

Physiological and fitness characteristics in well-trained adolescent soccer players: differences between age groups and playing position

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Abstract

Soccer is an effective game to enhance physical fitness and health in adolescents, although the interaction between age and position specialization causes significant problems in training design. The purpose of this study was to investigate the interaction of age and position of players on physiological and fitness characteristics in well-trained adolescent soccer players. Adolescent soccer players (n=860) participated in the study. Athletes were suppurated according to their age in under 15 (U15: N=258, defenders=100, midfields=78 and forwards=80), under 16 (U16: N=329, defenders=136, midfields=120 and forwards=73), and under 17 (U17: N=273, defenders=112, midfields=80 and forwards=81) groups. Athletes visited the laboratory on three different days during the off-season training period one week after the end of the competitions. Measurements included anthropometric characteristics, body fat, lower body flexibility, lower body maximum isometric torque (IPT), squat jump (SJ), countermovement jump (CMJ), and treadmill maximum oxygen consumption test (VO2 max). The results showed a non-significant interaction between age and position for all variables ($P>0.05$). However, significant main effects were found for age with the older groups having greater anthropometric characteristic ($P<0.05$), higher IPT, higher SJ, and CMJ ($P<0.05$) versus younger groups. Anthropometric differences seem to be more pronounced in the U15 group including body mass, body height, BMI, and body fat ($P<0.05$) versus U16 and U17 players. Defenders had greater body mass, body height, and body fat than midfields and forwards ($p<0.05$). Forwards had greater SJ and CMJ than defenders and midfields ($p<0.05$). These results suggest that physiological and fitness characteristics are age-dependent in well-trained adolescent soccer players, but the position selection of the player in the soccer field is not age-dependent. Coaches should thus consider physiological and fitness tests results to specialize players in each position.

Key Words: Team sport, body mass, maximum force, power, adolescent athletes.

Introduction

Soccer is probably the most popular sports in the world. Soccer training includes numerous of different motor skills such as shooting and passing the ball, dribble the ball, running with and without the ball, sprinting and jumping while is a great sport to enhance socialization, co-operation, self-esteem and develop the personality of young athletes (Rosh et al., 2000). Moreover, soccer is an effective sport to develop the cardio metabolic fitness, muscle strength, movement coordination and reduce the negative symptoms of the daily routine on the psychological health especially in young and adolescent athletes (Hoff and Helgerud, 2004; Balakova et al., 2015; Scharfen and Memmert, 2019; Hadjicharalambous et al., 2022). Consequently, soccer training is an effective activity for all ages to enhance physical fitness, psychology and health. However, enhancing physical fitness in adolescent soccer players is a complex issue, especially in the ages under (U) 15 years of age due to the interaction of growth, maturation, and training specialization (Harries et al., 2012). Consequently, chronological age is a determinant factor for designing training programs where training parameters like intensity, volume, frequency etc; are increased progressively in order to meet the training needs in every age.

In addition to the benefits arising from soccer training, a soccer competition requires from players to be placed into specific positions inside the soccer field. Many studies classify players into four categories: the goalkeepers, the defenders, the midfields and the forwards or attackers (Cometi et al., 2001; Gil et al., 2007). Each position has its specific physiological and fitness characteristics (Reilly et al., 2001). More specific, goalkeepers are the last line of defence. Goalkeepers are the tallest and heavier soccer players (Bernan-Orosco et al., 2020), have greater percentage of body fat, although lower VO2max compared to midfields and forwards (Silvestre et al., 2006; Matkovic et al., 2003; Deprez et al., 2014; Gjonbalaj et al., 2018). Similar to Goalkeepers, defenders aim to stop the offensive actions of the opponents. Defenders are more muscular, have greater body mass than midfields and are taller compared to midfields and forwards (Deprez et al., 2014). In addition, midfields are key players of the game who have an important role in both defence and attack. Midfields cover

the longer distance during a game compare to defenders and forwards (Gil et al., 2007), hence agility, endurance and low body fat are key variables for this position. Lastly, forward players aim to create goal conditions with frequently movements and sudden changes of direction. Thus, forwards are the faster players in the field producing greater power outputs and fast sprints compared to defenders (Marques et al., 2016). A recent systematic review confirms that each position has different metabolic and physical demands while each player has different tasks to perform, hence, training should be individualized for each position (Slimani and Nikolaidis, 2017).

The specific training for each playing position requires an early age specialization. Training young and adolescent soccer players focuses on enhancing all physical and fitness characteristics to increase their soccer performance. Study in young soccer players showed that players U14 had similar body composition values compared to general population probably because of the lower training experience compared to their U16 and U18 counterparts (Torres-Luque et al., 2015). In addition, elite players U15 and U16 are faster and cover longer distances in the field compared to their younger counterparts (Harley et al., 2010), while elite U17 Portuguese players covered longer distance in small sided games than players U19 and U15 (Abade et al., 2014). According to the recommendations of long-term athletic development, adolescent athletes above 14 years of age may participate in systematic training, regularly compete in soccer games and follow individualized training programs to enhance physical fitness and soccer performance (Chatzinikolaou et al., 2018; Lloyd et al., 2015). In line with these recommendations, as young soccer players mature, there is a progressive increase in training demands as well as an increase in the on-field obligations reflected in player's position. Still, whether the chronological age of players may determine the playing position needs further investigation.

Therefore, the purpose of the study was to investigate the interaction between age and team position and to compare the physiological and fitness characteristics of well-trained adolescent soccer players according to their age and team position. The hypothesis was that there would be a significant interaction between age and position in young soccer players while older players would possess greater physiological and fitness characteristics compared to their younger counterparts.

Materials and Methods

Experimental Approach to the Problem

The current study focused on the observation and the comparison of physiological and fitness characteristics between three different age groups: U15, U16 and U17, in well-trained adolescent soccer players. For the purpose of the study, 860 male well-trained adolescent players from 17 local soccer clubs (ranged from 1st to 3rd national category) participated in the study. Briefly, U15 players had a training experience of 5-6 years, participated approximately in 35-40 competitions per year, following 5-6 training sessions per week with duration of 60 to 80 minutes. Players of U16 had a training experience of 7-8 years, participated in approximately 40-45 competitions per year, following 6-7 training sessions per week with duration 70-100 minutes. Finally, U17 players had a training experience of 9-10 years, participated approximately to 40-50 competitions per year, following 6-7 training sessions per week with duration of 100-120 minutes. All measurements were performed on three different days for each player, during the off-season training period 1 week after the end of the competitions. More specific, during the first day players visited the laboratory for anthropometric measurements (body mass, body height and body composition), while a familiarization session with all fitness tests followed. On the second day, players performed the flexibility test, the squat jump (SJ), the countermovement jump (CMJ) and the lower body isometric peak torque test (IPT). On the third day players performed the maximum aerobic test (VO2max). Comparisons were made between age groups according to playing position and within each age group.

Participants

A total of 860 well-trained adolescent soccer players participated in the study. Players were suppurated into three different age groups U15, U16 and U17 years of age and three different positions: defenders, midfielders and forwards. More specific, 258 soccer players participated in the U15 group (defenders: N= 100; midfielders: N = 78; forwards: N = 80; age 14.0 ± 0.1 years, body mass = 61.2 ± 5.3 kg, body height = 1.72 ± 0.05 m), 329 soccer players participated in the U16 group (defenders: N = 136; midfielders: N = 120; forwards: N = 73; age 15.0 ± 0.1 years, body mass = 65.8 ± 4.8 kg, body height = 1.75 ± 0.04 m) and 273 soccer players participated in the U17 group (defenders: N = 112; midfielders: N = 80; forwards: N = 81; age 16.0 ± 0.1 years, body mass = 68.0 ± 5.5 kg, body height = 1.77 ± 0.06 m). Goalkeepers were excluded from the analysis because of the small number of players. All players were informed about the experimental procedures and signed the informed consent. Parental concern was also obtained from all players. Inclusion criteria include: a) absence of any cardiovascular and orthopaedic/neuromuscular maladies and b) absence of any illegal nutritional supplements. All players were instructed to consume a light meal before testing and avoid consuming alcohol or perform any demanding physical activity 48 hours before and during the period of measurements. All procedures were in accordance with the 1975 Declaration of Helsinki as revised in 2000 and were approved by the Institutional Ethics Committee.

Anthropometric and body composition measurements

The evaluation of body mass and body fat was performed with a bioelectrical impedance scale (Tanita MC-780MA, Tokyo, Japan). Body mass and body fat measurements performed during morning hours while players instructed to fasten for 8 hours and refrain from any strenuous exercise before weighting for at least 48 hours (Zaras et al., 2022; Torres-Luque et al., 2015). Athletes weighed in with minimal clothes. In addition, body height was measured with a wall-height meter tape with no shoes in the nearest cm. For all measurements, two trials were given and the mean values were used for the statistical analysis. The intra-class correlation coefficients (ICC) for body mass, body fat and body height measurements were: 0.991 (95% confident intervals (CI) with lower and upper bounds: 0.997-0.999), 1.000 (95%CI: 0.998-0.999) and 0.987 (95%CI: 0.995-0.999), respectively.

Flexibility

During the second day of measurements athletes started with a 10 min warm-up on a treadmill at 10km/h speed and zero gradient. Then without any stretching exercises athletes seated on the laboratory floor with legs stretched, knees joined closed and with their feet touching the sit and reach box without shoes (Parpa and Michaelides, 2021). Then, athletes instructed to reach as far as possible to the box with a calm and slow speed. In the same time a researcher kept the athlete's knees to the floor to avoid bending. Three trials were performed with approximately 1 minute of rest and the best was used for the statistics. The ICC for sit and reach measurement was 0.987 (95%CI: 0.957-0.997).

Squat and countermovement jump

After the sit and reach test, athletes performed a series of static and dynamic stretching exercises and then performed 4 CMJs with submaximal intensity. Subsequently, athletes performed 3 maximal CMJs with 2 minutes rest between jumps (Optojump Modular System, UK) with arms akimbo. Data were recorded and analysed (Optojump Next, UK) to calculate maximum vertical jump height. From the 3 CMJs the best was used for the statistical analysis. Five minutes after the CMJs athletes performed the SJ. Athletes instructed to perform a half squat according to their individual feeling and stand still until the signal of the researcher. Then, athletes jump as high as possible. Specific instructions were given to avoid the countermovement in the half squat position. During the SJ measurement, 2 researchers were present to monitor the technique of the jumps. The ICC for the CMJ and SJ height were 0.989 (95% CI, 0.957-0.997) and 0.980 (95%CI: 0.985-0.990), respectively.

Isometric Peak Torque

Fifteen minutes after the vertical jumps athletes performed the isometric leg extension torque measurement on an isokinetic dynamometer (Isoforce Isokinetic System, UK), for the evaluation of quadriceps maximum isometric peak torque (IPT). Athletes seated in the upright position and straps were used to ensure the stable position of the shoulders, hips and exercising leg. Hips angle was set at 110° flexion while knee angle was set at 60° flexion (0° = full extension) (Ioannides et al., 2020; Zaras et al., 2022). Three submaximal efforts were performed with progressively increasing force. Then, three maximal efforts were allowed with a 90 seconds rest. Real-time visual feedback of the force applied was provided for each effort via a computer monitor placed just in front of the isokinetic dynamometer. Data from the isometric measurement were recorded and analysed to calculate the maximum isometric torque which was calculated as the greater force generated from the torque-time curve. From the three maximum attempts the best was used for the statistical analysis. The ICC for IPT was 0.990 (95% CI: 0.964-0.998).

Maximum oxygen consumption

During the third day of measurements the maximum oxygen consumption test (VO2max) was performed. Measurement was performed during morning hours on a treadmill. The Bruce protocol (Badawy and Muaidi, 2019) was used for all athletes. Players initially walked 3 min at 2.75 km·h⁻¹ at 5 % inclination. Subsequently, velocity and inclination increased every 3 min until exhaustion according to the Bruce protocol. Heart rate was monitored continuously during the entire test procedure. Estimation of VO2max was performed using the formula: $4.38 \times T - 3.9$, where T = testing time (Pollock et al., 1982; Terzis et al., 2016). The ICC for VO2max was 0.981 (95% CI: 0.951-0.995).

Statistical Analysis

All data are presented as mean $\pm$ SD. A two-way analysis of variance (3 x age; 3 x position) with Bonferroni post-hoc was used to evaluate differences for each variable between groups. Calculation of effect sizes (η^2) was also performed. One-Way ANOVA (3 x position) with Bonferroni post-hoc, was used within all groups to examine differences between positions of players. Reliability for all measurements was performed using a two-way random effect intra class correlation coefficient (ICC) with 95% confident intervals (CI). The level of significance was set at $P \leq 0.01$.

Results

The interaction effect between age and position for body mass was not significant ($F_{(4,851)}=0.564$, $P=0.689$, $\eta^2=0.003$). There was a significant main effect for age ($F_{(2,851)}=119.629$, $P=0.000$, $\eta^2=0.219$) and for position ($F_{(2,851)}=14.650$, $P=0.000$, $\eta^2=0.033$). Post-Hoc Bonferroni analysis showed that there was a significant difference for body mass between all ages (Table 1), while significant difference was found between the

defenders compared to forwards and midfielders (Figure 1, A). In addition, significant main effects were found for defenders ($F_{(2,347)}=47.198$, $P=0.000$), midfielders ($F_{(2,274)}=29.119$, $P=0.000$) and forwards ($F_{(2,233)}=43.567$, $P=0.000$), with U17 be heavier compared to U16 and U15 (Figure 1, A). Significant main effects were found for body mass for the U15 ($F_{(2,255)}=6.603$, $P=0.002$, $\eta^2=0.049$) and U16 groups ($F_{(2,326)}=8.269$, $P=0.000$, $\eta^2=0.048$) (Table 2).

No significant interaction was found for body height ($F_{(4,851)}=2.051$, $P=0.085$, $\eta^2=0.010$). However, significant main effects for body height were found for age ($F_{(2,851)}=52.174$, $P=0.000$, $\eta^2=0.109$) and position ($F_{(2,851)}=8.946$, $P=0.000$, $\eta^2=0.021$). Significant difference was found between all ages (Table 1), while defenders were significant taller compared to midfielders and forwards (Figure 1, B). Significant main effects were found for defenders ($F_{(2,347)}=15.870$, $P=0.000$), midfielders ($F_{(2,274)}=9.478$, $P=0.000$) and forwards ($F_{(2,233)}=30.604$, $P=0.000$), with defenders U17 be taller compared to U15 and U16, midfielders U17 be taller compared to U15 and forwards U17 be taller compared to U15 (Figure 1, B). Main effects were found for body height only for U15 ($F_{(2,255)}=7.664$, $P=0.001$, $\eta^2=0.057$) (Table 2).

No significant interaction was found for BMI ($F_{(4,851)}=0.830$, $P=0.506$, $\eta^2=0.004$). Significant main effects for BMI were found for age ($F_{(2,851)}=58.712$, $P=0.000$, $\eta^2=0.121$), and position ($F_{(2,851)}=5.584$, $P=0.004$, $\eta^2=0.013$). Significant difference was found for BMI between all ages with the U17 having the highest BMI (Table 1), while, defenders had greater BMI compared to forwards only (Figure 1, C). Moreover, significant main effects were found for defenders ($F_{(2,347)}=35.945$, $P=0.000$), midfielders ($F_{(2,274)}=37.074$, $P=0.000$) and forwards ($F_{(2,233)}=15.054$, $P=0.000$), with defenders U15 having the lower BMI compared to U16 and U17 for all positions (Figure 1, C). Main effect was found for BMI only for U16 ($F_{(2,326)}=4.584$, $P=0.010$, $\eta^2=0.027$) (Table 2).

No significant interaction was found for body fat ($F_{(4,851)}=1.092$, $P=0.359$, $\eta^2=0.005$). In addition, no significant main effect for body fat was found for age ($F_{(2,851)}=1.691$, $P=0.185$, $\eta^2=0.004$), but significant main effects were found for position ($F_{(2,851)}=6.364$, $P=0.002$, $\eta^2=0.015$). No significant difference was found between all ages (Table 1), but defenders had greater body fat compared to midfield and forwards players (Figure 1, D). Significant main effect was found for defenders ($F_{(2,347)}=3.177$, $P=0.043$) with U16 having lower body fat compared to U17, but not for midfielders ($F_{(2,274)}=0.158$, $P=0.0854$) and forwards ($F_{(2,233)}=0.744$, $P=0.476$) (Figure 1, D). Main effect was found for body fat only for U16 ($F_{(2,326)}=5.617$, $P=0.004$, $\eta^2=0.033$) (Table 2).

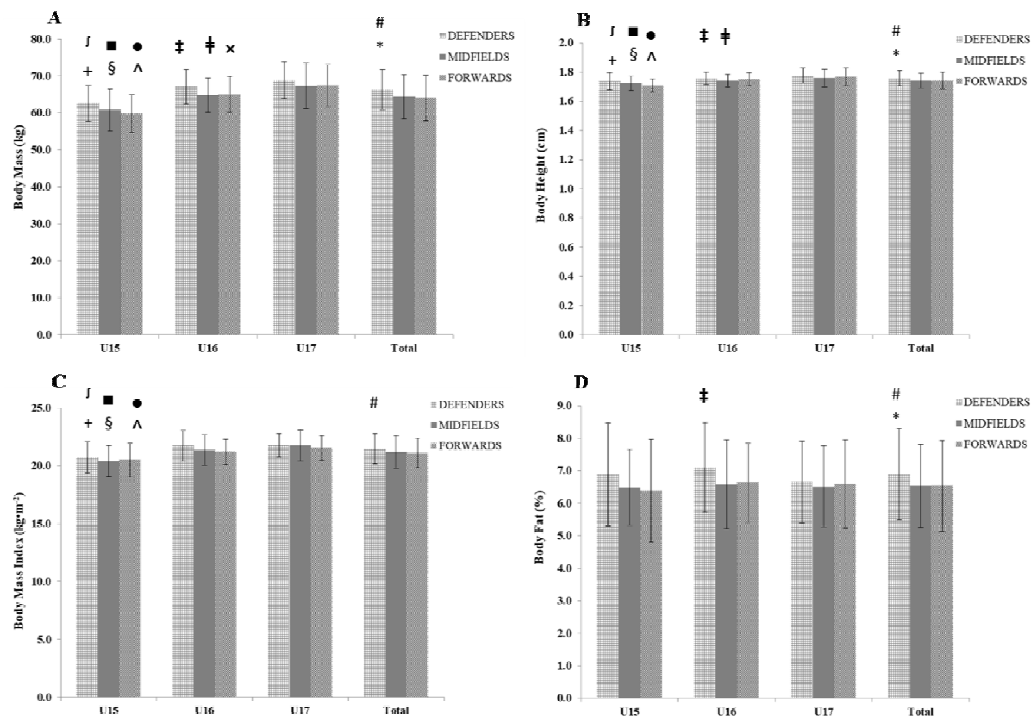


Figure 1. Anthropometric and body composition results: A) body mass, B) body height, C) body mass index and D) body fat.

*=Difference between Defenders and Midfields, #=Difference between Defenders and Forwards.

†=Difference between Defenders U15 and Defenders U16, ‡=Difference between Defenders U15 and Defenders U17, §=Difference between Defenders U16 and Defenders U17.

¶=Difference between Midfields U15 and Midfields U16, •=Difference between Midfields U15 and Midfields U17, ^=Difference between Midfields U16 and Midfields U17.

•=Difference between Forwards U15 and Forwards U16, ^=Difference between Forwards U15 and Forwards U17, ×=Difference between Forwards U16 and Forwards U17.

Table 1. Differences between all ages for anthropometrical characteristics, body fat and physical capacity.

	U15	U16	U17	P
Body Mass (kg)	61.2±5.3 ^{*#}	65.8±4.8 [§]	68.0±5.5	0.000
Body Height (m)	1.72±0.05 ^{*#}	1.75±0.04 [§]	1.77±0.06	0.000
BMI (kg·m ⁻²)	20.6±1.4 ^{*#}	21.5±1.3	21.7±1.12	0.000
Body Fat (%)	6.6±4.5	6.8±1.4	6.6±1.3	0.184
Flexibility (cm)	34.7±6.5	35.2±5.8	36.0±6.4	0.068
IPT Right (N·m ⁻¹)	155.6±20.9 ^{*#}	173.5±23.7 [§]	185.4±27.5	0.000
IPT Left (N·m ⁻¹)	157.7±25.1 ^{*#}	176.9±24.8 [§]	188.2±26.0	0.000
SJ (cm)	35.1±3.5 [#]	35.2±3.7 [§]	37.6±3.8	0.000
CMJ (cm)	42.7±3.9 [#]	43.5±4.1 [§]	44.8±4.1	0.000
VO2max (ml·kg ⁻¹ ·min ⁻¹)	57.4±3.5 [*]	63.4±1.4 [§]	57.1±3.7	0.000

*=Difference between U15 and U16, #=Difference between U15 and U17, §=Difference between U16 and U17, IPT = isometric peak torque, SJ = squat jump, CMJ =countermovement jump.

The interaction effect between age and playing position for flexibility was not significant ($F_{(4,851)}=1.012$, $P=0.400$, $\eta^2=0.005$). Similarly, no main effect for flexibility was found for age ($F_{(2,851)}=2.702$, $P=0.068$, $\eta^2=0.006$) (Table 1), but a significant main effect was found for position ($F_{(2,851)}=3.932$, $P=0.020$, $\eta^2=0.009$) with defenders having lower flexibility compared to midfielders (Table 2). Significant main effect was found only for defenders ($F_{(2,347)}=3.686$, $P=0.026$) with U15 having lower flexibility compared to U17 (U15: 33.5±5.9cm vs. U17: 35.7±5.9cm, $P=0.021$). No significant differences were found for midfielders and forwards for flexibility.

No significant interaction was found for IPT of the right limb ($F_{(4,851)}=0.262$, $P=0.902$, $\eta^2=0.001$) and for the left limb ($F_{(4,851)}=1.419$, $P=0.226$, $\eta^2=0.007$). On the contrary, significant main effect was found for age for the right limb ($F_{(2,851)}=99.145$, $P=0.000$, $\eta^2=0.189$) and for the left limb ($F_{(2,851)}=97.638$, $P=0.000$, $\eta^2=0.187$) (Table 1). Players U17 had greater IPT of the right limb compared to U15 and U16, while players U16 had greater IPT of the right limb compared to U15 players. Similarly, players U17 had greater IPT of the left limb compared to U15 and U16, while players U16 had greater IPT of the left limb compared to U15 players (Table 1). No significant interaction was found for position for the IPT of the right limb ($F_{(2,851)}=2.418$, $P=0.090$, $\eta^2=0.006$) and for the left limb ($F_{(2,851)}=2.775$, $P=0.063$, $\eta^2=0.006$).

No significant interaction was found for SJ ($F_{(4,851)}=1.155$, $P=0.329$, $\eta^2=0.005$). Main effects were found for age ($F_{(2,851)}=40.127$, $P=0.000$, $\eta^2=0.086$) and position ($F_{(2,851)}=5.768$, $P=0.003$, $\eta^2=0.013$). Significant difference was found for U17 compared to U16 and U15 (Table 1). Also, forwards had greater SJ compared to midfielders and defenders (Table 2). Significant main effect was found for defenders, midfielders and forwards with U17 having the higher SJ height compared to U15 and U16 (Defenders: U15: 35.1±3.5cm, U16: 34.9±3.7cm and U17: 37.4±3.4cm, $P=0.000$; Midfielders: U15: 34.1±3.8cm, U16: 35.0±3.8cm and U17: 37.8±3.9cm, $P=0.000$; Forwards: U15: 35.9±3.1cm, U16: 36.0±3.2cm and U17: 37.9±4.0cm, $P=0.000$). Significant main effect was found for SJ only for U15 ($F_{(2,255)}=5.516$, $P=0.005$, $\eta^2=0.041$) (Table 2).

No significant interaction was found for CMJ ($F_{(4,851)}=0.979$, $P=0.418$, $\eta^2=0.005$). Main effects were found for age ($F_{(2,851)}=18.175$, $P=0.000$, $\eta^2=0.041$) and position ($F_{(2,851)}=4.637$, $P=0.010$, $\eta^2=0.011$). Significant difference was found for U17 compared to U16 and U16 compared to U15 (Table 1). Also, forwards had higher CMJ compared to midfielders but not compared to defenders (Table 2). Significant main effect was found for defenders (U15: 42.7±3.6cm compared to U17: 44.6±3.6cm, $P=0.002$), midfielders (U15: 41.7±4.3cm compared to U16: 43.3±4.2cm $P=0.019$, and U17: 44.7±3.9cm, $P=0.000$) and forwards (U15: 43.7±3.6cm compared to U17: 45.3±3.6cm, $P=0.047$). Significant main effect was found for CMJ only for U15 ($F_{(2,255)}=5.852$, $P=0.003$, $\eta^2=0.044$) (Table 2). No significant interaction was found for VO2max ($F_{(4,851)}=1.597$, $P=0.173$, $\eta^2=0.007$). Main effects were found for age ($F_{(2,851)}=415.949$, $P=0.000$, $\eta^2=0.494$) but not for position ($F_{(2,851)}=1.553$, $P=0.212$, $\eta^2=0.004$) (Table 2). U16 group had greater VO2max compared to U17 and U15 (Table 1).

Table 2. Differences between playing positions for anthropometric characteristics, body fat and physical capacity.

	Defenders	Midfielders	Forwards	P
	All Age Groups			
Body Mass (kg)	66.4±5.4 ^{*#}	64.5±5.9	64.1±6.1	0.000
Body Height (m)	1.76±0.05 ^{*#}	1.74±0.05	1.74±0.06	0.000
BMI (kg·m ⁻²)	21.5±1.3 [#]	21.2±1.4	21.1±1.3	0.004
Body Fat (%)	6.9±1.4 ^{*#}	6.6±1.3	6.5±1.4	0.002
Flexibility (cm)	34.7±6.1 [*]	35.9±6.0	35.4±6.5	0.020
IPT Right (N·m ⁻¹)	172.2±27.5	173.9±27.5	169.1±25.2	0.090
IPT Left (N·m ⁻¹)	177.3±27.7	174.3±28.6	171.4±27.6	0.063
SJ (cm)	35.8±3.7 [#]	35.5±4.1 [§]	36.6±3.6	0.013
CMJ (cm)	43.6±4.0 [#]	43.2±4.3	44.3±4.1	0.010
VO2max (ml·kg ⁻¹ ·min ⁻¹)	59.5±4.4	60.1±3.9	59.2±4.0	0.212

U15				
Body Mass (kg)	62.6±4.8 [#]	60.8±5.7	59.8±5.1	0.002
Body Height (m)	1.74±0.06 [#]	1.73±0.05	1.71±0.04	0.001
BMI (kg·m ⁻²)	20.7±1.4	20.4±1.3	20.5±1.5	0.227
Body Fat (%)	6.9±1.6	6.5±1.2	6.6±1.5	0.049
Flexibility (cm)	33.5±5.9	36.0±6.7	34.9±6.7	0.030
IPT Right (N·m ⁻¹)	155.4±22.6	158.7±20.7	152.8±18.9	0.201
IPT Left (N·m ⁻¹)	159.7±27.5	160.9±24.6	151.9±21.4	0.045
SJ (cm)	32.0±3.5	34.1±3.8§	35.9±3.2	0.005
CMJ (cm)	42.7±3.6	41.7±4.3§	43.7±3.6	0.003
VO2max (ml·kg ⁻¹ ·min ⁻¹)	57.2±3.6	57.6±3.6	57.5±3.2	0.800
U16				
Body Mass (kg)	67.1±6.7 ^{*#}	64.9±4.6	65.0±4.9	0.000
Body Height (m)	1.76±0.0	1.74±0.04	1.75±0.04	0.27
BMI (kg·m ⁻²)	21.7±1.3 [#]	21.4±1.3	21.2±1.1	0.010
Body Fat (%)	7.1±1.4 [*]	6.6±1.4	6.6±1.2	0.004
Flexibility (cm)	34.8±6.1	35.4±5.5	35.8±5.5	0.448
IPT Right (N·m ⁻¹)	174.2±25.5	174.0±23.0	171.5±21.8	0.698
IPT Left (N·m ⁻¹)	180.8±24.5	174.1±25.3	174.4±24.3	0.061
SJ (cm)	34.9±3.7	35.0±3.8	36.0±3.2	0.074
CMJ (cm)	43.5±4.0	43.3±4.2	43.8±4.2	0.716
VO2max (ml·kg ⁻¹ ·min ⁻¹)	63.5±1.4	63.3±1.5	63.4±1.3	0.364
U17				
Body Mass (kg)	68.8±4.9	67.4±6.1	67.4±5.7	0.114
Body Height (m)	1.78±0.05	1.76±0.06	1.77±0.06	0.121
BMI (kg·m ⁻²)	21.8±0.9	21.8±1.3	21.5±1.1	0.280
Body Fat (%)	6.7±1.3	6.6±1.3	6.6±1.4	0.888
Flexibility (cm)	35.7±5.9	36.7±6.1	35.6±7.2	0.452
IPT Right (N·m ⁻¹)	184.8±26.5	188.7±31.6	182.9±24.8	0.395
IPT Left (N·m ⁻¹)	188.9±23.7	187.6±30.9	187.9±23.7	0.943
SJ (cm)	37.4±3.4	37.6±4.1	37.9±4.0	0.758
CMJ (cm)	44.6±4.2	44.6±3.9	45.3±4.1	0.444
VO2max (ml·kg ⁻¹ ·min ⁻¹)	56.6±3.9	57.7±3.5	57.2±3.6	0.090

*=Difference between Defenders and Midfields, #=Difference between Defenders and Forwards, §=Difference between Midfields and Forwards, IPT = isometric peak torque, SJ = squat jump, CMJ =countermovement jump.

Discussion

The purpose of the study was to investigate the interaction between age and position of the players on body composition and physical fitness in 860 well-trained adolescent soccer players. The main findings of the study are a) no interaction effect was found between age and position for all measurements, b) anthropometric characteristics and physical fitness are age-dependend with older players possess greater body mass and body height and produce greater IPT and power compared to their younger counterparts and c) defender players had greater anthropometric characteristics and body fat compared to midfields and forwards, but forward players had greater power outputs (SJ and CMJ) compared to defenders. Consequently, the results of the study suggest that soccer training should be designed according to the age of players while specific training programs should be planned for different player positions. In addition, the selection of the playing position is not age-dependend, thus coaches should regularly monitor the physiological and fitness characteristics of the players to choose the position of each young player.

Chronological age is a determining factor for biological maturation and linked with training and competition experience as well as with increased physical fitness in adolescent soccer players. Indeed, the findings of the current study showed that players U17 had greater body mass and body height, were stronger and powerful compared to U15 and U16 groups. These results are in agreement with previous studies which showed that older players may possess higher anthropometric characteristics and fitness performance compared to their younger counterparts (Marques et al., 2016; Harley et al., 2010). Interestingly, U16 players had higher VO2max values compared to U15 and U17 players. This result may be attributed to the different training focus between groups. For example, training for U15 players may focused on increasing all fitness parameters including strength, power as well as technical and tactical skills, while training for U17 players may focused on tactical skills development based mainly on previous years training experience and the existed higher level of fitness.

As was expected, defenders players had greater body mass, body height and body fat compared to midfields and forwards. Many studies in both adults and adolescent players have shown that defenders possess greater anthropometric characteristics and body fat compared to their counterparts (Gjonbalaj et al., 2018; Perroni et al., 2014; Gil et al., 2007; Deprez et al., 2014), but not compared to goalkeepers (Matkovich et al,

2003; Gil et al., 2007). Defenders central objective is to protect their defence area mainly by using their musculature system to guard the faster forward players and have a greater advantage for the high-balls especially in corners and fouls during the game. Similarly, defenders use these advantages at the offence in order to achieve a goal. Giving the nature of their position, defenders training should focused not only in tactical and technical development but also in increasing the lean mass as well. Consequently, coaches should choose taller players to create the defending line of the team while training should focus on increase the lean mass.

On the other hand, forwards had greater power production compared to defenders and midfields as found with the SJ and CMJ results. Deprez et al., (2014), showed that forward players were the fastest and the more agile players compared to midfields and defenders something which may be attributed to either inherent characteristics or a result from the long-term training-induced adaptations. In addition to these findings, Gil et al., (2007), showed that forwards were the leanest and best performers in all fitness tests compared to defenders and goalkeepers while Bernal-Orozko et al., (2020), showed that forward players possess greater muscle mass compared to their soccer counterparts. Furthermore, Marques et al., (2016), found that forwards had a higher performance in throwing the ball, CMJ and sprint compared to defenders, although Matkovich et al., (2003), showed that forwards were the shortest among all players in the field. Consequently, forward players are the most powerful athletes in the field; hence, training should focused on the development of power, speed, rate of force development (Greco et al., 2013) and enhance muscle mass. Therefore, coaches should monitor young athletes for inherent factors in speed and power since it might be a significant factor for this multi-task position in the game.

One interesting finding of the present study was that the differences between playing position were more pronounced for the U15 group compared to U16 and U17 group. Studies have showed that younger players cover less distance in the field with lower velocity sprints while training sessions are less physiological demanding due the young age and the focus on different training skills (Harley et al., 2010; Abade et al., 2014). In addition, as players mature so the training programs and training demands progressively increase. According to the long-term athletic development, athletes above 14 years of age may participate in systematic training, regularly compete in soccer games and follow individualized training programs to enhance physical fitness and soccer performance (Lloyd et al., 2015). Therefore, it can be hypothesized that players participated in U17 have already increase their physical fitness and reach a higher level of performance masking the differences between positions.

Although tempting, the results of the current study failed to uncover a significant interaction between age and position, question which needs further investigation. Still, the examination of specific biological factors such as lean mass and neural activation was not investigated in the current study which might provide a better insight into the results. In addition, players were measured during the end of the in-season training period where fatigue might influence the results. A strong element of the study is the large number of participants in all ages and positions. Hence, more research is needed in adolescent soccer athletes to examine the interaction between age and position of the game.

In conclusion, positions of players in the game seem to be independent of age. However, anthropometric characteristics and physical fitness are age-dependent in young soccer players, with older players possess greater anthropometric characteristics and perform better in strength and power actions. Defenders players have greater anthropometric characteristics and body fat compared to midfields and forwards, although forward players performed greater power outputs compared to defenders. These differences seemed to be more pronounced in U15 group compared to older groups.

Conclusions

The results of the current study reinforce the opinion that training programs for young and adolescent players should be age-dependent. Training should emphasize in the development of physical performance in young athletes as well as in technical and tactical skills development in adolescent soccer players. In addition, the selection of player's position may be determined according to anthropometric and physical fitness characteristics. Heavier and taller players might perform better in defensive position compared to lighter and faster players who might perform better in midfield and forward positions.

Conflict of Interest. There is no conflict of interest.

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