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Hand-Eye Coordination and its Relationship with Anthropometric characteristics of Professional Football Players based on their Playing Position

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ABSTRACT: Football is the most popular sport characterized by high and low intensity movements with repeated physical contact. Anthropometric characteristics, coordination motor skills, and functional movement abilities are part of important determinants of success in a football game. This study investigated the relationship between hand-eye coordination and anthropometric characteristics of professional football players based on their playing position. A correlational research design was utilised for this study. The population for this study comprised of 29 professional football players who are members of a professional football club in Nigeria. The participants comprised of 12 forwards, 6 midfielders, 4 goalkeepers and 7 defenders. The weight, height, waist circumference, and hip circumference measurements were obtained using standardised procedures. The body mass index and waist to hip ratio scores of the participants were calculated. The alternate hand wall toss test was used to determine the hand-eye coordination of the participants. Pearson's product moment correlation and linear regression were used to analyse the results. The level of significance was set at $p < 0.05$. A significant negative strong correlation was observed between waist to hip ratio and coordination among midfielders ($r = -0.841$, $p = 0.036$). There was no significant correlation between waist to hip ratio and coordination among forwards, defenders, and goalkeepers. In addition, there was no significant correlation between body mass index and coordination as well as waist circumference and coordination among football players in all the playing positions. Waist to hip ratio is an important anthropometric measure that can affect the coordination of midfielders in a football team. This should be considered by the coaches and football regulatory bodies before players are assigned to playing positions in the game of football. Position-specific training programmes should be encouraged to enhance football players' performance.

KEYWORDS: Anthropometric characteristics; Coordination; Professional football players.

INTRODUCTION

Football is a team game played between two teams with matches involving intermittent high-intensity sprints between periods of jogging, walking, and repeated physical contact. It is the most popular sport and is characterised by high intensity, short-term actions, and pauses of varying length [1,2]. The game of football involves four key positions. The goalkeepers, defenders, midfielders, and forwards are the four groups of football players. Each group has a specific area of the field that they cover. Forwards (sometimes known as strikers) are the players closest to the opposing team's goal and are primarily responsible for scoring goals and creating scoring opportunities for their team players. Midfielders (sometimes known as halfbacks) are players who play in the middle of the field, between the offensive forwards and the defenders. Defenders play behind the midfielders, and their major responsibility is to

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provide support to the team and to prevent the opposition from scoring goals. The goalkeeper's primary responsibility is to prevent the opposing team from scoring by catching, palming, or punching the ball from shots, headers, or crosses.

Every football player irrespective of the position of play requires the essential component of motor fitness for efficient performance during sports and other physical activities. Motor fitness also referred to as motor ability or skill-related fitness is the ability of an athlete to perform successfully at their sport [3]. In football training special and multifaceted motor fitness abilities have a direct impact on the special fitness of the football players. More so, motor fitness is very helpful as a selection criterion and useful for the evaluation of progress in a player's ability. The components of motor fitness include agility, balance, coordination, power (speed & strength) and reaction time [4]. A combination of these motor fitness components determines an athlete's motor fitness and is essential for high levels of performance in the game of football [5]. Coordination is an important aspect of motor fitness influencing a player's effectiveness during a match [6,7]. It entails the smooth and efficient movement patterns that are part of sports skills and tasks. During coordination, the muscles of the body work in an organized and synergistic fashion to produce both simple and complex movements. Studies have shown that increasing the level of specific coordination motor skills is one of the most important factors in achieving the intended performance results during sporting activities [6,8]. The level of coordination motor skills plays a decisive role determining whether a player is picked to play or not in the game of football [9]. Therefore, the game of football being the most popular competitive sport requires its players to combine the motor fitness components of which coordination is an important aspect before the individual skills inherent to the playing of football can be utilized to enhance performance [10]. `

Anthropometric characteristics are also essential elements for particular player positions in the game of football, where morphological traits vary depending on the competitive level and position in the game [10]. Anthropometric measures are a set of quantitative measurements of muscle, bone, and adipose tissue that are used to determine a person's body composition [11]. They can be used as a baseline for physical fitness and to measure the progress of fitness [12]. Studies have reported that they are important factors in selecting players in team sports [13,14] and can influence the success in achieving sports results [15]. Body Mass Index (BMI) is an anthropometric measure which entails the measurement of a person's weight with respect to his or her height. The BMI is used to assess a person's health risks associated with obesity and overweight. It has been reported that an increase in body weight or height is linked to increased playing time and higher pay rates among football players [16]. The waist circumference and waist/hip ratio are other anthropometric measures that are important for the evaluation of abdominal obesity [17]. Measurement of the waist circumference is recommended by the United States National Cholesterol Education program for the assessment of central obesity whereas the World Health Organisation recommends waist to hip ratio for the same purpose [18].

Therefore, to be successful in football, a player must have a high degree of athletic capabilities and the ideal anthropometric characteristics and body composition besides a high level of technical and tactical skills [19]. Studies have reported that players in the various positions have different position-specific physical performance and anthropometric characteristics required for success [20]. However, despite the worldwide popularity of the game of football in which anthropometric and motor performance characteristics are important elements and determinants for success, there is paucity of studies to ascertain if there is a relationship between coordination and anthropometric characteristics of football players, even in their various playing positions. Therefore, this study investigated the relationship between coordination and body mass index, waist circumference and waist to hip ratio of professional football players.

METHODS

Study participants

This correlational research design utilised football players who are members of a professional football club in Nigeria. The total population was utilised for the study. Football players with injuries or other co-morbidities were excluded from the study. Twenty-nine (29) out of 32 football players met with the selection criteria and gave consent to participate in the study. The 29 football players comprised of 12 forwards, 6 Midfielders, 4 Goal keepers and 7 Defenders.

Instruments

A digital weighing scale (Camry, Model: EB_9383, Dhaka) calibrated in kilogram was used to measure the weight of the participants to the nearest 0.1 kilogram while a portable stadiometer (SECA 213, Model: 41762, Deutschland) was used to measure the participant's height to the nearest 0.1 centimeter. An inelastic tape measure (Butterfly, China) of range 0-150 centimeter was used to measure the waist and hip circumference to the nearest 0.1 centimeter. The alternate hand wall toss test was used to measure the

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hand-eye coordination of the participants using a tennis ball. The validity and reliability score of the alternate hand wall test for hand-eye coordination has been reported as 0.718 (good) and 0.875 (acceptable) respectively [21]. A.marking tape was used to indicate the stance position for the alternate hand wall toss test while a stopwatch was used to measure the time interval of the test.

Procedure

Permission to conduct this study was sought and obtained from the manager and coach of the professional football team. After permission to conduct the study was granted to the researcher, the team players were visited to intimate them and give them insight on the study. On the dates fixed for the data collection, the participants were given informed consent forms to fill. Then the researcher and research assistants who have been trained by the researcher in the data collection process conducted the measurements and tests on the participants. Confidentiality of participants were ensured during the process of data collection. The participants were grouped according to playing positions into goalkeepers, defenders, midfielders and forwards. Measurements of weight, height, waist circumference and hip circumference were obtained according to the standard procedures of the International Society for the Advancement of Kinathropometry [22]. The weight of the participants were measured in minimal clothing to ensure accuracy. The participants were instructed to stand on the platform of the scale in light clothing's, without support and with the weight evenly distributed on both feet [22]. The readings were read off from the display unit of the scale to the nearest 0.1kg. The height was measured with the participants standing in an upright position on the platform of the stadiometer. The horizontal projection of the stadiometer was placed on the vertex, crushing the hair as much as possible. The researcher took the readings from the scale of the stadiometer to the nearest 0.1cm [22]. The body mass index (BMI) was calculated from height and weight of the participants using the expression [BMI=Weight/Height^2 (kg/m^2)] and were classified into underweight, normal weight, overweight and obesity according to World Health Organization [23]. Measurements of waist circumference were taken in a standing position with the participants' arms abducted. The measurement was taken at the level of the narrowest point between the lower costal (10th rib) border and the iliac crest. In the absence of no obvious narrowing, the measurement was taken at the midpoint between the lower costal (10th rib) border and the iliac crest [22]. The measurement of hip circumference was taken with the participants in a relaxed standing position and with the arms folded across the thorax. The girth was taken at the level of the greatest posterior protuberance of the buttocks [22]. The waist to hip ratio was calculated by dividing the waist circumference and the hip circumference of the participants and were classified according to the World Health Organisation reports into low, high and moderate health risk [24]. To carry out the alternate hand wall toss test, the researcher marked the floor with a marking tape at a distance from the wall (2 meters). The participants were instructed to stand behind the marked line facing the wall. They were given a tennis ball and instructed to throw the ball against the wall using one hand in an underarm action, and attempt to catch it with the opposite hand as quickly as possible. Then throw the ball back against the wall and catch it with the initial hand. The test continued for a period of 30 seconds. The number of successful catches in a 30 second period was recorded. The scores were rated as follows based on the number of successful catches in a 30 second period: excellent (>35), good (30-35), average (20-29), fair (15-19) or poor (<15) [25]. All the data were analyzed using SPSS (Statistical Package for Social Sciences) Version 23.0 (SPSS Inc, Chicago, IL). Pearson's product moment correlation and linear regression analysis were used to determine the relationship between the variables. Correlations were interpreted as follows: ≤0.2 = weak, 0.3–0.5 = fair, and 0.6-0.7 moderate ≥0.8= strong [26]. The level of significance for all statistical tests was set at $p < 0.05$.

RESULTS

Data of twenty-nine (29) football players were collected, collated, and analysed. The participants comprised of 12 forwards, 6 midfielders, 4 Goalkeepers and 7 defenders. The participants had a mean age of 22.34 ± 3.36 years. The forwards had a BMI of normal weight (50%) and overweight (50%). Most of the defenders [5(71.4%)] and midfielders [4(66.7%)] had BMI scores that are overweight while majority of the goalkeepers [3(75.2%)] had normal weight for their BMI scores. A greater number of the forwards [7(58.3%)], defenders [6(85.7%)], midfielders [5(83.3%)] and goalkeepers [3(75.2%)] had a low health risk based on their waist to hip ratio classification. All the forwards [12(100%)] and defenders [7(100%)] had average coordination scores. Most of the midfielders [5(83.3%)] had average coordination scores. Half of the goalkeepers [2(50.0%)] had ultrafast coordination scores while the remaining [2(50.0%)] had superb scores.

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Table 1: Relationship between body mass index, waist circumference, waist to hip ratio, and coordination among football players.

Playing positions			Forwards	Defenders	Midfielders	Goalkeepers
			Coordination	Coordination	Coordination	Coordination
Forwards	BMI	r	-0.301			
		p	0.342			
Defenders	BMI	r		-0.006		
		p		0.990		
Midfielders	BMI	r			0.045	
		p			0.933	
Goalkeepers	BMI	r				-0.230
		p				0.770
Forwards	WC	r	-0.229			
		p	0.474			
Defenders	WC	r		-0.285		
		p		0.536		
Midfielders	WC	r			-0.181	
		p			0.731	
Goalkeepers	WC	r				-0.783
		p				0.217
Forwards	WHR	r	-0.102			
		p	0.752			
Defenders	WHR	r		0.403		
		p		0.370		
Midfielders	WHR	r			-0.841	
		p			0.036*	
Goalkeepers	WHR	r				0.642
		p				0.358

Key: * correlation is significant at p< 0.05, BMI- Body mass index, WC- Waist circumference, WHR- Waist to hip ratio, r-Pearson's Product Moment Correlation Coefficient

Table 2 shows that for every one unit increase in BMI score, there is an approximately 0.316 decrease, 0.010 decrease, 0.035 increase and 0.064 decrease in the coordination of forwards, defenders, midfielders and goalkeepers; though not significant. Table 3 shows that for every one unit increase in waist circumference, there is an approximately 0.147 decrease, 0.126 decrease, 0.130 decrease and 0.211 decrease in the coordination of forwards, defenders, midfielders and goalkeepers respectively; though not significant.

Table 2: Linear Regression analysis between body mass index and coordination among football players.

Playing positions		Unstandardized coefficients		Standardized coefficient	t	Sig.	95% Confidence interval f or B	
		B	Std. Error	Beta			Lower bound	Upper bound
Forwards	BMI	-0.316	0.317	-0.301	-0.997	0.342	-1.023	0.391
Defenders	BMI	-0.010	0.778	-0.006	-0.013	0.990	-2.010	1.991
Midfielders	BMI	0.035	0.387	0.045	0.090	0.933	-1.041	1.111
Goalkeepers	BMI	-0.064	0.191	-0.230	-0.334	0.770	-0.887	0.759

Key: BMI- Body mass index

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Table 3: Linear Regression analysis between waist circumference and coordination among football players based on playing position.

Playing positions		Unstandardized coefficients		Standardized coefficient	t	Sig.	95% Confidence interval f or B	
		B	Std. Error	Beta			Lower bound	Upper bound
Forwards	WC	-0.147	0.197	-0.229	-0.745	0.474	-0.585	0.292
Defenders	WC	-0.126	0.189	-0.285	-0.665	0.536	-0.612	0.361
Midfielders	WC	-0.130	0.352	-0.181	-0.369	0.731	-1.107	0.847
Goalkeepers	WC	-0.211	0.118	-0.783	-1.778	0.217	-0.720	0.299

Key: WC-Waist circumference

Table 4 shows that there is a significant relationship between waist to hip ratio and coordination among midfielders (p=0.036). Hence, for every one unit increase in waist to hip ratio, there is an approximately 26.272 decrease in coordination among midfielders. Table 4 also shows that for every one unit increase in waist to hip ratio, there is an approximately 2.694 decrease, 8.801 increase and 6.982 increase in the coordination of forwards, defenders and goalkeepers respectively; though not significant.

Table 4: Linear Regression analysis between waist to hip ratio and coordination among football players based on playing position.

Playing positions		Unstandardized coefficients		Standardized coefficient	t	Sig.	95% Confidence interval for B	
		B	Std. Error	Beta			Lower bound	Upper bound
Forwards	WHR	-2.694	8.302	-0.102	-0.325	0.752	-21.193	15.804
Defenders	WHR	8.801	8.934	0.403	0.985	0.370	-14.165	31.767
Midfielders	WHR	-26.272	8.461	-0.841	-3.105	0.036*	-49.765	-2.780
Goalkeepers	WHR	6.982	5.891	0.642	1.185	0.358	-18.365	32.329

Key: * significant at p< 0.05, WHR- Waist to hip ratio

DISCUSSION

This study determined the relationship between coordination and BMI, waist circumference and waist to hip ratio of professional football players based on their playing positions.

The findings of this study showed that coordination had no significant relationship with BMI among the study participants. However, negative correlations were observed between BMI and coordination among forwards, defenders and goalkeepers whereas a positive correlation occurred between these variables among midfielders. Marija et al. [27] observed significant correlations between BMI and coordination though their study was conducted among overweight children. However, even though studies are sparse on the relationship between BMI and coordination even in football players, most evidence suggests these variables are negatively associated among children and adolescents [28]. Biomechanical difficulties were suggested as a potential explanation for the purported negative relationship between BMI and motor coordination level in previous research [28]. That is, the more body mass one has, the more mechanical labour one will have to do to complete motor tasks, especially those that demand body weight-bearing. However, it is still surprising that midfielders showed a positive relationship between BMI and coordination despite the fact that they reportedly cover greater total distances than players in the other positions on the field. Surprisingly, regardless of the participants' weight status in their various playing positions, there was no significant relationship between BMI and coordination among the study participants. Hence, it appears that BMI has no relationship with coordination, despite disparities in weight status based on BMI score.

Waist circumference showed no significant correlation with coordination among the study participants. Though there are scarcity of studies on the relationship between these variables among football players, waist circumference was negatively associated with

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motor coordination in a study on school children [28]. It was also noted that negative correlations were observed between waist circumference and coordination among the participants in the current study even though it was not significant. Despite the fact that these findings among the study participants didn't attain significance, based on previous research [29], it is logical to assume that an increase in adiposity may lead to an increase in body weight thereby, reducing the level of performance in a wide range of activities including those that have to do with an individual's coordination. However, despite these assumptions, waist circumference seems not to have a significant relationship with the level of coordination of football players in their various positions of play.

Midfielders showed a significant negative strong correlation between waist to hip ratio and coordination while there was no significant correlation between these variables in other playing positions. It was noted in this study that the coordination of the midfielders decreased significantly as their waist-to-hip ratio increased. Although it has been published in various articles that obesity affects cognitive function [30], this relationship was said to be significant for all tasks and obesity indices. However, contrary to these reports hand-eye coordination which is a complex cognitive ability seems to be affected only by the waist to hip ratio of midfielders in this current study unlike players in other playing positions. Notably, even though majority of the football players in the different positions had a low health risk based on their waist-to-hip ratio values, a significant correlation was attained between waist-to-hip ratio and coordination only among midfielders. This may be linked with the enormous responsibilities of the midfielders during a match compared to players in other positions. Midfielders are the most active players on a soccer field because they attack and defend as well as perform other diverse roles such as scoring goals from a distance, creating goal-scoring chances, and shielding the ball under pressure. They typically play the role of defense and offense because they assist the defense in making sure the opposing team doesn't get anywhere near their goal. They also get the ball passed up to the forwards for them to score a goal and atimes make their way to the opposing team's goal and score if the opportunity arises.

CONCLUSION

A significant negative strong correlation was observed between waist to hip ratio and coordination among midfielders. On the other hand, there was no significant correlation between body mass index and coordination as well as waist circumference and coordination among football players in all the playing positions. In addition, there was no significant correlation between waist to hip ratio and coordination among forwards, defenders, and goalkeepers.

Waist to hip ratio is an important anthropometric measure that can affect the coordination of midfielders in a football team. This should be considered by the coaches and the football regulatory bodies and should be factored in before players are assigned to playing positions in the game of football. Training programmes that are position-specific should be encouraged to enhance the performance of football players.

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