Comparison of Black and White Elderly Women on Muscle Mass Bone Mineral Density and Balance.

Tyanez Jones
*East Tennessee State University*

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Comparison of Black and White Elderly Women on Muscle Mass, Bone Mineral Density, and Balance

A thesis presented to the faculty of the Department of Physical Education, Exercise and Sport Sciences East Tennessee State University

In partial fulfillment of the requirements for the degree Master of Arts in Physical Education, Exercise and Sport Sciences

by

Tyanez C. Jones
December 2001

Lynn B. Panton, Chair Kathy D. Browder Jacqueline J. Lloyd Craig E. Broeder

Key words: Muscle Mass, Bone Mineral Density, and Dynamic Balance.
ABSTRACT

A Comparison of Black and White Elderly Women on Muscle Mass, Bone Mineral Density, and Balance

by
Tyanez C. Jones

Few studies have compared balance between aging black (BW) and white women (WW) and examined its relationship to muscle mass and bone mineral density (BMD). Nineteen BW and 56 WW between 60-91 years participated. Upper and lower body strength, body composition, BMD, volitional and non-volitional control of dynamic balance, and physical activity ratings were assessed. There were no differences in strength between the groups. A trend was reported for total body BMD (p=0.07). WW exhibited better control of rapid volitional movements, in the limits of stability and rhythmic weight shift tests. The relationships of strength and muscle mass to BMD and balance were weak. Physical activity ratings were higher for WW than BW (p<.05). In conclusion, differences reported between BW and WW for risk of falling may be due to other variables not assessed in this study. Future studies should examine other factors that contribute to increased risk of falling.
DEDICATION

I foremost would like to thank the most high God my Jehovah-Jireh for providing me with the strength, wisdom, and understanding to complete this project. His masterpiece thesis was the perfect guide to follow. To my husband and friend Anthony Jones Sr., you worried when I worried and rejoiced more than me to see this project end. I dedicate this to you, A.J, and little Ms. Trinity. I also dedicate this to my mom Gwendolyn M. Thomas and my sister Deanna for always encouraging me to do my best. To my dad, Ma-Pam, and my brothers your support throughout my educational career was appreciated. Thank you.
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CHAPTER 1
INTRODUCTION

Aging (to grow or to make older) is a process of changes that occur during maturation from childhood to adulthood. Many of these changes are modified by experience and altered by physiological declines (Konrad, Girardi, & Helfert, 1999). For example it is speculated that as a person ages, he or she gains wisdom, while becoming less able to carry out normal activities of daily living. The book of Job 30:2 describes this aging phenomenon as ‘Men whose ripe age and vigor had perished’ (The Amplified Bible). Physiological declines with aging affect all individuals, some more than others. Some of the areas affected by aging are muscle mass, bone mineral density (BMD), and balance (Custon, 1994). Age-related declines in muscle mass usually promote age-related declines in BMD and balance.

Sarcopenia, the age-related loss of skeletal muscle mass is derived from the Greek words sark (flesh) and penia (poverty) (Evans, 1996). Sarcopenia results in decreases in muscle strength, BMD, and balance, which increase the risk of falls (Doyle, Brown, & Lachance, 1970). Signs of sarcopenia appear around 20 years of age, and continue to increase as one ages. By the age of 70, a person may have lost up to 20% of his or her muscle mass (Butler, 1993). Sarcopenia occurs in all aging individuals. However, it is evident that the loss of muscle mass may differ among individuals of different racial groups (Rantanen et al., 1998).

Cross-sectional studies have shown that the decline in muscle mass is slower in aging black women than aging white women (Aloia, Vaswani, Ruimei, & Flaster, 1997;
Rantanen et al., 1998). It was initially reported that the higher muscle mass in black women was primarily due to an increased body weight, compared to white women. However, Aloia reported that when both ethnic groups were matched for similar body weight, black women consistently had more muscle mass than white women. The researchers in this study could not determine if the differences in muscle mass were due to ethnicity or lifestyle choices.

Clement (1974) performed a study comparing the changes in muscle strength between two groups of white women. The changes in muscle strength between the two groups were dependent upon whether the group was sedentary or participated in physical activity. Clement further reported that individuals who practiced sedentary habits experienced greater declines in muscle strength than individuals that were physically active. Researchers attempted to use the findings from Clement’s study to explain the differences in muscle mass between black and white women. However, other studies have shown that black women are less likely to participate in physical activity and less likely to practice beneficial health behaviors compared to white women (Clark, 1995; Young, Miller, Wilder, Yanek, & Becker, 1998). According to this research, the declines in muscle mass should occur at a faster rate in black women than in white women. Yet when compared to white women who were physically active, sedentary black women still had a higher muscle mass (Rantanen et al., 1998). The reason for these differences in muscle mass between black and white women is unknown.

The loss of muscle mass in older adults has a direct effect on the changes that occur in BMD. Bone mineral density is an area density used to describe bone mass,
which is a major determinant of bone strength (Mazess, Barden, Bisek, & Hanson, 1990). The strength of a bone reflects the weight and force of the muscle that connects with it (Doyle et al., 1970). For example if there was a decline or increase in muscle mass, a decline or increase would also be recorded in bone mass. Doyle reported that the decline in bone mass, after age fifty, is due to the noted declines in muscle mass. Muscle mass and BMD are highly correlated in all humans (Gasperino, Wang, Pierson, & Heymsfield, 1995), suggesting that BMD may also vary among ethnic groups.

Black women were previously reported as having higher muscle mass than white women, suggesting that they will also have higher BMD. According to Ortiz, Russell, and Aley (1992) black women have 10-15% more muscle mass and total BMD than their white counterparts. The greater bone mass in black women has been attributed to anthropomorphic differences such as longer upper and lower extremity bone lengths (Himes, 1988; Ortiz et al., 1992). However, Luckey et al. (1989) reported that there was no evidence of larger bone sizes in black women. Many researchers do not support the theory that higher bone mass in black women is caused by differences in bone make-up, but rather is due to the higher muscle mass recorded among black women (Aloia et al., 1997; Luckey et al.; Rantanen et al., 1998). Again, the reasons for higher muscle mass and BMD in black women are unknown.

Another area of decline seen with the loss of muscle mass is balance. Balance from a mechanical perspective is the ability to control the position of the body’s center of gravity. One of the most important aspects of balance control depends on the proper functioning of the muscles in the lower extremities (Tideiksaar, 1989). Dynamic balance
seems to be more affected by age-related declines in muscle mass than static balance. Lord, Ward, Williams, and Strudwick (1995) stated that a decline or increase in ankle dorsiflexion strength is associated with a decline or increase in dynamic balance. The physiological declines in muscle mass could alter balance function (Chang & Krebs, 1999). It is unknown if balance differs between black and white women.

Topp, Mikesky, Wigglesworth, Holt, and Edwards (1993) estimated that 10-25% of all falls among the elderly could be attributed to poor balance. It was proposed that balance is one of the major risk factors for falls in the elderly (Schwarz et al., 1994). Falling usually occurs during the phase of balance where the line of gravity becomes uncontrollable and falls outside the base of support. Englander, Hodson, and Terregrossa (1996) reported that over 30% of white women and men over 65 years of age will fall each year, and 40% over 80 years of age will fall. The occurrence rate for falls among black men and women is very similar to that of white men and women. Schwarz reported that 26% of black men and women over the age of 60 years and 54% of those over the age of 80 years would experience a fall. Up until the age of 80 falls were almost equal between both ethnic populations. After age 80, the percentage of falls for black women exceeded that of white women, suggesting that black women may lose their balance more than white women after this age.

The physiological declines in all aging individuals occur in a familiar sequence. First, there is a decline in muscle mass, followed by a decline in BMD and balance, which could ultimately result in a fall. Black women, however, experience slower age-related declines in muscle mass and BMD than white women. Therefore it may be
interpreted that black women will not be affected by balance impairments to the same
degree as white women. The percentage of falls in black women, in which balance is one
of the risk factors, is similar to that of white women. However, in elderly individuals
over the age of 80 years, the percentage of black women who fall exceeds that of white
women. Therefore, it cannot be assumed that elderly black women will lose their balance
less than elderly white women. There is little research documenting the effect of aging
on balance between elderly black and white women and the physiological measurement
of balance. However, there have been some studies evaluating the differences in muscle
mass and BMD between black and white women. This study will provide further data on
muscle mass and bone density in elderly black and white women and provide new
information on balance in these two groups of women.

Statement of the Problem

The purpose of this present study was to compare muscle mass, BMD, and
dynamic balance in elderly black and white women.

Hypotheses

The hypotheses tested were to determine if there were significant differences in
the morphological and physiological parameters of muscle mass, BMD, and dynamic
balance between black and white elderly women.
Delimitations

The delimitations for this study included the following:

1. A sample of black women (n = 19) and white women (n = 56) aged 60 years and older was recruited.

2. Subjects were free from exercise limiting diseases such as uncontrolled high blood pressure, poorly controlled diabetes, angina, movement limitations that prevent them from performing the tests, congestive heart failure, severe arthritis, and heart attack within the past six months.

3. Subjects did not consume any medications for osteoporosis with the exception of hormone replacement and calcium.

4. Black subjects were recruited from predominantly black churches in the Tri-cities area. Subjects were also recruited by television and newspaper advertisements.

5. Subjects were taught the proper techniques of the strength exercises performed during maximal testing.

6. The NeuroCom, Balance Master was used to measure dynamic balance and postural stability. The Dual Energy X-ray Absorptiometry (DEXA) was used to measure bone density.

7. Measurements were taken at East Tennessee State University, Veterans Administration Medical Center, and Johnson City Medical Center Clinical Building and Wellness Center. Each subject was assigned a time and day to perform testing measures.
Assumptions

The following assumptions were made:

1. The subjects followed the guidelines set by the researcher.
2. Subjects gave their best efforts during testing.
3. All laboratory equipment presented accurate and valid measurements over the course of repeated testing.

Limitations

The following shortcomings occurred during the study:

1. Subjects in the study were volunteers, which makes selection bias a potential problem.
2. Subjects out of laboratory activities (e.g., diet, sleep, etc.) were not controlled. Subjects were advised not to change their lifestyles during the testing period.

Definitions of Terms

1. Ankle Strategy: movement about the ankles to maintain balance, with the head in line with the center of gravity and the body moving about the ankles as a rigid mass (NeuroCom, Inc., 1999).
2. Anteroposterior (AP): the plane of the body from front to back (NeuroCom, Inc., 1999).
3. Balance: (from a mechanical perspective) controlling the position of the body’s center of gravity (Hall & Messier, 1993).
4. Bone Mineral Density (BMD): an area density, expressed in g/cm², that is used to describe bone mass per unit of projected bone area (Mazess et al., 1990).

5. Center of Gravity (COG): the point around which the body is balanced (Hall & Messier, 1993).

6. Directional Control (DCL): a comparison of the amount of movement in the intended direction (toward the target) to the amount of extraneous movement (away from the target) (NeuroCom, 1999).


8. End Point Excursion (EXE): the distance traveled by COG on the primary attempt to reach the target (NeuroCom, 1999).

9. Fast Twitch Muscle Fibers (FTa): (also called type IIa) fast oxidative fibers, have moderate capacities for both glycolytic and oxidative metabolism (Lash & Sherman, 1993).

10. Fast Twitch Muscle Fibers (FTb): (also called type IIb) fast glycolytic fibers, have high glycolytic metabolic capacities (Lash & Sherman, 1993).

11. Limits of Stability (LOS): maximum distance a person can lean in a given direction without losing balance (NeuroCom, 1999).

12. Maximum Excursion (MXE): the furthest distance traveled by COG during the trial (NeuroCom, 1999).

14. Muscular Strength: the maximal force or tension generated by a muscle or muscle group (Mofatt & Cucuzzo, 1993).

15. One Repetition Maximum (1-RM): maximum amount of weight that can be lifted one time through the full range of motion (Gettman, 1993).

16. Reaction Time (RT): the time in seconds between the signal to move and the initiation of movement (NeuroCom, 1999).

17. Sarcopenia: loss of muscle mass with age (Evans, 1995).

18. Slow Twitch Muscle Fibers (ST): (also called type I) slow oxidative fibers, have slow maximal contraction velocities (Lash & Sherman, 1993).

19. Strength Threshold: the minimum amount of strength associated with the capacity to perform basic motor functions (Rantanen et al., 1998).

20. Translations: a movement of the support surface from center to back or center to front in the plane parallel to the floor (NeuroCom, Inc., 1999).
CHAPTER 2
REVIEW OF LITERATURE

As more and more of the population age, a large percentage of elderly individuals will go through major physiological declines. These changes go unnoticed in most elderly until they have difficulty performing normal activities of daily living (Wolfson, Judge, Whipple, & King, 1995). Aging individuals then find themselves surrounded by limitations. For example, elderly women are afraid to bend over and tie their shoes because they feel they may lose their balance and fall down. Many physiological declines associated with the aging process occur in the areas of muscle mass, BMD, and balance. Declines in these areas often lead to a fall.

The three areas that were examined in this research project are muscle mass, BMD, and balance in black and white women. Researchers have reported that aging individuals of all racial backgrounds show decreases in muscle mass with age, which ultimately lead to a decline in BMD and dynamic balance. Although this process of aging occurs in all elderly individuals, there are degrees to which they may differ among people of different ethnic backgrounds. Black women, for example, experience slower declines in muscle mass and BMD than white women. Although many research studies assessing balance have been performed using white men and women as subjects, little research has been done using black men and women as subjects. For organizational purposes, the review of literature is presented under the following topics: (a) age-related declines in muscle mass, (b) age-related declines in BMD, and (c) age-related declines in dynamic balance.
Age-related Declines in Muscle Mass

Sarcopenia is the body’s natural age-related reduction in muscle mass. Sarcopenia may be due to wasting diseases such as cancer. Shakespeare described this phenomenon of aging as ‘the stockings of an old man much too large for his now smaller legs’ (Evans, 1995). Sarcopenia like any deconditioning syndrome progresses at an increased rate from sedentary living (Butler, 1993). Although physically active populations may suffer from sarcopenia, it is to a lesser degree than those that are inactive. The outcome of sarcopenia in later life includes muscle weakness, decline in BMD, increases in fat mass, poor balance, and less potential for rehabilitation following a fall or illness (Butler, 1993). Muscle mass and strength are important in carrying out activities of daily living. Jette and Branch (1981) reported that 40% of the female population ages 55 to 64 years, 45% of women ages 65 to 74 years, and 65% of women ages 75 to 84 years were unable to lift 4.5 kg. A high percentage of women from these populations reported that they were unable to perform some aspect of normal household work. This decline in muscle strength in aging adults reflects a decline in normal task performance.

According to some researchers, age-related changes in fiber type area and total number of muscle fibers may be one of the risk factors in the loss of muscle mass (Lexell, Henriksson-Larsen, Winblad, & Sjostrom, 1983). The reported decline in fiber type is a result of the age-related alterations in type II muscle fibers. Larsson (1983) conducted a histochemical analysis of the medial vastus lateralis muscle. Sedentary subjects ages 16 and 80 years of age were measured. Larsson reported that 16 year old subjects had 60% type II fibers and those 80 years of age had less than 30% of type II fibers. It was
concluded that the decline in muscle fibers was significantly ($p < .001$) related to age. Lexell further reported that muscle atrophy is a result of gradual and selective loss of muscle fibers. In this study a slice of muscle from the midsection of the vastus lateralis of autopsy specimens (all men) were analyzed and fiber distribution was recorded. The total number of fibers in elderly men ages 70-73 years was significantly lower ($p < 0.01$) than young men ages 19-37 years. Fiber type proportions between the young and old did not differ for type I fibers, but there was a 60% reduction in type II fibers in elderly men. These authors concluded that muscle atrophy is due to reductions of type II muscle fibers.

Lexell, Taylor, and Sjostrom (1988) reported a decline in overall cross-sectional area of muscle with age. The possible explanation given for this reduction in muscle mass was either a decrease in the volume of individual fibers, a reduction in the total number of fibers, or a combination of both. Lexell suggested that a decline in total number of muscle fibers began at age 25 and decreased 39% by age 80. A change in fiber size in relation to age was significant in type II fibers ($p < 0.001$), but no significance was found for type I fibers ($p = 0.05$). The average reduction in fiber size between the ages of 20-80 years is 26% for type II fibers and 13% for type I fibers. These researches concluded that the decline in type II muscle fibers was the cause of the decline in muscle mass.

Aniansson, Zetterberg, Hedberg, and Henriksson (1984) also found that as individuals age, type II muscle fibers decrease. Using muscle biopsies from the vastus lateralis, muscle function in the elderly was evaluated. These biopsies were used as an expression of muscle function. There were 43 female subjects, ages 66-100 years, and 9
male subjects, ages 70-89 years. The female subjects were separated into three sub-
groups according to age. The first sub-group ($S_{g1}$) included individuals 66-75 years, the
second sub-group ($S_{g2}$) 76-85 years, and the third sub-group ($S_{g3}$) 86-100 years. Because
there was a small population of male subjects, they were all placed in one group.

Aniansson measured muscle distribution and fiber size in slow twitch (ST) and fast
twitch (FTa- glycolytic-oxidative and FTb- glycolytic) muscle fibers. There were no
statistical differences ($p > .05$) within the female sub-groups in any of the variables
measured except in the ratio of FTa per ST fiber area ($S_{g1}$: 0.70 ± 0.05; $S_{g2}$: 0.65 ± 0.04;
$S_{g3}$: 0.56 ± 0.04). The recorded fiber area for ST, FTa, and FTb fibers in female subjects
was smaller than those reported for male subjects. An age-related increase in fiber area
for ST muscle fibers ($S_{g1}$: 3.09 ± 0.33 um$^2 \times 10^3$; $S_{g2}$: 3.07 ± 0.39 um$^2 \times 10^3$; $S_{g3}$: 3.28 ±
0.27 um$^2 \times 10^3$) was recorded among the women sub-groups. An age-related decline for
FTa ($S_{g1}$: 2.31 ± 0.23 um$^2 \times 10^3$; $S_{g2}$: 2.07 ± 0.25 um$^2 \times 10^3$; $S_{g3}$: 1.86 ± 0.17 um$^2 \times 10^3$)
fibers was also noted for the sub-groups. The changes in FTb fibers showed no age-
related trends ($S_{g1}$: 1.64 ± 0.20 um$^2 \times 10^3$; $S_{g2}$: 1.68 ± 0.22 um$^2 \times 10^3$; $S_{g3}$: 1.56 ± 0.26
um$^2 \times 10^3$). A change in muscle fiber type will occur in ST, FTa, and FTb up to age 60-
70 years. Although the changes in fiber area were minor, Aniansson reported that there
was an advanced reduction in fiber size for type II fibers. As individuals age the fiber
area for type IIA fibers decreases, which causes the decline in muscle mass.

It has been found that changes in muscle mass are not the same for black and
white elderly women. According to Evans (1997) a greater reserve of muscle mass in
black men and women has given them a physiological advantage over white men and
women. Gasperino et al. (1995) performed a cross-sectional study comparing age-related changes in musculoskeletal mass between healthy matched black (B) and white (W) women. Due to the large age range (21-75 yrs), subjects were divided into two groups premenopause (30 ± 5 yrs) and postmenopause (52 ± 10 yrs). Body composition measurements included, weight (B: 65.1 ± 7.5 kg; W: 64.4 ± 4 kg), height (B: 162.6 ± 5.7 cm; W: 163.1 ± 4.9 cm), and waist-to-hip circumferences (B: 0.837 ± 0.062; W: 0.788 ± 0.044). Appendicular skeletal muscle mass, total body potassium (TBK), and percent body fat were also measured in this study. Gasperino reported that black women (before separating into groups) had significantly higher TBK (B: 2,639 ± 472 mmol; W: 2,484 ± 313 mmol; p ≤ 0.05) and muscle mass (B: 17.9 ± 3.30 kg; W: 13.4 ± 2.33 kg; p ≤ 0.001) values than their white counterparts. When the two ethnic populations were separated into their premenopause or postmenopause group, the results were similar to those previously mentioned. Premenopausal black women had significantly higher TBK (B: 2,831 ± 476 mmol; W: 2,632 ± 342 mmol; p ≤ 0.05) and muscle mass (B: 18.4 ± 3.05 kg; W: 13.5 ± 2.30 kg; p ≤ 0.001) values than white women. No significant difference was found for TBK (p = .7458) between the groups of postmenopausal women, but a significant difference was noted for muscle mass in postmenopausal (B: 17.6 ± 7.6 kg; W: 13.4 ± 2.4 kg; p ≤ 0.003) black women. Black women had 31% more skeletal muscle mass relative to the age-matched white women. Gasperino concluded that differences in muscle mass between black and white women begin at birth and exist throughout their adult life spans. There is no research to explain why black women have higher muscle mass than white women.
Ortiz et al. (1992) conducted a study similar to that of Gasperino and associates (1995). They also found that black women had significantly higher ($p \leq 0.05$) TBK values than white women. Twenty-eight black women and 28 white women participated in this project. Ortiz reported that appendicular skeletal muscle mass in the upper (B: 6.1 ± 1.3 kg; W: 4.8 ± 1.2 kg; $p \leq .0001$) and lower (B: 11.9 ± 2.1 kg; W: 10.9 ± 1.6 kg; $p \leq 0.01$) extremities were significantly higher in black women. Ortiz et al. concluded that black and white women differ in body weight and proportions of skeletal muscle and bone mineral mass.

The decline in muscle mass is reflected in the changes in muscle strength and ultimately leads to the inability to carry out normal activities of daily living. The ability to associate a physical loss of muscle mass to the decline in muscle strength is difficult unless it is related to the inability to carry out previously performed activities. Rantanen et al. (1998) assessed the association of muscle strength to level of physical activity and severity of disability in black and white women. There were 1,002 participants, 284 of whom were black women and 713 white women. The researchers tested muscle strength, joint pain, body mass, and height. Muscle strength was measured using a hand held dynamometer (JAMAR Hand Dynamometer). Hip flexion and leg extension were also measured using a hand held dynamometer (Nicholas Manual Muscle Tester). Level of disability index, ranging from 2-4 was measured under four categories: upper extremity disability (difficulty carrying 10 pounds), mobility disability (difficulty doing heavy housework), higher functioning disability (difficulty shopping for personal items and light housework), and basic self-care disability (difficulty shaving or showering). The
participant’s activity level was ranked using three levels: extremely active (ex), minimally active (mi), and moderately active (mo). There were no significant differences in body height (B: 155.6 ± 6.9 cm; W: 155.2 ± 7.2 cm; p = .454), number of chronic conditions (B: 3.0 ± 1.6; W: 2.9 ± 1.6; p = .242), prevalence of hand pain (B: 55%; W: 52%; p = .336), and severity of disability (p = .143) observed according to race. Handgrip (HG) and hip flexion (HF) strength was significantly (p < .001) greater in blacks (HG: 22 ± 6.3 kg; HF: 12.5 ± 5.5 kg) than whites (HG: 19.8 ± 5.1 kg; HF: 11 ± 4.8 kg). There were no significant differences (B: 13.1 ± 5.1 kg; W: 13.0 ± 4.9 kg; p = .809) between the two groups observed in the leg extension. It was concluded that older individuals with the highest level of disability had the lowest level of physical activity and were the weakest. The mean adjusted handgrip strength in individuals with severe disability revealed similar measurements between black (HG: 19.6 ± 4.92 kg) and white (HG: 19.5 ± 6.97 kg) women. The mean adjusted disability ratings for minimally active or moderately active black women (mi: 22.5 ± 6.29 kg; mo: 22.6 ± 5.21 kg) for handgrip strength was significantly higher (p < 0.001) than minimally active or moderately active white women (mi: 20.3 ± 4.91 kg; mo: 20.5 ± 4.80 kg). Rantanen concluded by stating, if aging individuals maintain their muscular strength, disability would be less severe in both ethnic populations. However, muscle strength in elderly individuals must meet a threshold in to order meet performance requirements and protect against disability (Young, 1986). The strength threshold is a minimal amount of muscle strength associated with the capacity to perform basic motor functions such as standing up, walking, climbing stairs and carrying bags. Research by Rantanen has shown that there
are differences in muscle strength with age between black and white women and their level of disability is dependent upon these changes. There is still no research on how or why these differences occur.

Muscle strength for aging black women has been reported to be higher than strength in aging white women. Muscle strength has also been associated with changes in other physiological areas. Taaffe et al. (2001) performed a study on race and sex and the association between muscle strength, soft tissue, and BMD in healthy elderly adults. A sample of 2,619 participants between ages 70-79 years, was recruited. The participants included 738 white women, 599 black women, 827 white men, and 455 black men. Muscle strength was assessed using the Kin-Com 125AP isokinetic dynamometer, for knee extensor strength. Bone mineral density was assessed using the DXA Hologic 4500A. Lean mass (LM), fat mass (FM), and percent body fat was also assessed using the DXA Hologic. Isometric handgrip strength was measured using a hand held dynamometer on the dominant hand. Taaffe found that there were no differences between black and white women for age (B: 73.3 ± 2.9 yrs; W: 73.5 ± 2.8 yrs), height (B: 159.7 ± 6.3 cm; W: 159.5 ± 5.9 cm), and percent body fat (B: 38.2 ± 6.3 %; W: 37.1 ± 5.8 %). There were significant differences between black and white women for weight (B: 75 ± 16 kg; W: 66 ± 12 kg) and BMI (B: 29 ± 6 k/m²; W: 26 ± 5 k/m²). Whole body BMD (B: 1.046 ± 0.112 g/cm²; W: 0.988 ± 0.105 g/cm²), leg strength (B: 86 ± 24 Nm; W: 79 ± 20 Nm), and HG strength (B: 26 ± 7 kg; W: 23 ± 5 kg) were also significantly higher for black women than white women. Black women (82%) also had the highest percentages for participation in low levels of physical activity (less than 1000 kcal/week)
than white women (72%). Taaffe et al. (2001) also performed partial correlations for the entire group of subjects on the relationship of BMD on muscle strength of the lower body. It was concluded that LM was a major determinant of regional and whole body BMD for black women but not white women. It was also noted that muscle strength and BMD is dependent upon muscle mass.

**Age-related Declines in Bone Mass**

Muscle mass and bone mass are highly correlated. The force and weight of muscle mass reflects the force and weight on bones. Bone mass is often times described using measures of bone mineral density (BMD) and bone mineral content (BMC). Black and white women in the United States differ with respect to bone mass (Nelson, Feingold, Bolin, & Parfitt, 1991). Himes (1988) stated that the environment may be one of the factors in racial differences when dealing with physique. Other researchers concluded that the differences in bone density are due to variations in body size (fat and muscle mass) and bone lengths in the upper and lower extremities, which may exert a greater force on the bone (Cohn et al., 1977; Nelson et al., 1991). Ortiz et al. (1992) found that black women have a 10-15% increase in appendicular skeletal muscle and total bone mass than white women. This data supports the theory that body size in many black women is greater than that of white women. Other researchers have not supported the theory of greater bone lengths found in black women (Luckey et al., 1989).

Luckey et al. (1989) realized that data on the age of onset, rates, or duration of bone loss in black women were limited. Therefore, Luckey began to compare the radial and vertebral bone mass in healthy black and white women. A total of 219 subjects were
recruited, this included 105 black women and 114 white women. Bone mineral content (BMC) was measured using the SP 2 radial scanner and BMD of the lumbar spine was measured using a DP3 lunar radiation. Luckey found no racial differences in mean height (B: 163 ± 6 cm; W: 163 ± 7 cm), but mean weight (B: 61.7 ± 7.3 kg; W: 59.6 ± 6.8 kg; \( p = 0.03 \)), and body mass index (B: 22.5 ± 2.2; W: 21.7 ± 2.0; \( p = 0.007 \)) were significantly higher in black women. Bone mineral content adjusted for age was significantly higher in black women than white women at the radial site (B: 0.727 ± 0.006 g/cm; W: 0.678 ± 0.006 g/cm). Black women also recorded a higher BMD at the vertebral site (B: 1.212 ± 0.0128 g/cm²; W: 1.123 ± 0.0123 g/cm²). When the subjects were analyzed by decade BMC was significantly higher (\( p < 0.05 \)) in black women at each decade except at age 24-35 years. Vertebral density was higher in black women for all decades except the fourth decade (56-65 years of age). After age 46 declines in radial BMC occurred at 5.2% per decade for black women and at 8.9% per decade for white women. A similar pattern was noticed in vertebral BMD, white women declined by 4.2% per decade and black women declined 3.5% per decade. The rates of decline were not significant for vertebral BMD between the two ethnic populations. Luckey concluded that the bone mass began to peak between the ages of 25-30 years. Before premenopause is reached (< age 46), a decline in BMD was reported for white women, whereas, BMD in black women continued to increase until they reached 47 years of age. Although black women were reported as having higher radial BMC and vertebral BMD measurements, more than 25% of these women had vertebral BMD lower than white women. This suggests that all black women may not have a higher bone mass than white women.
Luckey further concluded that the higher bone mass found in young black women may contribute significantly to the higher bone mass of older black women.

Cohn et al. (1977), unlike other researchers, did not use measurements of an individual’s bone through radiography. Total bone mass was presented in the form of total body calcium (TBCa) which was measured using total body neutron activation analysis (TBNAA). The study was performed in order to determine whether the formulation for predicting TBCa’s in white women could be applied equally to black women. The population included black women (N = 26) ages 30-79 years and the data pertaining to the white subjects were taken from a previous study performed by Cohn et al. (1976). Subjects were separated into five subgroups (SG) according to age. The groups were: SG1 (30-39 years), SG2 (40-49 years), SG3 (50-59 years), SG4 (60-69 years), and SG5 (70-79 years). Cohn et al. (1977) found that TBCa levels declined with age in both black and white women. Black women in SG1 (985 ± 8.7 g) had significantly higher TBCa than those in SG5 (737 ± 14.7 g). Black women exhibited higher values for body weight in SG4 (B: 67.4 ± 16.4 kg; W: 63.1 ± 14.9 kg) and SG5 (B: 70.8 ± 16.5 kg; W: 57.9 ± 8.0 kg) than white women. Black women also showed higher values in TBCa for SG4 (B: 854 ± 10 g; W: 701 ± 12.2 g) and SG5 (B: 737 ± 14.7 g; W: 634 ± 15.9 g) than their white counterparts. When matched for age and body size (lean mass and height), black women still showed significantly higher mean ratios in TBCa (p = 0.01) and BMC (p = 0.01) than white women. Cohn et al. (1977) concluded that the formula for predicting TBCa for white women could be equally applied to black women. However, black women were reported as having greater skeletal mass and BMC.
following the adjustments in body weight, age, and height than aged matched white women.

Luckey, Wallenstein, Lapinski, and Meier (1996) performed a longitudinal study assessing the possibility of ethnic differences in bone loss in the radial and lumbar region using pre and postmenopausal women. Bone densitometry measurements were taken at baseline and every 6 months for three to four years. Bone mineral content was measured at the radius by the I-photon absorptiometric technique using the SP2 radial scanner. Lumbar BMD was measured by dual photon absorptiometry using a DP3 lunar radiation corporation. The subjects included 243 pre and postmenopausal women. The premenopause group contained both black (n = 65) and white (n = 63) participants. Weight was significantly higher ($p = 0.003$) in the black subjects ($62.2 \pm 6.4$ kg) than white subjects ($59.4 \pm 7.3$ kg). The mean radial BMC (B: $0.747 \pm 0.053$ g/cm; W: $0.700 \pm 0.052$ g/cm; $p < 0.0001$) and lumbar BMD at baseline (B: $1.236 \pm 0.119$ g/cm$^2$; W: $1.159 \pm 0.116$ g/cm$^2$; $p < 0.0005$) were significantly higher in the black subjects than their premenopausal white counterparts. The postmenopausal group, which contained black (n = 24) and white (n = 19) women, was separated into two groups early and late menopause. Early postmenopausal black women ($61.5 \pm 7.5$ kg) were reported as having significantly higher ($p \leq 0.001$) body weight than early postmenopausal white women ($60.4 \pm 5.3$ kg). Researchers found that when early postmenopause groups were analyzed lumbar bone loss was slower in the black women (-1.3%/year) than in white women (-2.2%/year), but the difference was not statistically significant ($p = 0.27$). Lumbar bone loss was similar for the late postmenopause and premenopause groups and did not differ
by ethnicity. It was concluded that premenopausal bone loss in both black and white women was minimal, but at the onset of postmenopause, radial and vertebral bone loss accelerated. Bone loss at the radius was twice as fast in white than black women and vertebral bone loss was similar. Luckey concluded that the changes in BMD in aging individuals whether black or white will decline. The only difference lies in the degree of change at which BMD will decline in these aging individuals, which could be affected by other changes that occur with aging.

**Age-related Declines in Balance**

Konrad et al. (1999) reported that balance includes the entire organism and its interaction to the environment. An organism uses its sensory organs to carry information to the nervous system, where information is integrated to initiate a coordinated response. The coordinated response is further transmitted to the musculoskeletal system to produce movement. As individuals age, the ability to produce static and dynamic movements using the musculoskeletal system is affected (Konrad et al., 1999). Individuals who are prone to diseases may experience even greater alterations in balance, skeletal integrity of muscle strength, and loss in flexibility.

Balance is maintained when an imaginary line passes vertically through the body’s center of gravity and falls within the base of support (Hall & Messier, 1993). The base of support is usually the area of the body that comes in contact with the ground, usually the feet. Static and dynamic balance must be maintained in order to prevent a fall from occurring. Measurements of static balance usually occur while in the sitting or standing phase. Static balance involves incorporating active and passive movement with
altered sensory cues, for example; eyes open and eyes closed, changes in proprioceptive surface, and sharpening stance (Konrad et al., 1999). Dynamic balance is an essential component of successful locomotion that ensures steady movement in every daily task (Alexander, 1994; Tang et al., 1998). Dynamic balance includes standing, rising from a chair, and walking (Konrad et al., 1999). Difficulty performing these daily tasks reflects difficulty in postural control (Alexander, 1994). Thus, having the ability to carry out these daily tasks and respond automatically to external disturbances represents the type of balance control required for daily life.

One of the primary contributors to loss of balance and falls is a decline in muscle mass, especially in older adults where a larger decline in strength occurs with aging (Heinonen et al., 1996). Strength decrements in the ankle, knee, and extensor muscles are associated with declines in performance speed and power associated with walking, climbing stairs, and rising from a chair (Alexander, 1994; Judge, Lindsey, Underwood, & Winsemalus, 1993). Wolfson, Judge, Whipple, and King (1995) studied the effects of lower extremity strength as well as gait and balance in the occurrence of falls in nursing home residents. Their study was based on the hypothesis that lower extremity strength is a fundamental component of the sensorimotor function, which supports mobility and mobility-related activities in preventing falls. The subject population included 17 fallers (F) with an average age of 82 years and 17 nonfallers (NF) average age of 85 years. Strength (peak torque for the knee and ankle) was measured using the Cybex II Isokinetic Dynamometer at velocities of 60°·s⁻¹ and 120°·s⁻¹. Balance was measured using the Postural Stress Test (PST). The relationship of balance to strength was measured using
the Sensory Organization Test on the Equitest Balance Platform. Higher muscle forces were seen in the non-fallers and lower forces were seen in the fallers at 60°·s⁻¹ when performing knee flexion (NF: 31.3 ± 12.2 Nm; F: 15.0 ± 6.7 Nm) and knee extension (NF: 44.9 ± 11.9 Nm; F: 25.8 ± 11.9 Nm). The non-fallers also showed higher values at 120°·s⁻¹ when performing knee flexion (NF: 25.0 ± 11.0 Nm; F: 12.4 ± 5.8 Nm) and knee extension (NF: 31.5 ± 7.9 Nm; F: 19.3 ± 8.6 Nm). Most of the subjects, principally fallers, showed poor muscle synergies in association with inability to effectively use backwards stepping (dynamic balance), thus resulting in a fall. Wolfson concluded that the quantitative nature of the relationship between strength and balance are yet to be determined, suggesting that strength may have a threshold to perform basic motor functions under which balance is compromised. Many of the subjects in this study, who had very poor strength, gait, balance, and recurrent falls, were beneath the strength threshold that was sufficient enough to maintain balance.

Other researchers opposed the findings that support muscle mass as one of the sole contributors to loss of balance. Gehlsen and Whaley (1990b) determined balance, strength, and flexibility by performing a comparison study using 55 men (n = 19) and women (n = 36) subjects with a mean age of (71.3 ± 4.4 yrs). The subjects were split into two groups those with a history of falls (HF; n = 25) and those with no history of falls (NHF; n = 30). Both static and dynamic balance measurements were assessed. Static balance was determined by having a subject stand on one foot with eyes opened and eyes closed. Static balance was scored using the number of seconds a subject maintained a balanced position. Dynamic balance was determined by having the subject
walk backwards on a solid 8-foot line. Dynamic balance was determined by the number of times a subject stepped off the line with his or her foot. Muscular strength was assessed using concentric contractions of the leg musculature at the hip, knee, and ankle joints using the Cybex™ leg press isokinetic dynamometer. A Zimmer goniometer™ was used to determine joint range of motion. The results showed significant differences between individuals with NHF and those with HF, in the areas of standing on one leg with eyes open (NHF: 18.7 ± 10.1 s; HF: 10.9 ± 5.6 s; p < 0.001) and standing on one leg with eyes closed (NHF: 5.2 ± 2.7 s; HF: 3.6 ± 2.9 s; p < 0.05). There was no significant difference found in the backward walking test for those with HF (1.5 ± 1.5 # of times foot came off line) and those with NHF (1.3 ± 1.7 # of times foot came off line). Muscle strength data recorded for women who had NHF (88.5 ± 31.6 kg-m) were higher than women with HF (69.7 ± 26.7 kg-m), but not statistically significant. There was a statistically significant difference in leg strength between the two genders. Gehlsen concluded that there was a low relationship (r = .19) between strength and balance. Therefore, the lack of strength was not the cause of a person losing his or her balance and falling. However, static balance, as measured by one-leg stance may be a better factor in distinguishing elderly fallers from non-fallers.

Although static balance is important, Lord, Ward, and Williams (1996) stated that it is the normal day to day activities of dynamic balance, such as walking that put many older people at a greater risk for falling. Age-related changes in dynamic balance are markers for poor balance (Judge et al., 1993). Dynamic balance is an important
component of locomotion that requires the support of several lower extremity muscle groups (Judge et al., 1993).

Tang et al. (1998) tested the hypothesis that proximal (trunk and hip) muscles like the distal (thigh and leg) muscles contribute to balance recovery from an unexpected simulated forward slip while walking. The subject population included female (n = 21) and male (n = 12) healthy young adults. Subjects were put through a simulation of slips using a custom built platform system. Translational movements of the right plate of 10 cm occurred at a constant velocity of 40 cm/s. The subject’s gait was perturbed stimulating a forward slip as the right foot came in contact with the plate. Fifteen bipolar surface EMG electrodes were used to investigate the activity of the tibialis anterior (TA), medial head of the gastrocnemius (MG), rectus femoris (RF), biceps femoris (BF), rectus abdominis (AB), erector spinae (ES), and both sides of the gluteus maximus. Kinematic data were obtained from the right side of the body using the Peak Performance 3-D Analysis System. Muscles that responded to the perturbation more consistently, with shorter onset latency, longer burst duration, and greater burst magnitude, were considered to contribute to balance recovery more significantly than others. Tang reported that the analytical sequence of muscle activation in 57% of the total trials showed postural activity from both distal and proximal muscles on the perturbed side. The data revealed that the leg and thigh muscles (TA, RF, and BF) showed greater occurrence rates than the proximal muscles. Tibialis anterior for both groups had the highest occurrence rates (100% and 94%), followed by RF (96% and 89%), and then BF (87% and 84%). All the other muscles showed occurrence rates of 68% or lower. The proximal muscles,
however, did not demonstrate a consistent activation of early onset latency, longer burst duration, or larger burst magnitude than distal muscles. Tang reported that proximal postural activation was often present in the first slip trial, but seemed to adapt in later trials. It was concluded that postural activity from bilateral anterior leg and thigh muscles and coordination between the two lower extremities were the key to reactive dynamic balance control and were sufficient for regaining balance. The role that lower extremity muscles take on when assessing dynamic balance is critical. The findings of Tang and many other studies uphold the fact that physiological declines in muscle mass affect balance in white men and women. Due to the lack of data on balance and muscle mass using black men and women, it is impossible to support or apply these findings across ethnic groups.

There are more specific tests for dynamic balance testing that can assess some of the physiological changes that occur with aging. Hageman, Leibowitz, and Blanke (1995) used the Balance Master’s Limits of Stability Test in order to study the age-related changes in balance and the risks of falls in older adults. The subject population included (N = 48) elderly men (n = 12), elderly women (n = 12), and young adults (n = 24). The mean age for the older adults (O) was 65 ± 4 years and the mean age for the young adults (Y) was 25 ± 4 years. The results for the LOS test were statistically significant for movement time (p = 0.001) to eight targets. When the older adults were compared to the younger adults, it was noted that older adults moved slower to the eight targets (O: 32.6 ± 5.9 s; Y: 21.9 ± 4.6 s). Hageman concluded that the longer response time for the LOS test in older adults could be attributed to the subject’s motivation level or the ability to
follow the instructions given. The slower movements in the older adults could have also been a result of being instructed to lean from the ankle joint to the eight targets without leaning from the hip joint. Hageman further concluded that implementing a new movement technique could have been difficult for the participants to adapt to.

Wolfson, Whipple, Derby, Amerman, and Nasher (1994) used the Equitest dynamic posturography platform to perform the motor coordination test (MCT). Two hundred and thirty-four healthy elderly men (n = 113) and elderly women (n = 121), average age 76 ± 5 years were recruited. The subjects were introduced to external disturbances of different amplitudes (small, medium, large) by the platform. Automatic motor reaction for the anterior and posterior translations was measured for the following variables: equilibrium quotient (EQ), balance strategy score (BSS), loss of balance (LOB), latency (RT), and angular movement (AM). Wolfson et al. (1994) reported that men had a longer RT for the large amplitude movement during both the forward (M: 157 ± 19 msec; W: 152 ± 13 msec) and backward (M: 161 ± 16 msec; W: 155 ± 17 msec) translations. Angular movement was also higher in men for the large amplitude forward translations (M: 9.9 ± 1.8 deg/sec; W: 9.1 ± 1.8 deg/sec). It was concluded that the differences in RT was the result of men having a greater height than women. The differences in AM were reportedly caused by the quicker response in generating the forces needed to counteract the backward sway momentum in the male subjects. The larger sway found for the women subjects for the large forward translation implies a deficit in the forces needed to counteract the backward movements. Alexander (1994) reported that the fast translations in both forward and backward directions require fast
postural responses, which seem to decline with age, resulting in larger sway, loss of balance, and in most cases a fall.

Movements from the sitting to standing position and vice versa are the most common and functional activities associated with declines in dynamic balance. It takes elderly individuals a longer time when changing positions from the sitting to standing phase (Alexander, 1994). In order to measure sit to stand and its correlation with falling, Cheng et al. (1998) recruited a group of stroke patients both fallers (F) and non-fallers (NF) and compared them to healthy elderly adults (H). Thirty-three stroke patients (mean age F: 63 ± 6 yrs; NF: 63 ± 6 yrs) and 25 healthy subjects (mean age 63 ± 8 yrs) participated. Researchers used the AMTI force-plate to measure peak vital force (PF) as a percentage of total body weight (%BW). The rate of rise in force (dF/dT), represented by peak power, was calculated during the rising movement from a chair. Center of pressure (COP) sway for the whole body during rising and sitting was also assessed. Subjects were seated in an armless and backless chair, adjusted to each subject’s knee height. There were no significant differences recorded between the groups for weight (F: 62.8 ± 10.7 kg; NF: 62.6 ± 9.1 kg; H: 57.8 ± 8.0 kg) and height (F: 160.5 ± 6.1 cm; NF: 156.7 ± 7.5 cm; H: 156.3 ± 6.8 cm). When the participants were commanded to stand from a seated position, it took both groups of stroke patients (F: 4.3 ± 2.2 s; NF: 2.7 ± 1.2 s) a significantly longer time to stand than healthy subjects (1.8 ± 4.8 s). A significant difference in the rate of peak power was also noted for the stroke patients (F: 52.9 ± 18.4 %BW; HF: 41.9 ± 20.9 %BW) compared to the healthy subjects (17.4 ± 5.9 %BW). The differences assessed between the two populations for peak power was associated with the
differences in COP (p = 0.05). An increased COP sway among the stroke patients (F: 21.1 ± 10 cm; NF: 12.1 ± 6cm) indicates poor balance control in comparison to healthy subjects (H: 7 ± 3.2cm). Cheng concluded that stroke patients required a longer time to complete the task of rising from a chair to better stabilize their COP sway. Cheng also suggested that peak power may have been related to muscle strength and the ability to walk. Suggesting that the amount of force generated while rising determines the amount of sway assessed. Cheng further concluded that the dynamics of movement during the sit-to-stand test are influenced by age, initial body position, and chair height. A third of the changes that occur in balance control, are usually age-related and occur during rising or sitting phase.

Dynamic balance measures in elderly populations have been made using a variety of alternate methods and systems. It is very important to use valid and reliable equipment when assessing balance in older adults. The NeuroCom Balance Master version 6.1 was selected for this study because it was readily accessible and showed criterion validity and test-retest reliability for healthy older adults (Clark, Rose, & Fujimoto, 1997; NeuroCom, Inc., 1999). According to NeuroCom, Inc. (1999) the Balance Master provides continuous feedback of COG in relation to LOS movements in various directions, measures the ability to shift COG laterally and anteroposteriorly (AP), assesses autonomic motor responses, and measures functionally ability to rise from a seated position. NeuroCom, Inc. (1999) comprised normative data using 28 subjects between the ages 60-79 years. The normative data for the LOS, rhythmic weight shift, and motor
control tests were set to provide guidelines to assist in identifying a patient’s functional
deficiencies in relationship to their performance capabilities (NeuroCom, Inc.).

Although various balance systems are used for assessment in the clinical setting
for elderly white patients, very little research has been published that identifies balance
measures for elderly black women. Therefore, the purpose of the present study is to
compare black and white women on the physiological measurements of muscle mass,
BMD, and dynamic balance.
CHAPTER 3
RESEARCH METHODOLOGY

Each year in the U.S., one out of every three people 65 years and older will suffer a fall (Province et al., 1995). One of the major contributors to falls is the decrease in muscle mass with age. Decreases in muscle mass have been shown to cause a decline in balance and BMD (Cohn et al., 1977; Wolfson et al., 1995). The degree of these declines, varies among ethnic populations. The purpose of this study is to compare black and white women on the physiological measures of muscle mass, BMD, and balance.

Subjects

A sample of 75 subjects, 19 black women and 56 white women was recruited from churches and senior groups around the Tri-Cities area to participate in this study. Recruitment was also done through television and newspaper advertisement. Subjects were between the ages of 59-91 years. Participants were informed of the testing dates and times.

All volunteers were asked to complete demographic, medical history, and physical activity questionnaires. Individuals were excluded from the study if they demonstrated or reported any intolerance to exercise, or functional disabilities that were contraindicated to maximal strength testing. All subjects were informed of the expectations, inherent risks, and hazards involved in the study and asked to sign a consent form approved by the East Tennessee State University Institutional Review Board (Appendix A).
Protocols

Participants followed standardized testing guidelines and were encouraged to complete all facets of the assessment process. Testing was completed over a 4-week period. The testing sequence was comprised of the following (a) Day 1: orientation and completing questionnaires; (b) Day 2: Dual energy x-ray absorptiometry (DEXA), height, and weight; (c) Days 3 & 4: maximal isotonic strength testing for the upper and lower body, isometric handgrip strength, and waist-to-hip circumferences; and (d) Day 5: dynamic balance assessment.

Anthropometric Measurements and Body Composition

Standing Height

Stature was measured against a fixed ruler. The subjects were instructed to remove their shoes (barefoot or wearing thin socks). Subjects stood erect with their heels, buttocks, and upper back in contact with the vertical upright. The chin of the subject was level and not lifted, and the weight of the subject was evenly distributed between legs. A vertical board was used to contact the most superior point of the head with height being measured.

Body Weight

Body weight was determined while the individual stood erect on a NITA digital scale. Light clothing was worn, excluding shoes. The scale was properly calibrated before participant arrived for testing. Subjects were to stand over the center of the platform, with their body weights evenly distributed between both feet.
Waist-to-Hip Circumference

The waist circumference was measured in a horizontal plane at the narrowest portion of the torso (usually 2 to 3 inches above the umbilicus) (Gettman, 1993). Hip circumference was measured in a horizontal plane at the level projection of the greater trochanters, which usually coincides with the greater protrusion of the gluteal muscles. If the two areas did not coincide, measurements were taken at the largest circumference around the buttocks.

Dual Energy X-ray Absorptiometry (DEXA)

The Hologic™ Dual Energy X-ray Absorptiometry was used to determine bone density (g/cm²). Subjects were placed in a supine position where the total body (TBMD) was scanned from head to toe, while the attenuation of the x-ray through the various body components were calculated. Bone mineral density for the Femur (FBMD) and lumbar (LBMD) were also calculated. The x-ray was measured with an energy discriminating detector that produces transverse scans of the entire body at 1-cm intervals. All technicians were trained in the operation, positioning of the subjects, and data management. Dual energy x-ray absorptiometry was assessed at the Johnson City Medical Center-Center for Applied Reproductive Science.

Handgrip Strength

Isometric handgrip strength (HG) was measured using the Lafayette Hand Dynamometer Model 78010 (Lafayette, IN). Handgrip strength was assessed while subjects stood in a vertical position with feet shoulder width apart. The wrist was in a neutral position with the arm held 3-4 inches away from the body. Subjects were
reminded to keep a slight bend in their knees (Rantanen, 1998). Each subject was instructed to breath deeply and then exhale while squeezing the dynamometer. During the testing subjects were strongly encouraged to use the greatest possible force. The highest of three trials on the left and right hands were recorded. The highest value for each hand was summed for the criterion measure. Results were recorded in kilograms.

**1-RM Strength Measure**

Muscle strength was measured using the one-repetition maximum (1 RM) test on the Cybex™ for the upper body (using a chest press machine) and lower body (using a leg extension machine). The testing protocol began with subjects using low weights that could easily and safely be lifted. The subjects slowly extended their arms or legs, and then slowly returned the weights to the starting position. Weights were gradually added until the subject could not complete one more repetition. Subjects were encouraged throughout the testing to perform purse-lip breathing with each lift. Breath holding by the subject or performing the valsalva maneuver was discouraged. A 1-minute rest interval was provided between repetitions. Subjects returned a second day for testing to verify the previous measurements recorded. This was done to eliminate any learning effect. The 1 RM was performed and assessed at the Johnson City Medical Center-Wellness Center.

**Balance Assessment**

The NeuroCom, Balance Master (Clackamas, OR.) was used for balance assessment. The Smart Balance Dynamic Test was the program used to measure balance. The dynamic balance program consisted of four different tests. The first test included the
Limits of Stability Tests (LOS), in which reaction time (RT), movement velocity (MVL), end point excursion (EPE), maximum excursion (MXE), and directional control (DCL) were recorded. The second assessment involved rhythmic weight shift (RWS) that allows the technician to record on-axis velocity and directional control for lateral and anteroposterior shifts. The third test assessed motor control (MCT), in which weight symmetry, latency, amplitude scaling, and strength symmetry were recorded. The final test involved the sit to stand (SS) functional test, where weight transfer, rising index, and sway velocity were measured. All tests were performed on the right and left leg. To prepare subjects for testing the following steps were taken (a) the appropriate harness size was selected (S, M, L) and placed on the subject, (b) shoes were removed, (c) subjects were strapped in the balance system, and (d) feet were properly placed on the platform. Two feet positions were required. First, the medial malleolus was placed over the horizontal line. Then, the ball of the foot was placed on the specified area depending on the subject’s height (44-55 inches = S line, 56-65 inches = M line, and > 65 inches = T line). A trained technician explained the purpose of the testing and gave verbal instructions of what would happen during the testing. The testing was discontinued if any of the following conditions occurred: (a) the subject asked to stop the test, (b) the subject fell, or if (c) the subject touched the wall to keep her balance. Testing took place at the Veteran’s Administration main hospital in the Vestibular Laboratory.

Limits of Stability Test

Subjects were placed on a platform in front of a small computer screen where the subject’s center of gravity (COG) and eight targets appeared. A cursor reflecting the
positioning of the COG was used to provide visual feedback to the subject. The subject controlled the cursor by shifting her weight. Verbal instructions and practice time was allotted to each subject. Subjects were aligned in a center target and instructed to move quickly and accurately to the next target, leaning from the ankles, when the command was given. The computer allowed eight seconds for each of the target trials. The eight trials were conducted in the following order: forward, forward-right, right, backward-right, backward, backward-left, left, and forward-left. All trials were assessed and scored.

**Rhythmic Weight Shift Test**

To perform this test subjects were asked to shift their weights laterally (left-to-right) or anteroposteriorly (front-to-back) on the platform. Subjects were instructed to follow the on screen cue (yellow sun) that moved between two end points (displayed as red lines). The cue moved at three speeds (slow, medium, and fast) corresponding to each directional condition. Verbal instructions and practice time were given to each participant. Transition times for the cue speeds were; slow- 3 seconds, medium- 2 seconds, and fast- 1 second. All trials were assessed and scored.

**Motor Control Test**

Participants were properly placed on the platform and instructed that a sequence of translations (small, medium, and large) would occur in both the forward and backward directions. Subjects were informed to stand as steady as possible with their arms at their side. The translations lasted less than one second. The technician remained directly
behind each participant to prevent a fall during these translations. All trials were assessed and recorded.

Sit to Stand Test

The subjects were seated on a wood box or chair placed on a platform. Two box sizes (high and low) and a chair with handles was used for this test. Subjects were instructed to sit relaxed with both feet touching the platform. Proper positioning for the feet required that the two big toes were aligned with each other. Subjects were instructed to sit steady until the GO signal or green box appeared at the top of the screen. Subjects then stood up quickly without using assistance and were asked to hold steady. Each assessment consisted of three trials of the same condition.

Statistical Analysis

The basis of this study was to compare black and white elderly women and the degree of variation in muscle mass, BMD, and balance. Means and standard deviations were calculated for the following dependent variables: (a) body composition measures of height, weight, BMI, lean mass, fat mass, percent body fat, BMD, and waist-to-hip circumference; (b) muscle strength measures of leg extension (LE), chest press (CP), and HG, and; (c) balance measures from the LOS, RWS, MCT, and SS tests. Independent t-tests were used to evaluate differences between dependent variables for black and white women. Subjects were collapsed into one group in order to compute correlations between the measured variables. Step-wise regression analyses were computed to evaluate if balance could be predicted by any of the dependent measures of strength, body composition, BMD, or physical activity. Data were expressed as means of ± 
standard deviation. All significance was accepted at $p \leq 0.05$, using the Statview Statistical Program.
CHAPTER 4

RESULTS

This research study was completed over a 15-week period of time, and required five visits to our facilities by each participant. The primary question of concern for this research project was to verify if any differences existed between aging black women and white women on the physiological measures of muscle strength, BMD, and dynamic balance.

Subjects

Seventy-five out of 79 women volunteers participated in this research study. Four of the 75 subjects failed to complete the study due to pain from illness, heart attack, or lack of time. Additionally, five of the 75 women were unable to complete the dynamic balance testing due to illness, surgery, or unwillingness to complete the balance testing. Each of the 75 participants was asked to complete a demographic questionnaire where race was documented (Appendix C). Nineteen black women (B) and 56 white women (W) took part in the study. Although only 19 black women participated in this study, this number was a fairly good representation of the entire population of Washington County, which is 92,315. Of this population 88,409 are white and 3,275 are black (Vickers & Cunningham 1999). The black population makes up 3.5% of the entire population of Washington county. In the present study the black women make up 25% of the sample. Therefore, this sample provides us with preliminary data on black and white women who represents the upper east Tennessee region. The subject characteristics for the 75 women volunteers are presented by race in Table 1. There were no statistically significant
differences ($p > .05$) between groups for mean age (B: $72 \pm 5$ yrs; W: $70 \pm 7$ yrs), weight (B: $77.1 \pm 38.2$ kg; W: $72.8 \pm 27.3$ kg), or waist-to-hip circumference (B: $0.831 \pm 0.11$; W: $0.814 \pm 0.08$). The subjects in the present study were slightly older than the subjects used in the studies by Ortiz et al. (1992), Luckey et al. (1996), and Gasperino et al. (1995). Their subjects ranged in mean age from 44 to 58 years. The subjects in the present study had a mean age of $72 \pm 5$ years for the black women and $70 \pm 7$ years for the white women. This age range was similar to the participants in the studies by Rantanen et al. (1998) (B: $77 \pm 8$ yrs; W: $79 \pm 8$ yrs), Cohn et al. (1977) (B: 75 yrs; W: 73 yrs), and Taaffe et al. (2001) (B: $73 \pm 3$ yrs; W: $74 \pm 3$ yrs).

Significance ($p < 0.05$) was found for mean height in the present study. White women were taller than their black counterparts (B: $159 \pm 2$ cm; W: $163 \pm 2$ cm). Body mass index values were also significantly different ($p < 0.05$) between black and white women. The subjects in the present study had high BMI scores that classified them as obese. The BMI values for black and white women were $31 \pm 7$ and $27 \pm 4$, respectively. The difference in BMI values was due to the black women being shorter than the white women. The values for BMI in the present study are similar to those reported by Rantanen et al. (1998) (B 30; W: 28) and Taaffe et al. (2001) (B: $29 \pm 6$; W: $26 \pm 5$). The studies completed on younger black and white women found no differences in height, weight, or BMI values (Ortiz et al., 1992; Luckey et al., 1996; Gasperino et al., 1995).
Table 1: Subject Characteristics of Black and White Women (N = 75).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Black Women (n = 19)</th>
<th>White Women (n = 56)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>72 ± 5</td>
<td>70 ± 7</td>
<td>p = 0.15</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>159 ± 2</td>
<td>163 ± 2*</td>
<td>p = 0.03</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>77.1 ± 38.2</td>
<td>72.8 ± 27.3</td>
<td>p = 0.20</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>31 ± 7</td>
<td>27 ± 4*</td>
<td>p = 0.02</td>
</tr>
<tr>
<td>Waist-to-Hip</td>
<td>0.831 ± 0.11</td>
<td>0.814 ± 0.08</td>
<td>p = 0.50</td>
</tr>
</tbody>
</table>

Values are means ± standard deviations.
* (p ≤ 0.05), significantly different from black women.
BMI - Body Mass Index

Muscle Strength

Muscle strength for the present study was determined using the chest press (CP) 1-RM for upper body, leg extension (LE) 1-RM for lower body, and a hand dynamometer to measure forearm and handgrip (HG) strength (Table 2). There were no statistically significant differences between black and white women for CP. The results measured for upper body muscle strength for black and white women were 29 ± 12 kg and 29 ± 10 kg. The values for this present study could not be compared to previous research because no other studies used the CP 1-RM to measure upper body strength between aging black and white women.
Table 2: Strength Measurements for Black and White Women (N = 75).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Black Women (n = 19)</th>
<th>White Women (n = 56)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest Press (kg)</td>
<td>29 ± 12</td>
<td>29 ± 10</td>
<td>p = 0.74</td>
</tr>
<tr>
<td>Leg Extension (kg)</td>
<td>43 ± 13</td>
<td>47 ± 14</td>
<td>p = 0.40</td>
</tr>
<tr>
<td>Handgrip (kg)</td>
<td>35 ± 14*</td>
<td>29 ± 12</td>
<td>p = 0.05</td>
</tr>
</tbody>
</table>

Values are mean ± standard deviations.  
* p = 0.05, significantly different from white women.

The subjects in the present study also showed no significant differences in lower body strength using the LE 1-RM. White women (47 ± 14 kg) were slightly stronger than black women (43 ± 13 kg) for lower body strength but again these differences were not significant (p > 0.05). The present study was comparable to a study by Rantanen et al. (1998) where lower body strength was measured in black and white women. Rantanen reported that there were no differences in lower body strength between black (13 ± 5 kg) and white women (13 ± 5 kg). However, Taaffe et al. (2001) reported that black women (86 ± 24 Nm) were significantly stronger than white women (79 ± 20 Nm). The reason for this difference in strength was not apparent in the study by Taaffe because black women were not as physically active as white women.

Upper body strength, in the present study, was also assessed, using the hand dynamometer to measure HG and forearm strength. Handgrip strength measures for
black women were (35 ± 14 kg) significantly higher than HG strength measures for white women (29 ± 12 kg). The subjects in the present study were slightly stronger than the subjects used in the studies by Rantanen et al. (1998) and Taaffe et al. (2001). Rantanen reported that HG strength measures for black women and white women were 22 ± 6 kg and 20 ± 5 kg, respectively. Handgrip strength when measured by Taaffe was 26 ± 7 kg for black women and 23 ± 5 kg for white women. Both of these studies found black women to have greater forearm and HG strength than white women. Again the reasons for the differences between black and white women are unknown. One reason that the white women in the present study may have been weaker than the black women for HG strength may have been due to arthritis. Many of the white women complained of stiffness and pain in their hands when completing this test. Only one black woman complained of arthritis pain during the test. Whether there is a racial difference in arthritis between black and white women is unknown. The arthritis pain did not seem to be a problem for the women when performing the CP 1-RM. Therefore, the CP may be a better measurement of upper body strength for this population.

Physical Activity Assessment

Measuring physical activity using the proper assessment tool for the elderly population is important. This present study used the physical activity scale for the elderly (PASE) to analyze the activity level of the participants (Appendix B). The results of this physical activity scale (Figure 2) revealed that white women (129 ± 60) had a higher score for participation in physical activity than black women (80 ± 42). The present study is similar to the study by Taaffe et al. (2001), which found that black women had
the lowest level of physical activity among white women, white men, and black men. This study showed that 81% of black women expended less than 1000 kcal/week through physical activity compared to 72% for white women. The remaining 28% of white women participated in more than 1000 kcal/week of physical activity. Normative means \((89.1 \pm 56)\) were available for the physical activity questionnaire for women 70 years of age and older in the present study. White women in the present study had a physical activity score that was above the normative score and black women had a physical activity score that was below the normative score for healthy adults. In previous studies high levels of physical activity are associated with higher muscle strength. This would suggest that the white women in the present study should be stronger than black women; however, this was not the case. The findings revealed that black women were less active but had similar strength measurements to white women. These results are consistent with previous research and activity levels in black and white elderly adults (Rantanen et al., 1998).

In previous research by Clark (1995) and Young et al. (1998) black women were less likely to participate in physical activity yet they still had a greater muscle mass than white women. Clement (1974) reported that a greater decline in muscle strength was noted when subjects did not participate in physical activity. Rantanen et al. (1998) measured the age-related declines in muscle mass, muscle strength, and physical activity. He also found that black women that were less active had higher strength measurements than white women who were more active. Although black women in the present study participated in less physical activity than white women, black women were not weaker.
Correlations to estimate the relationship between physical activity and muscle strength (CP, LE, HG) were completed after combining both groups of women. This present study found that the relationship between physical activity and CP ($r = .22$) was low and positive. A similar relationship with physical activity was noted for LE ($r = .29$) and HG ($r = .05$). The problem with the physical activity scale used in the present study is that it assesses activity that is more aerobic in nature. Having higher activity levels that are more aerobic in nature does not necessarily preserve or increase strength in the individual. Therefore, the physical activity scale may not accurately reflect strength in these subjects.
Body Composition

This study used the DEXA to assess the body composition measurements of lean mass (LM), fat mass (FM), and percent body fat (%BF) (Table 3). There were no significant differences found in LM ($p = 0.30$), FM ($p = 0.34$), or %BF ($p = 0.56$) between black and white women. Lean mass in this present study was $45 \pm 8$ kg for black women and $43 \pm 6$ kg for white women. The LM data in this present study are in agreement with the study performed by Ortiz et al. (1992) (B: $45 \pm 6$ kg; W: $44 \pm 5$ kg). The subjects from the previous study by Ortiz were younger than the subjects in the present study, but there were still similarities in LM values between the two groups. However, the study by Taaffe et al. (2001) found that black women ($44 \pm 6$ kg) had greater muscle mass than white women ($40 \pm 5$). It was not apparent from this study why black women have a greater muscle mass than white women. The subjects in the present study had higher body fat percentages than some of the previous studies (Ortiz et al., 1992; Gasperino et al., 1995). However, subjects in those studies were younger than the subjects in the present study. This present study found that there were no significant differences between black ($40 \pm 5 \%$) and white women ($39 \pm 6 \%$) for %BF. Like the present study Ortiz (B: $27.9 \%$; W: $28.9 \%$) and Gasperino (B: $37 \pm 8 \%$; W: $37 \pm 7 \%$) did not find differences between black and white women in percent body fat. The subjects used by Taaffe were similar in body fat to those that participated in the present study (B: $38 \pm 6 \%$; W: $37 \pm 6 \%$).

Dual x-ray absorptiometry (DEXA) was also used to assess BMD of the total body (TBMD), lumbar (LBMD), and femur (FBMD) (Table 3). There was a trend for
differences between black and white women for TBMD ($p = 0.07$) and LBMD ($p = 0.08$). There was no difference for FBMD ($p = 0.60$). These trends are similar to what has been seen in other studies comparing black and white women. Gasperino et al. (1995) (B: $1.144 \pm 0.106$ g/cm$^2$; W: $1.038 \pm 0.084$ g/cm$^2$) and Taaffe et al. (2001) (B: $1.046 \pm 0.112$ g/cm$^2$; W: $0.988 \pm 0.105$ g/cm$^2$) found significantly higher TBMD in their black women than in their white women. The values for LBMD in the present study were similar to the study by Luckey et al. (1996). Results from their study showed that black women had a LBMD of $1.030 \pm 0.116$ g/cm$^2$ and white women had a LBMD of $0.982 \pm 0.136$ g/cm$^2$. Participants in this present study were older than the participants in the study by Luckey, yet they had slightly higher LBMD values. The present study showed no differences in the FBMD between black and white women. However, Taaffe found significant differences between black and white women. Most studies show that black women have higher bone densities compared to white women (Gasperino et al., 1995; Luckey et al., 1996; Taaffe et al., 2001). The reason the present study found only trends may be due to the small sample size. However, like the previous literature we do not know why these differences are occurring in BMD between black and white women.
Table 3: Body Composition Measurements for Black and White Women \(^a\) (N = 75).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Black Women (n = 19)</th>
<th>White Women (n = 56)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat Mass (kg)</td>
<td>31 + 10</td>
<td>29 + 8</td>
<td>(p = 0.34)</td>
</tr>
<tr>
<td>Lean Mass (kg)</td>
<td>45 + 8</td>
<td>43 + 6</td>
<td>(p = 0.30)</td>
</tr>
<tr>
<td>% Body Fat</td>
<td>40 + 5</td>
<td>39 + 6</td>
<td>(p = 0.56)</td>
</tr>
<tr>
<td>TBMD (g/cm(^2))</td>
<td>1.133 + 0.154**</td>
<td>1.071 + 0.119</td>
<td>(p = 0.07)</td>
</tr>
<tr>
<td>LBMD (g/cm(^2))</td>
<td>1.048 + 0.199*</td>
<td>0.965 + 0.170</td>
<td>(p = 0.08)</td>
</tr>
<tr>
<td>FBMD (g/cm(^2))</td>
<td>0.865 + 0.184</td>
<td>0.842 + 0.138</td>
<td>(p = 0.60)</td>
</tr>
</tbody>
</table>

\(^a\) All measurements were made using DEXA. Values are means ± standard deviations. TBMD – Total Bone Mineral Density; SBMD – Spinal Bone Mineral Density; FBMD – Femur Bone Mineral Density

\(* p = 0.08\), significantly different from white women.

\(** p = 0.07\), significantly different from white women.

To further investigate TBMD, subjects were placed in one group and correlations were performed to assess the relationship of muscle strength (CP, LE, HG) to TBMD. The present study revealed that CP in relationship to TBMD was \(r = 0.21\), LE in relationship to TBMD was \(r = .13\), and HG in relationship to TBMD was \(r = 0.36\). These results indicate that the relationship between strength and BMD is low. A similar study performed by Taaffe et al. (2001) assessed the relationship of muscle strength (LE, HG) and TBMD. This study found even lower correlations than the present study for TBMD.
and LE (r = 0.20) and TBMD and HG (r = 0.17). These correlations from our study and the study by Taaffe seem to suggest that strength may not contribute to higher BMD.

**Dynamic Balance Testing**

The dynamic balance test assessed neuromuscular qualities that were considered to be essential to normal activities of daily living. Five (2-black and 3-white) out of 75 subjects were unable to complete the testing due to illness, surgery, or unwillingness to complete the study. Dynamic balance was assessed using the limits of stability (LOS), rhythmic weight shift (RWS), motor control (MCT), and sit to stand (SS) tests. The data were then formulated into composite scores and compared to normative data compiled by NeuroCom Inc, for women between the ages of 70-79 years. The findings were compared to normative data because limited studies have been completed using these balance tests for elderly black and white women.

The LOS test required subjects to lean as far as they could towards 8 targets (from the ankle joint) without losing their balance. Subjects from the present study were also instructed to move as quickly as possible when the signal (blue circle) was given. The variables that were measured included: reaction time (RT), movement velocity (MVL), endpoint excursion (EPE), maximum excursion (MXE), and directional control (DCL). For the results depicted in Figures 2-6, a statistical difference between black and white women was found only for reaction time (p ≤ .001). Reaction time was slower for black women (1.802 ± 0.486 s) as compared to the white women (1.292 ± 0.335 s).

When the two populations were compared to the normative means for RT (Figure 2), both groups of women had slower RT than the normative data (1.05 ± 0.37 s).
Statistical trends were seen for the variables MVL (B: 2.005 ± 0.754 deg/sec; W: 2.588 ± 1.020 deg/sec; p = 0.07) and EPE (B: 50 ± 11%; W: 57 ± 12%; p = 0.06), suggesting that white women displayed faster and more accurate movements. There were no significant differences for MXE (Figure 5) or DCL (Figure 6) between black and white women. When both groups were compared to aged matched normative data, this population of participants scored below normal for each variable. The reason our group had poorer performances than those individuals used to create the normative data may have been due to those subjects having unlimited practice time before testing.

There has been little dynamic balance data using elderly black women as participants, making it difficult to assess why black women move slower or are less accurate to their targets than white women. In a previous study by Hageman et al. (1995) young white and older white adults were tested using an older model of the LOS test. They found that response time to the target was much faster for the younger adults (21.9 ± 4.6 s) than the older adults (32.6 ± 5.9 s). Hageman concluded that the slower response time may have been caused by a participant’s motivational level, the ability to follow the directions given, or difficulty adapting to new movements. The same conclusions could be applied to the delayed RT during the LOS test. Observations during the study suggest that some of the black women naturally moved slower while walking and performing many of the other tasks. These differences in movement may be cultural. More research is needed in this area.
Figure 2. Limits of Stability Measurements for Reaction Time in Black ($n = 17$) and White ($n = 53$) Elderly Women. $\star p \leq 0.05$ significantly different from black women.

Figure 3. Limits of Stability Measurements for Movement Velocity in Black ($n = 17$) and White ($n = 53$) Elderly Women. $\star\star p = 0.07$ significantly different from black women.
Figure 4. Limits of Stability Measurements for Endpoint Excursion in Black (n = 17) and White (n = 53) Elderly Women. \( \star \star \star \) \( p = 0.06 \) significantly different from black women.

Figure 5. Limits of stability measurements for maximal excursion in black (n = 17) and white (n = 53) elderly women.
Figure 6. Limits of Stability Measurements for Directional Control in Black (n = 17) and White (n = 53) Elderly Women.

The dynamic balance rhythmic weight shift test (Table 4) was used to measure the ability to shift weight in the lateral direction (LAT) and anteroposterior (AP) directions. The variables measured for this test were on axis velocity (OAV) and directional control (DC) at three speeds. Significance \((p < 0.05)\) was found in (OAV) between the two populations for slow lateral shifts (B: 2.77 ± 0.61 deg/sec; W: 3.09 ± 0.55 deg/sec) and trends were recorded for the lateral OAV for the medium \((p = 0.07)\) shift. No significance was found in OAV for the fast lateral shift. No differences were found for OAV in AP shifts at any speed. This indicates that during the LAT shifts black women were able to match the pacing better than white women at the slow and medium speeds, while whites paced themselves better at the fast speeds. For DC no significant differences were found in the AP or LAT directions for any speed, though, a trend for a
difference was observed during the fast AP shift. This indicates that the control of shift did not differ between black and white women.

The dynamic balance motor control test was used to assess the autonomic motor response for three translations (small, medium, and large). The variables measured were weight symmetry, latency, amplitude scaling, and strength symmetry for forward and backward translations. The results for the motor control test can be found in Table 5. The motor control test revealed that there were no significant differences between groups for weight symmetry, latency (ms), and strength symmetry. Amplitude scaling for the large forward translations on both the left (B: 3.8 ± 1.7 H; W: 5.0 ± 1.3 H) and right legs (B: 3.5 ± 1.4 H; W: 4.2 ± 1.1 H) were significantly different between the two groups. The remaining measurements for amplitude scaling were not significantly different between black and white women. A study conducted by Wolfson et al. (1994) using the MCT test gave an interpretation of similar movements used during the present study. In this study an elderly group of men and women were put through simulated trials of external disturbances and the participants were instructed to hold steady without falling. The forces generated by the men, to prevent large sway movements or loss of balance were recorded. Researchers reported that the greater the forces generated during the movements, the less sway was recorded. The present study showed that white women were able to generate a greater force for the right and left legs than black women, during the large forward translations. Reasons could not be determined for this difference in force between black and white women especially since there were no significant differences in muscle strength.
Table 4: Rhythmic Weight Shift Test for Black and White Women (N = 70).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Black</th>
<th>White</th>
<th>Significance</th>
<th>Normals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n=17)</td>
<td>(n = 53)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LAT-OAV-S (deg/sec)</td>
<td>2.77 ± 0.61</td>
<td>3.10 ± 0.56*</td>
<td>p = 0.05</td>
<td>1.6 ± 0.2</td>
</tr>
<tr>
<td>LAT-OAV-M (deg/sec)</td>
<td>4.14 ± 0.65</td>
<td>4.64 ± 1.04**</td>
<td>p = 0.07</td>
<td>2.4 ± 0.3</td>
</tr>
<tr>
<td>LAT-OAV-F (deg/sec)</td>
<td>6.68 ± 1.99</td>
<td>7.73 ± 2.72</td>
<td>p = 0.15</td>
<td>4.4 ± 0.9</td>
</tr>
<tr>
<td>LAT-DC-S (%)</td>
<td>76.41 ± 8.28</td>
<td>76.00 ± 8.32</td>
<td>p = 0.90</td>
<td>73.9 ± 10.3</td>
</tr>
<tr>
<td>LAT-DC-M (%)</td>
<td>82.65 ± 4.95</td>
<td>82.11 ± 7.92</td>
<td>p = 0.80</td>
<td>78.8 ± 8.0</td>
</tr>
<tr>
<td>LAT-DC-F (%)</td>
<td>85.65 ± 4.34</td>
<td>85.02 ± 7.92</td>
<td>p = 0.76</td>
<td>84.0 ± 6.6</td>
</tr>
<tr>
<td>AP-OAV-S (deg/sec)</td>
<td>1.99 ± 0.74</td>
<td>1.90 ± 0.47</td>
<td>p = 0.55</td>
<td>2.6 ± 0.3</td>
</tr>
<tr>
<td>AP-OAV-M (deg/sec)</td>
<td>2.51 ± 0.85</td>
<td>2.60 ± 0.62</td>
<td>p = 0.78</td>
<td>3.8 ± 1.0</td>
</tr>
<tr>
<td>AP-OAV-F (deg/sec)</td>
<td>3.13 ± 1.43</td>
<td>4.44 ± 3.23</td>
<td>p = 0.11</td>
<td>6.8 ± 1.3</td>
</tr>
<tr>
<td>AP-DC-S (%)</td>
<td>62.35 ± 20.84</td>
<td>66.46 ± 17.60</td>
<td>p = 0.48</td>
<td>80.6 ± 6.5</td>
</tr>
<tr>
<td>AP-DC-M (%)</td>
<td>68.35 ± 20.89</td>
<td>72.4 ± 17.20</td>
<td>p = 0.43</td>
<td>84.2 ± 7.7</td>
</tr>
<tr>
<td>AP-DC-F (%)</td>
<td>66.71 ± 21.32</td>
<td>75.24 ± 15.2**</td>
<td>p = 0.07</td>
<td>87.5 ± 6.9</td>
</tr>
</tbody>
</table>

Values are means ± standard deviations.  
LAT-Lateral, OAV-On Axis Velocity, DC-Directional Control, and AP-Anteroposterior Direction, S-Slow, M-Medium, F-Fast.  
* p = 0.05, significantly different from black women.  
** p = 0.07, significantly different from black women.  

The results reported for black women during the MCT appeared contradictory to the increased RT reported during the LOS test. However, the LOS test is a measure of volitional control whereas the MCT assesses automatic postural responses. As Hageman et al. (1995) suggested, the slower volitional responses by black women may have been due to differences in motivation rather than physiological capabilities. The similar responses of black and white women for the balance tests lend further support to this point.
Table 5: Motor Control Test for Black and White Women (N = 70).

<table>
<thead>
<tr>
<th></th>
<th>Weight</th>
<th>Latency Left (ms)</th>
<th>Latency Right (ms)</th>
<th>Amplitude Scaling Left (H)</th>
<th>Amplitude Scaling Right (H)</th>
<th>Strength Symmetry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n = 17)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SB</td>
<td>97.9 ± 10</td>
<td>146.5 ± 42</td>
<td>143 ± 41</td>
<td>2.2 ± 1.5</td>
<td>1.8 ± 1.2</td>
<td>86.3 ± 26.9</td>
</tr>
<tr>
<td>MB</td>
<td>97.2 ± 10</td>
<td>147.6 ± 21</td>
<td>138 ± 41</td>
<td>4.3 ± 2.5</td>
<td>3.4 ± 1.5</td>
<td>92.5 ± 25.3</td>
</tr>
<tr>
<td>LB</td>
<td>97.4 ± 10</td>
<td>135 ± 19</td>
<td>134 ± 20</td>
<td>5.2 ± 2.5</td>
<td>4.4 ± 2.0</td>
<td>92 ± 21.1</td>
</tr>
<tr>
<td>SF</td>
<td>96.8 ± 11</td>
<td>124.1 ± 50</td>
<td>136 ± 41</td>
<td>2.2 ± 1.4</td>
<td>2.1 ± 1.2</td>
<td>106 ± 40.2</td>
</tr>
<tr>
<td>MF</td>
<td>97.4 ± 13</td>
<td>137.1 ± 17</td>
<td>136 ± 19</td>
<td>3.4 ± 1.5</td>
<td>3.1 ± 1.4</td>
<td>95.2 ± 24</td>
</tr>
<tr>
<td>LF</td>
<td>97.9 ± 10</td>
<td>127 ± 39</td>
<td>119 ± 52</td>
<td>3.8 ± 1.7</td>
<td>3.5 ± 1.4</td>
<td>95.1 ± 23</td>
</tr>
<tr>
<td>White</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n = 53)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SB</td>
<td>98.4 ± 10</td>
<td>150.4 ± 27</td>
<td>149 ± 33</td>
<td>1.8 ± 1.2</td>
<td>1.6 ± 1.0</td>
<td>93.3 ± 34</td>
</tr>
<tr>
<td>MB</td>
<td>98.6 ± 10</td>
<td>145.4 ± 11</td>
<td>146 ± 11</td>
<td>3.8 ± 2.0</td>
<td>3.3 ± 1.6</td>
<td>94 ± 20.1</td>
</tr>
<tr>
<td>LB</td>
<td>99 ± 12</td>
<td>135.2 ± 17</td>
<td>130 ± 38</td>
<td>5.0 ± 2.0</td>
<td>4.7 ± 2.0</td>
<td>96.4 ± 17.1</td>
</tr>
<tr>
<td>SF</td>
<td>98 ± 10</td>
<td>129 ± 39</td>
<td>134 ± 37</td>
<td>2.1 ± 1.3</td>
<td>2.0 ± 1.1</td>
<td>99 ± 24</td>
</tr>
<tr>
<td>MF</td>
<td>98.2 ± 10</td>
<td>135 ± 13</td>
<td>137 ± 12</td>
<td>3.8 ± 1.3</td>
<td>3.6 ± 1.3</td>
<td>96.8 ± 12.4</td>
</tr>
<tr>
<td>LF</td>
<td>97.4 ± 11</td>
<td>126 ± 28</td>
<td>122 ± 32</td>
<td>5.0 ± 1.3 *</td>
<td>4.2 ± 1.1 *</td>
<td>95 ± 10</td>
</tr>
</tbody>
</table>

Values are means ± standard deviations.
SB-Small Backward Translation, MB-Medium Backward Translation, LB-Large Backward Translation, SF-Small Forward Translation, MF-Medium Forward Translation, and LF-Large Forward Translation.
* p < 0.05, significantly different from black women.

The dynamic balance sit to stand is a functional test (Table 6) assessing the ability to rise from a seated position and move the center of gravity over the feet in an upward motion. The reported findings included the averages of three trials performed by each subject with a high box, low box, and chair with handles. No statistically significant
differences were observed for any of the following variables: weight transfer (s), rising
index (% weight), and sway velocity (deg/sec).

In conclusion there were no differences between black and white women in the
balance testing except for the limits of stability RT, rhythmic weight shift LAT-OAV
small, AP-DC large, and motor control test of amplitude scaling for large forward
translations. Whether these differences in the LOS, RWS, and MCT tests will influence
falls in this group is unknown. More research is needed in values that are important for
dynamic balance.
Table 6: Sit to Stand Test for Black and White women (N = 70).

<table>
<thead>
<tr>
<th></th>
<th>Weight Transfer (s)</th>
<th>Rising Index (% weight)</th>
<th>Sway Velocity (deg/sec)</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black (n = 17)</td>
<td>0.425 ± 0.215</td>
<td>13.71 ± 6.13</td>
<td>4.76 ± 0.88</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>0.547 ± 0.223</td>
<td>16.00 ± 8.40</td>
<td>4.85 ± 1.02</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>1.006 ± 1.020</td>
<td>17.46 ± 7.07</td>
<td>3.91 ± 0.97</td>
<td>Chair</td>
</tr>
<tr>
<td>White (n = 53)</td>
<td>0.516 ± 0.358</td>
<td>13.79 ± 5.00</td>
<td>4.39 ± 1.20</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>1.143 ± 4.223</td>
<td>15.40 ± 5.70</td>
<td>4.60 ± 1.37</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>0.590 ± 0.302</td>
<td>18.86 ± 8.64</td>
<td>3.80 ± 0.963</td>
<td>Chair</td>
</tr>
</tbody>
</table>

Values are means ± Standard deviations.
Each score represents the average of three trials.
CHAPTER 5
SUMMARY, DISCUSSION, AND RECOMMENDATIONS

Summary and Discussion

Physiological changes are observed in aging adults. The degree to which these changes occur between different ethnic groups often times goes unnoticed. It is assumed that ethnicity is not a factor in the process of aging, when in fact it plays a large role in the physiological changes that occurs between aging adults. The purpose of this study was to compare the differences between black and white elderly women on the physiological measures of muscle strength, BMD, and dynamic balance.

Seventy-five women volunteers from the Tri-Cities area were recruited for this study. The subjects were required to participate in a series of tests. These tests included muscle strength, BMD, and dynamic balance. The PASE questionnaire was used to assess the physical activity level of each participant. The testing took place over a 2-week period, and participants were scheduled for four assessments during this time.

Evaluation of the data revealed that there were no statistically significant differences between elderly black and elderly white women on the measures of age, weight, and waist-to-hip circumferences. White women in this study were significantly taller than black women. However, both groups were categorized as obese by BMI normative reports. Black women had significantly higher BMI values than white women. This may have been due to black women being shorter than white women.
The present study found no significant differences for upper body strength or lower body strength between the two groups. Forearm and handgrip strength was significantly higher for black women than white women. These differences may have been caused by an increased prevalence of arthritis pain among white women. Therefore, this present study recommends that upper body strength measures by chest press is a better assessment tool than the handgrip dynamometer in measuring upper body strength in these two populations.

Physical activity assessment between black women and white women was significantly different. White women were more physically active than black women; however, this tool may not be valid in assessing activities that may influence strength or BMD. The correlation between muscle strength and physical activity in this population of women was low.

Body composition measures for lean mass, fat mass, and percent body fat were not significantly different between the groups. Bone mineral density measures of the total body and lumbar demonstrated a trend to be different between black and white women. No differences were seen at the femur. Correlations assessing the relationship between bone mineral density and muscle strength for this population were low and positive. This could have occurred because there were no differences in muscle strength between black and white women.

Dynamic balance measures did not show any significant differences between the groups except for limits of stability measure of reaction time, rhythmic weight shift measures for lateral on axis velocity for slow and medium shifts, and motor control.
measure for amplitude scaling. There were small changes noted for balance between the groups, but it is unknown if these changes are profound enough to influence one’s ability to maintain balance to prevent a fall.

**Recommendations**

Several future recommendations can be made comparing elderly black and white women. First, is to conduct more research and analyze more variables for the test performed in the present research study. It is imperative that more information becomes available concerning physiological changes that occur with aging especially between ethnic groups. Researchers cannot assume that the physiological measures of aging white women would render a similar measure in aging black women. Recruiting elderly black women to participate in research projects is difficult. Many black women are aware of how important their participation in research is to the body of science. However, their knowledge of past research, where black men and women were improperly treated may be a barrier to their participation. Perhaps types of barriers that may hinder black women from participating in research need to be identified. Research to assess why black women are not actively participating weight bearing physical activity and exercise also needs to be assessed.
REFERENCES


East Tennessee State University and Johnson City Medical Center
Informed Consent to Participate in Research

Title of Project
A comparison of black and white elderly women on muscle mass, bone mineral density, and balance

Principal Investigators
Tyanne Jones
P.O. Box 70654 PEXS
(423) 928-1460

Lynn B. Panton, Ph.D.
P.O. Box 70654 PEXS
(423) 439-5260

Kathy Browder, Ph.D.
P.O. Box 70654 PEXS
(423) 439-5796

Craig E. Broeder, Ph.D.
P.O. Box 70654 PEXS
(423) 439-3380

This is a research project. This Informed Consent will explain about being a research subject in an experiment. It is important that you read this material carefully and then decide if you wish to be a volunteer. During this Informed Consent process I will thoroughly explain in laymen terms everything to you. There may be some terms in this document that may be unfamiliar to you. Please identify these terms and they will be explained to you. I will be happy to answer any questions that you may have.

Purpose of the Research
The purpose of this project is to compare the effects of aging on black and white elderly women on muscle mass, bone mineral density, and balance. By participating in this study you will receive a number of free tests that will assess your health.

Duration
The duration of the study will be approximately 2 weeks. You are free to withdraw from the study at any time.

Exclusion Criteria
To participate in this study, you must be free of severe uncontrolled high blood pressure (top number less than or equal to 160 mmHg and bottom number less than or equal to 100 mmHg), angina (pain in your chest), heart attack within the last six months, congestive heart failure, movement limitations, severe arthritis (severe joint pain), and poorly controlled diabetes (high sugar in blood). If you are presently taking medications for osteoporosis, other than hormonal replacement or calcium, you will also not be able to participate in the study.

Procedures
General Design. Data collection will occur during several test sessions over a 2-week period. Testing will take place during the morning hours at the Human Performance Laboratory located in the Mini Dome at East Tennessee State University, Department of Audiology and Speech Pathology located at the VA Medical Center, Department of Physical Therapy at the VA Medical Center, Sycamore Shoals Hospital, and the Johnson City Medical Center - Wellness Center. Johnson City Medical Center - Wellness Center.
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Craig Broeder

Data Collection. The type of data that will be collected from you will include completion
of questionnaires on topics about your quality of life and your exercise habits.
Measurements will also be taken on body composition (body fat), height, weight, girth,
bone density (bone thickness), blood pressures, resting heart rates, and strength and
flexibility measurements of upper and lower body.

Questionnaires. Questionnaires and interviews will consist of sociodemographic
information, health history, health beliefs, wellness and exercise identity, self-efficacy, fear
of falling, life stress, and exercise and diet history.

Body Composition. Body composition measurements will include sum of seven
skinfolds and circumferences. Skinfolds or pinches of skin will be held loosely and will be
measured by an instrument to determine thickness. Circumference measurements will be
taken with a tape measure around your arms, hips, abdomen, and waist. Waist-to-hip
ratios will also be evaluated. This measurement was chosen due to its high correlation with
heart disease, stroke, and diabetes (high blood sugar), in both men and women.

Bone thickness (bone density) will be evaluated by Dual-Energy X-ray Absorptiometry
(DEXA). Bone densities will be taken at the Women’s Pavilion of Sycamore Shoals
Hospital in Elizabethton, TN. During the evaluation of bone density you will lie still on an
elevated table while a bone scan is taken. The procedure is routinely done, is painless, and
will take approximately 15 minutes to complete.

Blood Pressures and Heart Rate. Resting and heart rates and blood pressures will be
taken.

Platform Posturography. During this test you will stand on a platform surrounded by a
screen. The platform will measure how much your body sways during six different test
conditions. During these conditions, the platform and/or the screen may slightly move
back and forth. The test measures how well you are able to keep your balance. You will
wear a harness belt to prevent you from falling.

Flexibility and Strength Measurements. Upper and lower body strength
measurements will be made on Cybex™ resistance machines. To measure upper body
strength you will sit in a machine and push a bar away from your body. If you can move
the bar easily more weight will be added. You will repeat this procedure until enough
weight is added that you can not push the bar away from your body. For the evaluation of
lower body strength you will sit in another machine and push against two bars resting on
your ankles. Again weight will be continually added until you can not push the weight
away with your legs. Your ankle strength will be measured on an isokinetic machine that
will have you push against a pad as hard and as fast as you can. Handgrip strength will be
measured using a handgrip dynamometer. For this procedure you will grip a handle and
squeeze as tightly as you can. Flexibility will be assessed using a sit and reach box.
During this test you will sit on the ground and place your feet on a box. You will then
reach toward your toes and try and touch the box. The measurement will be taken when
you reach as far as possible.
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Principal Investigators: Tyanez Jones, Lynn Panton, Kathy Browder & Craig Broeder

Possible Risks/Discomforts

There are minimal risks or discomforts with answering the enclosed questionnaires. You may choose not to complete the questionnaires and still be able to participate in the study.

Bone density (bone thickness) will be evaluated by Dual-Energy X-ray Absorptiometry (DEXA). This involves some radiation of approximately 12 mREM per spine or hip scan and 5 mREM per total body scan, or a total of about 25 mREM for the three scans. This is comparable to the radiation a person receives from a chest x-ray (20-50 mREM), but substantially less than a full dental x-ray (300 mREM) or an abdominal x-ray (250 mREM). The measurement of bone mineral using the DEXA is non-invasive.

During the Platform Posturography you will be placed in a harness to prevent you from falling in case you lose your balance. Someone will also be standing behind you during the testing procedures.

You may experience some muscle soreness after strength and flexibility testing. Care will be taken to try and minimize soreness by thoroughly stretching. There are little data on the injury rate in strength training. Previous experience with strength testing and training in older individuals indicates that the musculoskeletal injury rate is low during strength training. You may, however, experience some muscle soreness during training. The injury rate may be higher during strength testing, but the risk in the present study will be kept low by careful warm-up and slow progression. The risk of any cardiovascular complication during strength testing and training is also low. Studies of participants in recreational sports, which included some weight trainers, showed 1 cardiovascular complication per 495,000 participants.

One specific risk may be the added cost or inconvenience of transportation between the four (4) study sites.

Possible Benefits and/or Compensation

The benefits of your participation in the study will include a free battery of tests. Your results will be made available to you and your physician. You will also be able to see how your fitness levels compare to individuals your age in the general population.

Financial Costs

The possible financial costs to you as a participant in this research study may be incurred in the transportation between the four study sites.

Participation in this Research Experiment

Participation in this research experiment is voluntary and you are free to withdraw from the experiment at any time without penalty or loss of benefits or treatment to which you are entitled. Refusal to participate in this experiment will in no way jeopardize benefits or treatment to which you are otherwise entitled. You may withdraw from the experiment by
A comparison of black and white elderly women on muscle mass, bone mineral density, and balance

Principal Investigators: Tyanez Jones, Lynn Panton, Kathy Browder & Craig Broeder

notifying Tyanez Jones, whose number is 928-1460, Lynn B. Panton, Ph.D., whose phone number is 439-5260, by notifying Craig E. Broeder, Ph.D., whose phone number is 439-5380, or by notifying Kathy Browder, Ph.D., whose number is 439-5796. If, in their opinion, it would be advisable for you to continue to participate, you may be withdrawn at any time (without regard to your consent).

Contact for Questions

If there are any questions or research related problems at any time during this experiment you may contact Lynn B. Panton, Ph.D. at 439-5260, Kathy Browder, Ph.D. at 439-5796, or Craig E. Broeder, Ph.D. at 439-5380. In the event of a research related medical problem, you may call Lynn Panton, Ph.D. at 610-0113 during nights or weekends.

Compensation for Medical Treatment

East Tennessee State University will pay the cost of emergency first aid for any injury which may happen as a result of you being in this study. They will not pay for any other medical treatment. Claims against ETSU or any of its agents or employees may be submitted to the Tennessee Claims Commission. These claims will be settled to the extent allowable as provided under TCA Section 9-8-307. For more information about claims call the Chairman of the Institutional Review Board of ETSU at 423/439-6134. You may also call the Johnson City Medical Center Institutional Review Board at 423/431-5533 for any questions you may have about your rights as a research subject.

For studies performed at the James H. Quillen VAMC under the supervision of VA employees that have been approved by the Research & Development Committee: In case of a study-related injury, all participating subjects are entitled to emergency medical care. Under Federal Law, subjects are entitled to follow-up treatment if the injury was study related. Compensation may or may not be payable in the event of physical injury arising from this study under applicable Federal Law.

Confidentiality

Every attempt will be made to see that your results are kept confidential. A copy of the results from of this experiment will be kept on file in the Department of Physical Education, Exercise and Sport Sciences in room E-116 for at least 10 years after completion of the research project. The results of this study may be published and/or presented at meetings. The study records are accessible to Secretary of the Department of Health and Human Services, the East Tennessee State University/V.A. Medical Center Institutional Review Board, the Johnson City Medical Center Institutional Review Board, the Food and Drug Administration, and the ETSU Department of Physical Education, Exercise and Sport Sciences. Your medical records will be maintained in strictest confidence according to current legal requirements, and will not be revealed unless required by law, except as noted above.

For Veteran Research Subjects Only - If you are a Veteran taking part in a study at the James H. Quillen VA Medical Center, a copy of your signed and dated Consent Form will be placed in your medical records.
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Principal Investigators: Tyanez Jones, Lynn Panton, Kathy Browder &
Craig Broeder

Voluntary Participation

I understand that the nature demands, risks, and benefits of the project have been explained
to me as well as are known and available. I understand what my participation involves.
Furthermore, I understand that I may withdraw from the study at any time without penalty.
I have read, or have had read to me, and fully understand the consent form. I sign it freely
and voluntarily. A signed copy has been given to me. My study records will be
maintained in the strictest confidence according to current legal requirements and will not be
revealed unless required by law or as noted above.

Signature of Volunteer

Date

Signature of Investigator

Date

Signature of Witness

Date
LEISURE TIME ACTIVITY

1. Over the past 7 days, how often did you participate in sitting activities such as reading, watching TV or doing handcrafts?

   [0.] NEVER  [1.] SELDOM (1-2 DAYS)  [2.] SOMETIMES (3-4 DAYS)  [3.] OFTEN (5-7 DAYS)

   GO TO Q.#2

   1a. What were these activities?

   1b. On average, how many hours per day did you engage in these sitting activities?

       [1.] LESS THAN 1 HOUR  [2.] 1 BUT LESS THAN 2 HOURS
       [3.] 2-4 HOURS  [4.] MORE THAN 4 HOURS

2. Over the past 7 days, how often did you take a walk outside your home or yard for any reason? For example, for fun or exercise, walking to work, walking the dog, etc.?

   [0.] NEVER  [1.] SELDOM (1-2 DAYS)  [2.] SOMETIMES (3-4 DAYS)  [3.] OFTEN (5-7 DAYS)

   GO TO Q.#3

   2a. On average, how many hours per day did you spend walking?

       [1.] LESS THAN 1 HOUR  [2.] 1 BUT LESS THAN 2 HOURS
       [3.] 2-4 HOURS  [4.] MORE THAN 4 HOURS
3. Over the past 7 days, how often did you engage in light sport or recreational activities such as bowling, golf with a cart, shuffleboard, fishing from a boat or pier or other similar activities?

<table>
<thead>
<tr>
<th>0. NEVER</th>
<th>1. SELDOM</th>
<th>2. SOMETIMES</th>
<th>3. OFTEN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1-2 DAYS)</td>
<td>(3-4 DAYS)</td>
<td>(5-7 DAYS)</td>
</tr>
<tr>
<td>GO TO Q.#4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3a. What were these activities?

3b. On average, how many hours per day did you engage in these light sport or recreational activities?

<table>
<thead>
<tr>
<th>1. LESS THAN 1 HOUR</th>
<th>2. 1 BUT LESS THAN 2 HOURS</th>
<th>3. 2-4 HOURS</th>
<th>4. MORE THAN 4 HOURS</th>
</tr>
</thead>
</table>

4. Over the past 7 days, how often did you engage in moderate sport and recreational activities such as doubles tennis, ballroom dancing, hunting, ice skating, golf without a cart, softball or other similar activities?

<table>
<thead>
<tr>
<th>0. NEVER</th>
<th>1. SELDOM</th>
<th>2. SOMETIMES</th>
<th>3. OFTEN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1-2 DAYS)</td>
<td>(3-4 DAYS)</td>
<td>(5-7 DAYS)</td>
</tr>
<tr>
<td>GO TO Q.#5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4a. What were these activities?

4b. On average, how many hours per day did you engage in these moderate sport and recreational activities?

<table>
<thead>
<tr>
<th>1. LESS THAN 1 HOUR</th>
<th>2. 1 BUT LESS THAN 2 HOURS</th>
<th>3. 2-4 HOURS</th>
<th>4. MORE THAN 4 HOURS</th>
</tr>
</thead>
</table>
5. Over the past 7 days, how often did you engage in strenuous sport and recreational activities such as jogging, swimming, cycling, singles tennis, aerobic dance, skiing (downhill or cross-country) or other similar activities?

- [0.] NEVER
- [1.] SELDOM (1-2 DAYS)
- [2.] SOMETIMES (3-4 DAYS)
- [3.] OFTEN (5-7 DAYS)

  GO TO Q.#6

5a. What were these activities?

5b. On average, how many hours per day did you engage in these strenuous sport and recreational activities?

- [1.] LESS THAN 1 HOUR
- [2.] 1 BUT LESS THAN 2 HOURS
- [3.] 2-4 HOURS
- [4.] MORE THAN 4 HOURS

6. Over the past 7 days, how often did you do any exercises specifically to increase muscle strength and endurance, such as lifting weights or pushups, etc.?

- [0.] NEVER
- [1.] SELDOM (1-2 DAYS)
- [2.] SOMETIMES (3-4 DAYS)
- [3.] OFTEN (5-7 DAYS)

  GO TO Q.#7

6a. What were these activities?

6b. On average, how many hours per day did you engage in exercises to increase muscle strength and endurance?

- [1.] LESS THAN 1 HOUR
- [2.] 1 BUT LESS THAN 2 HOURS
- [3.] 2-4 HOURS
- [4.] MORE THAN 4 HOURS
7. During the past 7 days, have you done any light housework, such as dusting or washing dishes?

[1.] NO  [2.] YES

8. During the past 7 days, have you done any heavy housework or chores, such as vacuuming, scrubbing floors, washing windows, or carrying wood?

[1.] NO  [2.] YES

9. During the past 7 days, did you engage in any of the following activities?

Please answer YES or NO for each item.

<table>
<thead>
<tr>
<th></th>
<th>NO</th>
<th>YES</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Home repairs like painting, wallpapering, electrical work, etc.</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>b. Lawn work or yard care, including snow or leaf removal, wood chopping, etc.</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>c. Outdoor gardening</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>d. Caring for an other person, such as children, dependent spouse, or an other adult</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
WORK-RELATED ACTIVITY

10. During the past 7 days, did you work for pay or as a volunteer?

[1.] NO  [2.] YES


10a. How many hours per week did you work for pay and/or as a volunteer?

____ HOURS

10b. Which of the following categories best describes the amount of physical activity required on your job and/or volunteer work?

   [Examples: office worker, watchmaker, seated assembly line worker, bus driver, etc.]

[2] Sitting or standing with some walking.
   [Examples: cashier, general office worker, light tool and machinery worker.]

[3] Walking, with some handling of materials generally weighing less than 50 pounds.
   [Examples: mailman, waiter/waitress, construction worker, heavy tool and machinery worker.]

   [Examples: lumberjack, stone mason, farm or general laborer.]
DEMOGRAPHIC INFORMATION

Name _______________________________  Date _____/_____/_______

Last  First  MI  Month  Day  Year

Home address ___________________________________________________

Street ____________________________________________________________

City ________  State  ________  Zip  ________  Country

Home phone ____________________________
Office phone ____________________________

EMERGENCY INFORMATION

Family Physician _________________________________________________________

Individual to be contacted in the event of an emergency:

Name: ________________________________________________________________

Relationship to you: ____________________________________________________

Home address ____________________________  Home phone __________________

Office address ____________________________  Office phone __________________

Personal Information

Age ________  Date of birth _____/_____/_______

Height ________ in.  ________ cm

Weight ________ lb.  ________ kg

Sex

_____ Male

_____ Female

Race

______ White

______ Black

______ Asian

______ Hispanic

______ Other ____________
Marital status

_____ Single
_____ Married
_____ Divorced or separated
_____ Widowed

# years

Religion (optional)

_____ Catholic
_____ Protestant
_____ Jewish
_____ Jehovah Witness

_____ Hindu
_____ Muslim
_____ None
_____ Other: ________

Education Completed

_____ 1-8 years
_____ 9-12 years
_____ 13-16 years
_____ 17-18 years
_____ more than 18 years

_____ High school graduate
_____ Bachelor’s degree
_____ Master’s degree
_____ Doctoral degree

Occupation (list) _______________________________________________

Present work status

_____ Working full time
_____ Working part time
_____ Not employed – Reason _______ Medical _______ Other
_____ Retired

Indicate your family income before taxes (U.S. dollar equivalent)

_____ less that $10,000
_____ $10,000 – $50,000
_____ more than $50,000

STATEMENT OF CONFIDENTIALITY

I understand that information contained on this questionnaire is regarded as
confidential, and will not be released without my prior written permission. The will not
be used for the setting of fees. The research center may, however, use the information for
statistical and other research purposes.

______________________________________    ___________________
Signature         Date
VITA

Tyanez C. Jones

Personal Data:
Date of Birth: August 14, 1974
Place of Birth: Chicago, Illinois
Marital Status: Married

Education:
Academy of our Lady, Chicago, Illinois
Iowa State University, Ames, Iowa;
   Exercise and Sport Sciences., 1998
East Tennessee State University, Johnson City, Tennessee;
   Exercise Physiology, M.A., 2001

Professional Experience:
Exercise Specialist, Johnson City Medical Center Wellness Center;
   Johnson City, Tennessee, 2001 – Present
Graduate Assistant, East Tennessee State University,

Honors and Awards:
Outstanding Graduate Assistant, East Tennessee State University.