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

Mansour ALSOWAYAN *

College of Sport Sciences and Physical Activity, King Saud University, Riyadh, Saudi Arabia

*Corresponding author: Mansour Alsowayan, College of Sport Sciences and Physical Activity, King Saud University, Riyadh, Saudi Arabia. E-mail: malsowayan@ksu.edu.sa

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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 (VO₂peak); 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 VO₂peak 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 VO₂peak (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. 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. The game is played over 90 mins; it mainly depends on aerobic capacity, speed, agility, and power. Traditional-
ly, 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.6, 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 tests7 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 hockey21 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/m² (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>
<thead>
<tr>
<th>Characteristic</th>
<th>All players (N=188)</th>
<th>Goalkeepers (N=20)</th>
<th>Defenders (N=55)</th>
<th>Midfielders (N=68)</th>
<th>Forwards (N=45)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>15.5±0.6</td>
<td>15.4±0.7</td>
<td>15.6±0.6</td>
<td>15.5±0.5</td>
<td>15.5±0.5</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>168.5±6.8</td>
<td>174.1±5.8</td>
<td>169.9±6.7</td>
<td>166.5±6.6*</td>
<td>167.1±6.0*</td>
</tr>
<tr>
<td>Mass (kg)</td>
<td>57.8±7.7</td>
<td>61.8±8.8</td>
<td>58.6±7.5</td>
<td>55.4±7.0</td>
<td>58.6±7.5</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>20.4±2.1</td>
<td>20.4±2.3</td>
<td>20.4±2.3</td>
<td>20.0±1.9</td>
<td>21.0±2.2</td>
</tr>
<tr>
<td>Body surface area (m²)</td>
<td>1.66±0.13</td>
<td>1.75±0.14</td>
<td>1.68±0.12</td>
<td>1.62±0.13</td>
<td>1.66±0.12</td>
</tr>
<tr>
<td>Triceps (mm)</td>
<td>8.69±3.03</td>
<td>9.30±3.11</td>
<td>7.88±3.28</td>
<td>8.44±2.56</td>
<td>9.79±3.05†</td>
</tr>
<tr>
<td>Subscapular (mm)</td>
<td>8.94±2.22</td>
<td>9.63±2.66</td>
<td>8.71±2.03</td>
<td>8.63±2.08</td>
<td>9.38±2.36</td>
</tr>
<tr>
<td>Cali (mm)</td>
<td>8.47±2.81</td>
<td>8.65±2.64</td>
<td>8.12±2.6</td>
<td>8.18±2.62</td>
<td>9.24±3.31</td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>14.6±4.1</td>
<td>15.8±4.5</td>
<td>13.6±4.1</td>
<td>14.2±3.8</td>
<td>16.0±4.1†</td>
</tr>
</tbody>
</table>

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 sea-
son, 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 per-
formed according to standard procedures.23 Height
was measured to the nearest 0.1 cm via stadiom-
eter and mass, wearing only shorts, measured to
the nearest 0.1 kg using a calibrated digital scale
(Seca 220, Hamburg, Germany). BMI was cal-
culated as the ratio of mass (kg) and squared height
(m). Skinfold thickness was recorded to the near-
est 0.2 mm at the right triceps, subcapular and
medial calf muscle using Lange skinfold calipers
(Beta Technology, Santa Cruz, CA, USA). The per-
centage of body fat was estimated via Boileau
equations for 13-14-year-olds (equation 1) and
15-16-year-olds (equation 1).16, 24

\[
\text{Body fat} (\%) = 1.35 \times (T+S) - 0.012 \times (T+S)^2 - 4.4
\] (1)

\[
\text{Body fat} (\%) = 1.35 \times (T+S) - 0.012 \times (T+S)^2 - 5.4
\] (2)

(T and S are triceps and subcapular 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 re-
quired 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 verti-
cally 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

\[
\text{Peak power (W)} = \left[ \frac{60.7 \times \text{JH} + 45.3}{\text{mass} - 2055} \right] \times 0.1
\] (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 stand-
ing 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 rectan-
gle. 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 sec-
ond 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 mus-
cle strength endurance.29, 30 Participants were in-
structed to lie flat on a carpeted floor with knees
bent at approximately 90°, 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
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.

\[ Z = \frac{x - \mu_o}{\sigma} \] (5)

where \( Z \) is the test score used on a Z distribution table, \( x \) is the mean of a previously published population, \( \mu_o \) is the mean of the current study’s sample, and \( \sigma \) 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). Goalkeepers were taller than both midfielders (P<0.001) and forwards (P=0.001) 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 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).

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 players (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), Ita-

<table>
<thead>
<tr>
<th>Parameters</th>
<th>All players (N=188)</th>
<th>Goalkeepers (N=20)</th>
<th>Defenders (N=55)</th>
<th>Midfielders (N=68)</th>
<th>Forwards (N=45)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed (s)</td>
<td>7.03±0.48</td>
<td>7.22±0.59†</td>
<td>6.85±0.38</td>
<td>7.13±0.48†</td>
<td>7.01±0.48</td>
</tr>
<tr>
<td>Flexibility (inch)</td>
<td>14.89±2.39</td>
<td>15.30±2.40</td>
<td>15.14±2.08</td>
<td>14.75±2.40</td>
<td>14.59±2.75</td>
</tr>
<tr>
<td>Agility (s)</td>
<td>21.53±1.53</td>
<td>21.68±1.43</td>
<td>21.63±1.21</td>
<td>21.54±1.71</td>
<td>21.32±1.67</td>
</tr>
<tr>
<td>Vertical jump (cm)</td>
<td>47.1±6.9</td>
<td>47.1±8.5</td>
<td>47.0±6.9</td>
<td>46.9±6.5</td>
<td>47.6±7.1</td>
</tr>
<tr>
<td>Peak power (W)</td>
<td>342±584</td>
<td>3604±693</td>
<td>345±566</td>
<td>330±258</td>
<td>348±530</td>
</tr>
<tr>
<td>Sit-ups</td>
<td>39.5±8.1</td>
<td>37.0±6.0</td>
<td>39.3±7.9</td>
<td>41.2±8.5</td>
<td>38.3±8.3</td>
</tr>
<tr>
<td>Push-ups</td>
<td>21.3±8.8</td>
<td>17.6±5.5</td>
<td>23.1±8.4</td>
<td>21.6±9.5</td>
<td>20.3±9.1</td>
</tr>
<tr>
<td>Cooper test (m)</td>
<td>259±244</td>
<td>241±234</td>
<td>263±227*</td>
<td>263±219*</td>
<td>255±268</td>
</tr>
<tr>
<td>VO$_{2peak}$ (mL/kg/min)</td>
<td>46.70±5.45</td>
<td>42.75±5.22</td>
<td>47.59±5.08*</td>
<td>47.67±4.91*</td>
<td>45.91±6.00</td>
</tr>
</tbody>
</table>

*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.  

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>N</th>
<th>Age (years)</th>
<th>Position/standard</th>
<th>Mass (kg)</th>
<th>Height (m)</th>
<th>BMI</th>
<th>VO_{peak} (mL/kg/min)</th>
<th>Jump height (cm)</th>
<th>Body fat (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leatt (1987)⁶⁶</td>
<td>Canada</td>
<td>8</td>
<td>15.4</td>
<td>Not stated</td>
<td>-1.75</td>
<td>-0.60</td>
<td>-3.158</td>
<td>5.23*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reilly (2000)⁶</td>
<td>England</td>
<td>16</td>
<td>16.4</td>
<td>Elite</td>
<td>-4.81*</td>
<td>0.50</td>
<td>-7.248</td>
<td>-1.50</td>
<td>1.57</td>
<td></td>
</tr>
<tr>
<td>McMillan (2005)³¹</td>
<td>Scotland</td>
<td>11</td>
<td>16.9</td>
<td>Not stated</td>
<td>-1.58</td>
<td>-1.33</td>
<td>-2.988</td>
<td>1.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chamari (2004)¹⁰</td>
<td>Tunisia</td>
<td>34</td>
<td>17.5</td>
<td>Not stated</td>
<td>-1.98*</td>
<td>-1.39</td>
<td>-3.138</td>
<td>0.63</td>
<td>1.40</td>
<td></td>
</tr>
<tr>
<td>Impellizzeri (2004)¹³</td>
<td>Italy</td>
<td>19</td>
<td>17.6</td>
<td>Not stated</td>
<td>-2.64*</td>
<td>-2.08</td>
<td>-2.608</td>
<td>3.23*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vanderford (2004)¹⁸</td>
<td>USA</td>
<td>19</td>
<td>14.6</td>
<td>Not stated</td>
<td>-0.63</td>
<td>-1.12</td>
<td>-1.43</td>
<td>1.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
<td>15.7</td>
<td>Not stated</td>
<td>-1.37</td>
<td>-1.26</td>
<td>-1.74</td>
<td>1.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gil (2007)³²</td>
<td>Spain</td>
<td>29</td>
<td>17.6</td>
<td>Goalkeepers</td>
<td>-1.49</td>
<td>-0.92</td>
<td>-1.49</td>
<td>0.51</td>
<td>2.09*</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>77</td>
<td>17.3</td>
<td>Defenders</td>
<td>-1.13</td>
<td>-0.74</td>
<td>-0.85</td>
<td>-1.16</td>
<td>0.98</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>79</td>
<td>17.2</td>
<td>Midfielders</td>
<td>-1.35</td>
<td>-1.08</td>
<td>-1.10</td>
<td>-1.01</td>
<td>0.98</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>56</td>
<td>17.6</td>
<td>Forwards</td>
<td>-1.08</td>
<td>-1.13</td>
<td>-0.57</td>
<td>-1.53</td>
<td>3.85*</td>
<td></td>
</tr>
<tr>
<td>Wong (2009)¹⁵</td>
<td>China</td>
<td>16</td>
<td>16.2</td>
<td>Not stated</td>
<td>-0.79</td>
<td>-0.87</td>
<td>-2.56*</td>
<td>1.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>le Gall (2010)³⁵</td>
<td>France</td>
<td>16</td>
<td>15.4</td>
<td>International</td>
<td>-0.85</td>
<td>-1.01</td>
<td>-5.81*</td>
<td>-0.55</td>
<td>2.20*</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>57</td>
<td>15.4</td>
<td>Professional</td>
<td>-1.00</td>
<td>-0.83</td>
<td>-4.84*</td>
<td>-0.40</td>
<td>0.87</td>
<td></td>
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<tr>
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<td>70</td>
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<td>Lago-Peñas (2011)³⁴</td>
<td>Spain</td>
<td>35</td>
<td>15.6</td>
<td>Goalkeepers</td>
<td>-0.49</td>
<td>0.19</td>
<td>-1.08</td>
<td>1.55</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>53</td>
<td>15.6</td>
<td>Defenders</td>
<td>-1.16</td>
<td>-0.71</td>
<td>0.08</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>61</td>
<td>15.5</td>
<td>Midfielders</td>
<td>-0.65</td>
<td>-0.21</td>
<td>-0.82</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>72</td>
<td>15.6</td>
<td>Forwards</td>
<td>-0.21</td>
<td>-0.13</td>
<td>-0.15</td>
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</tr>
<tr>
<td>Matta (2014)³⁷</td>
<td>Brazil</td>
<td>161</td>
<td>14.2</td>
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<td>0.38</td>
<td>0.44</td>
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<td>84</td>
<td>16.1</td>
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<td>-0.41</td>
<td>-0.31</td>
<td>2.84*</td>
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</table>

*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.⁵, 10, 11, 15, 32-38

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>N</th>
<th>Age (years)</th>
<th>Position/standard</th>
<th>Weight (kg)</th>
<th>Height (m)</th>
<th>BMI</th>
<th>VO_{peak} (mL/kg/min)</th>
<th>Jump height (cm)</th>
<th>Body fat (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leatt (1987)⁶⁶</td>
<td>Canada</td>
<td>8</td>
<td>15.4±0.5</td>
<td>Goalkeepers</td>
<td>62.7±2.8</td>
<td>171.1±4.3</td>
<td>59.0±1.7</td>
<td>5.5±0.8</td>
<td>11.3±2.1</td>
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</tr>
<tr>
<td></td>
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<td>15</td>
<td>16.4±0.7</td>
<td>Sub elite</td>
<td>66.4±2.5</td>
<td>175.0±6.0</td>
<td>55.5±3.8</td>
<td>50.2±7.6</td>
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</tr>
<tr>
<td>Reilly (2000)⁶</td>
<td>England</td>
<td>16</td>
<td>16.4</td>
<td>Elite</td>
<td>63.1±1.1</td>
<td>171.0±5.0</td>
<td>59.0±1.7</td>
<td>55.8±5.8</td>
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</tr>
<tr>
<td></td>
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<td>6</td>
<td>17.0</td>
<td>Not stated</td>
<td>68.6±0.6</td>
<td>177.1±3.1</td>
<td>56.2±1.5</td>
<td>9.0±0.4</td>
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<tr>
<td>McMillan (2005)³¹</td>
<td>Scotland</td>
<td>11*</td>
<td>16.9±0.4</td>
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<td>70.6±8.1</td>
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<td>63.4±5.6</td>
<td>39.0±6.2</td>
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<tr>
<td>Chamari (2004)¹⁰</td>
<td>Tunisia</td>
<td>34</td>
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<td>70.5±6.4</td>
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<td>22.5±1.4</td>
<td>51.3±6.7</td>
<td>11.8±2.0</td>
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</tr>
<tr>
<td>Impellizzeri (2004)³³</td>
<td>Italy</td>
<td>19</td>
<td>17.6±0.7</td>
<td>Not stated</td>
<td>70.2±4.7</td>
<td>178.5±4.8</td>
<td>57.1±4.0</td>
<td>7.5±2.2</td>
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<td></td>
<td>20</td>
<td>15.7</td>
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<td>68.6</td>
<td>177.1</td>
<td>56.2</td>
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<td>0.4</td>
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<td></td>
<td>30</td>
<td>16.5</td>
<td>[0.1]</td>
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<td>68.6</td>
<td>177.1</td>
<td>56.2</td>
<td>9.0</td>
</tr>
<tr>
<td>Gil (2007)³²</td>
<td>Spain</td>
<td>29</td>
<td>17.6±2.4</td>
<td>Goalkeepers</td>
<td>73.6±7.9</td>
<td>179.5±5.9</td>
<td>22.9±1.7</td>
<td>48.4±11.1</td>
<td>12.2±1.7</td>
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<td>77</td>
<td>17.3±2.7</td>
<td>Defenders</td>
<td>68.9±9.1</td>
<td>175.5±7.6</td>
<td>22.3±2.2</td>
<td>58.6±9.5</td>
<td>11.7±1.9</td>
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<td>79</td>
<td>17.2±2.4</td>
<td>Midfielders</td>
<td>68.5±9.7</td>
<td>174.7±7.6</td>
<td>22.4±2.2</td>
<td>57.7±9.9</td>
<td>11.9±2.3</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>56</td>
<td>17.6±2.6</td>
<td>Forwards</td>
<td>68.4±9.1</td>
<td>174.8±6.8</td>
<td>22.2±2.2</td>
<td>62.4±10.8</td>
<td>11.0±1.3</td>
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<tr>
<td>Wong (2009)¹⁵</td>
<td>China</td>
<td>16</td>
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<td>Not stated</td>
<td>64.2±8.1</td>
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<td>60.5±5.4</td>
<td>39.3±4.8</td>
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<td>le Gall (2010)³⁵</td>
<td>France</td>
<td>16</td>
<td>15.4±0.4</td>
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<td>65.3±8.8</td>
<td>176.1±7.5</td>
<td>62.4±2.7</td>
<td>50.6±4.8</td>
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<td>Professional</td>
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<td>62.2±3.2</td>
<td>49.4±5.7</td>
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<td>Amateurs</td>
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<td>169.1±8.2</td>
<td>61.7±3.7</td>
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<tr>
<td>Lago-Peñas (2011)³⁴</td>
<td>Spain</td>
<td>35</td>
<td>15.6±1.8</td>
<td>Goalkeepers</td>
<td>67.5±11.6</td>
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<td>22.5±2.4</td>
<td>5.6±0.4</td>
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<td>53</td>
<td>15.6±1.8</td>
<td>Central defenders</td>
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<td>175.1±7.3</td>
<td>22.8±2.2</td>
<td>5.6±0.4</td>
<td>30.3±4.8</td>
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</tr>
<tr>
<td></td>
<td></td>
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<td>15.5±1.9</td>
<td>Central midfielders</td>
<td>62.1±10.3</td>
<td>168.3±8.4</td>
<td>21.8±2.2</td>
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<tr>
<td></td>
<td></td>
<td>72</td>
<td>15.6±1.8</td>
<td>Forwards</td>
<td>61.2±12.1</td>
<td>168.4±9.7</td>
<td>21.3±2.4</td>
<td>5.6±0.4</td>
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<tr>
<td>Matta (2014)³⁷</td>
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<td>Not stated</td>
<td>54.2±9.5</td>
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<td>84</td>
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<td>170.9±7.4</td>
<td>56.5</td>
<td>32.9±5.0</td>
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</tr>
</tbody>
</table>

*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 play-
ers’ 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) be-
tween 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). Sur-
prisingly, there were no differences in VO2peak
(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 foot-
ballers had distinctly poorer anthropometric
and fitness characteristics, with apparent lower
VO2peak compared to age-comparable peers from
other countries; 2) the anthropometric and fitness
characteristics of the Saudi footballers were not
dissimilar between playing positions; defend-
ers appeared to be physically superior to other
positions; anthropometric measures did not pre-
dict 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 play-
ers cover more total distance than goalkeepers;
midfielders and forwards cover greater distanc-
es 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 pat-
terns are likely to be replicated within training
programs and may account for the variations in
VO2max and anthropometric measurements be-
tween 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, goalkeep-
ers reported lower aerobic capacity (VO2max)
compared to defenders and midfielders. Indeed,
comparably aged (~13-year-old) Chinese
and
Saudi adult (~25-year-old) players have similar
VO2max among outfield players. This finding is
further cemented by a recent meta-analysis that
suggests VO2max values do not differ between
outfield players.8 Given that outfield players cov-
er a far greater distance than goalkeepers within a
match, it should be expected that a goalkeeper’s
VO2max would be lower than that of outfield play-
ers. For instance, Spanish outfield players, on av-
erage, have higher VO2max 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 VO2max values between goalkeep-
ers and forwards were similar. This may be part-
ly 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
VO2peak.34 Therefore, it is highly recommended
that coaches should consider implementing a
training approach for forwards that is designed
to lower body fat percentage besides increasing
their VO2max. Unfortunately, this study was un-
able 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 fit-
ness 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 clear-
est difference between the findings of relevant existing studies and those of the present study was in relation to VO\textsubscript{2max} (all Z scores between -0.51 and -7.24), with the Saudi players having statistically lower VO\textsubscript{2max} values than younger players (\textit{i.e.} U16s),\textsuperscript{35, 41} age-matched players (\textit{i.e.} U17s)\textsuperscript{6, 16, 36} and older players (\textit{i.e.}, U18s).\textsuperscript{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.\textsuperscript{35, 41} Though, a very large difference (Z=-4.05) was also observed between the Saudi players compared to their British amateur counterparts.\textsuperscript{35} Irrespective of football, it is also observed that the VO\textsubscript{2max} of Saudi males does not change between adolescence and young adulthood\textsuperscript{43} with the VO\textsubscript{2max} of the current Saudi group equivalent to the lower 50\textsuperscript{th} percentile of other Saudi boys aged 7-15.\textsuperscript{43} The differences in VO\textsubscript{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\textsuperscript{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).\textsuperscript{37} Given the ages of the players within the present study, they would likely have passed their PHV; their lower VO\textsubscript{2max} compared to age-matched non-footballers would further suggest that their physical development during their PHV period (\textit{i.e.}, pre-, during- and post-PHV) did not appropriately match their periods of accelerated development to maximize their physical characteristics.\textsuperscript{34, 45} Certainly, in other game-related sports,\textsuperscript{45, 35} the length of time players have participated in training is associated with a higher VO\textsubscript{2max}; this is likely to be similar in football. Certainly, predicted VO\textsubscript{2max} usually improves in players participating in training compared to non-players\textsuperscript{39} and so the lower VO\textsubscript{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\textsubscript{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.\textsuperscript{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 (\textit{i.e.}, U16s),\textsuperscript{8, 35, 48} U17s)\textsuperscript{6} and older age groups (\textit{i.e.}, U18s).\textsuperscript{7, 42} including those playing in equivalent positions.\textsuperscript{8, 33} Conversely, the Saudi players had consistently higher body fat percentages than all comparators, which were statistically higher than age-matched elite players\textsuperscript{35, 41} and older groups (\textit{i.e.}, U18s).\textsuperscript{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 associ-
ated 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.

**References**

22. Booth M, Coble S, Halaki M, Orr R. Is training age pre-


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