, Inc., Plymouth, MI). Waist circumference was measured at the natural waist, or the narrowest part of the torso, with the subject standing erect and the abdomen relaxed. Hip circumference was taken at the level of maximum extension of the buttocks. WHR was calculated from these measurements. Height was measured by a wall-mounted stadiometer (Seca Corporation, Columbia, MD).

Subjects arrived at the lab after an overnight fast and all were tested during the morning hours (10:00 am or earlier) in an effort to control physical activity prior to body composition measurements. Subjects were then seated for approximately 10 minutes while completing the informed consent form and health history questionnaire, and answering questions on the BRFSS survey.

For the body composition testing, all subjects wore a swimsuit or undergarments, with a lycra swimcap. Participants were also asked to remove all jewelry and metal from the body. Body composition was measured using the Bod Pod® (Life Measurement Instruments, Concord, CA) and testing was completed according to the manufacturer's instructions and specifications. A formula developed specifically for African-American females was used to calculate % body fat from the Bod Pod®-measured body density (41). The assumed fat-free mass density of the equation, 1.106 g/cc, was used. Body mass was measured by the Bod Pod® scale and BMI was calculated by dividing weight in kilograms by height in meters squared.

Physical Activity Monitoring

Following laboratory testing, subjects were instructed to wear a New Lifestyles Digi-Walker SW-200 (New Lifestyles, Inc., Lees Summit, MO) pedometer during all waking hours, except when in water. Subjects wore the pedometer for a total of seven consecutive days and recorded the total number of steps taken each day on an activity log (Appendix D). Subjects were shown the appropriate pedometer placement on the waistband at hip level, while its precise alignment was individually determined by the investigator based on a 20-step walking test to ensure that the pedometer's position would elicit optimal accuracy. Before putting the monitor on each morning, the subject was instructed to make sure it had been re-set and to record the time at which it was placed on the waistband. Each night before retiring, the subject recorded the number of steps on the pedometer for that day, noted the time at which the pedometer was taken off, and recorded the specific activities engaged in during that day. Two subjects' steps were measured by a New Lifestyles NL-2000 pedometer, which has been shown to be accurate and reliable (16, 44, 45), and yields steps counts that do not differ significantly from the Digi-Walker SW-200 over a 24-hour period (44). These subjects were simultaneously participating in a different study at the Applied Physiology Lab at the University of Tennessee comparing 2 different walking protocols in a sample of predominantly white, middle-aged women. All participants were strongly encouraged not to make any changes to their typical daily routine of work and leisure activity, in order to provide a true sense of their usual physical activity.

Diet Record

Also following laboratory testing, subjects were given a food log (Appendix E) and instructed to record everything they ate and drank for 3 consecutive days, including 2 weekdays and 1 weekend day. They identified each specific food item, method of preparation, and the amount eaten. Participants were strongly encouraged to remain consistent with their normal diet and record each item and its amount as accurately and specifically as possible. The subjects' diet for each day was analyzed using the Nutritionist Pro™ Software (First DataBank, Inc., San Bruno, CA). The average intake for the three-day span was then calculated to provide an estimate of each subject's typical daily caloric consumption.

Statistical Analyses

Statistical analyses were completed using SPSS for Windows version 11.5 (SPSS, Inc., Chicago, IL). A missing value analysis was performed to supplement a total of 6 missing step values in 4 different subjects. Descriptive characteristics were calculated for the entire sample. A one-way ANOVA was run to compare health variables among the three physical activity categories. Partial correlation coefficients controlling for age were calculated for steps/day and BMI, % body fat, waist and hip circumferences, and WHR. Chi-square tests were performed to analyze categorical data. Significance was set at $P < 0.05$ for all tests.

Results

Subject Characteristics

Of the 75 subjects tested, 69 subjects met all inclusion criteria and returned all data. Three subjects were deemed ineligible due to orthopedic limitations, one was ineligible due to occasional smoking, and two did not return data. Results are reported for the remaining 69 participants. Table 3 illustrates the descriptive characteristics of the entire sample. In general, subjects were middle-aged (51.4 $\pm$ 5.4), overweight women (BMI = 30.9 $\pm$ 6.8; % body fat = 42.2 $\pm$ 8.3) with low activity levels (average steps/day = 5,747 $\pm$ 2,630).

Physical Activity Comparisons

Figure 1 illustrates the relationship between steps/day vs. BMI for the entire sample. The figure shows a significant inverse correlation (R= - 0.4794). Figure 2 illustrates a similar relationship between steps/day vs. % body fat. Here, there was also a significant inverse correlation (R= - 0.5065).

Figure 3 is a bar graph showing BMI differences among the three activity groups of < 5,000 steps/day, 5,000-7,499 steps/day, and $\geq$ 7,500 steps/day. The mean BMI values $\pm$ SD for these groups were 33.9 $\pm$ 7.6, 30.0 $\pm$ 5.9, and 26.4 $\pm$ 4.5 kg/m^2, respectively. There was a significant difference between the least and most active group (P=0.005).

Table 4 shows the comparison of all variables among the same three activity groups. When comparing the least active group (< 5,000 steps/day) to the most active group ($\geq$ 7,500 steps/day), significant differences were observed for several variables including average steps/day (P < 0.001), body weight (P< 0.001), BMI (P=0.005), % body fat (P< 0.001), waist circumference (P=0.004), and hip circumference (P=0.043).

Table 5 illustrates categorical data across the activity groups for the BRFSS Survey data. This included self-reported physical activity and weight control efforts.

Table 3: Descriptive characteristics of subjects (N=69).

Variable	Mean ± SD	Minimum - Maximum
Age (y)	51.4 ± 5.4	40 - 62
Height (in)	64.6 ± 2.6	59.5 - 70
Weight (kg)	83.0 ± 18.1	54.3 – 153.0
BMI (kg/m^2)	30.9 ± 6.8	21.0 - 53.2
Waist (cm)	92.8 ± 13.9	67.0 – 135.1
Hip (cm)	111.1 ± 15.0	88.4 – 155.0
WHR	0.83 ± 0.06	0.71 – 0.94
Body Fat (%)	42.2 ± 8.3	21.6 – 58.9
Daily Energy Intake (kcal)	1891.8 ± 505.9	628 - 3250
Average Steps/day	5,747 ± 2,630	970 – 14,423

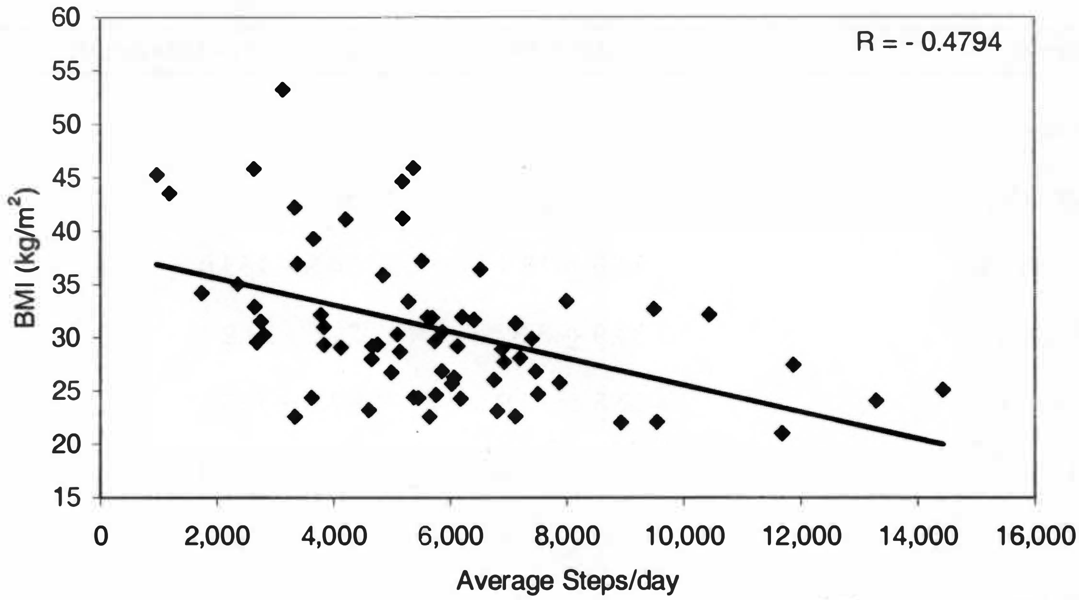

Figure 1: Regression of BMI and steps/day.

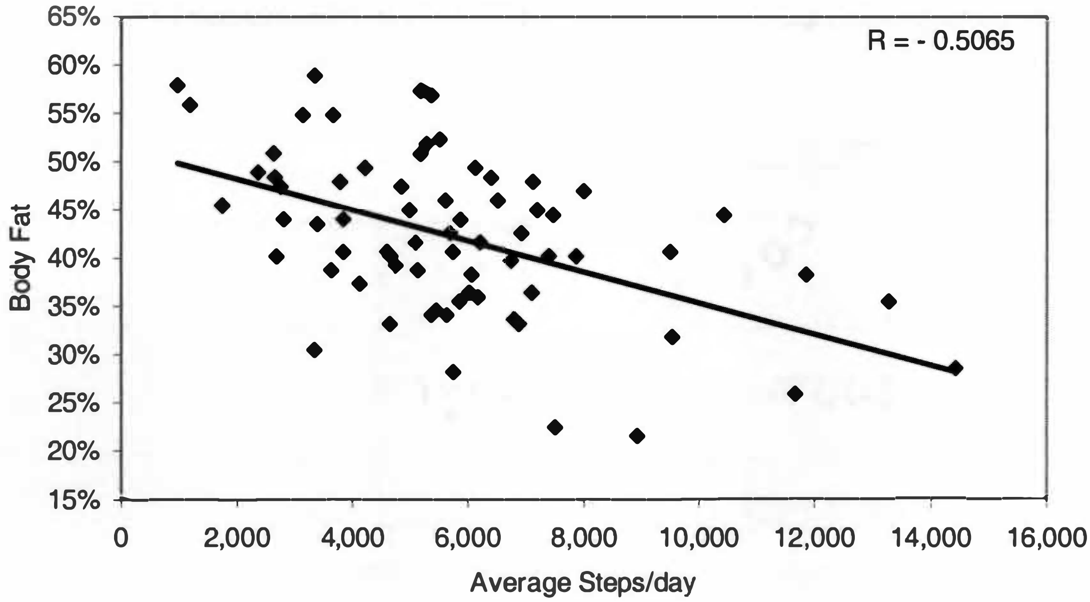

Figure 2: Regression of % body fat and steps/day.

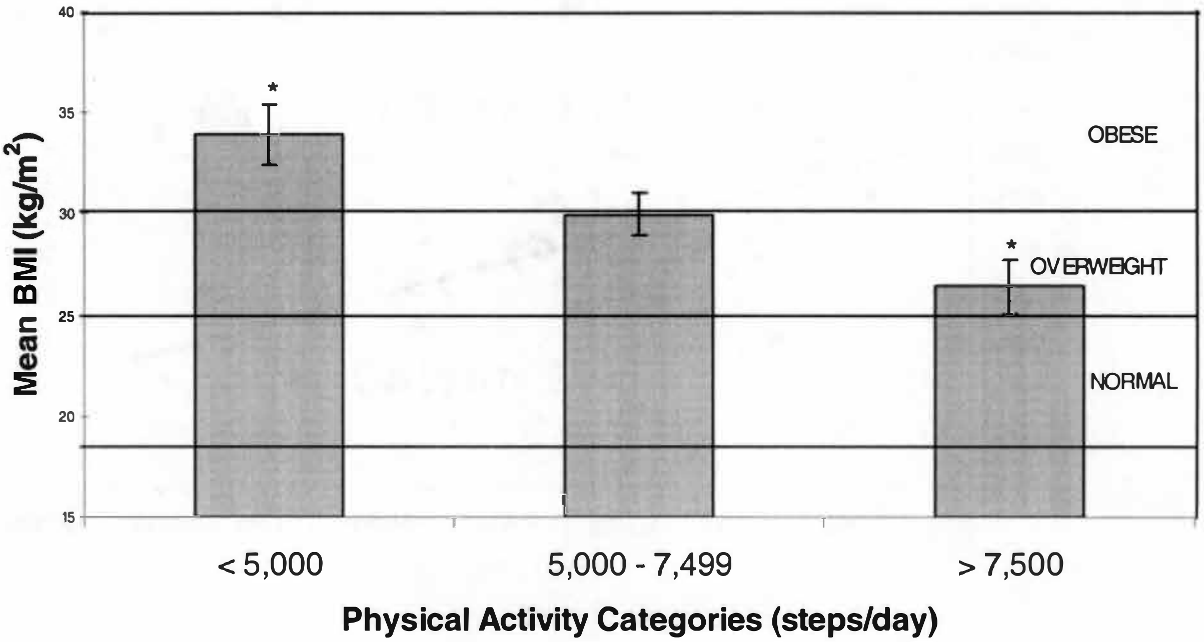

Figure 3: BMI among activity groups.

Table 4: Comparison of variables across activity groups (mean ± SD).

	< 5,000 steps/day (N=26)	5,000 – 7,499 steps/day (N=32)	≥ 7,500 steps/day (N=11)
Average Steps/Day	3,406 ± 1,095 ^{A}	6,111 ± 765 ^{B}	10,280 ± 2,287 ^{C}
Age (y)	54.1 ± 4.5 ^{A}	50.1 ± 5.4 ^{B}	48.8 ± 5.0 ^{B}
Height (in)	65.0 ± 2.7 ^{A}	64.2 ± 2.3 ^{A}	65.1 ± 3.1 ^{A}
Weight (kg)	92.1 ± 20.5 ^{A}	79.5 ± 14.9 ^{AB}	71.7 ± 9.4 ^{B}
BMI (kg/m^2)	33.9 ± 7.6 ^{A}	30.0 ± 5.9 ^{AB}	26.4 ± 4.5 ^{B}
Body Fat (%)	45.6 ± 7.3 ^{A}	42.2 ± 7.2 ^{A}	34.2 ± 8.8 ^{B}
Waist (cm)	99.8 ± 14.0 ^{A}	89.9 ± 12.5 ^{AB}	84.5 ± 10.8 ^{B}
Hip (cm)	115.9 ± 16.7 ^{A}	110.0 ± 13.7 ^{AB}	103.1 ± 10.2 ^{B}
WHR	0.86 ± 0.06 ^{A}	0.82 ± 0.06 ^{B}	0.82 ± 0.04 ^{A}
Daily Energy Intake (kcal)	1877 ± 484 ^{A}	1912 ± 567 ^{A}	1867 ± 396 ^{A}

Means with different letter superscripts are significantly different, $P < 0.05$.

Table 5: Categorical data across activity groups (percentage and N).

	< 5,000 steps/day (N=26)	5,000 – 7,499 steps/day (N=32)	≥ 7,500 steps/day (N=11)
BRFSS Survey			
No or Insufficient LTPA	50.0 (13)	67.7 (21)*	27.3 (3)
Met Recommendation	50.0 (13)	32.3 (10)*	72.7 (8)
Attempting Weight Loss	57.7 (15)	71.9 (23)	63.6 (7)
Attempting Weight Maintenance	26.9 (7)	21.9 (7)	36.4 (4)
Attempting No Weight Control	15.4 (4)	6.3 (2)	0.0 (0)

BRFSS = Behavioral Risk Factor Surveillance System

No significant differences between physical activity groups, as determined by Chi-square tests.

* One subject unable to specify duration of LTPA, N=31.

When a partial correlation was used to control for age while comparing steps/day to body composition variables, negative correlations still existed for each variable. These correlations, illustrated in Table 6, were significant for BMI (P< 0.001), % body fat (P< 0.001), waist circumference (P=0.002), and hip circumference (P=0.015).

Diet Record Comparisons

Daily energy intake, measured in kilocalories, was evaluated for each subject and averaged from the 3-day record. There was no significant difference in caloric intake between any of the three activity groups. A partial correlation controlling for kilocalories while comparing steps/day to the body composition variables showed that negative correlations remained for each variable. In addition, all the variables had significant negative correlations. These variables included BMI (P<0.001), % body fat (P<0.001), waist circumference (P<0.001), hip circumference (P=0.003), and waist-to-hip ratio (P=0.024).

Table 6: Pearson correlations and age-controlled partial correlations between average steps/day and body composition variables (N=69).

Variable	**Correlation (P-value)**	**Partial Correlation (P-value)**
BMI (kg/m^2)	- 0.479 (P< 0.001)*	- 0.4120 (P< 0.001)*
Body Fat (%)	- 0.506 (P< 0.001)*	- 0.4277 (P< 0.001)*
Waist (cm)	- 0.438 (P< 0.001)*	- 0.3726 (P=0.002)*
Hip (cm)	- 0.354 (P=0.003)*	- 0.2932 (P=0.015)*
WHR	- 0.273 (P=0.023)*	- 0.2290 (P=0.060)

* Significant relationships, P < 0.05.

Discussion

This is the first study to compare pedometer-assessed physical activity with body composition variables in middle-aged, African-American females. As hypothesized, an inverse relationship between steps/day and body composition variables was found. Women who accumulated more steps/day had lower BMI values, body fat percentages, and waist and hip circumferences. Significant differences ($P < 0.05$) were found for all these variables when comparing the least and most active groups.

Few studies have assessed physical activity in African-American females via pedometer. The results of these previous pedometer studies (51, 56) were consistent with questionnaire studies (2, 3, 15, 23, 29, 37, 55), in showing that middle-aged African-American females are generally a sedentary population. Whitt et al. (56) examined a sample of African-American women (39.6 $\pm$ 8.7 years) and concluded that most of the participants were not obtaining the recommended amount of physical activity, primarily due to the fact that they performed exercise bouts too few times per week. The subjects accrued 31.9 $\pm$ 18.0 min/day, but on only 3.1 $\pm$ 2.4 days/week. It was also discovered that participants with a BMI < 25 kg/m^2 accumulated more physical activity (9997 steps/day), compared to those with a BMI of 25.0-29.9 kg/m^2 (7595 steps/day) or $\geq$ 30 kg/m^2 (6210 steps/day). The findings of the current study were consistent with Whitt's in that the group that accumulated the most step/day had the lowest BMI values. BMI increased as the steps/day decreased for each subsequent group. Therefore, both studies showed an inverse relationship in steps/day and BMI in African-American females. The current study extends these findings by using a direct measure of adiposity (i.e. body composition) as determined by densitometric methods (Bod Pod®). In addition, the current study shows that these relationships hold even after controlling for age.

Tudor-Locke et al. (51) showed that African-American women took the fewest number of steps/day, had the highest % body fat, and highest BMI values among a bi-racial sample (black and white) men and women. Their study also showed an inverse relationship between both BMI and % body fat (measured by bioelectrical impedance) and steps/day, although the sample was not specifically divided by gender and race. The current study was consistent with these findings, in that there was an inverse relationship between steps/day and both BMI and % body fat. In addition, the relationship was evident in one ethnic- and gender-specific subgroup, African-American women.

A recent study by Thompson et al. (49) examined the relationship between steps/day and body composition in middle-aged Caucasian women. A strong inverse correlation between steps/day and both BMI and body fat was discovered. Their study used the Bod Pod®, a proven accurate method for obtaining body composition (17, 40), to determine % fat. The methods and results of the current study were similar to those of Thompson. However, activity groups were categorized differently for statistical analysis so that a more even distribution of participants would be present in the low, middle, and highly active groups. In order to directly compare the two studies, the sample of African-American women was divided into the categories used by Thompson et al. to evaluate racial differences in body composition variables among the activity groups. The Caucasian sample (N=80) had a more even distribution among the activity groups with 22 subjects categorized as inactive (< 6,000 steps/day), 33 subjects somewhat active (6,000-9,999 steps/day), and 25 regularly active (≥ 10,000 steps/day). The African-American sample (N=69) was unevenly distributed with 42, 22, and only five subjects, in each of the respective groups. This distribution also shows that the African-American women were generally less active than their Caucasian counterparts. Consistent with Thompson's findings for middle-aged Caucasian women, African-Americans showed a significant inverse relationship between physical activity and BMI, % body fat, and waist circumference. Between the inactive, somewhat active, and regularly active groups, BMI was 29.3, 25.6, and 23.6 kg/m^2 in the Caucasian sample and 33.1, 27.8, and 26.0 kg/m^2 in the African-American sample, respectively. Body fat percentages were 44.2, 35.1, and 26.4% in the white women and 44.7, 39.3, and 34.6% in the black women. Waist circumference was 94.6, 81.5, and 73.8 cm in Caucasians and 97.4, 85.9, and 84.2 cm in African-Americans. Unlike the Caucasian sample, African-Americans showed no significant difference among the activity groups for hip circumference or WHR.

Although significantly lower values were seen among the more highly active groups, it should be noted that African-American females not only had higher values for body composition variables when compared to their Caucasian counterparts, but that their values remained higher than recommended even in the most active group. BMI is considered normal at 18.5-24.9 kg/m^2 and a desirable body fat percentage for females 40 and older is 26.4-30.9% (24). Among the five African-American participants who met or exceeded the recommended 10,000 steps/day (mean $\pm$ SD = 12,337 $\pm$ 1,543), the average BMI and body fat percentages were above the optimal targets at 26.0 kg/m^2 and 34.6%, respectively. The 25 Caucasian women who accumulated at least 10,000 steps/day (mean $\pm$ SD =12,109 $\pm$ 1,524), had BMI values and body fat percentages within the recommended range at 23.6 kg/m^2 and 26.4%, respectively. A larger sample of active African-American women would be needed to test for a statistically significant difference between the two ethnic groups.

The CDC's method of determining whether or not individuals are accumulating a sufficient amount of physical activity is the BRFSS survey. A person is classified as meeting the national physical activity recommendation if they acquire moderate activity for $\geq$ 30 minutes, at least 5 times/week, or if they obtain $\geq$ 20 minutes of vigorous activity at least 3 days/week. If these criteria are not met, the individual is classified as accumulating an insufficient amount of physical activity. It was interesting to note that of the women averaging < 5,000 steps/day, 50% (13 out of 26 participants) reported that they were meeting the CDC/ACSM recommendation for physical activity. Moreover, 27% of those women (7 out of 26 participants) reported that they were meeting the recommendation through vigorous physical activity. This is surprising since pedometer values < 5,000 steps/day are typically considered to represent sedentary behavior (52). In addition, Whitt et al. (56) reported that obese African-American women taking 6,210 steps/day were accumulating physical activity in bouts of 1-4 minutes in duration, and they performed almost no activity in bouts of 10 minutes or longer. Since the BRFSS specifically asks about physical activity that is performed for "at least 10 minutes at a time," these brief 1-4 minute bouts should go unreported on the survey. This observation also implies that self-report measurements of physical activity may not be as reliable as objective pedometer-assessed physical activity.

This study had several limitations. The participants were not randomly selected, but recruited by public advertisements and "word of mouth." A larger group of active participants ($\geq$ 7,500 steps/day) would have been preferred for statistical analyses to make the sample more representative. Also, data for the study was collected during three winter months (January-March). This could have had an effect on the amount of time spent engaging in physical activity, especially outdoor activities. Previously, Tudor-Locke et al. (52, 53) examined daily step counts in a 365-day study in South Carolina and Tennessee, and found that individuals typically have lower step counts in the winter, compared to the year-round average.

In summary, the results of the current study suggest that higher levels of pedometer-determined physical activity, measured in steps/day, are associated with lower BMI and % body fat values in middle-aged, African-American women. One possible explanation for the observed inverse relationship between steps/day and body composition variables is that higher levels of walking may help to prevent obesity. There is growing evidence that an increase in physical activity may help prevent and/or control obesity (18), which has been well established as a major health threat in the United States, especially among African-American women (22, 29, 51, 56). Most importantly, physical activity can reduce obesity-related disparities and chronic diseases including hypertension, diabetes, stroke, and coronary heart disease (10, 35, 38).

Although this is a relatively small study, the results indicate that African-American women are less active than Caucasian women of similar age (49). The African-American women averaged 5,747 steps/day, which is reflective of a sedentary lifestyle. This could be important in explaining the higher prevalence of obesity in this population. Thus, a pedometer along with a daily step goal may be helpful in encouraging African-American women to increase their physical activity.

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APPENDICES

APPENDIX A

INFORMED CONSENT

INFORMED CONSENT FORM

Study Title: Study of Health Variables in African-American Females

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PURPOSE

You are invited to participate in a research study examining the relationship between physical activity and health variables in African-American females. All testing for this investigation will take place in the Applied Physiology Laboratory at the University of Tennessee, Knoxville. Testing will take approximately 1 hour. Following the testing, you will wear an activity monitor (pedometer), which will count each step you take for 7 consecutive days.

PROCEDURES

Background Information

In order to assess your current health status, physical activity, and dietary patterns, you will be asked to fill out questionnaires related to each of these components.

Blood Pressure

A cuff will be placed around your upper right arm. This cuff will be inflated with air and then slowly deflated. By listening to the sound of the pulse in your arm, it is possible to determine your blood pressure.

Body Composition

Body fat distribution will be estimated by measuring your waist and hip circumferences. Height and weight will also be measured. Your body fat percentage will be determined by the Bod Pod®. This is the device that measures your body composition as you sit inside it for approximately 3 minutes. You will need to wear a bathing suit or your undergarments and a swim cap for this procedure.

Measuring Steps per Day

You will be given an electronic pedometer to wear for 7 consecutive days during all waking hours, except when in water or sleeping. You will be instructed to wear the pedometer at hip-level on the waistband and make sure it is placed in the position established by the investigator for the greatest amount of accuracy. Every night before going to sleep, you will be asked to record the exact number of steps you took that day and note the time at which the monitor was removed from the waistband. You will also provide a brief description of your daily activity (such as walking, gardening, swimming, etc.). Before putting on the activity monitor each morning, you will make sure that it has been re-set and record the time at which you placed it on the waistband.

BENEFITS OF PARTICIPATION
This study will allow you to monitor your daily walking activity and evaluate whether or not you are meeting the recommended goals for optimal health. You will also receive the results of your blood pressure and body composition measurements, allowing you or your physician to evaluate whether or not these values are within normal ranges for optimal health and overall wellness.

RISKS OF PARTICIPATION
There is very minimal risk associated with participation in this investigation. You will be asked not to change your normal routine, therefore any physical activity encountered will be reflective of your own typical activities. There is no known risk in measuring blood pressure and body composition.

CONFIDENTIALITY
The information from this study's records will be treated as privileged and confidential. Information will be released to no one without your consent. All data collected will be coded by an identification number assigned to each participant. Therefore, names will not be associated with any information collected. Data will be stored in a locked file cabinet in the office of Lyndsey Hornbuckle. The final results of this research may be published or presented, but no reference will be made in oral or written reports that could link you to the study. After the study's completion, all data and the signed informed consent forms will be stored in a locked file cabinet (in 317 HPER) for at least 3 years. Beyond that period, consent forms will be destroyed and the data will be stripped of identifiers (i.e. the list connecting a number to a subject will be destroyed) and stored in the same location indefinitely.

FREEDOM OF CONSENT AND RIGHT TO ASK QUESTIONS
Any questions or concerns during any phase of this study or following its completion may be directed to Lyndsey Hornbuckle at (865) 974-8768 or Dr. David R. Bassett, Jr. at (865) 974-8766. If any events occur that will keep you from participating in this study in its entirety, please inform Lyndsey Hornbuckle immediately. You are free to withdraw your consent and discontinue participation in any aspect of the testing at any time without penalty or prejudice. Any further questions about your rights as a subject may be addressed by the Institutional Review Board of the University of Tennessee, Knoxville at (865) 974-3466.

AUTHORIZATION

By signing this informed consent, I am indicating that I have read this document and fully understand all its components. I agree to take part in this research study.

____________________________ ______________
Participant Signature Date

____________________________ ______________
Investigator Signature Date

APPENDIX B

HEALTH HISTORY QUESTIONNAIRE

HEALTH HISTORY QUESTIONNAIRE

1. Have you ever been diagnosed with or treated for (by a physician or health professional) any of the following conditions? If so, please check the appropriate column:

____Asthma	____Gout	____Metal in the Body
____Back Pain	____Heart Problems	____Osteoarthritis
____Bronchitis (chronic)	____High Blood Pressure	____Osteoporosis
____Cancer	____High Cholesterol	____Rheumatoid Arthritis
____Diabetes	____Hypoglycemia	____Stroke
____Emphysema	____Kidney Problems	____Thyroid Problem
____Epilepsy	____Liver Problems	

2. Do you have any other physical conditions that may limit your ability to be physically active? If so please describe:

____

____

3. Are you currently taking any medications? Yes No
If yes, please list:

____

____

4. Do you currently smoke or have you quit within the last 6 months? Yes No
If yes, what type of tobacco products and how many per day?

____

5. Of the following members of your family, please describe any cardiovascular disease, heart disease, stroke, or diabetes, along with the age of onset:

Father____

Mother____

Brother____

Sister____

APPENDIX C

BEHAVIORAL RISK FACTOR SURVEILLANCE SYSTEM (BRFSS) SURVEY - 2002

Section 3: Exercise

3.1 During the past month, other than your regular job, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise? (79)

1 Yes
2 No
7 Don't know/Not sure
9 Refused

Module 4: Physical Activity

If "employed" or "self-employed" to core Q12.8, continue. Otherwise go to Q2.

1. When you are at work, which of the following best describes what you do? (218) Would you say: **Please Read**

If respondent has multiple jobs, include all jobs	1	Mostly sitting or standing
	2	Mostly walking
	3	Mostly heavy labor or physically demanding work
Do not read	7	Don't know/Not sure
	9	Refused

We are interested in two types of physical activity: vigorous and moderate. Vigorous activities cause large increases in breathing or heart rate while moderate activities cause small increases in breathing or heart rate.

2. Now, thinking about the moderate physical activities you do **[fill in (when you are not working) if "employed" or "self-employed" to core Q12.8]** 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 small increases in breathing or heart rate? (219)

1 Yes
2 No **Go to Q5**
7 Don't know/Not sure **Go to Q5**
9 Refused **Go to Q5**

3. How many days per week do you do these moderate activities for at least 10 minutes at a time? (220-221)

_ _ Days per week
8 8 Do not do any moderate physical activity for at least 10 minutes at a time **Go to Q5**
7 7 Don't know/Not sure
9 9 Refused

4. On days when you do moderate activities for at least 10 minutes at a time, how much total time per day do you spend doing these activities? (222-224)

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

5. Now thinking about the vigorous physical activities you do **[fill in (when you are not working) if "employed" or "self-employed" to core Q12.8]** 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? (225)

1 Yes
2 No **Go to next module**
7 Don't know/Not sure **Go to next module**
9 Refused **Go to next module**

6. How many days per week do you do these vigorous activities for at least 10 minutes at a time? (226-227)

_ _ Days per week
8 8 Do not do any vigorous physical activity for at least 10 minutes at a time **Go to next module**
7 7 Don't know/Not sure **Go to next module**
9 9 Refused **Go to next module**

7. On days when you do vigorous activities for at least 10 minutes at a time, how much total time per day do you spend doing these activities? (228-230)

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

Module 12: Weight Control

1. Are you now trying to lose weight? (311)

   1 Yes **Go to Q3**
   2 No
   7 Don't know/Not sure
   9 Refused

2. Are you now trying to maintain your current weight, that is to keep from gaining weight? (312)

   1 Yes
   2 No **Go to Q6**
   7 Don't know/Not sure **Go to Q6**
   9 Refused **Go to Q6**

3. Are you eating either fewer calories or less fat to... (313)
   lose weight? **[if "Yes" on Q1]**
   keep from gaining weight? **[if "Yes" on Q2]**

   Probe for which

   1 Yes, fewer calories
   2 Yes, less fat
   3 Yes, fewer calories and less fat
   4 No
   7 Don't know/Not sure
   9 Refused

4. Are you using physical activity or exercise to...
   lose weight? **[if "Yes" on Q1]**
   keep from gaining weight? **[if "Yes" on Q2]**

   1 Yes
   2 No
   7 Don't know/Not sure
   9 Refused

5. How much would you like to weigh?

   _ _ _ Weight pounds
   7 7 7 Don't know/Not sure
   9 9 9 Refused

6. In the past 12 months, has a doctor, nurse or other health professional given you advice about your weight?

Probe	1	Yes, lose weight
for	2	Yes, gain weight
which	3	Yes, maintain current weight
	4	No
	7	Don't know/Not sure
	9	Refused

APPENDIX D
ACTIVITY LOG

Phone: (865) 579-6089
Fax: (865) 974-8981
Subject ID #: ________

MONTH: ________________ 2004

Sunday **Date:** Time On: _____ Time Off: _____ Total Steps: _______	**Monday** **Date:** Time On: _____ Time Off: _____ Total Steps: _______	**Tuesday** **Date:** Time On: _____ Time Off: _____ Total Steps: _______	**Wednesday** **Date:** Time On: _____ Time Off: _____ Total Steps: _______	**Thursday** **Date:** Time On: _____ Time Off: _____ Total Steps: _______	**Friday** **Date:** Time On: _____ Time Off: _____ Total Steps: _______	**Saturday** **Date:** Time On: _____ Time Off: _____ Total Steps: _______
Brief description of your activities	Brief description of your activities	Brief description of your activities	Brief description of your activities	Brief description of your activities	Brief description of your activities	Brief description of your activities

- The pedometer should be worn at all times except when swimming, showering, or sleeping.
- As soon as you wake up each morning, put the pedometer on your belt or waistband and write down the time that you put it on.
- Before you go to bed each night, remove the pedometer and write down your steps, activities for that day, and the time at which you take the pedometer off. **Then, re-zero the pedometer.**

APPENDIX E
DIET RECORD

DIETARY RECORD INSTRUCTIONS

1. Use the Dietary Record Forms provided to record everything you eat or drink for 3 consecutive days – two weekdays and one weekend day.
2. Indicate the name of the FOOD ITEM, the AMOUNT eaten, how it was PREPARED (fried, boiled, etc.), and the TIME the food was eaten. If the item was a brand name product, please include the name. Try to be accurate about the amounts eaten. Measuring with measuring cups and spoons is best, but if you must make estimates, use the following guidelines:
   - Fist is about 1 cup
   - Tip of Thumb is about 1 teaspoon
   - Palm of the hand is about 3 ounces of meat (about the size of a deck of cards)
   - Tip of Thumb is about 1 ounce of cheese
3. Try to eat what you normally eat and record everything. The project will only be useful if you are HONEST about what you eat. The information you provide is confidential.
4. MILK: Indicate whether milk is whole, low fat (1 or 2%), or skim. Include flavoring if one is used.
5. VEGETABLES and FRUITS: One average serving of cooked or canned fruits and vegetables is about a half cup. Fresh whole fruits and vegetables should be listed as small, medium, or large. Be sure to indicate if sugar or syrup is added to fruit and list if any margarine, butter, cheese sauce, or cream sauce is added to vegetables. When recording salad, list items comprising the salad separately and be sure to include salad dressing used.
6. EGGS: Indicate method of preparation (scrambled, fried, poaches, etc.) and number eaten.
7. MEAT / POULTRY / FISH: Indicate approximate size or weight in ounces of the serving. Be sure to include any gravy, sauce, or breading added.
8. CHEESE: Indicate kind, number of ounces or slices, and whether it is made from whole milk, part skim, or is low calorie.
9. CEREAL: Specify kind, whether cooked or dry, and measure in terms or cups or ounces. Remember that consuming 8 oz. of cereal is not the same as consuming one cup of cereal. 1 cup of cereal generally weighs about 1 ounce.
10. BREAD and ROLLS: Specify kind (whole wheat, enriched wheat, rye, etc.) and number of slices.
11. BEVERAGES: Include every item you drink excluding water. Be sure to record cream and sugar used in tea and coffee, whether juices are sweetened or unsweetened and whether soft drinks are diet or regular.
12. FATS: Remember to record all butter, margarine, oil, and other fats used in cooking or on food.
13. MIXED DISHES / CASSEROLES: List the main ingredients and approximate amount of each ingredient to the best of your ability.
14. ALCOHOL: Be honest. Record amounts in ounces. Specify with “light” or “regular” beer.

DIETARY RECORD FORM

Day of the Week: ________________

Date: ___________________

FOOD ITEM	AMOUNT	TIME

- Express approximate measures in cups (C), tablespoons (T), teaspoons (t), grams (g), ounces (oz.), pieces, etc.

VITA

Lyndsey Michelle Hornbuckle is a native of Huntington, West Virginia. Upon high school graduation, she completed her Bachelor of Science degree in Human Ecology, with a major in Nutrition, at the University of Tennessee, Knoxville. From there, she moved on to complete her Dietetic Internship at the Yale-New Haven Hospital in New Haven, Connecticut, where she graduated with distinction. Lyndsey then returned to the University of Tennessee, Knoxville to pursue a Master of Science degree in Exercise Science, with a concentration in Exercise Physiology. Lyndsey was active in numerous campus organizations as an undergraduate, and served as a Graduate Teaching Associate in the Physical Education and Activity Program both years while completing her Masters degree. She was also awarded the A. W. Hobt Memorial Scholarship for Excellence in Teaching both years. She will receive her Master of Science degree in August 2004.