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ORIGINAL ARTICLE

Fitness and physical characteristics of Saudi youth football players: a comparative study

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ABSTRACT

BACKGROUND: This study aimed to gather an anthropometric and fitness dataset for young Saudi footballers and compare their characteristics to other populations.
METHODS: The sample comprised male football players (N.=188) participating in an U17s Saudi football league (mean±SD age: 15.5±0.6 yrs.; height: 168.5±6.8 cm; BMI: 57.8±7.9 kg). Participants completed a battery of fitness tests to calculate their predicted maximal oxygen uptake (VO_{2peak}); a vertical jump test; a 50m speed test; agility test. Anthropometric measurements included height, weight, body fat percentage, and BMI. These data were compared against previously reported data from age-matched players around the world according to playing positions using Z-scores.
RESULTS: Goalkeepers and defenders were taller than other players (P<0.05), and forwards had higher BMI and triceps skinfold values compared to midfielders and defenders (P<0.05). No other differences in anthropometric characteristics existed between the participants. Defenders were faster than goalkeepers and midfielders in the 50-m speed test (6.85±0.38 *vs.* 7.22±0.59 and 7.13±0.48 s, respectively, P<0.05). Defenders and midfielders had a higher VO_{2peak} than goalkeepers (47.6±5.1 and 47.7±4.9 *vs.* 42.8±5.2 mL/kg/min; respectively, P<0.05). None of the anthropometric measures could predict fitness characteristics in the participants. In comparison to players from around the world, Saudi players had lower body mass, (Z≤-1.98), more body fat (Z≥2.20), and lower predicted VO_{2peak} (Z≤-2.56, respectively, P<0.05).
CONCLUSIONS: Saudi defenders appeared to be more physically developed than other players, but had lower cardiorespiratory fitness compared to age-matched players from around the world; this could be due to inadequate training programs.

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Key words: Physical fitness; Soccer; Exercise test; Athletes; Anthropometry.

Football, also known as soccer, is one of the world's most popular games. In football, physical development and monitoring physical attributes during a player's maturation are critical.[1, 2] However, in Middle Eastern countries, there appears to be a distinct lack of youth football academies that offer efficient training despite the relative improvements in national teams' success and professionalism in their major leagues in the last 15 years.

Football is a dynamic game and encompasses multifaceted physical attributes.[3] The game is played over 90 mins; it mainly depends on aerobic capacity, speed, agility, and power.[4] Traditionally, the 11 players on the field take different positions such as goalkeeper, defenders, midfielders, and forwards. Furthermore, each position can be split into more specific roles (e.g., central defenders and right midfielders). Given each position has more specific roles, the respective fitness characteristics differ.[5, 6] Numerous valid and reliable methods have been developed to evaluate key fitness components and physical attributes in footballers, such as multi-stage fitness tests (*e.g.*, Yo-Yo or the 12-min run Cooper test) for aerobic capacity, repeated/maximal jump tests[7] for power, and multi-directional sprint/change of direction tests for agility.[8] These tests also serve other purposes such as aiding selection/deselection,[6, 9] training and monitoring purposes,[10] and predicting youth development.[11, 12] Many studies have evaluated fitness and physical attributes in adult footballers from around the world (*i.e*. Europe, America, Australia, Asia, and the Middle East.[3, 13-17] Some of these investigations compared data between ages,[18, 19] positions,[5, 6] sexes,[20] and other team sports such as field hockey[21] and rugby.[17] The majority of these studies used fitness tests and physical attributes assessments including height, BMI, speed, and cardiorespiratory fitness.[6, 7, 9, 15] However, there is a noticeable lack of studies that investigated fitness and physical characteristics related to football performance in youth footballers in Middle East populations, especially in Saudi Arabia.

Saudi football has steadily increased in participation and quality, becoming increasingly prominent on the world stage. The Saudi Professional League ranked 27th among the top 50 Football Leagues in 2022.[22] In addition, Saudi Arabia's national team has won the Asian Championship three times and qualified for the FIFA World Cup six times in the last 30 years. Identifying talented young football players is integral to the continuous development of a high-quality Saudi national team. As such, the monitoring and progression of youth players' fitness and physical attributes are very important; however, the literature provides scant findings that can be used as baseline data for Saudi youth football players. Therefore, to address this gap in the literature, this study aimed to investigate the fitness and physical characteristics related to football performance in Saudi youth players and compare these findings with equivalent data from youth footballers of other counties. It is hoped that the present study may help Saudi coaches to focus on the gaps in performance, track player development, and identify talented football players more effectively.

Materials and methods

Subjects

Saudi youth male football players (N.=188; mean age: 15.5±0.6 years old; height: 168.5±6.8 cm; body mass: 57.8±7.9 kg; Body Mass Index (BMI): 20.4±2.1 kg/m^2 (Table I), were recruited; both players' and guardians' consent to participate in this study were obtained after receipt of detailed verbal and written information about the testing procedures. Players were recruited from the under-16s and under-17s teams playing in seven top-level Saudi professional football clubs. All players were participating in the under-17s Saudi League. The players were divided

Table I.—*Mean values of anthropometric measurements.*

Characteristics	All players (N.=188)	Goalkeepers (N.=20)	Defenders (N.=55)	Midfielders (N.=68)	Forwards (N.=45)
Age (years)	15.5±0.6	15.4±0.7	15.6±0.6	15.5±0.5	15.5±0.5
Height (cm)	168.5±6.8	174.1±5.8	169.9±6.7	166.5±6.6*†	167.1±6.0*
Mass (kg)	57.8±7.7	61.8±8.8	58.6±7.5	55.4±7.	58.6±7.5
BMI (kg·m^{-2})	20.4±2.1	20.4±2.3	20.4±2.3	20.0±1.9	21.0±2.2 ‡
Body surface area (m^2)	1.66±0.13	1.75±0.14	1.68±0.12	1.62±0.13	1.66±0.12
Triceps (mm)	8.69±3.03	9.30±3.11	7.88±3.28	8.44±2.56	9.79±3.05 †
Subscapular (mm)	8.94±2.22	9.63±2.66	8.71±2.03	8.63±2.08	9.38±2.36
Calf (mm)	8.47±2.81	8.65±2.64	8.12±2.6	8.18±2.62	9.24±3.31
Body fat (%)	14.6±4.1	15.8±4.5	13.6±4.1	14.2±3.8	16.0±4.1 †

BMI: Body Mass Index.
*P<0.05 compared to goalkeepers; † P<0.05 compared to defenders; ‡ P<0.05 compared to midfielders.

into groups based on their playing position (20 goalkeepers, 55 defenders, 68 midfielders, 45 forwards).

Study design

This observational study was approved by the Ethics Committee at King Saud University (KSU-HE-20-712). The fitness and physical characteristics of each player were assessed in two testing sessions during the competition season, which incorporated fitness, physical and physiological measurements. Participants had no more than one week between testing sessions. Participants were requested to abstain from high-intensity training in the 48 hours prior to each test and to abstain from caffeine at least 6 hours before the tests.

Anthropometric measurements

All anthropometric measurements were performed according to standard procedures.[23] Height was measured to the nearest 0.1 cm *via* stadiometer and mass, wearing only shorts, measured to the nearest 0.1 kg using a calibrated digital scale (Seca 220, Hamburg, Germany). BMI was calculated as the ratio of mass (kg) and squared height (m). Skinfold thickness was recorded to the nearest 0.2 mm at the right triceps, subscapular and medial calf muscle using Lange skinfold calipers (Beta Technology, Santa Cruz, CA, USA). The percentage of body fat was estimated *via* Boileau equations for 13-14-year-olds (equation 1) and 15-16-year-olds (equation 1).[16, 24]

$$\text{Body fat (\%)} = 1.35\cdot(T+S) - 0.012\cdot(T+S)^2 - 4.4 \quad (1)$$

$$\text{Body fat (\%)} = 1.35\cdot(T+S) - 0.012\cdot(T+S)^2 - 5.4 \quad (2)$$

(T and S are triceps and subscapular skinfold measurements in mm, respectively).

Physical fitness and physiological assessments

Lower-body power

A Sargent Jump and Reach test (vertical jump test) was used to estimate lower-body power.[25] To measure standing reach, participants were required to stand perpendicular to a wall-mounted tape measure and instructed to reach up as high as possible with the arm adjacent to the wall whilst both feet remained flat-footed on the ground. Following this, jumping reach was recorded by participants bending their knees, and hips and swinging their arms sequentially to jump vertically without pausing and reach as up as high as possible with the same arm. Vertical jump height was recorded as the difference between the standing reach and jumping reach heights to the nearest 0.1 cm. A maximum of three trials was used for subsequent analysis. Peak power output was estimated *via* Sayers' equation:[26]

$$\text{Peak power (W)} = [(60.7\cdot JH) + 45.3] \cdot (\text{mass} - 2055) \quad (3)$$

where JH is jump height (cm) and mass is body mass (kg).

Speed

The speed test was measured over a 50 m dash completed on an athletics track from a standing start position to achieve maximal running speed.[27] Time was recorded to the nearest 0.01 second from the fastest of three attempts. Verbal encouragement for an all-out effort was given to players throughout the run.

Agility

The Barrow zigzag run test was used to assess agility.[28] The course was set out in a rectangular shape measuring 4.87 x 3.05 m (16 x 10 ft) with cones at each corner and the centre of the rectangle. Each player ran three laps around the cones in a figure-of-eight shape, including two turns on the right side and two turns on the left side per lap. Time was recorded to the nearest 0.01 second from one trial (*i.e.*, the total of the three laps) and verbal encouragement for an all-out effort was given to players throughout the run.

Strength endurance

A sit-up test was used to evaluate abdominal muscle strength endurance.[29, 30] Participants were instructed to lie flat on a carpeted floor with knees bent at approximately 90º, feet flat on the ground and hands rested and crossed on their chest. Their feet were held in place by an investigator. The players contracted their abdominals and raised their trunks upright until their elbows touched their knees. Then, the participants lowered their trunks until their scapula touched the floor. Players were encouraged to do as many sit-ups as possible in one minute. A revised push-up test was used to examine upper body muscle strength endurance as described previously.[31] Participants started prone with their hands placed on the floor directly under the shoulders and elbows pointed backwards. Participants were instructed to push up to elbow arm extension whilst maintaining a neutral body position throughout then lower until the chest and thighs contacted the floor. This movement was repeated until participants could no longer perform the movement with the correct form or failed, with the number of full repetitions being recorded.

Cardiorespiratory fitness

A Cooper 12-minute run test was performed to evaluate cardiorespiratory fitness.[23] The test was performed on an outdoor 400 m athletics running track. Players were encouraged to run as fast as they could to cover the greatest distance possible within 12 minutes. Cones were placed every 10 m around the track to help record participants' distance; their overall distance at the end of 12 minutes was recorded to the nearest 10 m and used to estimate maximal oxygen consumption (VO_{2max}) based on equation 4:[23]

$$\text{predicted } VO_{2max} = \frac{\text{distance run (m)} - 504.9}{44.73} \quad (4)$$

Statistical analysis

Statistical analyses were conducted using SPSS v. 26. Data were assumed to be parametric following normality tests (Shapiro-Wilk Test) and equal variance tests (Levene's Test), being greater than 0.05. A simple one-way ANOVA was used to observe the main effects between the groups for all variables. Where effects were observed, a Tukey *post-hoc* test was used to identify the differences between positions. Pearson's correlations were also used to identify potential relationships between the anthropometric and fitness characteristics of the whole group and the different player groups. Alpha was set to <0.05, with all data being presented as mean and standard deviation.

Comparisons to published data

To observe if the current group and positional data were similar to other youth players from different nations, we used a simple Z-score (equation 5). Any results >1.96 and <-1.96 were deemed statistically significant (P<0.05). For studies that did not report positional data, the mean of the entire sample of the current study was compared. Where studies reported positional data (*i.e.*, defenders, midfielders, and forwards), mean positional data from the current study were compared.

$$Z = (x - \mu\_o)/\sigma \quad (5)$$

where Z is the test score used on a Z distribution table, *x* is the mean of a previously published population, μ_o is the mean of the current study's sample, and σ is the standard deviation of the current study's population.

Results

Anthropometric measurements

All anthropometric and fitness measurements for each position are presented in Tables I and II. There were no associations between anthropometric and physical measures for the whole group or within each position (P>0.05).

There was no difference in month age between positions (P=0.972). There was a main effect of body mass (P=0.003), height (P<0.001), and BMI between positions (P=0.047). Goalkeepers were heavier than midfielders (P=0.005); there were no other differences in body mass (P>0.05, Table I). Goalkeepers were taller than both midfielders (P<0.001) and forwards (P=0.001) but similar in height to defenders (P=0.083, Table I). Defenders were also taller than midfielders (P=0.018) but similar in height to forwards (P=0.133, Table I). There was no difference in height between midfielders and forwards (P=0.941, Table I). Midfielders had a higher BMI than forwards (P=0.026); there were no other differences in BMI between positions (P>0.05, Table I).

Skinfolds and body fat

There was a main effect in triceps skinfold thickness between positions (P=0.011); there was no difference in subscapular (P=0.117) or calf skinfold thickness (P=0.120). There was a main effect between positions for the sum of skinfolds (P=0.024) and body fat percentage (P=0.015). Forwards had a higher triceps skinfold thickness than defenders (P=0.010); all other positions had similar triceps skinfold thickness (P>0.05, Table I). The only difference in the sum of skinfolds was between defenders and forwards: Defenders had a higher sum of skinfold measurements (P=0.049, Table I). There was no difference between players' body fat percentage between positions, other than forwards having a greater percentage of body fat than defenders (P=0.024, Table I).

Fitness measurements

There was a main effect in the Cooper run distance (P=0.002), estimated VO_{2peak} (P=0.002), and speed (P=0.002) between positions. Defenders and midfielders both ran further in the Cooper run test compared to goalkeepers (P=0.003 and P=0.002, respectively); forwards and goalkeepers completed a similar distance (P=0.103, Table II). There was no difference in distance covered between defenders, midfielders, and forwards (P>0.05, Table II). Similarly, defenders and midfielders both had a higher predicted VO_{2peak} than goalkeepers (P=0.003 and P=0.002, respectively, Table II). There was no difference in predicted VO_{2peak} between any other positions (P>0.05). Defenders were the fastest over 50 m; both goalkeepers (P=0.018) and midfielders (P=0.011) were slower (Table II). There was no difference in 50 m speed between players in any other positions (P>0.05, Table II). There was no difference in maximal push-ups (P=0.082), maximal sit-ups (P=0.125), vertical jump height (P=0.978), peak power (P=0.120) or agility (P=0.707) between each position (Table II).

Comparisons to published data

Compared to age-matched mean data on players from other countries, the Saudi players were consistently inferior, although not all values were statistically different (*i.e.*, outside the±1.96 Z score).

Anthropometric comparisons

Within the age group below (*i.e.* U16s), the Saudi players were similar in body mass (Z -0.21 to -1.75, P>0.05), height (Z -0.07 to -1.26, P>0.05), and BMI (Z -0.15 to -1.08, P>0.05) compared to counterparts from other nations (Table III, IV),[6, 10, 11, 15, 32-38] but had a higher body fat percentage than Canadian (Z=-5.23, P<0.05) and French players (Z=-2.02, P<0.05) (Table IV). Compared to the same age group (*i.e.*, U17s), Saudi players were lighter than English players (Z -3.44 to -3.44, P<0.05); no other anthropometric differences existed. Compared to the age group above (*i.e.*, U18s), Saudi players were lighter than Tunisian (Z=-1.98, P<0.05) and Italian players (Z=-2.64, P<0.05) and were shorter than Italian players (Z=-2.08, P<0.05, Table IV). Saudi players also had more body fat than Italian players (Z=3.23, P<0.05, Table IV).

Fitness comparisons

The largest and most prevalent difference was a lower VO_{2peak} in the Saudi players compared to English (Z -2.32 to -7.24, P<0.05), Scottish (Z=-2.98, P<0.05), Tunisian (Z=-3.13, P<0.05), Ital-

TABLE II.—*Mean values of physical fitness and physiological data.*

Parameters	All players (N.=188)	Goalkeepers (N.=20)	Defenders (N.=55)	Midfielders (N.=68)	Forwards (N.=45)
Speed (s)	7.03±0.48	7.22±0.59 †	6.85±0.38	7.13±0.48 †	7.01±0.48
Flexibility (inch)	14.89±2.39	15.30±2.40	15.14±2.08	14.75±2.40	14.59±2.75
Agility (s)	21.53±1.53	21.68±1.43	21.63±1.21	21.54±1.71	21.32±1.67
Vertical jump (cm)	47.1±6.9	47.1±8.5	47.0±6.9	46.9±6.5	47.6±7.1
Peak power (W)	3423±584	3604±693	3454±566	3302±586	3488±530
Sit-ups	39.5±8.1	37.0±6.0	39.3±7.9	41.2±8.5	38.3±8.3
Push-ups	21.3±8.8	17.6±5.5	23.1±8.4	21.6±9.5	20.3±9.1
Cooper test (m)	2594±244	2418±234	2634±227*	2637±219*	2559±268
VO_{2peak} (mL/kg/min)	46.70±5.45	42.75±5.22	47.59±5.08*	47.67±4.91*	45.91±6.00

*P<0.05 compared to goalkeepers; † P<0.05 compared to defenders; ‡ P<0.05 compared to midfielders.

TABLE III.—*Calculated Z scores between studies that provide anthropometric and fitness data for youth and adolescent groups around the world and the current study.*[6, 10, 11, 15, 32-38]

Study	Country	N.	Age	Position/standard	Mass	Height	BMI	VO_{2peak}	Jump height	Body fat
Leatt (1987)[36]	Canada	8	15.4		-1.75	-0.60		-3.158		5.23*
Reilly (2000)[6]	England	16	16.4	Elite	-4.81*	0.50		-7.248	-1.50	1.57
McMillan (2005)[11]	Scotland	11 §	16.9		-1.58	-1.33		-2.988	1.52	
Chamari (2004)[10]	Tunisia	34	17.5	Not stated	-1.98*	-1.39	-1.51	-3.138	-0.63	1.40
Impellizzeri (2004)[33]	Italy	19	17.6		-2.64*	-2.08		-2.608		3.23*
Vanderford (2004)[38]	USA	19	14.6	Not stated	-0.63	-1.12		-1.43		1.67
		20	15.7	Not stated	-1.37	-1.26		-1.74		1.36
Gil (2007)[32]	Spain	29	17.6	Goalkeepers	-1.49	-0.92	-1.49	-0.51		2.09*
		77	17.3	Defenders	-1.13	-0.74	-0.85	-1.16		0.98
		79	17.2	Midfielders	-1.35	-1.08	-1.10	-1.01		0.98
		56	17.6	Forwards	-1.08	-1.13	-0.57	-1.53		3.85*
Wong (2009)[15]	China	16	16.2	Not stated	-0.79	-0.87		-2.56*	1.63	
le Gall (2010)[35]	France	16	15.4	International	-0.85	-1.01		-5.81*	-0.55	2.20*
		57	15.4	Professional	-1.00	-0.83		-4.84*	-0.40	0.87
		70	15.5	Professional				-4.05*	-0.14	0.80
Lago-Peñas (2011)[34]	Spain	35	15.6	Goalkeepers	-0.49	0.19	-0.89			
		53	15.6	Defenders	-1.16	-0.71	-1.08			
		61	15.5	Midfielders	-0.65	-0.21	-0.82			
		72	15.6	Forwards	-0.21	-0.13	-0.15			
Matta (2014)[37]	Brazil	161	14.2	Not stated	0.38	0.44			1.55	
		84	16.1	Not stated	-0.41	-0.31			2.84*	

*Falls outside ±1.96 boundary; § pre-training intervention.

TABLE IV.—*Mean±SD or mean [SEM] data from studies that provide anthropometric and fitness data for youth players around the world.*[6, 10, 11, 15, 32-38]

Study	Country	N.	Age (years)	Position/ Standard	Weight (kg)	Height (m)	BMI (kg/m^2)	VO_{2peak} (mL/kg/min)	Jump height (cm)	Body fat (%)
Leatt (1987)[36]	Canada	8	15.4±0.5		62.7±2.8	171.1±4.3		59.0±3.9		7.8±1.3
Reilly (2000)[6]	England	16	16.4	Elite	63.1±1.1	171.0±5.0		59.0±1.7	55.8±5.8	11.3±2.1
		15	16.4	Sub elite	66.4±2.5	175.0±6.0		55.5±3.8	50.2±7.6	13.9±3.8
McMillan (2005)[11]	Scotland	11*	16.9±0.4		70.6±8.1	177.0±6.4		63.4±5.6	37.7±6.2	
Chamari (2004)[10]	Tunisia	34	17.5±1.1	Not stated	70.5±6.4	177.8±6.7	22.5±1.4	61.1±4.6	51.3±6.7	11.8±2.0
Impellizzeri (2004)[33]	Italy	19	17.6±0.7		70.2±4.7	178.5±4.8		57.1±4.0		7.5±2.2
Vanderford (2004)[38]	USA	19	14.6 [0.1]	Not stated	62.8 [0.3]	176.1 [0.3]		54.5 [1.3]		7.7 [0.5]
		20	15.7 [0.1]	Not stated	68.6 [0.4]	177.1 [0.3]		56.2 [1.5]		9.0 [0.4]
Gil (2007)[32]	Spain	29	17.6±2.4	Goalkeepers	73.6±7.9	179.5±5.9	22.9±1.7	48.4±11.1		12.2±1.7
		77	17.3±2.7	Defenders	68.9±9.1	175.5±7.6	22.3±2.2	58.6±9.5		11.7±1.9
		79	17.2±2.4	Midfielders	68.5±9.7	174.7±7.6	22.4±2.2	57.7±9.9		11.9±2.3
		56	17.6±2.6	Forwards	68.4±9.1	174.8±6.8	22.2±2.2	62.4±10.8		11.0±1.3
Wong (2009)[15]	China	16	16.2±0.6	Not stated	64.2±8.1	173.0±5.2		60.5±5.4	39.3±4.8	
le Gall (2010)[35]	France	16	15.4±0.4	International	65.3±8.8	176.1±7.5		62.4±2.7	50.6±6.4	11.3±1.5
		57	15.4±0.4	Professional	66.0±8.2	175.3±8.2		62.2±3.2	49.4±5.7	12.6±2.3
		70	15.5±0.5	Amateurs	58.8±9.2	169.1±8.2		61.7±3.7	47.8±4.9	12.6±2.5
Lago-Peñas (2011)[34]	Spain	35	15.6±1.8	Goalkeepers	67.5±11.6	172.5±8.4	22.5±2.4			
		53	15.6±1.8	Central defenders	70.0±9.8	175.1±7.3	22.8±2.2			
		61	15.5±1.9	Central midfielders	62.1±10.3	168.3±8.4	21.8±2.2			
		72	15.6±1.8	Forwards	61.2±12.1	168.4±9.7	21.3±2.4			
Matta (2014)[37]	Brazil	161	14.2±0.5	Not stated	54.2±9.5	165.0±8.0		54.3	39.2±5.1	
		84	16.1±0.6	Not Stated	61.7±9.6	170.9±7.4		56.5	32.9±5.0	

*Pre-training intervention.

ian (Z=-2.60, P<0.05), French (Z=-4.05, P<0.05), Canadian (Z=-3.15, P<0.05), and Chinese players (Z=-2.56, P<0.05, Table IV). Lastly, Saudi players' jump height was similar to French players (Z -0.14 to -0.55, P>0.05), but higher than Brazilian players (Z=2.84, P<0.05, Table IV).

Positional comparisons

There were no differences in body mass (Z -0.21 to -1.16, P>0.05), height (Z -0.13 to -0.71, P>0.05) or BMI (Z -0.15 to -1.08, P>0.05) between equivalent age groups or positions when compared to Spanish players. Compared to U18s, there were no differences in body mass (Z -1.08 to -1.49, P>0.05), height (Z -0.07 to -1.13, P>0.05) or BMI (Z -0.57 to -1.49, P>0.05). Surprisingly, there were no differences in VO_{2peak} (Z -0.51 to -1.53, P>0.05); goalkeepers (Z=2.09, P>0.05) and forwards (Z=3.85, P>0.05) both had higher body fat percentages than Spanish players (Table IV).

Discussion

To the best of our knowledge, this is the first study to provide a comprehensive dataset on the physical fitness and anthropometrics of a large group of young Saudi footballers. The study's two key findings were: 1) Saudi youth footballers had distinctly poorer anthropometric and fitness characteristics, with apparent lower VO_{2peak}, compared to age-comparable peers from other countries; 2) the anthropometric and fitness characteristics of the Saudi footballers were not dissimilar between playing positions; defenders appeared to be physically superior to other positions; anthropometric measures did not predict the fitness characteristics in the Saudi youth players.

Within-group comparisons

Having high aerobic capacity is a determining factor for success in football.[12, 39] Outfield players cover more total distance than goalkeepers; midfielders and forwards cover greater distances in matches than defenders.[32] The movement characteristics of outfield players differ during a match depending on their playing position.[40] In professional settings, these movement patterns are likely to be replicated within training programs and may account for the variations in VO_{2max} and anthropometric measurements between positions.[32] However, the characteristics of Saudi youth footballers were fairly similar between positions. Surprisingly, defenders were the most physically developed compared to other positions. There were no significant differences in the distance covered during the Cooper run between defenders, midfielders, and forwards; defenders and midfielders completed a greater distance in the test. As anticipated, goalkeepers reported lower aerobic capacity (VO_{2max}) compared to defenders and midfielders. Indeed, comparably aged (~13-year-old) Chinese [15] and Saudi adult (~25-year-old) players[13] have similar VO_{2max} among outfield players. This finding is further cemented by a recent meta-analysis that suggests VO_{2max} values do not differ between outfield players.[8] Given that outfield players cover a far greater distance than goalkeepers within a match, it should be expected that a goalkeeper's VO_{2max} would be lower than that of outfield players. For instance, Spanish outfield players, on average, have higher VO_{2max} than goalkeepers.[8, 33] One of the key findings of the present study was that the covered distance in the Cooper Run Test and predicted VO_{2max} values between goalkeepers and forwards were similar. This may be partly explained by the higher body fat percentage of forwards (Table I) as a higher percentage of body fat was found to be associated with lower VO_{2max}.[34] Therefore, it is highly recommended that coaches should consider implementing a training approach for forwarders that is designed to lower body fat percentage besides increasing their VO_{2max}. Unfortunately, this study was unable to report on the match-related or training-related movement patterns of the young Saudi players; this topic should therefore be considered in future work.

Comparisons with international footballer peers

Many papers have previously compared the fitness characteristics of footballers with other work descriptively. While this is a viable approach, we attempted to statistically compare our data to similar age groups and positions of players of other nations using simple Z-statistics. The clearest difference between the findings of relevant existing studies and those of the present study was in relation to VO_{2max} (all Z scores between -0.51 and -7.24), with the Saudi players having statistically lower VO_{2max} values than younger players (*i.e.* U16s),[35, 41] age-matched players (*i.e.* U17s)[6, 16, 36] and older players (*i.e.*, U18s).[7, 42] Unsurprisingly, the largest differences were observed between the Saudi players and their elite/professional British and Canadian counterparts of the same age, Z -3.15 to -5.81.[35, 41] Though, a very large difference (Z=-4.05) was also observed between the Saudi players compared to their British amateur counterparts.[35] Irrespective of football, it is also observed that the VO_{2max} of Saudi males does not change between adolescence and young adulthood[43] with the VO_{2max} of the current Saudi group equivalent to the lower 50th percentile of other Saudi boys aged 7-15.[43] The differences in VO_{2max} between the current findings and those from other continents, such as Europe, are likely due to the lower intensity, duration, and volume of Saudi training sessions. The average length of training of Saudi players was ~2 years with players completing 2-4 sessions per week for ~7 months per year. The earlier professionalization of players of other continents compared to those of Middle Eastern countries has likely affected the latter's physical development and integration within long-term player development programs[37] for youth teams in Saudi Arabia; that said, evidence to support this conjecture is not yet available. One of the aims of long-term player development programs is monitoring players' maturation, such as peak height velocity (PHV).[37] Given the ages of the players within the present study, they would likely have passed their PHV; their lower VO_{2max} compared to age-matched non-footballers would further suggest that their physical development during their PHV period (*i.e.*, pre-, during- and post-PHV) did not appropriately match their periods of accelerated development to maximize their physical characteristics.[44, 45] Certainly, in other game-related sports,[45, 46] the length of time players have participated in training is associated with a higher VO_{2max}; this is likely to be similar in football. Certainly, predicted VO_{2max} usually improves in players participating in training compared to non-players[39] and so the lower VO_{2max} compared to other Saudi groups that do not play football would certainly suggest that training programs and/or training sessions are not eliciting the appropriate physiological responses to achieve a similar level to age-matched groups nor to improving the level of professional sides once young players progress through league age groups. Given that the total training period of the Saudi group in the current study was ~2 years, the reason for their lower VO_{2max} compared to non-footballers is unclear. Further explanations may include differences in the genetic profile of Saudi players compared to their European or American counterparts. Indeed, variations in genotype frequency according to different ethnicities have been reported for several single nucleotide polymorphisms that have recently been associated with elite football player status in youth players from England and Uruguay.[47] However, there appears to be no data in the literature pertaining to training effects or the genetic profiles of Saudi footballers.

Anthropometric measurements

There were few differences between the anthropometric data of the present study and comparable data from different nations. In general, the body mass of the Saudi youth players was consistently lower compared to their peers from different countries (*i.e.* U16s;[8, 35, 48] U17s)[6] and older age groups (*i.e.*, U18s)[7, 42] including those playing in equivalent positions.[8, 33] Conversely, the Saudi players had consistently higher body fat percentages than all comparators, which were statistically higher than age-matched elite players[35, 41] and older groups (*i.e.*, U18s).[42] Although a non-statistically significant difference was found, the consistently lower body mass and higher body fat percentage of the Saudi players compared to age-matched comparators from around the world would suggest that the former have lower muscle power and poorer endurance. That said, neither the current study (nor the others we compared) directly measured muscle mass, so the above suggestion is speculative and further work is required. Therefore, this would suggest that elite groups' training encompasses hypertrophy-based work and associated elements; however, the current data showed that the Saudi players' jump heights were lower but not statistically different to players of other countries[6, 36] with jump height being higher than Brazilian players.[49] The consistently lower jump heights among the Saudi players compared to those of players from other countries would again suggest that the use of models such as the long-term player development (LTAD) plan and PHV-related considerations are either neglected, poorly understood, or inappropriately used by the trainers of the current Saudi group. This is a particularly important consideration for the development of young Saudi players as it has been suggested that successful players (*i.e.*, ones that transition to adult/professional careers) have superior physical attributes compared to their age-matched counterparts.[4, 8, 48, 50]

Conclusions

This study aimed to measure the anthropometric and fitness characteristics of Saudi youth football players and compare these data to comparable age-matched populations. The data suggested that, generally, the physical fitness and anthropometric characteristics of the Saudi players did not differ significantly between players of different positions. Defenders and goalkeepers, however, appeared to have a slight physical advantage over players in other positions ($P<0.05$). Importantly, the comparisons between our data and that from other populations suggested that the Saudi players are significantly poorer in terms of physical fitness and anthropometric development. There are several potential reasons for this, such as training modality, frequency, duration, and genetic profiles; however, further research to elucidate this is required in Saudi youth footballers.

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Conflicts of interest

The author certifies that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

History

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