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European Journal of Sports and Exercise Science, 2015, 4 (3):1-7
(http://scholarsresearchlibrary.com/archive.html)

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ISSN: 2278 – 005X

Physiological and skill fitness differences of professional footballers: Position of play

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ABSTRACT

The international federation of football history and statistics ranked Asante Kotoko Sporting Club as the African club of the 20th century. This study examined if this pedigree inform the physiological and skill fitness qualities of the club's players based on position of play. Twenty-five regular players (mean ± SD age, 23.26 ± 2.57 years) were categorised into nine playing positions participated in the study. Players' body mass index, heart rate and blood pressures were measured and also speed (30meter dash); agility (Illinois agility run) and muscular endurance (Burpee) were tested. Players significantly possessed selected physiological and skill fitness qualities ($p<0.05$). Based on position of play, differences in the selected qualities were not significant except in muscular endurance [$F_{(8, 16)} = 3.151$, $p<0.05$]. Holding midfielders returned higher speed (6.56±0.58 seconds); centre-forwarders had best agility score (18.05 ±0.93seconds); and goalkeepers had the highest muscular endurance score (35.67 ±0.57 rpm). Players' training patterns appeared to lack developmental approaches through positional specificity. Athletic trainers and the coaching crew should structure training specificity fitness programs focusing on agility, speed and muscular endurance of the players in order to improve their skills in relation to positions of play.

Keywords: Blood pressure, Agility, Speed, Muscular endurance, Heart rate

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INTRODUCTION

Soccer is the most popular sport worldwide which is characterized by high intensity, short-term actions and pauses of varying length[1].Success in soccer is dependent on variety of factors such as physiological and skill performance parameters of players[2] [3]. Soccer also requires a combination of various functional features. Speed, strength, agility, flexibility, muscular endurance and coordination are factors that play a role in performance [4].

Soccer players play for 90 minutes at about 70 percent VO^2max, expend about 18kCal/minute and covers between 10 and 15km per match. But this would be obscuring the real challenge which is that, the game comprises multiple sprints, jumps, changes in direction, kicks, tackles and ball interactions in attack and defence[5]. Maximal oxygen uptake or VO^2max refers to the highest rate at which the body of a player can take up and consume oxygen during soccer[6].Maximal oxygen uptake functions effectively with blood pressure and heart rate because oxygen delivery depends on blood and heart rate capacity of the players. Heart rate is the speed of the heartbeat measured by the number of heartbeats per unit of time - typically beats per minute(bpm).The heart rate can vary according to the body`s physical needs including the need to absorb oxygen and excrete carbon dioxide since competitive soccer match play requires a complex combination of both cardio respiratory and neuromuscular fitness[7],the ability of heart rate variability measures to predict changes in both aerobic fitness and neuromuscular performance might offer a potential tool to assess a player`s readiness to perform. Blood pressure is one of the vital signs that healthcare practitioners measure in general health condition. Blood pressure is the measurement of the force of blood as it hits the walls of the arteries. It is expressed as two numbers: the systolic pressure (which is the pressure as heart beats) and the diastolic pressure (which is the measurement as the heart relaxes between beats).Blood pressure is recorded

as systolic over diastolic (120/80).Body mass index (BMI) is also one of the vital physiological parameters concerning soccer players.

Different positions on the field are characterised by specific physical activities and demands [8]. In modern soccer, for a player to attain optimal performance, individualised training promotes skill possession and efficiency in execution for success. In the absence of skills, players are unable to execute coach`s vision of how the game should be played [9]. Schmidt and Lee [10] define skills as movements that are dependent on practice and experience for their execution as opposed to being genetically. For example agility which is one of the skill performance parameters that are needed by soccer players. Agility was originally defined by Clarke [11] as "speed in changing body positions or in changing direction". More recently, Sheppard & Young [12] defined agility as "a rapid whole-body movement with change of velocity or direction in response to a stimulus," based on the conception that agility has relationships with both physical and cognitive components. Speed is very crucial to the game of soccer. An effective speed training program would be based on the realistic aspects of the game. When soccer players play on the field there are a couple of aspects such as reflexes, tactical anticipation, and agility that influence their speed [13]. Another relevant skill performance parameter needed by soccer players is muscular endurance. Boone, et al., [8] are of the view that average work intensity of a soccer game is close to the anaerobic threshold (i.e., the highest exercise intensity at which the removal of lactate equals its production) at a heart rate (HR) of approximately 85% HRpeak, which puts much pressure on muscular demand. Muscular contraction of football players differ greatly based on position of play during competition.

Concentration on the development of players in soccer and rugby based on position of play in developed countries has been reported [8][9][14] but information on such, especially on soccer which is widely embraced in Africa with reference to Ghana, is scarce. The most outstanding club in Ghana is Asante Kotoko Sporting Club (Asante Kotoko or Ashanti Kotoko) with noble pedigree. The club has won the Ghana Premier League for twenty-four times, CAF championship twice, FA cup eight times and Ghana super cup twice. It is the only club that has attained this status and currently in partnership with Sunderland Club in the English Premiership. The training patterns of the club have received recommendation from some local league clubs. This should reflect in the physiological and skill fitness qualities of her players and have modern flair (position of play specific training) for other clubs to emulate. It is from this angle that this study comparatively examined selected physiological and skill fitness qualities of professional soccer players in Kumasi Asante Kotoko Sporting club, Ghana, based on position of play.

MATERIALS AND METHODS

Participants

Ex-post facto research design was used in this study. Twenty five professional players of the Kumasi Asante Kotoko Sporting club were recruited for this study after consent was sought from the management of the team. Kumasi Asante Kotoko Sporting club is based in Kumasi in the Ashanti Region of Ghana and was founded in August 31, 1935. It was the first sporting club in Ghana to win the Africa cup in 1970 and the second in 1983. The club has won trophies more than any other clubs in Ghana.

Instruments: Instruments for data collection included, automatic digital blood pressure monitor, electronic weighing scale, measuring tape, cones and stop watch. These were used to measure body mass index (BMI), blood pressure, metres sprint speed test, Illinois agility test and the Burpee test.

Body mass index (BMI): Electronic personal scale (digital) was used to measure the weight. Players took off their boot and holes. They stood on the scale and were asked to look straight forward. The scale read their weights and recorded each player`s figure. A tape measure was used to measure the player`s height. The players removed their boot and holes and anything that would inflate height besides hair. They stood on a flat floor with no carpeting next to a wall. They stood with their neck to the wall, with their feet together and heels touching the wall. They looked straight ahead and kept their shoulders levelled. A book was placed onto their heads to form a 90 degree angle with the wall and marked where the book touched the wall with pencil. They moved away from the wall and measured the space from the floor to the marked place with the tape measure and recorded each player`s results. BMI was then calculated using the formula weight (kg)/height^2 (m)^2.

Blood pressure and heart rate: Automatic digital blood pressure monitor (sphygmomanometer) was used for both blood pressure and heart rate. The players sat, relaxed, and rested for ten minutes. The cuff was placed around the relaxed and heart levelled upper arm so it covered the brachial artery. The cuff was then inflated above 170mmHg at the pressed of the ―ON/OFF‘‘button. The cuff automatically deflated and the systolic, diastolic and pulse rate were displayed on the screen. The results of each player were recorded.

Speed: Running speed was evaluated using a 30m dash. The players warmed – up for 10 minutes before the 30 metres speed. In a sprint position, players were given the command—on your marks, set, 'GO' and started the stopwatch and the players ran as fast as possible to the finish line. The stopwatch was stopped immediately the players' torso crossed the finish line. Each player`s time made in the 30 metres speed was recorded.

Agility: Agility was assessed using the Illinois agility run. The players warmed –up for 10 minutes before the test. The players went down on the field at the start cone. The assessor gave the command —GO —was given and started the stopwatch. The players ran as fast as possible around the course in the direction indicated below without knocking the cones over to the finish line. The stopwatch was stopped immediately the players got to the finish line. The time they made were recorded.

Muscular endurance: Muscular endurance was also assessed using the Burpee test. There was a 10 minutes warm-up before the test. The players stood erect, arms by their sides, and the assessor gave the command —GO —and started the stopwatch. The players placed their hands on the field in front of the feet (squat position) and thrust their legs back to assume in a push up position with a straight line from the shoulders to the heels. They returned to the squat position and finally returned to the starting position. They performed as many repetitions as possible within one minute. A point was given for every successfully completed repetition, and a half was given for poor technique.

Statistical analyses: Data collected were analysed using the IBM SPSS for windows version 20.0. Descriptive statistics of mean and standard deviation as well as analysis of variance (ANOVA) were used to test hypotheses at 0.05.

RESULTS

Out of the 25 players used in the study, 3(12%) were goalkeepers, 6(24%) centre-back players, 1(4%) left back player, 2(8%) right back, 3(12%) holding midfielders, 2(8%) box-to-box midfielders, 1(4%) play worker, 2(8%) wide midfielders, and 5(20%) centre-forwarders.

Table 1: Statistical Distribution of Parameters according to Position of Play

VARIABLES	GK N=3	CB N=6	LB N=1	RB N=2	HM N=3	BBM N=2	PM N=1	WM N=2	CF N=5	M±SD	t-value
Age (yr)	23.33 ±4.04	23.67 ±1.21	22.00	24.50 ±2.12	21.33 ±1.53	26.00 ±5.66	27.00	23.00 ±2.82	22.00 ±2.00	23.28 ±2.57	45.217*
PD (yr)	5.33 ±2.31	4.33 ±0.52	6.00	4.00 ±0.00	3.67 ±1.15	7.50 ±2.12	7.00	4.00 ±0.00	3.60 ±1.61	4.60 ±1.60	14.310*
Height(m)	1.75 ±0.01	1.73 ±0.04	1.69	1.65 ±0.01	1.72 ±0.05	1.63 ±0.01	1.64	1.67 ±0.02	1.73 ±0.04	1.70 ±.04	173.720*
Weight(kg)	80.70 ±3.90	77.13 ±7.55	74.00	72.05 ±2.89	76.50 ±1.55	63.75 ±0.63	66.00	64.65 ±0.92	72.48 ±4.52	73.50 ±6.72	54.622*
BMI(kg/m^2)	26.23 ±0.84	25.65 ±2.01	25.90	26.30 ±0.83	26.01 ±1.89	23.84 ±0.44	24.53	23.32 ±0.92	24.21 ±1.44	25.16 ±1.63	76.874*
HR(bpm)	62.33 ±2.51	59.33 ±6.12	55.00	54.00 ±8.48	58.33 ±0.57	61.00 ±16.97	57.00	58.50 ±4.94	56.20 ±8.07	58.32 ±6.41	45.461*
SBP(mmHg)	120.67 ±3.05	120.16 ±1.33	119.00	121.50 ±3.53	119.33 ±0.58	120.00 ±1.41	117.00	118.00 ±0.00	119.80 ±0.84	119.80 ±1.70	350.738*
DBP(mmHg)	82.33 ±6.66	74.66 ±4.18	68.00	69.50 ±13.44	64.66 ±7.57	72.50 ±3.54	78.00	71.50 ±2.12	65.40 ±8.41	71.56 ±8.09	44.180*
Speed(secs)	7.88 ±0.06	7.06 ±0.75	6.78	6.75 ±0.21	6.56 ±0.58	7.48 ±0.69	7.40	7.07 ±0.29	6.57 ±0.35	7.01 ±.62	56.478*
ME(secs)	35.67 ±0.57	30.83 ±2.04	36.00	32.00 ±0.00	32.33 ±2.51	31.50 ±2.12	35.00	30.00 ±0.00	31.80 ±1.79	32.24 ±2.35	68.591*
Agility(secs)	18.70 ±0.17	18.29 ±0.37	18.20	18.20 ±0.27	18.09 ±0.27	18.39 ±0.55	18.48	18.36 ±0.67	18.05 ±0.93	18.27 ±.34	267.409*

**Significant at 0.05 level*

PD= Playing duration, GK=goalkeeper, CB=central-back, LB=left back, RB=right back, HM= holding midfielder, BBM=box-to-box midfielder, PM=playmaker, WM=wide midfielder, CF=centre-forward, ME=muscular endurance, SBP=systolic blood pressure, DBP=diastolic blood pressure, HR=heart rate, PD=playing duration, BMI=body mass index, M±SD = mean ±standar d deviation.

As indicated in table 1, average age of the players is 23.26(±2.57), and playing year is 4.60(±1.60). Mean height, weight, BMI are 1.70(.04), 73.50(±6.72) and 25.16(±1.63) respectively. The mean and standard deviation of speed, muscular endurance, agility, pre-heart rate, pre-DBP, pre-SBP, post-SBP, post-DBP and post-heart rate are presented in table 1.Pairwise comparison between players' physiological characteristics and normative values showed no significant different ($t=1.24$, $p>0.05$) in the heart rate and normative value. Also there was no significant difference between the systolic and diastolic blood pressures ($t=-0.90$, $p>0.05$ and $t=-5.04$, $p>0.05$ respectively). The players on the average covered 35m sprint within 7.01 seconds, which indicate significant difference ($t=15.47$, $p<0.05$) and suboptimal compared to normative values. The study also indicates that the players used 18.27 seconds to cover for the agility test. This departs from the norm by 1.99 points and the difference is significant ($t=29.23$,

p<0.05). The players also executed an average of 32.24 repetitions in a minute in the Burpee test with a significant difference (t=-98.20, p<0.05).

Table 2 shows a statistically insignificant difference in the players heart rate, systolic and diastolic blood pressures [$F_{(8, 16)}$ =0.33, p>0.05; $F_{(8, 16)}$ =1.07, p>0.05; $F_{(8, 16)}$ =2.08, p>0.05 respectively] based on their positions of play.

Table 2: Multivariate Analysis between Physiological Variables and Position of Play

Source of Variation	HR		SBP		DBP		BMI	
	Corrected Model	Error	Corrected Model	Error	Corrected Model	Error	Corrected Model	Error
SS	141.473[a]	845.967	24.533[b]	45.467	802.793[c]	771.367	25.287[d]	39.003
Df	8	16	8	16	8	16	8	16
MS	17.684	52.87	3.067	2.84	100.349	48.21	3.161	0.312
F-ratio	.334		1.079		2.081			
P-value	.940		.424		0.101			

HR= heart rate, SBP=systolic blood pressure, DBP=diastolic blood pressure, SS=sum of squares, df =degree of freedom, MS=mean square, BMI=body mass index

a. R squared = 0.143 (Adjusted R Squared = -0.285)
b. R squared = 0.350 (Adjusted R Squared = 0.026)
c. R squared = 0.510 (Adjusted R Squared = 0.265)
d. R squared = 0.393 (Adjusted R Squared = 0.090)

Also shown in table 3 are the insignificant differences between the speed and agility of the players [$F_{(8, 16)}$ =2.01, p>0.05; $F_{(8, 16)}$ =1.08, p>0.05 respectively] and their positions of play but a significant difference between muscular endurance [$F_{(8, 16)}$ =3.15, p<0.05] and positions of play.

TABLE 3: Multivariate Analysis between Skill Variables and Position of Play

Source of Variation	Speed		Agility		Muscular Endurance	
	Corrected Model	Error	Corrected Model	Error	Corrected Model	Error
SS	4.645[a]	4.60	0.987[b]	1.81	81.093[c]	51.46
Df	8	16	8	16	8	16
MS	0.581	0.28	0.123	0.11	10.137	3.21
F-ratio	2.019		1.087		3.151	
P-value	0.110		0.420		0.024	

SS=sum of squares, df =degree of freedom, MS=mean square

a. R squared = 0.502 (Adjusted R Squared = 0.254)
b. R squared = 0.612 (Adjusted R Squared = 0.418)
c. R squared = 0.352 (Adjusted R Squared = 0.028)

Illustration of means of speed, agility and muscular endurance and positions of play are respectively shown in figure 1, 2, 3.

Figure 1. Illustration of Speed Performance Based on Position of Play

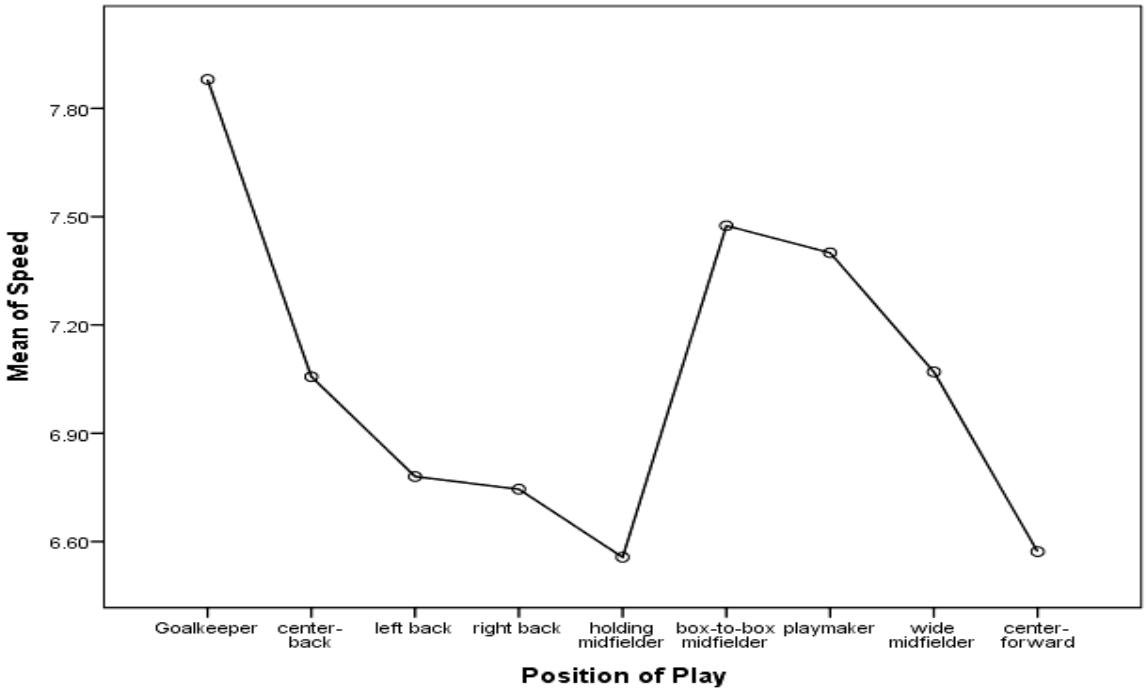


Figure 2: Illustration of Agility Performance Based on Position Of Play

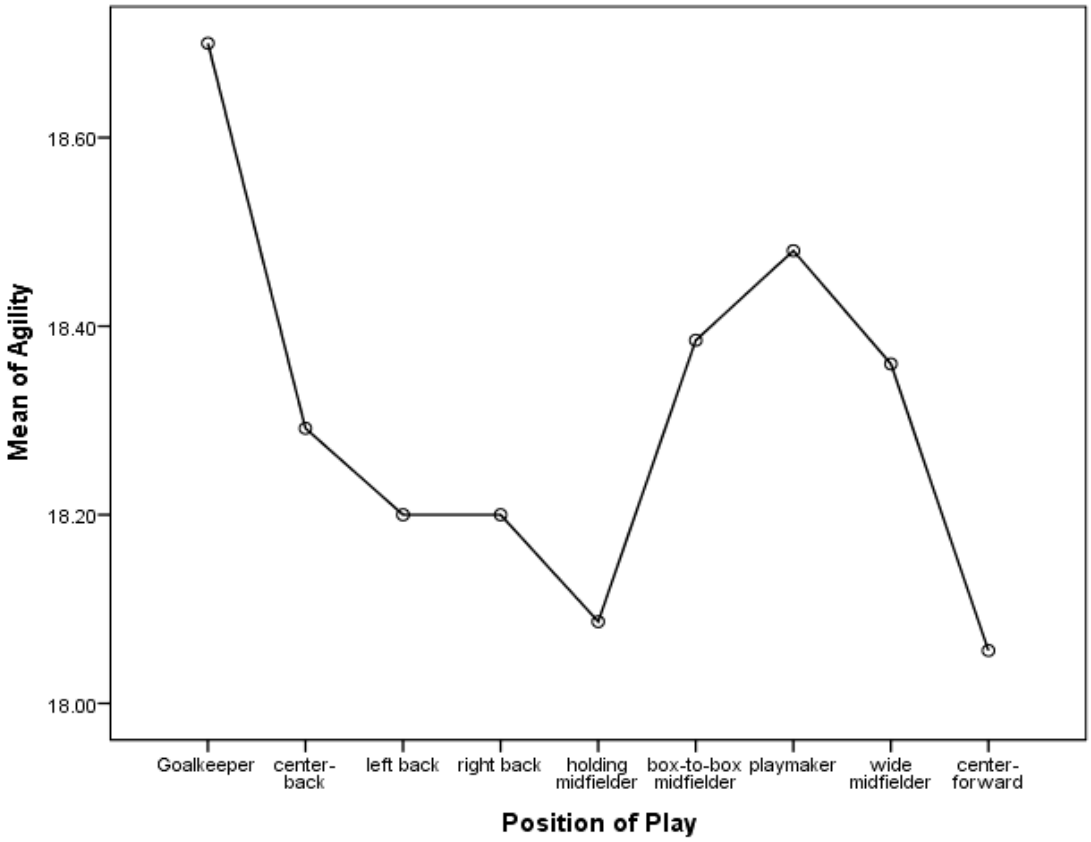
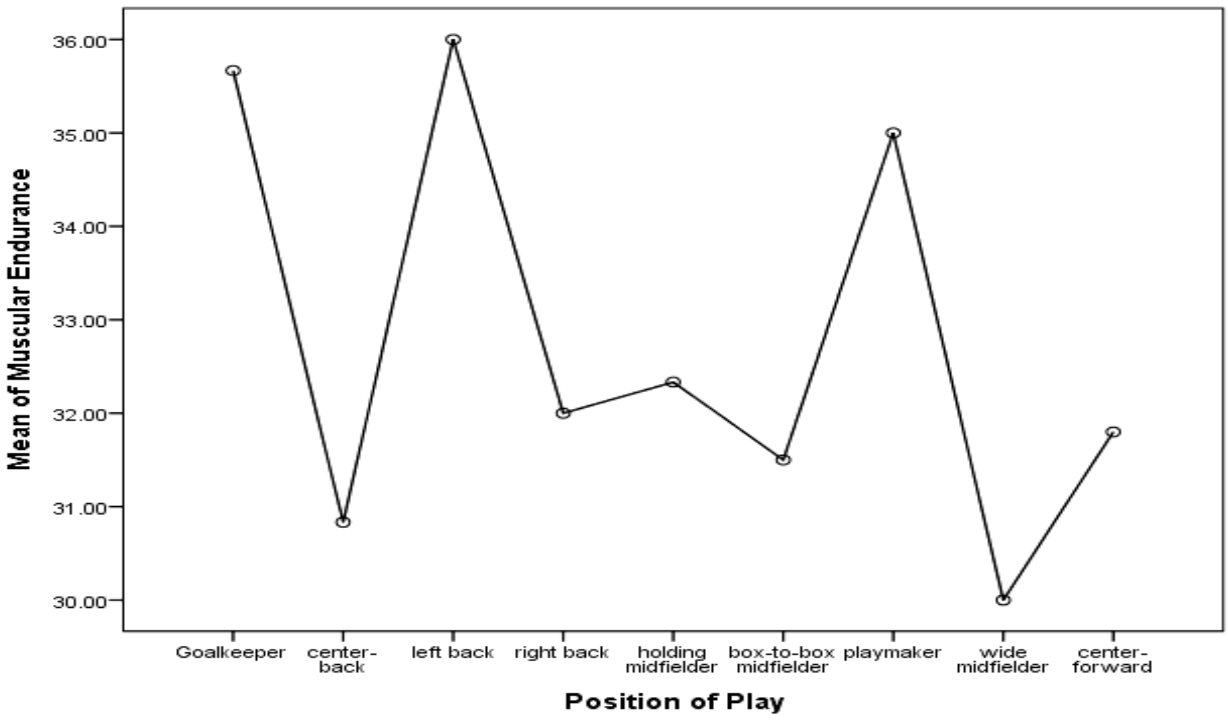


FIGURE 3: Illustration of Muscular Endurance Performance Based on Position of Play



DISCUSSION

In this study, we found an insignificant difference (t=1.24, p>0.05) between heart rate and normative values. This could be attributed to the level of training of these professional players. The heart rate, among different physiological data, is the most sensitive indicator of quick metabolic change that occurs during physical activities [15]. These values together with the distance uncovered during a match indicate a very strong metabolic commitment of a player during a match. Body size has a significant impact on soccer players [16] [17]. The tall players are recruited as goal keepers, defenders and forward position; however, a standard height should be maintained for midfield players [18]. Body mass is a considerable factor in soccer since body contact is essential in the game [19]. Also, unlike sports where BMI could misclassify elite athletes as overweight or obese, soccer is a sports that is characterised by normal values of BMI (about 23kgm-2) [20], as it has been shown by research on four elite European leagues [21]. We found the mean BMI to be 25.16(+1.63) which indicates overweight, but we believe the increase in body mass is as a result of increased muscle size and mass but not necessarily fat accumulation. This is because of the high fitness level of the players. Long-term effect of regular physical exercise has a positive effect on systolic blood pressure, left ventricular systolic and diastolic diameters in soccer players [4]. In this study, we found an insignificant difference between systolic and diastolic pressures and normative values which indicate that on the average, the players have good blood pressure levels.

Holding midfielders were reported in this study as having the fastest speed, followed by the centre-forward, right back, left back and centre back. The goalkeepers were the slowest. This corroborates with the numerous findings that indicate goalkeepers as slow. Karavelioğlu [22] compared 30 m scores of 77 sportsmen from the top six teams in the amateur league and obtained the result that the keepers are slower than all the other positions. The stoppers were the slowest group in 60 m sprint in the study performed with 13 keepers, 22 stoppers, 24 side players, 35 midfielders and 41 offense players. Offense players were found to be faster than the keepers and the stoppers [23]. While it is expected from a wing player to have advanced movement speed with and without the ball, it is primarily expected from a midfielder to have good decision making speed [24]. The many studies that have focused on agility and soccer, Brahim, Bougatfa and Mohamed [25] reported midfielders as having the fastest agility values. Boone, *et al*., [8] also reported strikers as significantly faster than goalkeepers, defenders and midfielders. However in this study, centre-forwarders had the fastest agility scores followed by holding midfielders, with goalkeepers having the slowest agility values. Additionally, midfielders are reported in this study as having the lowest muscular endurance, followed by centre and right backs. The goal keepers and left backs had the highest muscular endurance scores.

CONCLUSION

Selected physiological and skill performance parameters of the players did not meet the normal standard required with exception of the heart rate and blood pressure. Also, it is expected to have an impact on the performance of the players at both national and international level. It is recommended for the players to work on their physiological and skill performance parameters by working with private drills in order to bring their characteristics to higher levels of performance. Fitness programs with regard to the agility, speed and endurance of the players should be structured well in order to improve their skills and also their positions of play.

Acknowledgements
We the authors appreciate the contribution of all the staff and students in the Department of Sports and Exercise Science for their immense support during the conduct of this research.

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