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Force-velocity Characteristics of the Leg Muscles and Anaerobic Performance in African-American and Caucasian College-aged Males

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To the Graduate Council:

I am submitting herewith a thesis written by Stacy D. Hunter entitled "Force-velocity Characteristics of the Leg Muscles and Anaerobic Performance in African-American and Caucasian College-aged Males." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Exercise Science.

David Bassett, Major Professor

We have read this thesis and recommend its acceptance:

Eugene Fitzhugh, Dixie L. Thompson

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

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

To the Graduate Council:

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FORCE-VELOCITY CHARACTERISTICS OF THE LEG MUSCLES AND
ANAEROBIC PERFORMANCE IN AFRICAN-AMERICAN AND CAUCASIAN
COLLEGE-AGED MALES

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

Stacy Denise Hunter
May 2008

DEDICATION

This is dedicated to my parents, Carey and Oretha. Thank you both for all your love and support that you've provided me with over the years. Thanks for always encouraging me to pursue my heart's desires no matter what. I could not have done this without you. I love you both.

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ABSTRACT

PURPOSE: To compare vertical jump height and power and sprint time in African-American and Caucasian college-aged males, to compare isokinetic knee extension and flexion torques between the two groups, and to examine correlations between these variables. **METHODS:** The participants were fifty recreationally active, college-aged males (23 African-American and 27 Caucasian). Physical activity was assessed using the Behavioral Risk Factor Surveillance Survey (BRFSS) Physical Activity module, body composition was determined using the Bod Pod, and anthropometric measures (height, weight, and thigh circumference) were taken. Subjects performed a 100-m sprint on an outdoor track and a countermovement vertical jump. Vertical jump power was calculated using both the Lewis and Sayers equations. Isokinetic knee extension and flexion testing were performed on a Biodex System 3 at angular velocities of 60, 120, 210, 300, and 400 degrees per second. Peak torques and relative torques (using torque generated at 60 degrees per second as the reference) were used in data analysis. **RESULTS:** There were no significant differences between African-Americans and Caucasians in anthropometric variables, physical activity, wind velocity measured during the 100-m dash, or isokinetic extension and flexion peak and relative torques. When controlling for body fat percentage, there were significant differences between the two groups with African-Americans having greater jump heights ($p < .001$), greater vertical jump power using the Sayers equation ($p < .05$), and faster 100-m sprint times ($p < .05$). In the entire sample, vertical jump height significantly correlated with 100-m sprint time ($r = -.769$, $p < .001$). Vertical jump power using both equations significantly correlated with isokinetic knee extension peak torque at all angular velocities and with knee flexion at 120, 300 and 400

degrees per second. There were no significant correlations between 100-m sprint times and isokinetic knee extension and flexion variables. CONCLUSION: African-Americans performed better than Caucasians in the vertical jump and 100-m dash but not in isokinetic knee flexion and extension testing. However, African-Americans showed a trend towards greater peak torques at high angular velocities indicative of faster speeds of muscle contraction.

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CHAPTER 1: INTRODUCTION

Racial variation in anaerobic performance has been a topic of investigation for the past 80 years. Vertical jump, sprint running, the Wingate and the Margaria-Kalamian stair run are tests of anaerobic performance that have been examined among African-American and Caucasian children, adolescents, and young adults. Most previous studies have shown differences between the two groups in vertical jump and sprint running tests in favor of African-Americans [1-11]. However, Babel et al. [6] showed no significant difference between individuals of African descent and Caucasian males in 30-m sprint performance.

Isokinetic testing provides information about the force-velocity characteristics of the muscles by allowing torque production to be assessed for a given velocity of movement. Several studies have found correlations between isokinetic contractions and sprint running and vertical jump performance [12-21]. Isokinetic knee extension and flexion peak torques at angular velocities above 100 degrees per second have correlated with vertical jump performance [12-16]. In addition, isokinetic knee extension and flexion and hip abduction and adduction peak torques have correlated with sprint running performance [17-21]. The results of these studies show that the ability of the muscle to development tension rapidly is related to performance in the vertical jump and sprint running tests of anaerobic power.

Type II muscle fibers generate tension more rapidly than type I muscle fibers, which makes them more suitable for anaerobic activities. Previous studies have shown positive correlations between isokinetic contractions at high angular velocities (e.g. above

100 degrees per second) and the proportion of type II muscle fibers [22-25]. Coyle et al. [23] performed muscle biopsies and isokinetic leg extension testing at 5 angular velocities ranging from 57 to 400 degrees per second. Peak torque at 57 degrees per second was used as the reference and all subsequent torque values were expressed relative to that value. Individuals possessing more than 50% type II muscle fibers generated significantly higher relative torque values at all angular velocities, and significant correlations were shown between the percentage of type II muscle fibers and relative torques at 115, 200, 287, and 400 degrees per second.

A possible explanation for racial differences in anaerobic performance between African-Americans and Caucasians is a difference in muscle fiber type distribution. Studies have shown a trend towards individuals of African descent possessing a higher percentage of type II muscle fibers than Caucasians [26-28], however, significant differences between the two groups were shown in only one of three studies [27]. Ama et al. [27] showed that West African students possessed a significantly higher percentage of type IIa muscle fibers and a significantly lower percentage of type I muscle fibers than Caucasian students.

Though the results of several studies have consistently shown that African-Americans out-perform Caucasians in jumping and sprint running, the physiological rationale for these differences remains unclear. Some possible explanations include differences in muscle fiber type distribution and anthropometric characteristics, including leg length and the height of the gastrocnemius insertion point. Though many studies have compared African-Americans and Caucasians in anaerobic performance and muscle

physiology, none have compared the force-velocity characteristics of the leg muscles using isokinetic testing. Since isokinetic measures have been shown to correlate with sprint running and vertical jump performance, variation in this measure may partially explain the racial variation in anaerobic performance. The objectives of this study were to:

- 1) Compare the force-velocity characteristics of the leg muscles using isokinetic knee extension and flexion relative torque values in African-American and Caucasian males at 60, 120, 210, 300, and 400 degrees per second.
- 2) Compare 100-m sprint time and vertical jump performance in college-aged African-American and Caucasian males.
- 3) Examine the relationships between isokinetic knee extension and flexion relative torque values and 100-m sprint and vertical jump performance.
- 4) Examine the relationship between 100-m sprint and vertical jump performance.

CHAPTER 2: LITERATURE REVIEW

The topic of racial differences in anaerobic performance has been investigated over the past 80 years. Previous studies have compared anaerobic performance in African-American and Caucasian males, and the results of several have shown that African-Americans perform better while others show no significant differences between the two groups. Anaerobic power is measured by performance tests that assess the ability of the subject to complete a given amount of work at a high work rate in a short time period. Tests of anaerobic performance such as the Wingate, vertical jump, and Margaria tests can be used to calculate anaerobic power while sprint running tests up to 800 meters yield information about anaerobic capacity without yielding a specific power value. These tests can be classified as ultra short-term and short-term tests [29]. Ultra short-term tests assess the capacity of the ATP-CP system and include the vertical jump and sprint running tests lasting up to 10 seconds. Short-term tests assess the capacity of the anaerobic glycolysis energy pathway and include bouts of activity lasting 10 to 60 seconds (like the Wingate test) and sprint running bouts of 100 meters or longer.

Vertical Jump Performance

The vertical jump test was developed by Sargent [30] as a test of explosive, lower-body muscular power [31, 32] in which the height of the jump is used in the calculation of power. Vertical jump height is often used as an indicator of athletic ability in sports that require explosive muscular power like football and basketball [31]. The jump-and-reach test was derived from the Sargent jump test and can be initiated in the

crouched position with both legs bent at 90 degrees. It is also referred to as the static vertical jump or squat jump [33]. It can be initiated in the standing position followed by a bending movement right before the jump is initiated, which is referred to as the countermovement jump [11, 33]. The jump height is calculated as the difference between standing reach height and the highest point of vertical displacement during the jump. The Vertec (Sports Imports, Hilliard, OH) is a device in which the height of a metal pole can be adjusted to the reach height of the individual [33]. Colored plastic swivel vanes are attached to the metal pole at ½-inch increments. The individual being tested stands under the swivel vanes, jumps and reaches with the dominant hand, and displaces the highest possible swivel vane when maximal vertical displacement is achieved. Once the jump height is obtained, it is used in the Lewis Nomogram formula to calculate muscular power [11]:

$$\text{Power index (kg}\cdot\text{m/s)} = \sqrt{4.9 \cdot \text{Body mass} \cdot \sqrt{\text{Jump height (m)}}$$

Several studies have shown racial differences in vertical jump performance between African-American and Caucasian males [1, 6-11]. Barker et al. [11] examined racial differences in the countermovement and static vertical jump tests among Division 1AA college football players and found that African-Americans had a significantly higher mean vertical jump height for both tests than Caucasians. The subjects were separated into the following groups based on their position: offensive backs and wide receivers, defensive backs, offensive linemen and tight ends, defensive linemen, and linebackers. The distribution of African-Americans and Caucasians in each group was uneven. Most of the offensive backs and wide receivers were African-American and

most of the subjects in all other groups were Caucasian. There were 21 African-American and 38 Caucasian subjects. The mean countermovement vertical jump heights were 66 cm and 58.5 cm for African-American and Caucasian males, respectively. The mean static vertical jump heights were 62.7 cm and 55.5 cm for African-American and Caucasian males, respectively. Another variable measured for both vertical jump tests was take-off velocity. This was calculated by dividing the vertical jump power by the subject's body mass. The African-American males had significantly higher take-off velocities for the countermovement and static vertical jump tests than the Caucasian males.

Laeding [7] compared pull-up performance, vertical jump height, agility run, and reaction time in African-American and Caucasian male high school sophomore students. The African-American and Caucasian students were matched by age into the following age into 15- and 16-year-old groups. The vertical jump was measured using a board in which the reach height and height of the highest position of vertical displacement during the jump were both marked with chalk. Reaction time was measured by having the subject react to a timer which caused a light to come on. Once the light came on, the subject had to turn it off as quickly as possible. The only significant difference between the 2 groups was in the vertical jump test. The African-American males jumped 6.624 cm higher than the Caucasian males. African-American males also showed trends towards faster reaction time in the 16-year old groups, agility, and strength as measured by pull-ups, but these did not attain statistical significance.

Lauro [10] examined motor performance in 6-8 year old African-American and Caucasian children in elementary school. The motor performance measures included static and dynamic balance, standing broad jump, jump and reach performance, and hip-spine flexibility. The results showed significant differences in the jump and reach test scores in favor of the African-American boys and girls in each age group. African-American boys jumped 5.13 cm higher and African-American girls jumped 4.19 cm higher on average than Caucasian boys and girls respectively. Significant differences were also shown in broad jump scores in favor of African-American, 8 year old boys and 7 and 8 year old girls. Among other findings, the African-American boys in each grade level showed a trend towards greater dynamic balance, but they did not reach statistical significance.

Codwell [1] examined motor performance, including vertical jump performance, 60-yard dash, running high jump, 12-pound shot, chinning strength, agility and muscle coordination as measured by the Burpee Test, and motor ability composite in 505 African-American and Caucasian high school male students. Based on the Von Luschan Color Scale which uses skin color and other characteristics like eye color and hair type, the subjects were grouped into 3 racial categories. The first category consisted of individuals thought of as predominantly African-American, the second group consisted of those thought of as “intermediate” (bi-racial), and the third group consisted of those identified as Caucasian. In the vertical jump, both the African-American and intermediate groups jumped significantly higher than the Caucasian group. The African-American and intermediate groups performed significantly better on the test of agility and

muscle coordination than the Caucasian group. The African-American group showed trends towards better performance in the 60-yd dash, running high jump, 12-pound shot, chinning strength, and the motor ability composite, but they did not attain statistical significance.

Babel et al. [6] examined countermovement vertical jump and sprint running performance in sedentary, prepubescent, Caribbean males, 8 of which were Caucasian and 9 were of African descent. The boys of African descent jumped significantly higher than those of European descent. The mean vertical jump heights were 36.77 cm and 31.12 cm for the boys of African and European descent, respectively. Alactic anaerobic power (AAP) was calculated using the Sayers equation [34] and no significant differences were found between the two groups in vertical jump power. There was no significant difference between the two groups in 30-m sprint time or stride number.

Sprint Running

The 100-m dash is a performance test of running speed, acceleration, anaerobic endurance, and reaction time. Success in the 100-m dash is a result of the ability to react quickly to the firing of a starter pistol, the ability to quickly accelerate to a high running velocity, and the ability to maintain a high running velocity. Other factors also play a role in sprinting success like stride length, which is affected by leg length, stride frequency, which is determined by the ability of the leg muscles to rapidly generate tension, muscular strength, and leg coordination [6, 35]. The primary metabolic

pathways for this sprint are the ATP/CP system and anaerobic glycolysis, both of which are influenced by creatine kinase and glycolytic enzyme activity.

Previous studies have shown racial differences in sprinting performance between African-American and Caucasian males and females in various age categories. Milne et al. [2] examined 30-yd and 400-ft sprint times of African-American and Caucasian children in kindergarten through the second grade and found that the African-American children were significantly faster than the Caucasian children in the 30-yd dash, but not in the 400-ft run. The results of this study indicate that racial differences in running speed may only exist for short distance events.

Hutinger [3] compared 35-yard dash times in African-American and Caucasian girls and boys in the fourth, fifth, and sixth grades from 5 elementary schools. Statistically significant differences were shown between African-American and Caucasian boys in the fourth and fifth grades and girls in all 3 grade levels showing that African-Americans were significantly faster than Caucasians. The African-American boys in the sixth grade were faster on average than the Caucasian boys, although the difference did not reach statistical significance.

Barker et al. [11] found that African-American football players were significantly faster than Caucasian players in the 5-yd shuttle run, but not in the 10-yd, 300-yd, or 1.5 mile runs. However, the African-Americans showed a trend towards being faster in the 10-yd and 300-yd runs and slower in the 1.5 mile run than the Caucasian players, though the differences did not reach statistical significance. The findings of this study are in agreement with the findings of Milne et al. [2] and indicate that while African-Americans

are faster in short distance sprints, Caucasians may be better suited for longer distances requiring aerobic endurance.

Ponthieux and Barker [4] examined racial differences in various measures of physical fitness in African-American and Caucasian girls and boys in the fifth and sixth grades. The fitness tests used were pull-ups, sit-ups, 40-yard shuttle run, standing broad jump, 50-yard dash, softball throw and 600-yard run and were all part of the AAHPER Youth Fitness Test. The data were analyzed at the 0.01 alpha level. The African-American boys performed significantly better on pull-ups, standing broad jump, 50-yard dash, softball throw, and 600-yard run-walk. There were no significant differences between the 2 groups in sit-ups and the 40-yard shuttle run, though the Caucasian boys performed slightly better on sit-ups. The African-American girls performed better on the 50-yard dash, softball throw, and the 600-yard run-walk while the Caucasian girls performed better on pull-ups. The Caucasian girls also performed better on sit-ups, although the difference was not statistically significant.

Hunter [5] compared tests of anaerobic performance including the Wingate and Margaria power tests, the vertical jump, and the 40-yard dash in African-American and Caucasian male high school students. The results showed significant differences between the 2 groups in the vertical jump and 40-yard dash tests in favor of African-American males. African-American males jumped 0.055 meters (5.5 cm) higher than the Caucasian males and ran the 40-yard dash 0.22 seconds faster on average. The Lewis Nomogram formula was used to calculate power from vertical jump height and African-American

males were significantly more powerful than the Caucasian males. No significant differences were found between the two groups in the Wingate and Margaria power tests.

Isokinetic Testing and Vertical Jump Performance

Isokinetic concentric and eccentric muscular contractions have been shown to correlate with vertical jump and sprint running performance. One of the determinants of explosive types of activities is the ability of the involved muscles to rapidly develop tension. Isokinetic testing provides a means of measuring the force-velocity characteristics of the muscles by controlling the speed of movement and measuring peak torque or force developed about the joint axis of rotation. Bosco et al. [12] examined the relationship between peak torque at 28.6, 57, 120, 179.9, 240, and 280 degrees per second and vertical jump performance in male members of the Italian volleyball team. The subjects performed three maximal repetitions at each angular velocity. The three vertical jump protocols examined were the squatting jump in which the jump is initiated from the squatting position with no countermovement, the countermovement jump, and the best drop jump in which the jump is initiated after various stretch loads were applied to the leg extensor muscles by having the subject drop from a platform. The stretch load resulting in the highest jump was used for the best drop jump value. Strong correlations were found between squatting jump and peak torque at 179.9 ($r = 0.64$), 240 ($r = 0.71$), and 280 ($r = 0.69$) degrees per second, between countermovement jump and peak torque at 120 ($r = 0.65$), 179.9 ($r = 0.66$), and 240 ($r = 0.74$) degrees per second, and between best drop jump and peak torque at 240 degrees per second ($r = 0.60$). The strongest

correlation was shown between countermovement jump and isokinetic peak torque at 240 degrees per second.

Liebermann and Katz [13] examined the relationship between isokinetic knee extension power and countermovement jump power in young men and women. The angular velocities used were 120, 180, and 240 degrees per second and isokinetic knee extension power was determined at these velocities. Significant correlations were found between countermovement jump power and isokinetic knee extension power at all angular velocities. The strongest relationship was displayed between countermovement jump and knee extension power at 180 degrees per second ($r = 0.737$) and the weakest correlation was shown at 240 degrees per second ($r = 0.599$).

Latin [14] examined the correlations between isokinetic knee and elbow extension and flexion and three tests of anaerobic power in male college students: Margaria-Kalaman power test, vertical jump, and Cranking power. Cranking power is a modified version of the Wingate test in which the subject pedals maximally at a resistance of 5 kg for 30 seconds and then performs a second test on an arm ergometer in which the resistance is set to 3 kg for 30 seconds. Subjects performed 5 maximal repetitions at 60 degrees per second and 25 maximal repetitions at 240 degrees per second. All isokinetic test power scores were summed in order to create a measure of total isokinetic power (TIP). Significant correlations were shown between TIP and the vertical jump ($r = 0.77$), Margaria-Kalaman ($r = 0.84$), Wingate leg crank ($r = 0.79$), and Wingate arm crank ($r = 0.43$) tests.

Iossifidou et al. [15] examined the relationship between isokinetic knee extension peak power and the squat vertical jump, a vertical jump initiated in the crouched position, in young athletes. The subjects performed five repetitions of knee extension and flexion at 30, 90, 180, and 300 degrees per second. The only significant correlation was shown between isokinetic knee extension peak power at 300 degrees per second and squat vertical jump ($r = 0.91$). Another finding was that the strength of the correlation between squat vertical jump and isokinetic knee extension power increased with increasing angular velocity.

Kovaleski et al. [16] investigated the relationship between lower-body closed-linear-kinetic and open-kinetic-chain isokinetic muscular contractions and three function tests. Five maximal repetitions of open-kinetic chain isokinetic knee extensions were performed at 60 degrees per second and five maximal repetitions of closed-kinetic-chain isokinetic leg press exercises were performed at 25 cm/s. The function tests included the single-leg hop, a jump test which is started in the squatting position in which the subject hops as far as possible on the dominant leg, the single-leg vertical jump which is a modified version of the vertical jump in which the subject starts in the squatting position and jumps with the dominant leg only, and the speed/agility run consisting of a 6.1-m course in which the direction of movement is changed three times. The results showed significant correlations between the isokinetic leg press and the single-leg hop ($r = 0.448$), the isokinetic leg press and the shuttle run ($r = -0.494$), the isokinetic knee extension and the single-leg hop ($r = 0.623$), and the isokinetic knee extension and the shuttle run ($r = -0.510$). The vertical jump did not significantly correlate with the

isokinetic leg press or knee extension. The results of this study indicate that no relationship exists between isokinetic knee extension at slow angular velocities and are consistent with the findings of Bosco, Mogroni, and Luhtanen [12] that showed no correlation between vertical jump and knee extension at 28.6 or 57 degrees per second.

Isokinetic Testing and Sprint Running Performance

Previous studies have shown that isokinetic strength of the leg muscles (including the quadriceps, hamstrings, abductors and adductors) correlated with sprinting performance in distances of 100 meters or less [17-21]. Isokinetic testing provides a measure of strength, which is an important factor in running velocity. Muscular strength influences running velocity because of the Impulse-Momentum relationship which states that the size of the applied impulse, which is the force applied against the ground by the foot during the contact phase, determines the change in running velocity [36]. Kano et al. [17] examined the relationship between isokinetic muscular strength of the quadriceps, hamstrings, and adductors and 100-m sprint time in adult male sprinters. The subjects were tested on an isokinetic dynamometer at angular velocities of 60, 180, and 300 degrees per second. The results showed significant correlations between 100-meter sprint time and knee extension peak torque at 300 degrees per second and between sprint time and knee flexion peak torque at 180 and 300 degrees per second. There were no significant relationships between 100-m sprint time and peak torque in leg adduction at any angular velocity or knee extension or flexion at 60 degrees per second. The results of this study indicated that sprint time is related to knee extension and flexion torque at

higher angular velocities, but not necessarily at an angular velocity of 60 degrees per second, and that muscular strength of the adductor muscles may not play a major role in sprint time.

Dowson et al. [18] investigated the relationships between isokinetic knee extension and flexion, hip extension and flexion, and ankle plantar and dorsiflexion and 15- and 35-m sprint times in rugby players, track sprinters, and other athletes. The isokinetic testing consisted of the following: concentric knee extension and flexion at 60, 150, and 240 degrees per second, eccentric knee extension at 60 and 240 degrees per second, concentric hip extension and flexion at 60, 119.7, and 179.9 degrees per second, eccentric hip extension at 60 and 179.9 degrees per second, concentric ankle plantar and dorsiflexion at 60, 119.7, and 179.9 degrees per second, and eccentric ankle plantar flexion at 60 and 179.9 degrees per second. Sprint time was measured using photoelectronic cells and the best of three trials was recorded. The speed test was conducted by having the subject sprint 35 m and recording the time for the last 5 m of the trial. Acceleration was measured over a distance of 15 m in which overall time to completion and times for each 5-m section were recorded. Significant correlations were found between 15-m sprint time and peak torque in concentric knee extension ($r = -0.421$) and flexion at 150 degrees per second ($r = 0.471$), between 15-m sprint time and concentric knee extension ($r = -0.518$) and flexion ($r = -0.514$) at 240 degrees per second, and 15-m sprint time and eccentric knee extension at 60 degrees per second ($r = -0.428$). A significant correlation was also shown between 15-m sprint time and concentric ankle plantar flexion at 119.7 ($r = -0.513$) and 179.9 degrees per second ($r = -0.474$).

Significant correlations were shown between 30-35 m sprint time and concentric knee extension and flexion and eccentric knee extension at all angular velocities tested.

Significant correlations were also found between 30-35-m sprint time and concentric hip extension at 119.7 and 179.9 degrees per second, concentric hip flexion at 60 and 119.7 degrees per second, and concentric ankle plantar flexion at 119.7 and 179.9 degrees per second. Another finding of this study is that the highest correlations were shown for both 15-m ($r = -0.518$) and 30-35-m times ($r = -0.688$) and concentric knee extension at 240 degree per second. The results of this study indicated that knee extension and flexion and ankle plantar flexion appear to be more related to sprint time than hip flexion and extension. The strongest relationship between isokinetic peak torque and sprint times for the 15- and 30-35 m distances was for knee extension at 240 degrees per second, indicating that the ability of the quadriceps to contract concentrically influences performance in the 15- and 30-35-m sprints.

The relationships between 40-m sprint performance and isokinetic measures, 10-m sprint, and vertical jump in athletes engaged in anaerobic sports like football, lacrosse, and baseball were examined by Nesser et al. [19]. The isokinetic testing included the following: hip and knee extension and flexion at 60, 179.9, and 449.8 degrees per second and ankle plantar and dorsiflexion at 60, 179.9, and 300 degrees per second. Vertical jump and 10-m sprint performance were both related to 40-m sprint times. Of the isokinetic measures, hip flexion at 179.9 degrees per second ($r = -0.573$), hip extension at 449.8 degrees per second ($r = -0.537$), knee extension at 449.8 degrees per second ($r = -0.546$), and knee flexion at 179.9 ($r = -0.561$) and 449.8 ($r = -0.613$) degrees per second

were all significantly correlated to 40-m sprint time. No significant correlations were shown between 40-m sprint performance and ankle plantar or dorsiflexion at any angular velocities tested. Knee extension and flexion peak torque at 60 degrees per second were not significantly related to 40-m sprint performance. The results of this study indicated that knee extension and flexion at an angular velocity of 60 degrees per second, a relatively slow speed, were not related to 40-m sprint performance while knee extension and flexion at higher angular velocities over 100 degree per second were related to sprint performance. It is possible that the speed of contraction required for sprinting 40 m is more closely linked to the speed of contraction of the quadriceps and hamstrings at 179.9 and 449.8 degrees per second.

The relationships between 40-yard sprint time and isokinetic hip flexion and extension were examined in Division 1 college football and baseball players [20]. The isokinetic testing consisted of 4 maximal repetitions of hip extension and flexion at 60 degrees per second and 25 maximal repetitions at 240 degrees per second. Peak torque was reported relative to body weight. The results showed significant correlations between 40-yard sprint time and hip flexion at 60 ($r = -0.57$) and 240 degrees per second ($r = -0.42$) and extension peak torque at 60 ($r = -0.56$) and 240 degrees per second ($r = -0.41$).

Miyashita and Kanehisa [21] investigated the relationships between 50-m sprint speed and isokinetic knee extension peak torque in active girls and boys between the ages of 13 and 17. The subjects performed 2 maximal knee extensions at 210 degrees per second, and they sprinted 50 meters. The results showed that overall, a significant

correlation existed between sprinting speed and knee extension peak torque for boys ($r = 0.688$) and girls ($r = 0.373$). When separated for age group, significant correlations were shown between sprint time and knee extension peak torque in 13-, 14-, and 15-year old boys and 13-, 15-, 16-, and 17-year old girls.

Some studies have not shown significant correlations between sprint performance and isokinetic contractions. Farrar and Thornland [37] examined the relationship between 40-yd and 100-yd sprint time and isokinetic peak torque in 52 college-aged, non-athlete males. Isokinetic thigh flexion and extension and leg flexion and extension were performed at 60 and 300 degrees per second. No significant correlations were shown between the 40-yd and 100-yd sprints and any of the isokinetic measures. When the subjects were divided into two groups (faster and slower), based on the median time, the faster group displayed significantly average higher torque values in thigh extension and leg extension at 60 degrees per second.

Correlations between isokinetic knee extension and flexion and 30-m sprint performance were investigated in 14 sixth grade boys by Berg et al. [38]. Isokinetic knee extension and flexion were performed at 30 and 300 degrees per second. Hydrostatic weighing was performed to measure percent body fat and lean body mass and hip extensor flexibility was assessed using a Leighton flexometer. No significant correlations were shown between 30-m sprint performance and any other variables.

Isokinetic Testing and Muscle Fiber Type Distribution

Among the factors influencing vertical jump and sprint running performance are the ability of the muscles to rapidly use muscle phosphagen stores [14] and the ability of the muscles to generate tension rapidly which is affected by the rate at which the action potential travels along the neuron, the rate at which calcium is released from the sarcoplasmic reticulum, and the rate at which ATP is broken down [29]. Muscle physiology is an important determinant of vertical jump and sprint running performance. Type II muscle fibers are more suited for explosive activities like the vertical jump and sprint running because they can generate tension more absolute tension more rapidly than type I muscle fibers and can generate more power at high velocities of movement [29].

Previous studies have shown correlations between isokinetic peak torque and muscle fiber composition. In 1979, Coyle et al. [23] investigated the relationship between leg extension peak torque and the proportion of type II muscle fibers in the vastus lateralis in 21 males in various physical training states. Each subject performed three maximal repetitions of isokinetic leg extension at 57, 115, 200, 287, and 400 degrees per second. Peak torque obtained at 57 degrees per second was used as the reference and each subsequent peak torque was expressed as a percentage of that value. Once the muscle biopsies were obtained, subjects were divided into two groups: more than 50% type II fibers and less than 50% type II fibers. The groups possessing more than 50% type II muscle fibers were able to generate 11%, 16%, 23%, and 47% higher relative peak torque at 115, 200, 287, and 400 degrees per second respectively. Significant correlations were also shown between the percentage of type II muscle fibers

and relative torque at 115 ($r = 0.44$), 200 ($r = 0.63$), 287 ($r = 0.65$), and 400 degrees per second ($r = 0.75$) and the strength of the correlation increased with increasing angular velocity. The results of this study indicated that individuals with higher proportions of type II muscle fibers were able maintain higher levels of force production at higher angular velocities over 100 degrees per second than those with lower percentages of type II muscle fibers. The findings also showed that the strength of the relationship between type II muscle fibers and peak torque increased as the tested angular velocity increased up to 400 degrees per second.

Inbar et al. [24] investigated the relationships between knee extension peak torque, muscle fiber type distribution, 40-m sprint time, and 300- and 2,000-m run times in trained and sedentary males between the ages of 16 and 35. Isokinetic knee extension was performed at an angular velocity of 180 degrees per second and 50 repetitions were completed. Maximal peak torque, average peak torque of the 50 repetitions, and the difference between maximal peak torque and lowest peak torque were calculated. The decline in peak torque was expressed as a percentage of maximal peak torque. Muscle biopsies were taken from the lateral portion of the vastus lateralis muscle. When trained and sedentary groups were combined, significant correlations were shown between 40-m running speed and average peak torque ($r = 0.47$), between 300-m running speed and average peak torque ($r = 0.47$) and peak torque decrease ($r = -0.62$), and between 2,000-m running speed and average peak torque ($r = 0.42$) and peak torque decrease ($r = -0.84$). Significant correlations were shown in trained subjects between 40-m running speed and maximal peak torque ($r = 0.58$) and peak torque decrease ($r = 0.74$). Significant

correlations were also shown in trained subjects between 300-m running speed and peak torque decrease ($r = 0.67$) and between 2000-m running speed and peak torque decrease ($r = -0.54$). In sedentary subjects, significant correlations were shown between 2000-m running speed and peak torque decrease ($r = -0.80$). No significant correlations were shown between 300- or 2,000-m running speeds and maximal or average peak torque in sedentary subjects. When expressed per unit of body weight, maximal peak torque was significantly related to 40-m ($r = 0.64$) and 300-m ($r = 0.47$) running speeds in trained subjects and to 2000-m ($r = 0.71$) running speed in sedentary subjects. When average peak torque was expressed per unit of body weight, it significantly correlated with 40-m sprint performance ($r = 0.52$) in trained subjects and with 2,000-m running speed ($r = 0.75$) in sedentary subjects. In trained subjects, the percentage of fast twitch muscle fibers was significantly related to maximal peak torque ($r = 0.52$), average peak torque ($r = 0.37$), and to peak torque decrease ($r = 0.67$). The proportion of fast twitch muscle fibers was also significantly related to 40-m running speed ($r = 0.73$) and 2,000-m run times ($r = -0.60$) in trained subjects. No significant relationships were shown between the proportion of fast twitch muscle fibers and running or sprinting performance in sedentary subjects. The results of this study indicated that isokinetic peak torque at 180 degrees per second is more related to sprinting and running performance in trained individuals than in sedentary individuals and that muscle fiber composition is more related to isokinetic peak torque and running and sprinting performance in trained individuals.

Thorstensson et al. [22] examined correlations between isokinetic knee extension peak torque relative to maximal voluntary contraction and the relative area of type II

muscle fibers. Muscle biopsies were obtained from the vastus lateralis. The subjects performed two maximal repetitions of isokinetic knee extensions at 15, 30, 60, 90, and 180 degrees per second. The subjects also performed isometric contractions at each angular velocity at knee angles of 90, 75, 60, 45, 30, and 15 degrees, respectively. Peak torque obtained from isometric contractions was used a reference value for each subject and peak torque for each tested angular velocity was expressed as a percentage of this value. The only significant correlation was between the relative area of type II muscle fibers and relative peak torque at 180 degrees per second ($r = 0.50$).

Suter et al. [25] developed a regression equation from the relationship between isokinetic measures and muscle fiber type distribution of the vastus lateralis. The subjects were 24 male and 7 female athletes and non-athletes. Subjects performed four isometric contractions at a joint angle of 120 degrees and the highest peak torque value was reported relative to fat free mass of the thigh. Subjects also performed four maximal repetitions of isokinetic knee extensions at 60, 90, 120, 200, 220, 240, 260, 280, and 300 degrees per second. Power was determined for each angular velocity and expressed relative to fat free mass of the thigh. A fatigue test was conducted in which 60 repetitions of knee extensions were performed at 90 degrees per second. The average torque values from repetitions 3-5, 13-15, 23-25, 33-35, 43-45, 53-55, and 57-59 were calculated and expressed relative to highest torque reached during the test. Significant correlations were shown between the proportion of type II muscle fibers and isometric peak torque ($r = 0.39$) and power at 200, 220, 240, 260, 280, and 300 degrees per second relative to fat free mass of the thigh with correlations ranging from 0.48 to 0.58. The strongest

correlation was shown between the percentage of type II muscle fibers and power at 260 degrees per second ($r = 0.58$). A negative correlation was found between the proportion of type II muscle fibers and relative torque from the fatigue test. The strength of the correlation increased with increasing test duration with the highest correlation was seen for repetitions 53-55 ($r = -0.64$). The following regression equations were developed:

$$\text{Type II fibers} = 52.239 - 0.533 (T^{55}) + 0.512 (P^{280}/\text{FFMT}), \quad [1]$$

$$\text{Type II fibers} = 50.563 - 0.436 (T^{55}) + 0.476 (P^{280}/\text{FFMT}), \quad [2]$$

T^{55} is the relative torque during the fatigue test after 53-55 contractions, P^{280} is the power at 280 degrees per second, and FFMT is the fat free mass of the thigh. Both equations were used to predict the proportion of type II muscle fibers of the study sample and results were compared to the values obtained from muscle biopsies. The root mean square errors of prediction was 8.1% for equation 1 and 11.0% for equation 2, indicating that equation 1 is slightly more accurate in predicting type II muscle fiber proportion.

Muscle Fiber Type Distribution

One possible explanation for the superiority of African-Americans in vertical jump and sprint running performance is a difference in muscle fiber type distribution. Previous studies have shown a trend in males of African descent possessing a higher percentage of type II muscle fibers than their Caucasian counterparts. Type II muscle fibers are also referred to as fast twitch muscle fibers due to their ability to rapidly generate peak tension. Type II muscle fibers have a larger cross sectional area and generate more absolute tension than type I muscle fibers and are recruited for high-

intensity, short duration activities like sprinting and jumping. Though they are capable of rapidly developing more tension than type I muscle fibers, their endurance capacity is very low due to their reliance on anaerobic pathways utilized by the muscle under contracting conditions. Due to the characteristics of type II muscle fibers, individuals possessing a higher proportion of this type of muscle fiber are better equipped for activities like sprinting and jumping.

Among the studies that have shown racial differences in muscle fiber type distribution is a study by Ama et al. [27]. They compared muscle characteristics of the vastus lateralis between 23 African male students from Senegal, Cameroon, Zaire, Ivory Coast, and Burundi and 23 Caucasian male students. Both groups were sedentary and the subjects were matched for age, height, body weight, and body mass index (BMI). The muscle biopsy from the vastus lateralis was histochemically stained for myofibrillar ATPase and the muscle fibers were identified as type I, type IIa, and type IIb. The results showed significant differences in the two groups in the proportion of type I and type IIa muscle fibers. The African subjects possessed 6.7% more type IIa muscle fibers, on average, and the Caucasian subjects possessed 8.3% more type I muscle fibers. Though the difference was not significant, the African subjects possessed 2.8% more type IIb muscle fibers on average than the Caucasian subjects. The African subjects also possessed significantly higher phosphagenic and glycolytic enzyme activities in the vastus lateralis than the Caucasian subjects.

Coetzer et al. [26] investigated possible mechanisms underlying the superior distance running performance in South African runners of African descent over those of

European descent. The subjects were South African elite distance runners of African (n = 11) and European (n = 9) descent. VO_2 max and blood lactate concentration were obtained from a maximal treadmill running test, running economy was determined, isometric quadriceps strength was measured, and muscle biopsies were obtained from the vastus lateralis muscle. The results showed that the athletes of African descent were able to maintain a significantly higher running speed and percentage of their VO_2 max than those of European descent. The athletes of European descent had 10% more type I muscle fibers although the difference was not statistically significant. The athletes of African descent possessed significantly less muscle mass and lower lean thigh volume. The athletes of European descent were also able to generate significantly higher isometric peak torque of the quadriceps and were slower to fatigue.

Duey et al. [28] examined muscle fiber type distribution and capillary density in untrained African-American (n = 14) and Caucasian college students (n = 14). Muscle biopsies were obtained from the vastus lateralis and stained for myosin ATPase and capillary density. Peak oxygen uptake was measured during a maximal, graded exercise test on a cycle ergometer. The African-American subjects possessed 3.4% and 4.5% more type IIa and IIb muscle fibers respectively, than Caucasian subjects. The Caucasian subjects possessed 5.4% more type I muscle fibers and 12 more capillaries per mm^2 than the African-American subjects. The slight differences in muscle fiber type distribution and capillary density between the two groups did not attain statistical significance.

Anthropometric Characteristics in African-Americans and Caucasians

Racial variation between African-Americans and Caucasians in anthropometric characteristics and correlations between these measures and motor performance have been examined in previous studies. Albert Marino [8] compared vertical jump height and gastrocnemius insertion relative to the height of the tibia in 40 African-American and 40 Caucasian high school, non-athlete males. A higher gastrocnemius insertion point is associated with larger gastrocnemius muscle fibers. The gastrocnemius is one of the major muscles involved in the vertical jump and success in this activity is dependent upon the ability of this muscle to generate force. A sliding caliper was used to determine gastrocnemius insertion while each subject stood on his toes. Significant differences between the 2 groups were shown in vertical jump height and gastrocnemius insertion. The African-American subjects jumped 9.19 cm higher than the Caucasian subjects on average. The point of insertion of the gastrocnemius was 6.5% higher on average in African-American than Caucasian subjects. No significant correlations were shown between vertical jump performance and gastrocnemius insertion in either of the 2 groups. The results of this study showed that the African-American subjects did have higher gastrocnemius insertion points and possibly larger gastrocnemius muscles.

Eleanor Metheny [39] compared various bodily proportion measures of 51 African-American and 51 Caucasian male college students. The anthropometric measures were the following: standing height, weight, sitting height, cervical height, supersternale height, tragion height, tibiale height, sphyrion height which is a distal point on the malleolus, ilium height, hip width, ilium width, anterior superior spine width,

posterior superior spine width, lumbale above or below posterior superior spine, shoulder width, upper arm length, forearm length, hand length, elbow width, knee width, chest width, chest depth, neck girth, upper arm girth, forearm girth, thigh girth, calf girth, foot length, foot width, heel to sphyrion, heel to proximal end of the first metatarsal, chest front fat, chest back fat, abdomen fat, and suprailiac fat. These measures were used to calculate the following: upper head height which is the standing height minus the tragion height, neck length, torso length which is the cervical height minus leg length, “chest slant” which is the cervical height minus the height of the supersternum, leg length, arm length, lower leg length, upper leg length, total fat, chest index which is the chest width divided by the depth of the chest, metatarsale to toe, which is the length of the foot minus the heel to the metatarsale, and ilium index which is the anterior superior spine width divided by the posterior superior spine width. Leg length is a particularly important factor in sprint running performance because running speed is the product of stride length and frequency and racial differences in this characteristic may partly explain the differences in sprinting ability. The Caucasian males were 2.12 cm taller on average than the African-American males. The difference in mean height was not significant, but in order to eliminate the influence of this difference on other measures, the investigator divided each measure by individual standing height and measures were expressed as percentages of standing heights. The African-American males weighed 2.54 kg more than the Caucasian males. The African-American males had longer arms, forearms, hands, legs, and feet, wider elbows, knees, and feet, greater arm, forearm, thigh, calf, neck girths, greater sphyrion height relative to body height, torso and neck length, chest

width, depth, and index, shoulder width, and ilium height than Caucasian males. The Caucasian males had greater upper leg and torso length, sitting height, upper head height, “chest slant”, hip width, ilium width, ilium index, and posterior superior spine width than African-American males.

Ronald Martin [9] compared anthropometric measurements of 50 African-American and 50 Caucasian male high school students and examined the relationships between these measures, vertical jump performance and isometric knee extension strength. The anthropometric measures were the following: height, weight, girths of the ankle, calf, and thigh, bi-iliac width, knee, ankle, and foot width, and foot, total leg, thigh, and lower leg lengths. Isometric knee extension was measured using cable tension. The subject performed two maximal trials with the knee flexed at 115 degrees. The best of the two trials was recorded. Vertical jump height was obtained from a jump and reach test in which the subject performed four jumps from a self-chosen starting position. The results showed no significant differences between the two groups in height, weight, ankle, calf, and thigh girths, and knee, ankle, and foot widths. The Caucasian males had significantly greater bi-iliac widths on average than the African-American subjects. The African-American subjects had significantly greater leg, upper and lower leg lengths, foot length, standing reach height, and vertical jump height on average than the Caucasian males. The difference between the two groups in vertical jump height was 5.36 cm. There were no significant differences between the two groups in isometric knee extension strength. Height, weight, ankle, calf, and thigh girths, knee, ankle, and foot widths, and bi-iliac width all significantly correlated to isometric knee extension strength. Total leg,

lower leg, and thigh lengths all significantly correlated with vertical jump performance ($r = 0.22, 0.28, \text{ and } 0.20$, respectively). A significant negative correlation was shown between bi-iliac width and vertical jump ($r = -0.21$). A significant correlation was also shown between isometric knee extension strength and vertical jump height ($r = 0.28$). The correlations between leg length, isometric knee extension and vertical jump height along with the greater leg lengths and isometric knee extension torque in African-Americans indicate that greater leg length or isometric knee extension strength could possibly explain the superiority of African-Americans in vertical jump performance.

Codwell [1] examined anthropometric measures in 505 African-American, 218 biracial, and 94 Caucasian high school males. The anthropometric measures were weight, stature, sitting height, leg length, and total span. No significant differences were shown between the two groups, but trends were shown. The African-American males had higher mean body weight, total span, and greater leg length than the Caucasian males. The Caucasian males had greater height and sitting height than the African-American males.

In summary, many studies have shown racial differences between African-American and Caucasians in motor performance, anthropometric measures, and muscle physiology. Most of the studies have shown that African-Americans surpass their Caucasian counterparts in vertical jump and sprint running performance. The mechanisms behind these racial differences in performance that have been investigated have yielded somewhat consistent results showing differences in the gastrocnemius insertion point, leg length and muscle fiber type distribution, but more definitive information is needed. While only one of the studies on muscle fiber type distribution

has shown significant differences, the other studies indicate a trend for African-Americans to have larger quantities of type II muscle fibers which may enable them to perform better on anaerobic activities. The above studies show that isokinetic testing is related to and can be used as a possible predictor of muscle fiber type distribution. The literature also shows that isokinetic testing is related to sprinting and vertical jump performance. Thus, racial differences in this measure may explain some of the variation in sprinting and jumping performance between the two groups.

CHAPTER 3: METHODS

Sample/Participants

The participants were 23 African-American and 27 Caucasian males between the ages of 18 and 30 years. All participants were recreationally active, and participated in physical activity at least two days per week. In order to take part, each participant had to have a body mass index (BMI) between 18 and 29 kg/m². Participants were recruited via flyers posted on campus. All participants were informed about the testing procedures and signed an informed consent form prior to taking part in the study (Appendix A). Study procedures were approved by the Institutional Review Board (IRB) before testing began.

Procedures

The protocol consisted of two days of testing. On the first day of testing, the test procedures were explained to the participant and an informed consent form was signed. A contact form was completed for the purpose of contacting the subject to schedule the second day of testing. The Behavior Risk Factor Surveillance Survey (BRFSS) Physical Activity module was completed to obtain information about moderate and vigorous physical activity levels (Appendix B). In addition to the BRFSS questionnaire, the subjects were asked if they participated in lower-body strength training and if so, how often they performed this activity (Appendix C). Body fat testing, vertical jump, and a 100-m dash were all completed on the first day of testing. The second day of testing consisted of unilateral isokinetic knee extension and flexion testing using the dominant leg.

Body Composition

Prior to body fat assessment, individual height was measured to the nearest millimeter using a stadiometer (Seca Corporation, Columbia MD). Body composition assessment was performed using the Bod Pod (Life Measurement Instruments, Concord, CA). The participant wore spandex shorts or swimwear for this measurement in order to ensure accuracy. The Bod Pod was calibrated and the subject was weighed on the Bod Pod electronic scale prior to entering into the chamber. The participant sat in the chamber for two to three trials. Each trial lasted approximately one minute and the subject was asked to remain as still as possible while maintaining a normal breathing pattern during the one-minute trials. The subject's body volume was measured and this value in combination with the subject's body weight was used to calculate body density. Body density was entered into the Siri equation in order to estimate body fat percentage. After body fat testing, mid-thigh circumference of the dominant leg was measured. The distance between the inguinal crease and proximal portion of the patella was measured and a site midway between the two was marked. Mid-thigh circumference was measured at the previously marked site.

Vertical Jump

Prior to the vertical jump test, the subject completed a warm-up which consisted of treadmill running at an intensity of 80% of age-predicted maximum heart rate. The total warm-up time was 5 minutes, including the time required to reach the previously specified intensity. A countermovement jump (CMJ) was used to assess vertical jump

performance. Standing reach height was measured using a stadiometer with the subject standing in plantar flexion reaching with the hand on the dominant side. Vertical jump was assessed using a Vertec vertical jump tester (Sports Imports, Hilliard, OH). The subject was instructed to stand with both feet flat on the floor with their dominant side facing the Vertec and to jump as high as possible with their dominant hand reaching up in order to push the levers on the device when they reach their highest position of vertical displacement. Three trials were performed and the best value was recorded and used to compute vertical jump power using the Lewis nomogram and the Sayers equation [34]. The Sayers equation for the CMJ has been validated in college-aged males and females against the use of a force-platform [34]. The formulas are as follows:

The Lewis Nomogram

$$\text{Power (kg}\cdot\text{m/s)} = \sqrt{4.9 \cdot \text{body weight (kg)} \cdot \text{distance jumped (m)}}$$

The Sayers Equation

$$\text{Power (W)} = 51.9 \cdot \text{CMJ height (cm)} + 48.9 \cdot \text{body mass (kg)} - 2007$$

100-meter Dash

The subject completed the 100-m dash on a 400-m outdoor, all-weather track. The starting and finishing points were clearly marked on the track and a standing start was used. The subject was instructed to assume the proper starting position standing with opposing arm and leg forward and to run from the start to the finish line as fast as possible after the starter pistol was fired. The sprint was timed by the investigator using a stopwatch. The investigator stood at the finish line and the timing was initiated when the

smoke from the starter pistol was visible and ended when the subject reached the finish line. Wind velocity was measured during the test using an anemometer (La Crosse Technology, La Crosse, WI) and the highest average wind velocity was recorded. Each subject performed one 100-m sprint trial.

Isokinetic Testing Procedures

On the second day of testing, isokinetic testing was performed on the Biodex System 3 (Biodex, Shirley, New York). The Biodex System 3 isokinetic dynamometer is a device which controls movement velocity and provides electronically controlled, accommodating resistance throughout the joint range of motion. Prior to testing, a site was marked on the lower portion of the dominant leg of each subject, two centimeters above the lateral malleolus. This was the point at which the limb-support pad on the isokinetic dynamometer was aligned. The Biodex System 3 was calibrated before each use with a known weight of 67.8-N·m to create torque on the shaft of the dynamometer, in accordance with the manufacturer's instructions. The participant was seated on the device with their upper body and dominant leg strapped to the seat. The shaft red dot on the dynamometer was aligned with the participant's lateral epicondyle, which was used as the anatomical landmark for the joint axis of rotation. The limb-support pad was then aligned with the previously marked site on the lower leg above the lateral malleolus and the lower leg was tightly fastened the pad. The range of motion limits were cleared and reset for each subject prior to testing. Gravity correction was performed at 30 degrees for each subject. The device weighed the dominant limb attached to the support pad in order

to correct for gravity. The subject performed three to five practice repetitions to become familiar with the device, followed by three maximal repetitions at 60, 120, 210, 300 and 400 degrees/second. Each repetition consisted of maximal knee extension followed by maximal knee flexion. There was a 1-minute rest period between each set of 3 repetitions to allow time for recovery. The investigator provided verbal encouragement throughout the trials and the highest torque was used for each angular velocity.

Data Analysis

Isokinetic peak torque values from each angular velocity were analyzed for differences between the two groups. In addition to peak torque, relative torque was calculated for 120, 210, 300 and 400 degrees per second by dividing each torque value by peak torque at 60 degrees per second. All relative torque values were expressed as a percentage of peak torque at 60 degrees per second. Relative torque values were calculated because Coyle et al. [23] observed positive correlations between relative torque at 115, 200, 287, and 400 degrees per second and the proportion of type II muscle fibers. Force-velocity curves for both groups were constructed based on relative torque values for both groups.

Physical activity data obtained from the BRFSS questionnaire were converted to MET·minutes per week using 4 METs for moderate intensity and 8 METs for vigorous intensity activity. Vertical jump power was calculated using both the Lewis and Sayers equations [34]. All data were normally distributed, and therefore, were analyzed using parametric statistical analyses. Mean differences in anthropometric measures, wind

velocity, and physical activity were assessed using independent samples t-tests. Significant differences between means in vertical jump height, vertical jump power using both equations, and sprint time were analyzed using a univariate analysis of covariance (ANCOVA). Mean differences in peak and relative torques were assessed by a multivariate analysis of variance (MANOVA). Body fat percentage was entered as a covariate in the ANCOVA and MANCOVA. In addition, wind velocity was entered as a covariate when assessing mean differences in sprint time due to the possible effect of wind velocity on sprint performance. Statistical significance for differences between the means was tested at the 0.05 level. Partial correlations controlling for body fat percentage were used to assess the correlations between sprint time, vertical jump performance, and isokinetic torques.

CHAPTER 4: RESULTS

Anthropometric characteristics and physical activity data are presented in Tables 1 and 2. There were no significant differences between the two groups in anthropometric measures or physical activity levels. African-Americans had a slightly higher mean BMI than Caucasians, although the difference was not statistically significant ($p = 0.173$). The proportion of subjects in each group that performed lower body strength training was 70%.

Table 1. Anthropometric Characteristics

	African-American (n = 23)	Caucasian (n = 27)	
	Mean (SD)	Mean (SD)	P
Age	22.4 (3.1)	22.1 (2.6)	0.699
Height (cm)	177.6 (7.0)	177.9 (6.7)	0.882
Weight (kg)	77.2 (12.3)	73.7 (10.6)	0.284
Body Mass Index (kg/m²)	24.5 (3.5)	23.2 (2.7)	0.173
Fat Free Mass (kg)	66.0 (9.7)	64.5 (8.0)	0.552
Body Fat %	14.0 (6.7)	12.0 (6.9)	0.284
Thigh Circumference (cm)	52.0 (5.9)	50.3 (4.4)	0.261

Table 2. Physical Activity

	African-American (n = 23)	Caucasian (n = 27)	
	Mean (SD)	Mean (SD)	P
Moderate MET·min/wk	1368 (1018.8)	1495 (1244.3)	0.702
Vigorous MET·min/wk	4600 (9463.6)	3377 (5725.8)	0.589
Total MET·min/wk	5969 (9469.5)	4622 (5797.9)	0.621
Strength Training days/wk	2 (.8)	2 (1.0)	0.687

Vertical Jump Performance

The results of the vertical jump group means are presented in Table 3. A main effect of race was significant for vertical jump height ($F(1,48) = 12.598, p < 0.01$) with African-Americans jumping 8 cm higher on average, than Caucasians. ANCOVA revealed a marginally significant effect of body fat percentage on jump height ($F(1,47) = 3.846, p = 0.056$). In controlling for body fat percentage, the difference in vertical jump height between the two groups remained significant ($p < 0.001$) as shown in Table 4.

Using the Lewis equation, the main effect of race on vertical jump power was not statistically significant ($F(1,47) = 3.669, p = 0.062$) and body fat percentage was significantly related to vertical jump power ($F(1,47) = 4.816, p < 0.05$). Using the Sayers equation, the main effect of race on vertical jump power was significant ($F(1,47) = 6.202, p < 0.05$) and body fat percentage was not significantly related to vertical jump power ($F(1,47) = 2.118, p = 0.152$).

Table 3. Vertical Jump Group Means

Race	African-American (n = 23)	Caucasian (n = 27)
	Mean (SD)	Mean (SD)
Jump Height (cm)	63.2 (6.9)	55.2 (8.7)
VJ Power (kg·m/s)	135.6 (22.0)	121.4 (23.5)
VJ Power (W)	5048.6 (689.4)	4461.0 (818.7)

Table 4. ANCOVA for Vertical Jump controlling for Body Fat%

Dependent Variable: Vertical Jump

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1027.5(a)	2	513.8	8.596	0.001
Intercept	41565.665	1	41565.665	695.429	0.000
Percent B.F.	229.896	1	229.896	3.846	0.056
Race	914.782	1	914.782	15.305	0.000
Error	2809.180	47	59.770		
Total	177240.652	50			
Corrected Total	3836.691	49			

a R Squared = 0.268 (Adjusted R Squared = 0.237)

Sprint Performance

The group means for 100-m sprint time and average wind velocity are shown in Table 5. An independent samples t-test showed no significant differences in wind velocity between the two groups ($t(48) = 1.421, p = 0.162$). ANOVA showed no significant main effect of race on sprint time ($F(1,48) = 2.458, p = 0.123$). The results of the ANCOVA controlling for body fat percentage and wind velocity are shown in Table 6. A significant effect of body fat percentage was shown on sprint time ($F(1,46) = 11.54, p < 0.01$). After controlling for body fat percentage and wind velocity, the difference in sprint time was significant ($F(1,46) = 5.78, p < 0.05$) and the adjusted marginal means were 13.19 and 13.7 seconds for African-Americans and Caucasians, respectively. The partial correlation between vertical jump height and sprint time after controlling for body fat percentage, is shown in Figure 1. There was a significant correlation between sprint time and vertical jump height ($r = -0.769, p < 0.001$) when controlling for body fat percentage.

Table 5. 100-m Sprint Time and Wind Velocity

Race	African-American (n = 23)	Caucasian (n = 27)
	Mean (SD)	Mean (SD)
Sprint time (s)	13.27 (.7)	13.63 (.9)
Wind velocity (mph)	1.50 (1.2)	1.03 (1.1)

Table 6. ANCOVA for Sprint Time controlling for Body Fat % and Wind Velocity

Dependent Variable: Sprint Time

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	8.506(a)	3	2.84	5.38	0.003
Intercept	1392.18	1	1392.18	2641.0	0.000
Percent B.F.	6.08	1	6.08	11.54	0.001
Wind Velocity	0.529	1	0.529	1.004	0.322
Race	3.05	1	3.05	5.78	0.02
Error	24.25	46	0.527		
Total	9100.22	50			
Corrected Total	32.76	49			

a R Squared = 0.26 (Adjusted R Squared = 0.211)

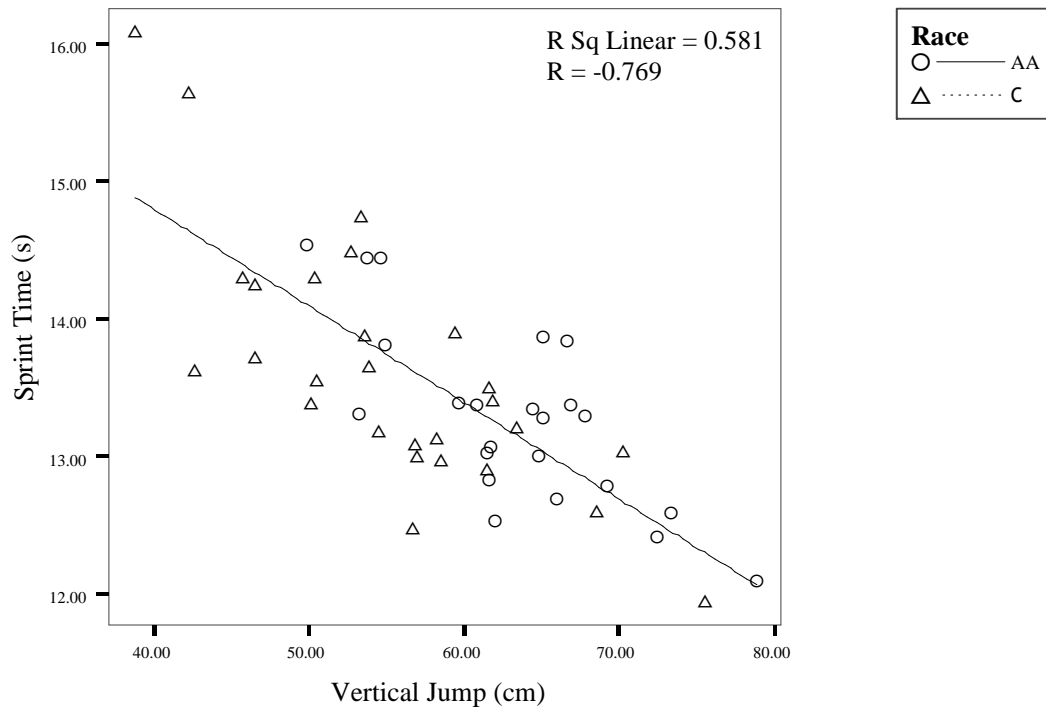


Figure 1. Correlation between Vertical Jump and Sprint Time

Isokinetic Strength

The group means for isokinetic extension and flexion peak torques are presented in Table 7. There were no significant differences between the two racial groups in extension ($F(5, 43) = 0.846, p = 0.525$) or flexion peak torques ($F(5, 44) = 1.844, p = 0.124$) at any angular velocities. MANCOVA revealed no significant effect of body fat percentage on isokinetic extension peak torque ($F(5,43) = 0.584, p = 0.712$) or flexion peak torque ($p = 0.124$). Therefore, body fat percentage was not entered as a covariate when comparing isokinetic torque means. African-Americans demonstrated a trend

Table 7. Isokinetic Peak Torque

Angular Velocity (°/s)	Peak Torque (N·m)		P
	African-American (n = 23)	Caucasian (n = 27)	
Extension	Mean (SD)	Mean (SD)	
60	217.691 (37.967)	209.844 (48.812)	0.534
120	188.813 (41.292)	174.03 (41.464)	0.214
210	149.991 (30.764)	140.844 (32.068)	0.311
300	133.687 (33.051)	119.537 (27.493)	0.105
400	117.891 (28.049)	103.956 (26.535)	0.078
Flexion			
60	121.183 (24.282)	128.093 (39.275)	0.468
120	117.313 (39.776)	104.763 (24.787)	0.180
210	87.126 (21.794)	90.152 (24.524)	0.649
300	82.087 (27.117)	78.056 (19.023)	0.541
400	88.830 (24.161)	80.541 (19.911)	0.190

towards higher peak torque than Caucasians for knee extension at 300 and 400 degrees per second ($p = 0.105$ and 0.078 respectively), although it was not statistically significant.

The group means for isokinetic extension and flexion relative torques are presented in Table 8. There were no significant differences between the two groups in extension ($F(4, 45) = 0.858$, $p = 0.497$) or flexion ($F(4, 45) = 2.198$, $p = 0.084$) relative torques at any angular velocities. African-Americans demonstrated a trend towards generating higher relative torque for knee flexion at 120 and 300 degrees per second ($p = 0.063$ and 0.107 , respectively).

Knee extension relative torque force-velocity curve for both groups are presented in Figure 2.

Correlation Coefficients between Vertical Jump Performance and Isokinetic Torque

Correlation coefficients between isokinetic peak torque, vertical jump, and 100-m sprint time for the entire sample are shown in Table 9. All partial correlations between isokinetic strength, vertical jump height and vertical jump power were controlled for body fat percentage due to the effect of body composition on sprint and vertical jump performance. There were no significant correlation coefficients between isokinetic peak or relative torques and vertical jump height. The highest correlation coefficient was between jump height and extension peak torque at 400 degrees per second ($r = 0.237$), although this was not statistically significant ($p = 0.101$).

Knee flexion relative torque force-velocity curves for both groups are presented in Figure 3.

Table 8. Isokinetic Relative Torque Group Means

Angular Velocity (°/s)	Relative Torque (Peak Torque/Peak Torque at 60°/s)		
	African-American (n = 23)	Caucasian (n = 27)	
Extension	Mean (SD)	Mean (SD)	P
120	.866 (.101)	.833 (.083)	0.209
210	.695 (.124)	.676 (.075)	0.520
300	.618 (.131)	.575 (.075)	0.155
400	.545 (.111)	.500 (.085)	0.108
Flexion			
120	.979 (.320)	.845 (.152)	0.063
210	.726 (.141)	.731 (.192)	0.919
300	.681 (.185)	.631 (.125)	0.267
400	.741 (.158)	.662 (.179)	0.107

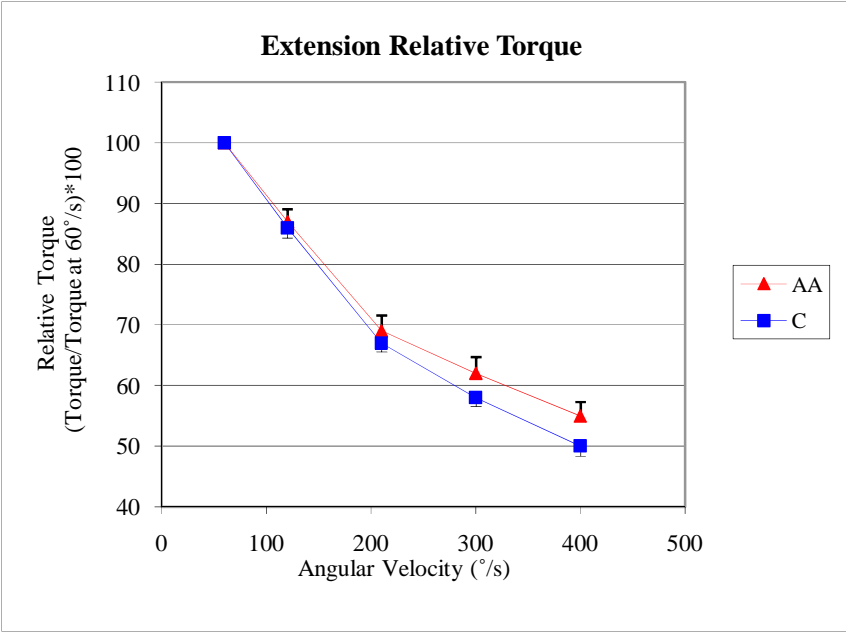


Figure 2. Isokinetic Extension Relative Torque Force-Velocity Curve

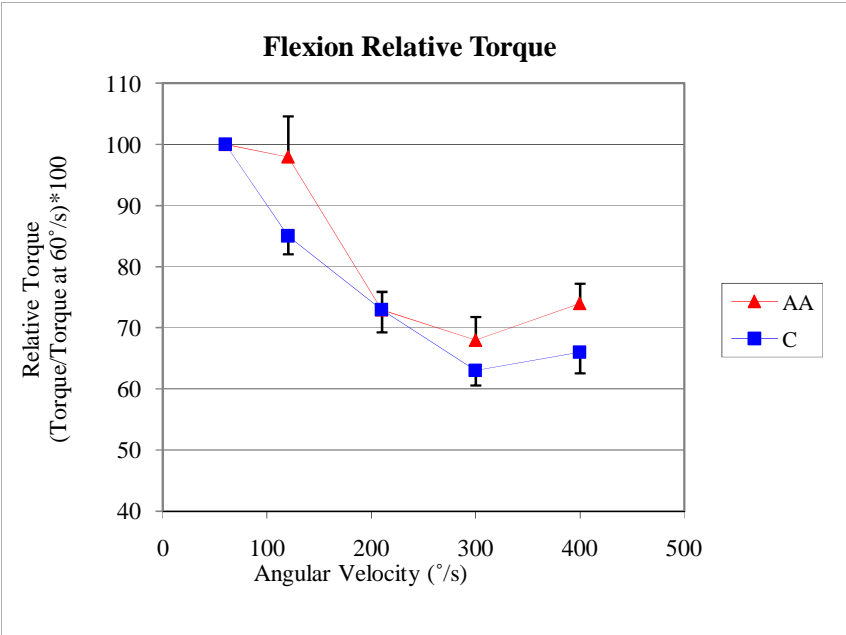


Figure 3. Isokinetic Flexion Relative Torque Force-Velocity Curve

Table 9. Partial Correlation Coefficients between Isokinetic Peak Torque, Vertical Jump Height and Power (Sayers Equation), and Sprint Time adjusted for Body Fat Percentage

Angular Velocity (°/s)	Vertical Jump Height	Vertical Jump Power	100-m Sprint Time
Extension Peak Torque			
60	0.148	0.340*	0.033
120	0.184	0.388**	-0.151
210	0.143	0.297*	-0.063
300	0.180	0.400**	-0.151
400	0.237	0.456**	-0.101
Flexion Peak Torque			
60	0.016	0.107	0.033
120	0.130	0.294*	-0.151
210	0.046	0.143	-0.063
300	0.148	0.293*	-0.151
400	0.147	0.335*	-0.101

* = $p < .05$

** = $p < .01$

When examining the groups individually, there were no significant correlations between vertical jump height and isokinetic torque in either of the groups. In African-Americans, a marginal correlation was shown between jump height and flexion peak torque at 210 degrees per second ($r = 0.41$, $p = 0.058$).

Vertical jump power calculated using both the Lewis and Sayers equations were significantly correlated to isokinetic knee extension peak torque at all angular velocities and knee flexion peak torque at 120, 300, and 400 degrees per second ($p < 0.05$). The correlation coefficients between isokinetic peak torque and vertical jump power using the Sayers equation are shown in Table 9. The correlation coefficients between jump power using both equations and knee flexion peak torque at 60 and 210 degrees per second were not significant.

In African-Americans, vertical jump power using the Sayers equation was significantly related to isokinetic knee extension peak torque at 60 ($r = 0.667$, $p < 0.01$), 120 ($r = 0.713$, $p < 0.001$), 210 ($r = 0.569$, $p < 0.01$), 300 ($r = 0.687$, $p < 0.001$), and 400 degrees per second ($r = 0.725$, $p < 0.001$). In African-Americans, isokinetic knee flexion peak torque was significantly related to vertical jump power using the Sayers equation at 60 ($r = 0.568$, $p < 0.01$), 120 ($r = 0.499$, $p < 0.05$), 210 ($r = 0.604$, $p < 0.01$), 300 ($r = 0.528$, $p < 0.05$), and 400 degrees per second ($r = 0.617$, $p < 0.01$). There were no significant correlations between relative torque and jump power in African-Americans. There were no significant correlations between isokinetic torque and vertical jump power in Caucasians.

Correlation coefficients between isokinetic relative torque, vertical jump performance, and 100-m sprint time were controlled for body fat percentage and are shown in Table 10. There were no significant correlation coefficients between vertical jump height or power and relative torque in extension or flexion.

Table 10. Partial Correlation Coefficients between Isokinetic Relative Torque, Vertical Jump Performance, and 100-m Sprint Time adjusted for Body Fat Percentage

Angular Velocity (°/s)	Vertical jump Height	Vertical Jump Power	100-m Sprint Time
Extension Relative Torque			
120	0.037	0.110	-0.049
210	0.000	-0.060	-0.128
300	0.021	0.111	-0.126
400	0.136	0.228	-0.256
Flexion Relative Torque			
120	0.142	0.190	-0.244
210	0.005	-0.005	-0.137
300	0.180	0.219	-0.268
400	0.196	0.223	-0.241

Correlation Coefficients between Sprint Time and Isokinetic Strength

There were no significant correlation coefficients between isokinetic extension peak or relative torque and sprint time. There were no significant correlation coefficients between sprint time and flexion peak or relative torque. There were marginal correlation coefficients between sprint time and extension relative torque at 400 degrees per second ($p = 0.076$) and flexion relative torque at 120, 300, and 400 degrees per second that did not reach statistical significance ($p = 0.091, 0.063, 0.095$, respectively).

When the groups were separated, significant correlations were shown in African-Americans between sprint time and flexion peak torque at 210 degrees per second ($r = -0.477, p < 0.05$) and between sprint time and flexion relative torque at 210 degrees per second ($r = -0.525, p < 0.05$). There were marginal correlations in African-Americans between sprint time and extension peak torque at 400 degrees per second ($r = -0.402, p = 0.062$). Marginal correlations were also shown in African-Americans between sprint time and flexion relative torque at 120 ($r = -0.372, p = 0.088$) and 300 degrees per second ($r = -0.356, p = 0.104$). There were no significant correlations between isokinetic torque and sprint time in Caucasians.

CHAPTER 5: DISCUSSION

The objectives of this study were to compare vertical jump, sprint running performance, and isokinetic strength at five angular velocities between African-American and Caucasian college-aged males and to determine if correlations existed between the anaerobic performance measures and isokinetic strength.

Vertical Jump Performance

African-American males jumped 8 cm higher on average than the Caucasian males. The results of this study coincide with the findings of several other studies [1, 6-11]. Barker et al. [11] compared vertical jump performance in college football players and found that African-Americans jumped 7.5 cm higher on average than Caucasians. They also found that the African-Americans had a significantly lower percentage of body fat and were significantly shorter than Caucasians. They did not control for body fat percentage or height and commented on the possible effect of body composition on their results. The authors stated that the lower body fat percentage of the African-Americans could have favorably influenced their vertical jump performance. They also suggested that a possible explanation for their superior performance could have been a higher percentage of type II muscle fibers and greater glycolytic enzyme concentrations. There were no significant differences in body composition between the two groups in this study. We chose to control for body fat percentage due to the significant effect of body fat percentage on vertical jump performance revealed by MANCOVA. Because there was

no difference in body composition between the two groups, it is unlikely that this explains the racial difference in vertical jump performance.

Using the Lewis equation, there was no significant difference between the two groups in vertical jump power. Barker et al. [11] also found no significant difference between African-Americans and Caucasians in vertical jump power using the Lewis equation, although the difference in vertical jump height was statistically significant. In contrast, Hunter [5] found that African-Americans were significantly more powerful than Caucasians in the vertical jump using this equation. Thus, there are conflicting results when comparing vertical jump power between African-Americans and Caucasians using the Lewis equation. It has been suggested that this equation significantly underestimates vertical jump power when compared with force-platform measurements of power [34]. It has however, been used in several studies as a calculation of muscular power.

Using the Sayers equation [34], the African-Americans were significantly more powerful in the vertical jump. These findings are not in agreement with those of Babel et al. [6] who found that, although Afro-Caribbeans jumped significantly higher than Caucasians, there was no significant difference in vertical jump power using this equation, between the two groups.

There are a few possible reasons for the difference in vertical jump performance. African-Americans may have a higher proportion of type II muscle fibers and higher glycolytic enzyme activities, both of which would enhance anaerobic performance. However, these variables were not measured in this study. Therefore, it cannot be concluded that muscle fiber type or enzyme activity are the reasons for the differences in

performance shown here. Another possibility is greater leg length among African-Americans, which has been found to significantly correlate with vertical jump performance [9]. Leg length was not measured in this study, but other studies have reported that African-Americans have greater leg lengths than Caucasians [9, 39].

Sprint Performance

The difference between African-Americans and Caucasians in 100-m sprint time was not significant until body fat percentage was entered as a covariate. Controlling for body fat percentage, African-Americans were significantly faster than Caucasians. To our knowledge, there are no other studies that have shown this racial difference in sprint running performance for a distance of 100 m. All other studies that have compared sprint performance have used distances of 50 m or less. The 100-m dash was chosen because it is a test of running speed whereas shorter dashes, like the 15-, 30-, or 40-m dashes, rely heavily on acceleration. The acceleration phase of a sprint may last up to 50 m for elite sprinters and the distance may be shorter for untrained individuals [40]. Therefore, we sought to compare running speed between African-Americans and Caucasians.

The significant effect of body fat percentage on sprint time is understandable. It is logical that increased body fat negatively impacts sprint running performance. There were no significant differences between the two racial groups in anthropometric characteristics and therefore, it is unlikely that body fat percentage impacted the results. One of the anthropometric factors that could have influenced the superior sprinting performance in African-Americans is longer leg length, which would result in greater

stride length. Metheny [39] showed that African-American male college students had greater leg lengths than Caucasians. This variable was not measured in this study and therefore, it cannot be concluded that this is the reason for the racial difference in sprint performance. Another possible explanation is a slightly higher percentage of type II muscle fibers among the African-American males, as shown by Duey et al. [28], which would lead to an enhanced ability of the muscles to rapidly generate tension rapidly.

Wind velocity was measured because tailwinds can assist runners during a sprinting event whereas headwinds impede running performance. A significant difference in this measure could have resulted in a difference in sprinting speed between the two groups. However, because there was no significant difference in wind velocity between the two groups, it is not likely that this accounted for the racial difference in running speed.

In any study on human performance, effort is a major factor influencing the results which cannot be directly measured. Perhaps the reason for the racial differences in vertical jump and sprint running performance is a difference in effort between the two groups. Due to the fact that this variable cannot be directly measured, it cannot be concluded that variability in effort caused the racial differences in performance.

Correlation between Vertical jump and 100-m dash

A significant relationship between vertical jump and sprint performance was shown with a correlation coefficient of -0.789. This corresponds with the findings of Young et al. [41], Jurimae [42], and Liebermann and Katz [13]. Young et al. [41] found

a correlation of -0.79 between vertical jump and maximum sprinting speed for a distance of 50 m. Jurimae [42] found a correlation of -0.472 between 100-m sprint time and vertical jump height. Liebermann and Katz [13] found a significant correlation of -0.882 between vertical jump and 20-m sprint performance. Sprinting and jumping are both activities which rely upon anaerobic energy pathways and are indicative of muscular power. The significant relationship between the two activities in this study and others is to be expected.

Isokinetic Testing Measures

There were no significant differences between African-Americans and Caucasians in isokinetic knee extension or flexion torques. Isokinetic torque was compared between the two groups in this study, based on the findings of Coyle et al. [23] that individuals with more than 50% type II muscle fibers were able to generate significantly higher relative torque (relative to torque generated at 57 degrees per second) than those with less than 50% type II muscle fibers. Since studies have shown a trend for Africans and African-Americans to possess a higher proportion of type II muscle fibers than Caucasians [26-28], it was hypothesized that they might also be able to generate more relative torque at the high angular velocities used by Coyle et al. [23].

In this study, both relative and peak torque values were compared between the two groups. Though none of the differences were significant, there was a trend for African-American males to generate higher knee extension peak torque at 300 and 400 degrees per second, knee extension relative torque at 400 degrees per second, and knee

flexion relative torque at 120 and 400 degrees per second. One of the reasons that these differences did not attain statistical significance could have been due to the sample size, particularly in the African-American group. With an increased sample size, some of the differences in isokinetic torque might have attained statistical significance.

African-Americans showed a trend towards generating higher isokinetic knee extension peak torque at 300 and 400 degrees per second, flexion peak torque at 400 degrees per second, and flexion relative torque at 120 and 400 degrees per second. Inbar et al. [24] showed a significant correlation between the percentage of type II muscle fibers and peak torque at 180 degrees per second. Based on the previous findings of Coyle et al. [23] and Inbar et al. [24], a possible explanation for the difference in relative and peak torques could be a slightly higher proportion of type II muscle fibers in African-Americans.

Coyle et al. [23] compared individuals with predominantly type II muscle fibers in the vastus lateralis to those with less than 50% type II muscle fibers and found that individuals with predominantly fast twitch fibers generated significantly higher relative torques. Studies have shown that West Africans possessed a significantly higher percentage of type IIA muscle fibers than Caucasian Americans and other individuals of African descent show a trend towards possessing higher proportions of type II muscle fibers [26-28]. The results of Ama et al. [27] and Duey et al. [28] showed that although Caucasians had a lower proportion of type II muscle fibers than Africans and African-Americans, both studies showed that Caucasians had more than 50% type II muscle fibers in the vastus lateralis muscle. The only study that showed that Caucasians possessed less

than 50% type II muscle fibers was Coetzer et al. [26] who compared South Africans of African and European descent. Thus, an explanation for the marginal differences between African-Americans and Caucasians in isokinetic torque of the leg muscles is that both groups have a preponderance of type II muscle fibers.

Correlations between Isokinetic Torque and Vertical Jump

There were no significant correlations between isokinetic torque and vertical jump height. This contradicts the findings of other studies. Bosco et al. [12] found strong correlations between countermovement jump, the version of the vertical jump test employed in this study, and isokinetic peak torque in male athletes at 120, 179.9, and 240 degrees per second with correlation coefficients ranging from $r = 0.65$ to 0.74 .

Liebermann and Katz [13] found significant correlations between vertical jump and isokinetic knee extension power in young men and women at 120, 180, and 240 degrees per second with the highest correlation shown at 180 degrees per second. The only correlation that seemed to approach statistical significance was between vertical jump and isokinetic knee extension peak torque at 400 degrees per second with a correlation coefficient of 0.237 .

There were significant correlations between isokinetic knee extension and flexion peak torques and vertical jump power calculated using both equations. All angular velocities tested during knee extension showed significant correlations to vertical jump power in the entire sample and in African-Americans. The results indicated that muscular strength, both at slow and faster velocities of movement is related to vertical

jump power. Although the racial differences in isokinetic peak torque were not significant, a trend was shown for African-Americans to produce higher peak knee extension peak torque at 300 and 400 degrees per second. This trend may account for some of the variability in vertical jump performance between the two groups.

Correlations between Isokinetic Torque and 100-m Dash

There were no significant correlations between isokinetic torque and 100-m sprint times in the entire sample. The correlations between isokinetic knee flexion relative torque and 100-m sprint time approached statistical significance at angular velocities of 120, 300 and 400 degrees per second with correlation coefficients of -0.244, -0.268, and -0.241, respectively. The strongest correlation was shown at 300 degrees per second ($p = 0.063$), though this was still not significant. Our findings are consistent with the findings of Farrar and Thornland [37]. They examined correlations between 40-yd and 100-yd sprint performance and isokinetic leg extension and flexion peak and relative torques at 60 and 300 degrees per second in college-aged males and found no significant correlations.

However, in African-Americans, isokinetic peak and relative torques were significantly related to 100-m sprint time. Dowson et al. [18] found significant correlations between 30-35-m sprint time and isokinetic knee extension and flexion at 60, 150, and 240 degrees per second. The strength of the correlation increased with increasing angular velocity. Kano et al. [17] found significant correlations between isokinetic knee extension and flexion peak torque and 100-m sprint time. Alexander [36]

found significant correlations between isokinetic peak torque at 230 degrees per second and 100-m sprint time.

Our findings suggest that there is not a strong relationship between muscular strength and 100-m sprint time in college-aged males. Though Kano et al. [17] and Alexander [36] found significant correlations between 100-m sprint time and isokinetic peak torque, both studies investigated this relationship among athletes including elite sprinters and rugby players. Thus, the correlation between 100-m sprint time and muscular strength may only exist in trained groups of individuals. It has been suggested that commercially available isokinetic dynamometers can only reach 20-30% of maximum physiological movement velocity [43]. This could also account for the lack of correlation between isokinetic torque and sprint performance. If the isokinetic dynamometer was able to attain the same angular velocities reached while sprinting, the correlations between peak torque and sprint time might have been stronger.

Summary

African-American college-age males performed better in the vertical jump and 100-m dash, after controlling for body fat percentage. There were no significant differences between the two groups in isokinetic torque. However, African-Americans showed a trend towards producing higher peak torques in extension at 300 and 400 degrees per second. In the whole sample, isokinetic knee extension and flexion peak torque correlated with vertical jump power, but not with vertical jump height. In conclusion, this study found some support for the hypothesis that superior vertical jump

performance in African-American males is related to the force-velocity characteristics of the knee extensors and knee flexors. However, a physiological basis for the faster sprint speeds previously reported for African-Americans could not be identified.

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Appendices

Appendix A: Informed Consent

Strength and Power of the Quadriceps and Hamstrings Muscle Groups in College-Aged Males

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Purpose: Muscular strength is an important measure of physical fitness and is associated with successful performance of particular activities like running, jumping and various sports that involve these activities. The purpose of this study is to measure leg muscle strength and power. If you choose to participate in this study, you will visit the Applied Physiology Laboratory and during this visit, the procedures will be explained to you in detail. You must be 18 to 30 years old and a non-varsity athlete to participate in this research study. The details are described below.

Testing Procedures: You will visit the Applied Physiology Laboratory and your height and weight will be measured. Your legs will be marked just above the ankle and you will then be interviewed by the researcher. This interview will include questions about your physical activity during the previous 7 days. You will then do a 5-minute warm-up which will consist of running on a treadmill inside the Applied Physiology Laboratory. You will be escorted to the Biomechanics Laboratory where you will perform a vertical jump test in which you will be instructed to jump as high as you can while touching the highest point on the Vertec vertical jump testing device that you are able to reach. You will perform this test 3 times and your highest jump will be recorded. You will then be escorted to the Tom Black Track where you will perform a 100-meter dash once. You will then go to the Neyland-Thompson Athletic Training Room where you will perform leg extension and flexion exercises on the isokinetic dynamometer. This device is set up much like a seated leg curl or a leg extension machine in a fitness center and will control the speed at which you are extending and flexing your legs while you press against it as hard as you can. You will perform 2 maximal trials of extension and flexion on both legs at 4 speeds, with a 1-minute rest period between each trial. The total time involvement for this study is 1 and a half hours.

Potential Risks: The risks involved include a loss of confidentiality and possible muscle soreness or injuries resulting from the running and jumping tests. To decrease the possibility of muscle soreness, you will perform a 5-minute warm-up which will consist of running at 80% of your age-predicted maximum heart rate before performing any of the tests.

Benefits of Participation: You will be given a copy of your test results as well as information about suggested norms for the vertical jump and the 100-meter dash. You will also be given a printout which will include your leg strength values as well as differences in strength between your quadriceps and hamstrings muscles of the thighs.

Confidentiality: To protect your confidentiality, you will be assigned an identification number and your name will not be linked with your test results. None of your results will be provided to others without your written consent. Though it is the intention of the researchers to publish the results of this study, your identity will not be disclosed.

Compensation: No compensation is provided.

Emergency Medical Treatment: In the event of an injury, the University of Tennessee does not automatically reimburse participants for medical claims or other compensation. If physical injury is suffered during the course of this research, or for more information, please notify the investigators, Stacy Hunter at 974-8768 or Dr. David Bassett at 974-8766.

Contact Information: If you have questions about your participation in this study, you may contact the principal investigator, Stacy Hunter at 974-8768. If you have questions about your rights as a research participant, contact the University of Tennessee Office of Research Compliance Office at 974-3466.

Voluntary Participation: Your participation in this study is voluntary and you may withdraw from this study at any point. If you withdraw from this study prior to completing your data collection, your data will be destroyed.

Consent: I have read the above information. I have received a copy of this form. I agree to participate in this study. Researchers may keep my confidential contact information in the event that follow-up studies are conducted in subsequent years.

Participant's Signature: _____ Date _____

Investigator's Signature: _____ Date _____

Appendix B: Behavioral Risk Factor Surveillance Survey Physical Activity Module



Please read:

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

18.2 Now, thinking about the moderate activities you do [fill in “when you are not working” if “employed” or self-employed”] in a usual week, do you do moderate activities for at least 10 minutes at a time, such as brisk walking, bicycling, vacuuming, gardening, or anything else that causes some increase in breathing or heart rate? (177)

- 1 Yes
- 2 No [Go to Q18.5]
- 7 Don't know / Not sure [Go to Q18.5]
- 9 Refused [Go to Q18.5]

18.3 How many days per week do you do these moderate activities for at least 10 minutes at a time? (178-179)

- __ Days per week
- 8 8 Do not do any moderate physical activity for at least 10 minutes at a time [Go to Q18.5]
- 7 7 Don't know / Not sure [Go to Q18.5]
- 9 9 Refused [Go to Q18.5]

18.4 On days when you do moderate activities for at least 10 minutes at a time, how much total time per day do you spend doing these activities? (180-182)

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

18.5 Now, thinking about the vigorous activities you do [fill in “when you are not working” if “employed” or “self-employed”] in a usual week, do you do vigorous activities for at least 10 minutes at a time, such as running, aerobics, heavy yard work, or anything else that causes large increases in breathing or heart rate? (183)

- 1 Yes
- 2 No [Go to next section]
- 7 Don't know / Not sure [Go to next section]
- 9 Refused [Go to next section]

18.6 How many days per week do you do these vigorous activities for at least 10 minutes at a time? (184-185)

- __ Days per week
- 8 8 Do not do any vigorous physical activity for at least 10 minutes at a time [Go to next section]
- 7 7 Don't know / Not sure [Go to next section]
- 9 9 Refused [Go to next section]



18.7

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

(186-188)

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

Appendix C: Strength Training Questions

Do you participate in lower body strength training exercises?

If so, how many days per week?

Vita

Stacy Hunter was born in Charleston, South Carolina, on October 9, 1979. She graduated from high school in 1997 and attended the University of North Carolina at Charlotte until December, 1999. She took four years off from school and came home to work full time. During that period, she obtained the American College of Sports Medicine Health Fitness Instructor certification and began her personal training career in 2003. She has trained in fitness centers and in the homes of clients. In 2006, she graduated from the College of Charleston with a Bachelor of Science degree in Physical Education with a concentration in Exercise Science. She obtained a graduate teaching assistantship at the University of Tennessee, Knoxville, in 2006 where she began the Masters of Science program in Exercise Physiology. She has worked as a graduate teaching assistant and a personal trainer during her time here in Knoxville. She has also conducted seminars in health and fitness at a local church. Her research interests include racial differences in physiology, performance, and exercise response. She began this study in 2007 working with Dr. Bassett.