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Correlations between anthropometric characteristics and physical fitness profile in different age and level categories of soccer players

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Abstract

Introduction. Determination of the fitness profile in soccer players of different categories using the field test is particularly useful. It can be used to assess the physical condition of other soccer teams, but also to show differences between the categories. Aim of Study. This study aimed to compare anthropometric and physical fitness profiles of U10, U12, U14, amateur and semiprofessional male soccer players, as well as find correlations between the measured indicators. Material and Methods. Subjects included 228 athletes. Anthropometric characteristics and field fitness parameters were measured. Results. Differences were observed in height, weight and BMI of the athletes between all the groups ($p < 0.001$) except for the amateur and semiprofessional groups ($p = 0.091$). In fitness tests, groups of semiprofessional and amateur players showed better performance than all the groups of developmental ages. Also, semiprofessionals performed better than amateurs in all the tests except for the sit and reach and abdominal test. At the developmental ages the U14 differed from the U10 and U12 in terms of 30 m, LJ and T-tests, while no other differences were observed. In the case of the correlations it is characteristic that the percentage of body fat is negatively related to LJ at the developmental ages and to SJ in adults. The CMJ was the fitness test that showed the greatest relationships with anthropometric characteristics and other tests. Conclusions. In conclusion, this study presents the profile of the physical condition for players of developmental ages (non-elite), amateurs and semiprofessionals. The improvement in performance depends on training, but also on biological maturation and development. In adults the different level of athletes is shown in terms of all the physical abilities tests, with semiprofessionals performing better. Greater specialization of training contents (increase in volume and intensity at the highest level) causes more effective adaptations in soccer players.

KEYWORDS: field tests, anthropometric characteristics, youth soccer players, fitness profile.

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Introduction

Adult soccer is an intermittent sport that includes activities with low and high intensity. In high-level soccer players run a total distance of 10-13 km during the match. Running at high intensity is about 10% of this distance [3]. At the developmental ages the total distance covered during matches ranges from ~4 km for the under 10-year old team (U10) up to 8 km for the under 16-year old team (U16) [18]. At the same time, players at all levels perform many other activities during the match, such as accelerations, decelerations, changes of direction and jumps [17].

At the developmental ages physical development and maturation can significantly affect performance [8]. Frequently coaches and sports scientists look for norms to compare and evaluate the physical performance of their players. However, certain factors such as ethnicity, level and age can affect these norms (e.g. anthropometric characteristics).

Physical performance in soccer is a general term that includes several abilities and cannot be described

by a single parameter [14]. For this purpose several different fitness tests (laboratory and field) are used to form an overall picture of the player's physical performance. Thus, laboratory measurement, which is the most accurate method, requires the use of expensive equipment, well-trained personnel and a lot of time for measuring large groups of athletes such as that of a soccer team. All the reasons mentioned above lead to the development of different field tests to estimate physical abilities [1, 12] which can be used to measure a large number of players in less time, using much less equipment.

Thus, the first aim of the study was to compare the anthropometric characteristics, speed, horizontal and vertical jumping ability, flexibility, agility, strength of the abdominal and aerobic ability in amateur and semiprofessional Greek soccer players, as well as the developmental categories: the under 10-year old team (U10), under 12-year old team (U12) and under 14-year old team (U14). Another purpose was to investigate correlations between tests and compare these correlations between categories. It was hypothesized that anthropometric and fitness measures would increase across the age and level groups. Also, it was hypothesized that many correlations will be observed between the fitness tests.

Material and Methods

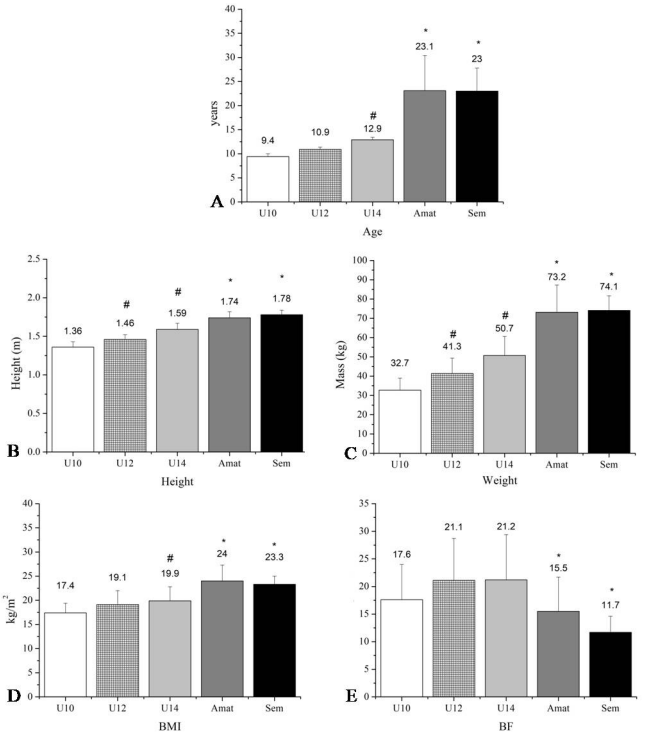
Design

This was a cross-sectional comparative study aimed at characterizing the anthropometrical and fitness profiles of soccer players across three different developmental age groups (U10, U12, U14), amateur and semiprofessional levels (n = 228). Assessments included height, body mass, body mass index, body fat percentage (4 skinfold), maximal sprint speed, jump height, jump distance, agility, flexibility, abdominal endurance and aerobic capacity. Between the developmental ages and adults there were some changes in the tests, in which no comparisons were made between them. More specifically, in the developmental ages the long jump, the T-test and the Yo-Yo intermitted endurance test level 1 vs the squat jump, to the Illinois agility test and to the Yo-Yo intermitted recovery test level 1 used in adults. Measurements were carried out in the pre-season period, in the afternoon (18:00-21:00), on a synthetic soccer field across two testing days to avoid fatigue and any circadian variation in performance [20]. Participants were advised to abstain from vigorous exercise for 24 hours before the testing.

Subjects

Male soccer players (n = 228) from Greek soccer teams participated in this study. The inclusion criteria to participate in the study were as follows: 1) not to have musculoskeletal injuries for ≥6 months prior to the study, 2) having participated in ≥80% of training sessions of the last year, and 3) not to be taking any medication. All participants and their parents (for the youth) were informed of the potential risks and benefits of the study and consent was signed by them or their parents. The study was performed in the spirit of the Helsinki Declaration.

Twenty players were members of the U10, 25 belonged to U12, 63 belonged to U14, 36 belonged to the senior's amateur team and 60 belonged to the senior semiprofessional team. All players were familiarized with the procedures two weeks before the testing day. Participants' characteristics are shown in Figure 1.



* significant differences between adults (amateur, semiprofessional) and groups of developmental ages;
# significant differences between U14, U12 and U10 groups

Figure 1. Anthropometric characteristics. A – age of the subjects; B – height of the subjects; C – weight of the subjects; D – BMI of the subjects; E – body fat of the subjects

Procedures

Anthropometric measurements

Body mass was measured to the nearest 0.1 kg using an electronic digital scale with the participants wearing

only their underclothes and being barefoot. Standing height was measured to the nearest 0.1 cm (Seca 220e; Hamburg, Germany). Body fat percentage was estimated based on the sum of four (biceps, triceps, suprailiac, subscapular) skinfold thicknesses measured with a specific caliper by Lafayette, Ins. Co., Indiana, on the right side of the body as described [24]. Estimation of the body density was calculated according to the equation proposed by Durning and Rahaman [7] for male adults older than 16 years and estimated by the equation of Siri [23].

Fitness tests

Fitness tests were completed in the following order: squat jump (SJ) or long jump (LJ) (for youth), countermovement jump (CMJ), 30 m linear sprint, and the Illinois agility test or T-test (for youth). The next day performed: abdominal endurance, flexibility (sit and reach test), and Yo-Yo intermitted recovery test level 1 (YYIR1) or Yo-Yo intermitted endurance test level 1 (YYIE1) (for youth). The better time of two attempts was considered as the fitness test score except for the Yo-Yo tests where they performed only one attempt. The interval between the tests was fuel. At the beginning of each testing session soccer players performed a 15-minute warm-up and at the end a 10-minute cool-down period. During the tests all the participants consumed water ad libitum to ensure proper hydration.

Speed testing

A 30 m sprint test was used to measure speed performance. Sprint testing was performed with the participants wearing soccer shoes on the synthetic grass of a soccer field. After a 5-second countdown the participants ran in front of two infrared photoelectric gates (Microgate, Bolzano, Italy) that recorded times at each gate. The participants sprinted from a standing starting position with the toe of the front foot approximately 0.3 m behind the first gate. Photocells were placed 0.6 m above the ground (approximately at the hip level) to capture the movement of the trunk rather than a false signal because of a limb motion [15]. The coefficient of variation for test–retest trials was 3.8%.

Standing long jump testing

The participants adapted a starting standing position with their feet at shoulder width (behind a line marked on the ground) and their hands free. The participants executed a countermovement with their legs and with a hand movement and then jumped horizontally as far as possible, as described [9]. The horizontal distance between the starting line and the heel of the rear foot was recorded with a tape measure. The coefficient of variation for test–retest trials was 3.9%.

Vertical jump testing

The participants performed two jump tests: (a) SJ: participants, from a stationary semi-squatted position (90^{o} angle at the knees), performed a maximal VJ; (b) CMJ: participants, from an upright standing position, performed a fast-preliminary motion downwards by flexing their knees and hips followed by an explosive upward motion by extending their knees and hips. All the tests were performed with the arms akimbo. The VJ height was measured with the Chronojump Boscosystem (Chonojump, Barcelona, Spain). The coefficients of variation for the test–retest trials were 3.0 and 3.8% SJ and CMJ, respectively.

Agility: T-test

The participants performed the T-test: Subjects began with both feet behind the starting point A. At their own discretion, each subject sprinted forward 9.14 m to point B and touch the base of a cone with the right hand. They then shuffled to the left 4.57 m and touched the base of a cone (C) with their left hand. Subjects then shuffled to the right 9.14 m and touched the base of a cone (D) with their right hand. They then shuffled to the left 4.57 m back to point B and touched the base of the cone with their left hand. Subjects then ran backwards, passing the finish line at point A. At point A an infrared photoelectric gate (Microgate, Bolzano, Italy) was placed which recorded the time of each attempt [22].

Agility: Illinois test

The Illinois agility test was set up with four markers forming a square area of 10 × 5 m. The start and finish gates were positioned at two consecutive angles of a square area, while two markers were positioned on the opposite side to indicate the two turning points. Four other markers were in the center, positioned at an equal distance apart (3.1 m). Each participant had to run as quickly as possible from the start gate, follow a planned route, and slalom through the markers without knocking them down or cutting over them. From a standing position, each athlete sprinted 10 m on command and returned to the starting line, then had to swerve in and out of the markers, perform another sprint of 10 m and complete the test by running to the finish gate. The photocells at the start and finish gates recorded the test time. A graphic representation of the test is shown in Figure 2.

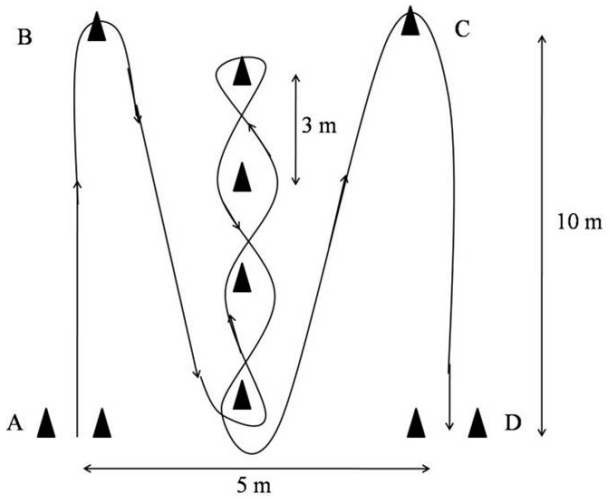


Figure 2. Graphic representation of the Illinois agility test

Flexibility testing

The participants performed the sit and reach test to evaluate flexibility of the lower back and hamstring muscles. We used the Eurofit manual that suggests having 15 cm at the level of the feet. The participants were sitting barefoot on the floor with legs stretched out straight ahead. The soles of the feet were placed flat against the box. Both knees were locked. With the palms facing downwards and the hands on top of each other or side by side, the subjects were reached forward along the measuring line as far as possible.

Abdominal endurance test

The participants performed as many sit-ups as they could in 30 seconds. They were instructed to lie on the mat with the knees bent at right angles, with the feet flat on the floor and held down by a partner. The fingers were to be interlocked behind the head. On the command 'Go', the participants raised the chest so that the upper body was vertical, then returned to the floor. This was continued for 30 seconds. For each sit up the back had to return to touch the floor. The maximum number of correctly performed sit ups in 30 seconds was recorded. The sit up was not be counted if the subjects failed to reach the vertical position, failed to keep their fingers interlocked behind their head, arch or bow their back and raise their buttocks off the ground to raise their upper body, or let their knees exceed a 90-degree angle.

Statistical analysis

Data are presented as means ± SD. Furthermore, for fitness variables the confidence intervals (CI) were given. Data normality was verified with the 1-sample Kolmogorov–Smirnoff test; therefore, a nonparametric test was not necessary. A one-way analysis of variance (ANOVA) was used to compute any differences in the subjects' performance on the tests. Wherever a significant difference was found, the post hoc Bonferroni test was applied. Pearson's two-tailed correlation analysis determined relationships between the anthropometric characteristics and fitness tests. The level of significance was set at $p < 0.05$. The SPSS version 25.0 was used for all analyses (SPSS Inc., Chicago, IL, USA).

Results

The confidence intervals for the variables are presented in Table 1.

Differences were observed between all the groups for height, weight and BMI ($p < 0.001$) with the exception of the amateur and semiprofessional groups ($p = 0.091$), where the semiprofessionals were slightly taller and lighter. In the developmental categories the values of characteristics increased with age. The characteristics are presented in Figure 1.

In the percentage of body fat, semiprofessionals had the lowest value followed by amateurs. Differences were observed between the adult groups and the developmental age groups ($F = 21.121$, $p < 0.001$). More specifically, semiprofessionals differed from all the developmental groups (U10 $p = 0.007$, U12 and U14 $p < 0.001$). Amateurs differed from the U12 ($p = 0.003$) and U14 players ($p = 0.001$). Of the developmental groups, the lowest value was showed by U10, with the U12 and U14 having similar and high values, although these differences were not statistically significant ($p > 0.05$). The differences are presented in Figure 1.

In the fitness tests the groups of semiprofessionals and amateurs showed better performance than all the groups of developmental ages. In the 30 m sprint semiprofessionals were faster than amateurs ($p = 0.019$). In the same test the U10 and U12 did not differ statistically ($p = 0.092$), with the U12 being faster than the U10. The U14 were faster than the U12 and U10 ($p < 0.001$). The differences are given in Figure 3.

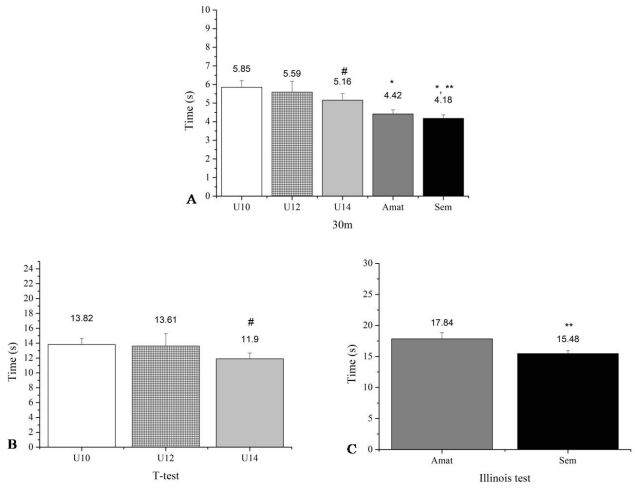
In the agility test the semiprofessionals were faster in the Illinois agility test than the amateurs ($F = 226.528$, $p < 0.001$), while in the T-test for the developmental ages the U14 players were faster than the U10 and U12 ($F = 35.965$, $p < 0.001$) without any other differences observed. The differences are presented in Figure 3.

As for the jumps in the CMJ that were common to all groups, the performance of adults differed with those of the developmental ages ($p<0.001$), but also between them ($p < 0.001$), with semiprofessionals showing a higher

Table 1. Confidence intervals

Variable	Amateur	Semiprofessional	U10	U12	U14
Age	20.6-25.7	21.8-24.3	9.1-9.7	10.7-11	12.8-13
Height	1.71-1.77	1.77-1.80	1.33-1.40	1.45-1.48	1.57-1.61
Weight	68.5-78	72.1-76	29.7-35.7	38.8-43.7	48.2-53.2
BMI	22.8-25.2	22.9-23.8	16.5-18.4	18.3-20	19.2-20.7
Body fat	13.3-17.7	11-12.5	14.6-20.7	18.8-23.4	19.2-23.3
30 m	4.34-4.49	4.13-4.23	5.68-6.03	5.41-5.77	5.07-5.25
LJ			144-158	146-160	167-178
SJ	28.3-30.2	34.8-36.2			
CMJ	28-32.1	34-37.2	17.5-22.5	17.7-20.6	19.6-21.5
T-test			13.41-14.24	13.11-14.11	11.70-12.09
Illinois test	17.49-18.19	15.36-15.61			
Sit and reach	22.11-27.11	26.72-30.22	12.98-20.60	12.81-16.90	10.58-15.03
YYIE1			767-1186	850-1177	836-1135
YYIR1	596-780	1013-1121			
Abdominals	27.4-33.5	27.3-28.9	18.5-21.8	18.6-22.2	21.5-24.7

U10 – under 10; U12 – under 12; U14 – under 14; BMI – body mass index; LJ – long jump; SJ – squat jump; CMJ – countermovement jump; YYIE1 – Yo-Yo intermittent endurance test level 1; YYIR1 – Yo-Yo intermittent recovery test level 1



* significant differences between adults (amateur, semiprofessional) and groups of developmental ages;
** significant differences between semiprofessional and amateur;
# significant differences between U14, U12 and U10 groups

Figure 3. Group performance at: A – 30 m linear sprint; B – T-test; C – Illinois agility test

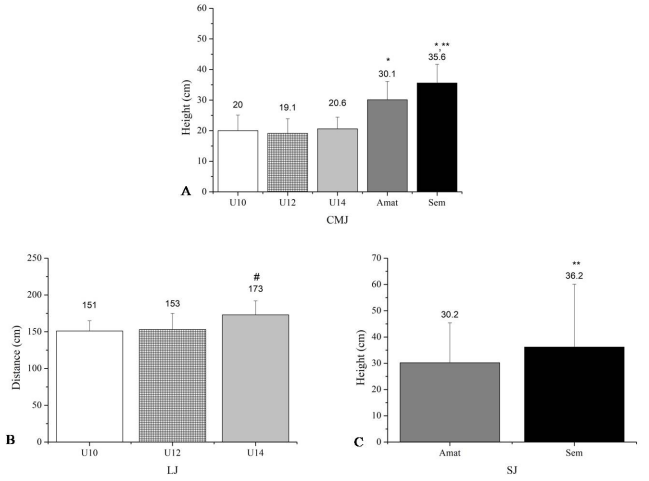
performance. No differences appeared between the U10, U12 and U14 groups (p>0.05). In SJ, semiprofessionals performed better than amateurs (F = 33.626, p < 0.001). In LJ, the U14 players performed better than the U10 and the U12 (F = 17.131, p < 0.001), while no other differences were recorded. The differences are presented in Figure 4.

In the sit and reach test, groups of adults differed from those of developmental ages, showing better performance (F = 38.234, p < 0.001). The worst performance was shown by the U14 players, but there are no statistical differences between the development groups. The differences are given in Figure 5.

In the endurance of the abdominal muscles differences were observed between the groups of adults (semiprofessional, amateur) and the groups of the developmental ages (F = 24.48, p < 0.001). The best performance was shown by semiprofessionals in adults and U14 in developmental ages. The differences are shown in Figure 5.

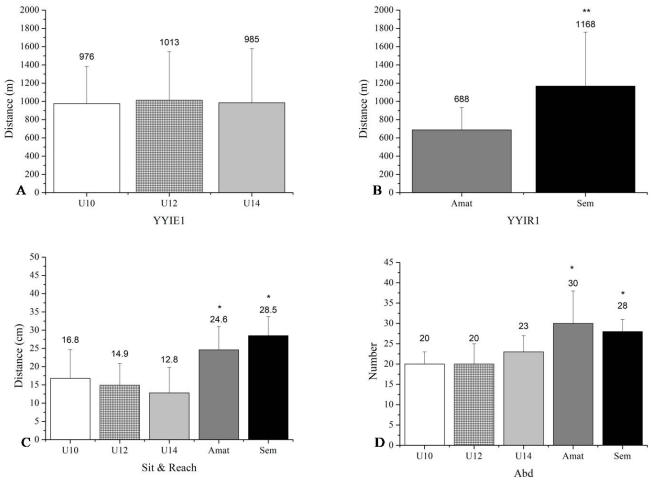
In the YYIR1 test semiprofessionals ran a longer distance than amateurs (F = 18.153, p < 0.001). In the YYIE1 test there were no differences between the groups of developmental ages (p = 0.958), with the U12 showing the best performance. The differences are presented in Figure 5.

The correlations between anthropometric characteristics and fitness tests are given in Table 2.



* significant differences between adults (amateur, semiprofessional) and groups of developmental ages;
** significant differences between semiprofessional and amateur;
# significant differences between U14 and U12 and U10 groups

Figure 4. Group performance at: A – CMJ; B – LJ; C – SJ



* significant differences between adults (amateur, semiprofessional) and groups of developmental ages;
** significant differences between semiprofessional and amateur

Figure 5. Group performance at: A – YYIE1; B – YYIR1; C – sit and reach; D – Abdominal endurance test

Table 2. Correlations between variables

Group		Weigh	Height	BMI	BF	30 m	LJ/SJ	CMJ	T-test/ Illinois	S&R	Abd	YYIE/ YYIR
K10	Weight		r = 0.845 p < 0.001	r = 0.866 p < 0.001	r = 0.808 p < 0.001							
	Height			r = 0.469 p = 0.043	r = 0.676 p = 0.001							
	BMI				r = 0.675 p = 0.002							
	BF						r = –0.536 p = 0.022	r = –0.469 p = 0.043		r = –0.597 p = 0.009		
	30 m						r = –0.521 p = 0.022					
K12	Weight		r = 0.670 p < 0.001	r = 0.919 p < 0.001	r = 0.805 p < 0.001	r = 0.412 p = 0.007	r = –0.442 p = 0.002	r = –0.425 p = 0.004	r = 0.385 p < 0.009		r = –0.392 p < 0.029	
	Height			r = 0.331 p = 0.026	r = 0.310 p = 0.038							
	BMI				r = 0.863 p < 0.001	r = 0.353 p = 0.022	r = –0.531 p < 0.001	r = –0.370 p = 0.012	r = 0.316 p = 0.034		r = –0.383 p = 0.033	
	BF						r = –0.510 p < 0.001	r = –0.479 p = 0.001				
	30 m						r = –0.761 p < 0.001	r = –0.572 p < 0.001	r = 0.737 p < 0.001		r = –0.708 p < 0.001	
	LJ/SJ							r = 0.532 p < 0.001	r = –0.552 p < 0.001		r = 0.595 p < 0.001	
	T-test/ Illinois							r = –0.546 p < 0.001				
	Abd							r = 0.390 p = 0.03				
	YYIE/ YYIR							r = 0.359 p = 0.018				

K14	Weight	r = 0.686 p < 0.001	r = 0.873 p < 0.001	r = 0.541 p < 0.001			r = –0.270 p = 0.032		r = 0.350 p = 0.023	
	Height		r = 0.252 p = 0.046			r = 0.324 p = 0.01				
	BMI			r = 0.692 p < 0.001	r = 0.400 p = 0.001		r = –0.283 p = 0.025		r = 0.315 p = 0.042	
	BF				r = 0.607 p < 0.001	r = –0.335 p = 0.007	r = –0.312 p = 0.013			
	30 m					r = –0.500 p < 0.001	r = –0.487 p < 0.001	r = 0.392 p = 0.002		r = –0.370 p = 0.04
	LJ/SJ						r = 0.486 p < 0.001	r = –0.456 p < 0.001		r = 0.435 p = 0.014
	T-test/ Illinois						r = –0.325 p = 0.009			r = 0.401 p = 0.025
	YYIE/ YYIR			r = –0.338 p = 0.007	r = –0.271 p < 0.031			r = –0.438 p < 0.001		
Amateur	Weight	r = 0.771 p < 0.001	r = 0.890 p < 0.001	r = 0.540 p = 0.007						
	BMI	r = 0.404 p = 0.02		r = 0.606 p < 0.001					r = 0.433 p = 0.027	
	BF					r = –0.496 p = 0.005			r = 0.465 p = 0.022	
	30 m					r = –0.404 p = 0.016	r = –0.449 p = 0.007	r = 0.361 p = 0.033		
	LJ/SJ						r = 0.893 p < 0.001			r = 0.454 p = 0.001
	Abd						r = –0.352 p = 0.048	r = –0.490 p = 0.004		
	YYIE/ YYIR					r = 0.473 p = 0.008				
Semiprofessional	Weight	r = 0.682 p < 0.001	r = 0.739 p < 0.001	r = 0.430 p = 0.001				r = 0.266 p = 0.043		
	BMI			r = 0.447 p < 0.001			r = –0.350 p = 0.007	r = 0.298 p = 0.023		
	BF					r = –0.265 p = 0.043				
	LJ/SJ						r = 0.802 p < 0.001	r = –0.507 p < 0.001		
	T-test/ Illinois						r = –0.436 p = 0.001			
	YYIE/ YYIR				r = –0.338 p = 0.009			r = –0.318 p = 0.015		

BMI – body mass index; BF – body fat; LJ – long jump; SJ – squat jump; CMJ – countermovement jump; S&R – sit and reach test; Abd – abdominal test; YYIE – Yo-Yo intermittent endurance test level 1; YYIR – Yo-Yo intermittent recovery test level 1

Discussion

The main purpose of this study was to compare anthropometric characteristics and physical performance in players of four different age groups (U10, U12, U14, adults) and two different level groups (amateur, semiprofessionals). In addition, the existence of correlations between anthropometric characteristics and fitness tests was investigated. The results showed that anthropometric characteristics change with age, while semiprofessionals showed lower BMI and % body fat than amateurs. In fitness tests, adults performed better than players of the developmental ages. Between the two groups of adults, semiprofessionals performed better than amateurs. BMI and the percentage of body fat were correlated with many variables. It is noteworthy that none of the YY tests (for any age) were correlated with any anthropometric characteristic. With the exception of the U10 group, where the main correlation was between

the two jump tests and between LJ and 30 m in all the other groups, there was a correlation between jump tests and agility test performance. Also, in the three groups (U12, U14, amateur) the performance in jump tests was correlated with the performance in the 30 m and abdominal tests.

The results showed that in the CMJ in the sit and reach test, the abdominal endurance test and the YYIE level 1 test there were no differences between the developmental groups. In CMJ the values were similar, which may be due to the limited training stimuli for vertical jumping ability at the developmental ages. It is known that the stretch-shortening cycle (SSC) plays a significant role in the CMJ [6]. However, in order to improve it, appropriate training stimuli (e.g. plyometric exercises) should be applied.

In the sit and reach test the U10 players performed best and the U14 participants performed the worst among the developmental groups. However, these differences were not statistically significant. The decrease in performance may be due to the increase in the height of the players (10 cm between U10 and U12, and 13 cm between U12 and U14), where the connective and muscle tissue has not had time to adapt to this development [19].

The abdominal endurance test showed no differences between the developmental age groups, with the U14 performing slightly better. The performance of these three groups coincides with the average performance of children of the same age in the general population [25].

In the YYIE level 1 test there was no statistically significant difference between the three groups of developing ages (U10, U12, U14). The performance of the U12 was slightly better than that of the other two groups. These findings are also confirmed by a previous study [21], where 11- and 12-year olds had an average performance of 1420 m, while 12- and 13-year olds had an average performance of 1407 m (similar distances).

In the 30 m sprints, in the LJ and in the T-test the performance of the U14 differed from that of the U10 and U12 players. More specifically, in all the three tests the increase in age was accompanied by an improvement in performance. These are three tests, where force/time is a key factor for performance. It is known that the force and speed is positively related to muscle mass, which increases with the growth and biological maturation of soccer players [11]. However, if we look at the average age of each group (U10: 9.4y, U12: 10.9y, U14: 12.9y) we find that U10 with U12 have a difference of about 1.5y, while U12 with U14 have a difference of 2y. This may have affected the results for these observations with significant differences appearing only in the U14 group.

Semiprofessionals performed better than amateurs in all the tests. The difference in the level justifies this difference. Training at the highest level is characterized by higher intensities, greater loads and are more specialized for the improvement of players.

From the correlations it is characteristic that the percentage of body fat is negatively related to LJ at the developmental ages and to SJ in adults. Also, in the U10 group the only correlation between fitness tests was observed between LJ and 30 m sprint. The CMJ was the fitness test that showed most relationships with anthropometric characteristics and other tests [16].

More specifically, only the semiprofessionals showed no correlation between a jump test and the 30 m sprints. However, previous studies reported a relationship between jump performance and maximum speed [2, 10, 16, 27]. During acceleration, which is the initial phase of the sprint, power (force in the unit of time) plays an important role [28].

The performance in the T-test in the developmental ages U12 and U14 was significantly correlated to the LJ and to the 30 m sprint, while the Illinois test with the performance in the 30 m in the amateurs and with the SJ in the semiprofessionals. Correlations between agility tests with speed and jumping tests were also reported in previous studies. More specifically, Michailidis et al. [16] reported correlations between performance at 30 m and performance in two different agility tests, while previously Vescovi and McGuigan [27] and Little and Williams [13] reported similar findings. The lack of a correlation between performance in the Illinois test and performance in the 30 m test in the semiprofessionals is in line with the findings of Chaouachi et al. [5] in high-level young players. These differences between the groups in the present study and between different studies are due to the influence of different age, experience and different design of the researches [4].

Flexibility was related in some groups (U10, U14, amateur) only with anthropometric characteristics such as weight, BMI and body fat percentage. The performance in strength endurance of the abdominal muscles was related to the performance in the jump tests (LJ and SJ) in the U12, U14 and amateur groups. Performance in the Yo-Yo test was positively related to performance in the CMJ in the U12 group. Amateurs' performance in the SJ was correlated negatively with performance in the 30 m test. Performance of SJ for U14 and semiprofessional players was negatively correlated with performance in the T-test and the Illinois test, respectively.

The present study has some limitations. More specifically, at the developmental ages the groups are two years apart; it is a better solution to have a one year interval to minimize the biological maturity differences. Also, at the developmental ages biological maturation, which we did not evaluate, plays a very important role in performance of athletes.

Conclusions

In conclusion, this study presents the physical condition profile of players in developmental ages (non-elite), amateurs and semiprofessionals. The improvement of performance depends on training, but also on biological maturation and development. The study performed at the beginning of the training year (pre-season), after ~8 weeks of summer holidays, also reflects the phenomenon of detraining on the subjects' performance [26]. In adults the different level of athletes is shown in all physical ability tests with semiprofessionals performing better. Greater specialization of training contents (increase in volume and intensity at the highest level) causes more effective adaptations in soccer players.

Conflict of Interests

The authors declare no conflict of interest.

References

1. Bangsbo J, Iaia FM, Krustrup P. The Yo-Yo intermittent recovery test: a useful tool for evaluation of physical performance in intermittent sports. Sports Med. 2008; 38(1):37-51.
2. Bissas AI, Havenetidis K. The use of various strength-power tests as predictors of sprint running performance. J Sports Med Phys Fitness. 2008;48(1):49-54.
3. Carling C, Bloomfield J, Nelsen L, Reilly T. The role of motion analysis in elite soccer: contemporary performance measurement techniques and work rate data. Sports Med. 2008;38:839-862.
4. Chamari K, Hachana Y, Ahmed YB, Galy O, Sghaier F, Chatard JC. Field and laboratory testing in young elite soccer players. Br J Sports Med. 2004;38(2):191-196.
5. Chaouachi A, et al. Lower limb maximal dynamic strength and agility determinants in elite basketball players. J Strength Cond Res. 2009;23(5):1570-1577.
6. Diallo O, Dore E, Duche P, Van Praagh E. Effects of plyometric training followed by a reduced training programme on physical performance in prepubescent soccer players. J Sports Med Phys Fitness. 2001;41:342-348.
7. Durning S, Rahaman M. The assessment of the amount of fat in the human body from measurements of skinfold thickness. Br J Nutr. 1967;21:681-689.
8. Henrıquez-Olguın C, Baez E, Ramırez-Campillo R, Cañas R. Perfil somatotıpico del futbolista profesional chileno (Profile of professional male soccer Chilean players). Int J Morphol. 2013;31:225-230.
9. Ingle L, Sleap M, Tolfrey K. The effect of a complex training and detraining programme on selected strength and power variables in early pubertal boys. J Sports Sci. 2006;24:987-997.
10. Kale M, Asci A, Bayrak C, Acikada C. Relationships among jumping performances and sprint parameters during maximum speed phase in sprinters. J Strength Cond Res. 2009;23(8):2272-2279.
11. Kanehisa H, Yata H, Ikegawa S, Fukunaga T. A cross-sectional study of the size and strength of the lower leg muscles during growth. Eur J Appl Physiol Occup Physiol. 1995;72:150-156.
12. Léger LA, Lambert J. A maximal multistage 20-m shuttle run test to predict VO2 max. Eur J Appl Physiol Occup Physiol. 1982;49(1):1-12.
13. Little T, Williams AG. Specificity of acceleration, maximum speed, and agility in professional soccer players. J Strength Cond Res. 2005;19(1):76-78.
14. Meylan C, Cronin J, Oliver J, Hughes M. Review: Talent identification in soccer: The role of maturity status on physical, physiological and technical characteristics. Int J Sport Sci Coach. 2010;5:571-592.
15. Meylan C, Malatesta D. Effects of in-season plyometric training within soccer practice on explosive actions of young players. J Strength Cond Res. 2009;23:2605--2613.
16. Michailidis Y, et al. Arrowhead agility test in elite U19 soccer players: positional differences and relationships with other performance tests. Trends Sport Sci. 2021; 28(1):37-44.
17. Mohr M, Krustrup P, Bangsbo J. Fatigue in soccer: a brief review. J Sports Sci. 2005;23:593-599.
18. Palucci Vieira LH, Carling C, Barbieri FA, Aquino R, Santiago PRP. Match running performance in young soccer players: a systematic review. Sports Med. 2019; 49(2):289-318.
19. Philippaerts RM, et al. The relationship between peak height velocity and physical performance in youth soccer players. J Sports Sci. 2006;24(3):221-230.
20. Reilly T, Brooks GA. Exercise and the circadian variation in body temperature measures. Int J Sports Med. 1986; 7:358-362.
21. Schmitz B, Pfeifer C, Kreitz K, Borowski M, Faldum A, Brand SM. Normative Yo-Yo Intermittent Recovery Level 1 and Yo-Yo Intermittent Endurance Level 1 test values of boys aged 9-16 years. J Sci Med Sport. 2019; 22(9):1030-1037.

22. Semenick D. Test and measurements: The T- test. NSCA. 1990;12(1):36-37.
23. Siri WE. The gross composition of the body. Adv Biol Med Phys. 1956;4:239-280.
24. Slaughter MH, et al. Skinfold equations for estimation of body fatness in children and youth. Hum Biol. 1988;60:709-723.
25. Tambalis KD, et al. Physical fitness normative values for 6-18-year-old Greek boys and girls, using the empirical distribution and the lambda, mu, and sigma statistical method. Eur J Sport Sci. 2016;16(6):736-746.
26. Vassilis S, Yiannis M, Athanasios M, Dimitrios M, Ioannis G, Thomas M. Effect of a 4-week detraining period followed by a 4-week strength program on isokinetic strength in elite youth soccer players. JER. 2019;15(1):67-73.
27. Vescovi JD, McGuigan MR. Relationships between sprinting, agility, and jump ability in female athletes. J Sports Sci. 2008;26(1):97-107.
28. Weyand PG, Sternlight DB, Bellizzi MJ, Wright S. Faster top running speeds are achieved with greater ground forces not more rapid leg movements. J Appl Physiol. 2000:89(5):1991-1999.