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Correlates of body composition and motor performance variables of University of Ilorin male handball players

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Abstract
Motor performance is crucial for high-level performance in handball but the individual players' body composition determines the attainment of the enormous physical, psychological, technical and tactical demands required for team success. The study examined the correlates of body composition and motor performance variables of university of Ilorin male handball players. The descriptive correlational research design was adopted. All the 14 University of Ilorin male handball players were purposively selected for the study. Standardised instruments: non-elastic tape rule, weight scale, height scale, cones, whistle, measuring tape and stopwatch were used for data collection. Prior to data collection the weight scale and stopwatch were recalibrated while a pilot study was conducted to ascertain the reliability of the instrument. A Spearman rho of 0.89 was obtained as a confirmation of the instruments reliability. The data was analyzed using percentages, means, standard deviation and Pearson Product Moment Correlation at 0.05 alpha level. The study found moderate to high correlation of body composition with speed, agility and muscular endurance of University of Ilorin handball players. It was recommended that periodic assessment of body composition of the University of Ilorin male handball team should be included as part of the training requirement in other to maintain normal fat mass and fat-free mass for high-level performance.

Introduction

Handball is a sport that integrates complex intermittent bouts of activities, which require players to have general and specific aerobic and anaerobic adaptations for the sport. Several studies (Bakinde, 2014) lay emphasis on motor abilities such as sprinting, jumping, flexibility, agility and co-ordination as necessary parameters for high performance of individual player and the entire team.

Handball game requires comprehensive skills, including physical, technical, mental, and tactical abilities. Among them, physical abilities exert marked effects on the skill of the players and the tactics of the team. Since ball games demand repeated maximum exertion such as dashing and jumping, players must therefore have physical abilities to complete rapid and powerful movements (Bakinde, 2014). Jayakumar and Chittibabu (2014) also observed that playing handball involves a wide range of skills and movements during which the player constantly makes sudden stops, turns, jumps, pivots, sprints fakes, hits, blocks and pushes. It is therefore important that handball players must be proficient in a combination of jumping, throwing and sprinting to execute these fundamental skills.

Body composition, which refers to the relative percentages of fat and fat-free tissues, is considered one of the major component of physical fitness for athletes' performance. Fat mass consist of essential and nonessential fat. Essential fats are lipids incorporated into tissues and organs like brain, kidney, heart, lungs, liver and mammary glands. Non-essential fats are primarily located within the adipose tissues. Fat-free mass include the bones, muscles, water, connective tissues, organ tissues and teeth (Brooks, Fahey, White & Baldwin, 2000). The amount of fat mass in general population is determined by age, gender, genetics, nutrition and physical activity level. The more fat-free mass the better an athlete will be able to perform. In most cases changes in body composition of athletes is determined by fat deposition, which is due mainly to nutrition and level of activity.

According to Ramos-Campo, Sanchez, Garcia, Arias, Cerezal, Clemente-Suarez, and Diaz (2014), excessive fat mass acts as a dead body mass which impedes activities during locomotion and jumping, decreases performance and increases energy demands. The size of muscles contributes to the energy production, accounts for increase in absolute strength and power for activities such as jumping to shoot at goal or sprinting around the court during games. Nikolaos, Dimitrios, Charalambos, Theodoros, Savvas, Aggelos and Konstantinos (2014) reported a significant correlation between body composition and athletic performance in high-level handball players. Therefore, greater attention should be given to continuous monitoring of body composition in order to regulate training processes and related issues that positively affect the top performers in handball.

Although, other motor performance variables contribute to excellence in handball, several researchers rank agility, speed and muscular strength, among the top motor performance variables that ultimately contribute to proficiency in execution of skills and of course winning of championships (Hennassi, 2014)

Agility is defined as a rapid whole-body movement with changes of velocity or direction in response to a stimulus. It is an important motor ability in sports involving multi-directional changes of direction such as rugby, football, tennis, basketball and handball (Chatzopoulos, Galazoulas, Patikas, & Kotzamanidis, 2014). A significant proportion of real-sport-agility depends on quick and accurate responses to stimuli specific to sport environments (Spasic, Krolo, Zenic, Delextrat, & Sekulic, 2015). The change of direction of actions during handball games can be categorized into actions requiring acceleration, power, flexibility, endurance and maximal speed, or agility.

Hermassi (2014) opined that agility is the most important motor performance factor that discriminates between elite and sub-elite youth handball players. The capacity of handball players to produce varied agility and speed actions is essential for winning or conceding, ball possession and significantly influences performance in handball matches.

Speed is the ability to move the body in one intended direction as fast as possible. It is the product of stride rate and stride length. Although certain aspects of speed are dependent on genetic factors, it is a motor performance variable that can be learned through an integrated training program (Mark, Lucett & Sutton, 2012). The bulk of high intensity runs and action in handball depends on speed. These high intensity runs and actions (such as jumps, stops, changes of direction, duels and sprinting to win a ball or sprinting during counter-attacks) are generally crucial for game outcomes and have significant physiological effects. For example, they can trigger neuromuscular fatigue or inflammatory responses and can deplete glycogen when repeated (Karcher & Buchheit, 2014). In order to minimize the physiological effect and extend glycogen threshold of athletes, speed may be improved with proper core strength, plyometrics training, and technique.

Muscular Endurance is the ability of a muscle or group of muscles to sustain repeated contractions against a resistance for an extended period of time (Brooks, Fahey, White & Baldwin, 2000). Muscular endurance is a prerequisite for power - the ability to exert force rapidly. Strong, powerful muscles are important for the smooth execution of skills in sports. For example, handball players can execute skills like jumping, pivoting, sprinting and blocking with greater ease and effectiveness. Souza, Gomes, Leme and Silva (2006) noted that variables, which determine the physical performance in high response of intermittent sports, depend on the energy production, especially on the anaerobic system and the muscle capacity for energy utilization.

This implies that handball game demands a high development of the anaerobic power, since it influences the performance of the velocity and strength capacities. A handball player's energy requirement will hence be mainly the ATP-PC and glycolytic energy system to provide for the muscles with about 20% oxidative energy system for cardiorespiratory endurance.

Handball is a very versatile game that demands enormous physical, psychological, technical and tactical demands, but players' physical fitness components such as body composition, muscular strength, speed, aerobic power, anaerobic power and agility directly determine the level of demand that can be put on their technical, tactical and psychological abilities (Bakinde, 2014). Prior to NUGA and other tertiary institutions competitions, the University of Ilorin handball team undergoes rigorous training in order to develop these capabilities but it has not been able to perform well in the tournaments.

This poor performance has been a major concern to University of Ilorin Sport Council, coaches and the fans of the team. Most of the related researches conducted on University of Ilorin handball players where centred on performance, facilities and injury but few have addressed the relationship between body composition and motor performance variables. Evidence based researches elsewhere, however proves that performance in tasks involving body movement through space is negatively affected by high body fat (van Buuren, Cocks, Maluleke & Cruger, 2015). This is because fat is not a contractile tissue, and it represents extra weight that athletes carry during movement. Athletes with high fat free mass and low fat mass are known to perform better in tasks that require the kind of movement typical of handball. Fat free mass is important for production of speed, agility, coordination, strength, power as well as minimize injuries. This research would provide knowledge in this area by studying the correlates of body composition and motor performance variables of University of Ilorin male handball players.

The objective of this study was to determine the correlation between body composition and motor performance variables of University of Ilorin male handball players. To reach that objective, some research questions guided this study as follow:

1. What are the body composition and motor performance variables of University of Ilorin male handball players'?

2. What are the correlations among body composition and motor performance variables of University of Ilorin male handball players?

Methodology

This study adopted descriptive correlation research design. The population comprised 14 University of Ilorin male handball players were selected using purposive sampling technique. Standardised instruments such as non-elastic tape rule, weight scale, height scale, cones, whistle and stopwatch were used. Non-elastic tape was used to measure circumferences; weight scale was used to measure weight to the nearest 0.1kg, height scale to measure height to the nearest 0.1m and stopwatch for timing in seconds. The measuring tape was used to measure the area for the test, cones were used to mark the test area and whistle was used to indicate the start or end of test.

Prior to data collection the weight scale and stopwatch were calibrated while a pilot study was conducted to ensure familiarity as well as reliability of the instruments. A Spearman rho of 0.89 was obtained as a confirmation of the instruments reliability. The data collection lasted for two weeks. Three research assistants were initially trained for three days before data collection. The participants were informed about the procedure, benefit and risk of the study and informed consent form was given to them, it was signed and returned before participating in the study. The first stage of the study was measurement of body composition variables and the second consisted of motor performance testing.

Measurement of Body Composition Variables

The participants were instructed to drop all personal effects, empty the their pockets, wear light clothing and take off their shoes before the measurements in order to avoid wrong readings of measurement values. The measurements were taken while the participant stood with arms at the sides, feet positioned close together, and weight evenly distributed across the feet. Each measurement was done thrice and the average was recorded. The measurement were taken in the following order:

1. Height/Stature: Height was measured to the nearest 0.1m using metre rule marked in centimetre and metre.
2. Weight: This was measured to the nearest 0.1kg using the weight scale. The participants were instructed to mount the weight scale and the reading was taken.
3. Waist circumference: This was measured to the nearest 0.1cm using non-flexible tape at the narrowest point between the bottom rib and the iliac crest, in the mid-axillary plane. If there was no obvious narrowing the mid-point between these two landmarks were used (Yildirim, Arundell & Cerin 2014). The participants were asked to relax and take a few deep, natural breaths before the actual measurement was taken, to minimize the inward pull of the abdominal contents during the waist circumference measurement.
4. Hip circumference: This measurement was taken to the nearest 0.1 cm around the widest portion of the buttocks.
5. Waist-to-hip ratio (WHR): This was calculated as the ratio of waist circumference and hip circumference. For both waist and hip, the tape was snug around the body parallel to the floor at the level at which the measurement was made. The tape was not pulled tightly in other to avoid constriction.

6. Body Mass Index (BMI): BMI was calculated as $\frac{weight\ (kg)}{height\ (m^2)}$ (i.e. by dividing weight in kilogram (kg) by height in metre squared (m^2).
7. Rating for Body Composition

Table 1

Reference cut-off points for Waist Circumference (WC)

Indicator	Gender		Risk of Level
	Male	Female	
Waist Circumference	<80 cm	<70cm	Very Low
	80-99cm	70-89cm	Low
	100-120cm	90-110cm	High
	>120cm	>110cm	Very High

Source: America College of Sport Medicine (ACSM, 2014)

Table 2

Reference cut-off for Body Mass Index (BMI)

Classification	Principal Cut-off Points BMI(kg/m^2)
Underweight	<18.50
Severe thinness	<16.00
Moderate thinness	16.00 — 16.99
Mild thinness	17.00 — 18.49
Normal range	18.50 — 24.99
Overweight	>25.00
Pre-obese	25.10 — 29.99
Obese class I	30.00-34.99
Obese class II	35.00-39.99
Obese class III	>40.00

Source: World Health Organization (2011)

Table 3

Reference cut-off for Waist-to-Hi Ratio (WHR)

Indicator	Gender		Risk of Level
	Male	**Female**	
Waist-to-Hip Ratio	>0.90cm	>0.85	Substantially increased

Source: World Health Organization (2011)

Motor Performance Testing

Each test was conducted with intervals of two days to allow full recovery and to control for the effect of fatigue from the proceeding test. Participants were also given time on separate days to practice in order to get them familiar with the test procedure and each test was preceded with a 10 minutes warm up and 5 minutes warm down. The following tests were conducted to test the motor performance of the participants.

Test of Agility

1. Type of Test: Illinois agility test
2. Purpose: To determine the ability to accelerate, decelerate, turn in different directions, and run at different angles in the shortest possible time.

3. Equipment Required: Flat non-slip surface, whistle, marking cones, stopwatch and measuring tape.
4. Description: The length of the course is 10 meters and the width (distance between the start and finish points) is 5 meters. Four cones are used to mark the start, finish and the two turning points. Another four cones are placed down the center an equal distance apart. Each cone in the center is spaced 3.3 meters apart.
5. Procedure: Subjects lied on their front (head to the start line) and hands by their shoulders. At the blast of whistle signaling the start of the test, the stopwatch is started, and the athlete gets up as quickly as possible and runs around the cone in the direction indicated, without knocking the cones over, to the finish line, at which the timing is stopped.
6. Results: Rating scores for the test is shown in table 4.

Table 4
Illinois Agility Run Rating (in secs)

Rating	Males	Females
Excellent	<15.2 secs	<17.0 secs
Good	16.1 - 15.2 secs	17.9 - 17.0 secs
Average	18.1 - 16.2 secs	21.7 - 18.0 secs
Fair	18.3 -18.2 secs	23.0 - 21.8 secs
Poor	>18.3 secs	>23.0 secs

Source: Ashok, (2008).

Test of Muscular Endurance

1. Type of Test: Push-up test.
2. Purpose: The purpose of the Push- Up test is to assess the endurance of the athlete's upper body muscles.
3. Equipment Required: Flat non-slip surface, whistle, stopwatch and measuring tape.
4. Procedure: The participants lied on the floor with hands shoulder width apart and fully extended. At the blast of whistle signaling the start of the test, they lower their body until the elbows reach 90° and returns to the starting position with the arms fully extended. The toes were placed shoulder width apart and held in position while the push up action continues without rest as the participant tried to complete as many repetitions as possible within 60 seconds.
5. Results: Rating scores for the test is shown in table 5.

Table 5
Push up rating for male (in one minute)

Age (in	**Excellent**	**Good**	**Average**	**Fair**	**Poor**
20 – 29	>54 reps	45 — 54 reps	35 -44 reps	20 —34 reps	<20 reps
30 – 39	>44 reps	35 — 44 reps	25 —34 reps	15 —24 reps	<15 reps
40 – 49	>39 reps	30 — 39 reps	20 — 29 reps	12 - 19 reps	<12 reps
50 – 59	>34 reps	25 —34 reps	15 — 24 reps	8 -14 reps	<8 reps
60+	>29 reps	20 — 29 reps	10 — 19 reps	5-9 reps	<5 reps

Source: Ashok, (2008)

Test of Speed

1. Type of Test: 50 metres dash. The test involved running a single maximum sprint over 50 metres, with the time recorded in seconds.

2. Equipment Required: Flat non-slip surface, whistle, marking cones, stopwatch and measuring tape.
3. Purpose: To determine the player's maximum sprint speed and the ability to accelerate from a stationary position.
4. Procedure: The start was from a stationary standing position, with one foot in front of the other. The participants' front foot was placed behind the starting line. This starting position was held for two seconds prior to starting, and no rocking movements were allowed. The researcher provided hints for maximizing speed (such as keeping low, driving hard with the arms and legs) and encouraged participants to continue running hard through the finish line.
5. Results: The time elapsed was recorded using stopwatch.

Data Analysis

The Statistical Package for Social Science (SPSS) version 20 software was used for data analysis. Mean and standard deviation were used to describe the physical, body composition and motor performance variables of the participants. Pearson Product Moment Correlation (PPMC) was used to test the hypotheses at 0.05 alpha level.

Results

Table 6

Description of pysical and body composition variables of University of Ilorin male handball players

VARIABLES	Age	Height (metre)	Weight	Waist Circumferen (cm)	Waist to Hip Ratio	Body Index (Kg/m²)
N	14	14	14	14	14	14
Minimum	18	1.67	56.9	70	0.77	18.5
Maximum	27	1.87	77.0	86	0.96	24.8
M±SD	22.85+2.	1.73=0.0	64.96=5.9	78.46+4.54	0.84±0.0	21.65+1.9

Table 6 present descriptive data on physical and body composition variables of University of Ilorin Male handball players. Their age ranged between 18 and 27 years with a Mean and standard deviation of 22.85±2.70 years. The tallest among them was 1.87m, while the shortest 1.67m and the Mean and standard deviation of the height were 1.73±0.06 metres. The result obtained for body composition variables reveal that they have a Mean and standard deviation for weight were 64.9±5.96kg. The heaviest player weighs 77kg and the lightest player weighs 56.91(2. Their waist circumference ranged between 70cm and 80cm with a Mean and standard deviation of 78.46±4.54cm. They had a Mean and standard deviation waist-to-hip ratio of 0.84±0.05. the highest was 0.96 and the lowest was 0.77. Their Body Mass Index (BMI) ranged between 18.5 and 24.8kg/m^2, the Mean and Standard deviation were 21.65±1.95. Considering the reference cut-off in tables 1, 2 and 3 this result implies that all the players had normal body fat mass as indicated from their scores in waist circumferences, waist—to—hip circumferences and BMI respectively.

A description of motor performance variables of University of Ilorin male handball players was presented in table 7. In the 50-metre dash test for speed, the participants had a Mean and Standard deviation score of 6.03±.42 seconds; the fastest participant completed the test in 5.5 seconds while the slowest participant completed it in 6.8 seconds. Their Mean and Standard deviation score in the Illinois agility test was 13.41+.79 seconds; the mostagile participant completed the test in 11.6 seconds while the least agile participant completed it in 14.5 seconds. The sit up test for muscular strength shows a Mean and Standard deviation score of 51.46+5.77 repetitions per minute; the best score was 61 repetitions per minute and the least score was 44 repetitions per minute. Considering the scoring standard in tables 4 and 5, this result is an indication that the University of Ilorin male handball players have good muscular strength and excellent agility for the sport.

Table 7

Description of Motor Performance Variable of University of Ilorin Male Handball Players

VARIABLES	Speed (50 metres dash in secs)	Agility (Illinois test in secs)	Muscular strength (push up in reps per min)
N	14	14	14
Maximum	6.8 secs	14.5 secs	61 reps
Minimum	5.5 secs	11.6 secs	44 reps
M±SD	6.03±.42	13.41±.79	51.46±5.77

Test of Hypotheses

In table 8, rows one through three presents the results of hypotheses 1, 2, and 3 respectively that were formulated to test the correlation between body composition (waist circumference, waist-to- hip ratio and BMI) and each of the three motor performance variables (Agility, speed, muscular endurance). There was a low to high positive correlation between all the tested body composition variables and motor performance variables of University of Ilorin male handball players. In $H0_1$, the participants' waist circumference correlated moderately with speed, agility and muscular endurance N=14; df=13; R = .50, .56, and .48 while the R^2 were 25%, 31% and 23% respectively. The hypothesis was rejected at 0.05 alpha level.

Table 8

Correlation between body composition and motor performance variables of University Ilorin male handball players

Variables	N	d	Speed		Agility		Muscular	
			R	R	R	R^2	R	R^2
Waist Circumference	1	1	.50*	25	.56*	31%	.48*	23
Waist-to-hip ratio	1	1	.32**	10	.65**	6.3%	.77**	59
BMI	14	13	.25**	6.3%	.67**	45%	.62*	38%

** significant @ 0.01 level (2-tailed); *significant @ 0.05 level (2-tailed)

In H_{02}, the participants waist-to-hip circumference had low correlation with speed, high correlation with agility and muscular endurance N=14; df=13; R=.32, .65 and .77 while the R^2 were 10%, 42% and 59% respectively. The hypothesis was rejected at 0.01 alpha level.

In H_{03}. the participants' BMI had low correlation with speed, high correlation with agility and muscular endurance N=14; df=13; R=.25, .67 and.62 while the R^2 were63%, 45% and 38% respectively. The alpha level of significance 0.05 for speed and 0.01 for agility and muscular endurance. Therefore, the hypothesis was rejected.

Discussion

The sample mean age of 22.85 years findings revealed that the players have normal body composition parameters as revealed in their waist-to-hip ratio, waist circumference and BMI with means of 0.84+4.54, 78.46+5.96cm and 21.65+1.95kg/m^2 respectively. This implies that they have higher fat-free mass than fat mass, which is a prerequisite for high-level performance in sports. According to Ramos-Campo, Sanchez, Garcia, Arias, Cerezal, Clemente-Suarez, and Diaz (2014) excessive fat mass acts as a dead body mass which impedes activities during locomotion and jumping, decreases performance and increases energy demands.

Motor performance variables tested were speed, agility and muscular endurance. The participants' score were good in speed (Mean = 6.03+042) and muscular endurance (Mean = 51.46±.77) and was excellent in agility (Mean = 13.41+.79). When correlated with body composition all the hypotheses were rejected because minimal to high positive correlations were found.

The result showed there was a moderate positive correlation of waist circumference with speed, agility and muscular endurance (R = .50, .56, and .48) respectively indicating that waist circumference was a contributing factor for speed, agility and muscular endurance of University of Ilorin male handball players. The R^2 of 25%, 31% and 23% respectively showed a low variance in the participants' scores for the tested variables. This implies that all the players have normal abdominal fat and their waist circumference did not affect their performance.

Furthermore , there was low correlation of waist-to-hip ratio with speed (R = .32 and R^2 = 10%). There was high correlation of waist-to-hip ratio with agility and muscular endurance (R = .65 and .77). This is an indication that waist-to-hip ratio was a major contributing factor for agility and muscular strength of University of Ilorin male handball players. Unlike speed, the R^2 coefficient of 42% and 59% showed a high variance in the participants' scores for agility and muscular endurance in relation with waist-to-hip ratio. The implication of this is that some of the players' waist-to-hip ratio is high and may be affecting their performance as well as the entire team.

Also, there was low correlation of BMI with speed (R = .25 and R^2 = 6.3%). There was high correlation of BMI with agility and muscular endurance (R = .67 and .45). This indicates that BMI was a major contributing factor for agility and muscular endurance of University of Ilorin male handball players. The R^2 coefficients were 45% and 38% showed a high variance in the participants score agility and muscular endurance in relation to BMI. This finding of the study shows that there was significant correlation between body composition and motor performance of University of Ilorin handball players. The findings affirm the opinion of Nikolaos. Dimitrios, Charalambos, Theodoros, Savvas, Aggelos and Konstantinos (2014) who noted that there is a significant correlation between body composition and athletic performance in high-level handball players. The correlation of the participants' body composition and motor performance variables (speed, agility and muscular endurance) is indicative of greater ability of sufficient anaerobic and glycolytic energy stores for the intermittent high intensity like jumping, shooting and sprinting actions that is embedded in handball games.

This finding shows significant correlation between body composition and motor performance of University of Ilorin handball players. The findings supports by Nikolaos, et al, (2014) who noted that there is a significant correlation between body composition and athletic performance in high-level handball players. The correlation of the participants' body composition and motor performance variables (speed, agility and muscular endurance) is indicative that University of Ilorin handball players have a great level of anaerobic and glycolytic energy stores for the intermittent high intensity activities like jumping, shooting and sprinting actions that is embedded in handball games.

Conclusion

Based on the findings of the study the following conclusion were drawn: (1) there was a moderate positive correlation of waist circumference with speed, agility and muscular endurance of University of Ilorin male handball players, (2) there was a positive correlation of waist-to-hip ratio with speed, agility and muscular endurance of University of Ilorin male handball players. The correlation was low for speed but high for agility and muscular endurance, (3) there was a positive correlation of BMI with speed, agility and muscular endurance of University of Ilorin male handball players. However, the correlation was low for speed but high for agility and muscular endurance. The following recommendations were made: (1) periodic assessment of body composition of the University of Ilorin male handball team should be included as part of the training program to maintain normal fat mass and fat-free mass for high-level performance and (2) tactical and technical training should be integrated so as to convert their high motor performance scores to winning in competitions.

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