Original Article

Evaluation of soccer performance in professional, semi-professional and amateur players of the same club

EVANGELIA PAPADEVANGELOU¹, THOMAS METAXAS², CHRISTOS RIGANAS³, ATHANASIOS MANDROUKAS⁴, EFSTRATIOS VAMVAKOUDIS⁵

^{1,2,3,4,5}Laboratory of Ergophysiology-Ergometry, Department of Physical Education and Sports Science, Aristotle University of Thessaloniki, Thessaloniki, GREECE.

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Abstract

The aim of the present study was to evaluate and compare the body composition and the cardiorespiratory performance as well as to examine the isokinetic muscle strength of the lower extremities and the vertical jump performance in professional, semi-professional and amateur Greek soccer players of the same club. Subjects formed three groups: professionals, U-21 and U-17. All subjects underwent anthropometric measurements, body fat assessment and performed a maximal exercise test on treadmill to determine VO_{2max} . Jumping ability was measured with two different tests and muscle strength of the quadriceps and hamstrings was examined at three angular velocities. The absolute values of VO_{2max} (ml/min) were higher in professionals compared to U-21 and U-17 ($p<0.05$, $p<0.001$) while the relative values (ml/kg/min) did not differ between groups. Professionals presented significantly higher values in SJ and CMJ compared to U-21 by 11.3% and 10.5% and U-17 by 10.5% and 9.4%, respectively ($p<0.001$ and $p<0.01$). Professionals and U-21 demonstrated higher peak torque values at all angular velocities of knee flexors and extensors compared to U-17 ($p<0.05$, $p<0.001$). Conclusively, the professionals obtained higher values in muscle strength and jumping ability. These findings can be attributed to age, training experience, and specific strength training program. Moreover, the cardiorespiratory performance and body composition may be improved if the specific training program is followed by a balanced diet too.

Key words: physiological profile, VO_{2max} , isokinetic muscle strength, vertical jump, physical fitness, elite soccer.

Introduction

Soccer is a team sport with an intermittent nature of physical activity. It primarily involves running but also explosive-type efforts such as sprints, jumps, tackles, kicking, changing pace and duels for winning the possession of the ball (Cometti et al., 2001). All these actions require a variety of skills which must be combined so that to ensure that the player's performance will be successful. Such explosive actions often turn out to be decisive in game situations that lead in scoring. The ability to generate explosive muscle force within fractions of a second is an important determinant of performance (Thorlund et al., 2009). The execution of technical skills followed by effects of fatigue may cause an increase in playing errors (Mohr et al., 2003; Lyons et al., 2006; Huijgen et al., 2009). Muscle fatigue is difficult to define but it has been reported as the inability to maintain the required or expected force in the initial high level (De Ste Croix et al., 2003; Westerdal et al., 1991). For these reasons, it is important for aerobic performance and muscle strength to be examined for high level amateurs and young soccer players.

There seems to be a high relevance between high levels of cardiorespiratory endurance and competitive ranking, quality of play and distance covered during a soccer match (Bangsbo and Linguist, 1992; Krstrup et al., 2003; Impellizzeri et al., 2005; Wisløff et al., 1998). Previous studies have shown that the values of VO_{2max} professional soccer players vary from 55 – 65 ml/kg/min (Metaxas et al., 2009; Metaxas et al., 2005; Ekblom, 1994; Reilly et al., 2000) and 65-70.7 ml/kg/min in young players (Chamari et al., 2005). Muscle strength deficiency has been thought to be as one of several risk factors for hamstring injury (Yamamoto, 1993; Worrell, 1994; Askling et al., 2003). Knee flexor strength is extremely important in a soccer player because it provides joint stabilization during soccer-related actions and maneuvers (Aagaard et al., 1996; Cometti et al., 2001). Quadriceps peak torque values that have been reported in the bibliography (Metaxas et al., 2009) are 256 - 270 Nm at $60^{\circ}\cdot\text{sec}^{-1}$ in different division players and hamstring values are 144 – 155 Nm at the same angular velocity.

Jumping and pivoting is also frequently performed in soccer. As a player jumps an average of 15.5 times during a soccer game (Reilly and Thomas, 1976) and for every 2 turns a player performs during a game, a landing from a jump or header occurs (Withers et al., 1986). Studies have shown that landing with decreased knee flexion may increase the forces on the anterior cruciate ligament (ACL) (Griffin et al., 2000). According to Boden et al. (2000) most ACL injuries occur when the knee is near full extension during a sharp deceleration or while landing after a jump. This extended position of the knee joint, together with eccentric contraction of the quadriceps muscle, increases the strain on the ACL and it may lead to an injury, especially if there are low levels in muscle strength or muscle imbalances between the hamstrings and quadriceps. Soccer players should be taught correctly the technique in landing after a jump which demands a smaller knee flexion angle, as the extended knee may have less dynamic control and the ability to absorb the produced forces (Lloyd et al., 2005). Cometti et al. (2001) examined vertical jump in three different divisions and demonstrated CMJ values of 41.56 ± 4.18 cm, 39.71 ± 5.17 cm, 43.93 ± 5.65 cm in first, second and third division, respectively as well as SJ values of 38.48 ± 3.8 cm, 33.86 ± 7.47 cm, 39.83 ± 5.51 in each division, respectively. Recently, Wisløff et al. (2004) presented CMJ values of 56.4 ± 4.0 cm in elite male soccer players which are similar to those observed by McMillan et al. (2005) in CMJ (53.4 ± 4.2 cm) and in SJ 40.3 ± 4.0 cm.

Fat seems to be a very good insulator of the human body because it tends to preserve the heat that's been produced during exercise in the core of the body. Therefore, a soccer player whose body fat levels are above normal is in great danger of hyperthermia (overheating), especially, when the game takes place in an environment where heat and humidity levels are significantly higher. Such extreme conditions prevent the evaporation of sweat and the body cooling cannot be easily achieved, so there is a high danger of thermal disorder (Can et al., 2004). It is widely reported that a soccer player should have low fat levels because extra fat overloads the athlete with extra weight without increasing his power at the same time. Moreover, the metabolic cost that is necessary for the athlete's motion is actually increased and there is a subsequent deterioration of performance (Wilmore, 1982). Body composition of soccer players that is reported in bibliography vary from about 9-14% in different divisions (Ekblom, 1994; Reilly et al., 2000; Metaxas et al., 2005; Metaxas et al., 2009).

Although there are reports in the bibliography about studies that compare soccer players of different categories and ages (Metaxas et al., 2009) there is no report concerning the comparison in the fitness levels of soccer players in different categories within the same club. The aim of the present study was to evaluate and compare the body composition and the cardiorespiratory performance, the isokinetic muscle strength of quadriceps and hamstring muscles and finally, the vertical jump performance in Greek professional, semi-professional and amateur soccer players of the same club.

Material & methods

Participants

Twenty-nine professional players (aged 27.1 ± 3.8 yrs, training experience 9.0 ± 3.9 yrs), twenty-six U-21 (aged 19.8 ± 0.7 yrs, training experience 8.1 ± 2.5 yrs) and twenty-two U-17 soccer players (aged 16.8 ± 0.7 yrs, training experience 7.2 ± 1.4 yrs) were examined in our study. The professionals were trained six times per week and played one soccer game or five times a week and two soccer games per week, while the semi-professionals and amateurs were trained five times per week and one soccer game per week. All three groups were trained under the same training programs and philosophy and had the same design throughout the season. The protocol of this study was in accordance with the guidelines of the Ethical Committee of Aristotle University of Thessaloniki and the revised Declaration of Helsinki. All participants gave their written consent of participating in the study.

Procedures

Anthropometric measurements and body composition

All participants underwent anthropometrical examination and body composition assessment. Height and body weight were determined to the nearest 0.1cm and 0.1kg, respectively, using an electronic digital scale (Seca 220e, Hamburg, Germany). For the assessment of body fat percentage (BF%) using the four-fold skinfold measurement method: Biceps (S1), triceps (S2), suprailiac (S3) and subscapular (S4) using a specific caliper (Dr Lange, Santa Cruz, California). Estimation of body density was calculated according to Durnig and Rahaman (1967) equation for male adults older than 16 years old:

$$D = 1.161 - 0.0632 \times \log (S1+S2+S3+S4)$$

The percentage of body fat was estimated by the equation of Siri (1956):

$$BF (\%) = [(4.95/D) - 4.5] \times 100$$

Cardiorespiratory endurance

All participants after having a 10 – minute warm-up and stretching performed a maximal exercise test on treadmill (HP Cosmos, Pulsar, Nussdorf-Traustein, Germany). They all exercised till exhaustion according to a maximal incremental continuous protocol. The initial inclination and speed were set at 1% and 10 km/h, respectively. The speed was increased by 2 km/h per stage. The oxygen uptake was determined by means of absolute oxygen (ml/min) and relative values (ml/kg/min) adjusted to body weight, using an ergospirometric device based on a breath-by-breath gas analyzing system (Oxycon-Pro, Jaeger Wurzburg, Germany). The HR, HR_{AT} and HR_{max} were determined using a telemetry system (Polar, Kempele, Finland) connected to the ergospirometric device. The room temperature was 20-22°C and the relative humidity was approximately 50%. Blood lactate concentrations were drawn from samples of the hand fingertips at the fifth minute of recovery using an enzymatic lactate analyzer (Accusport, Boehringer, Mannheim, Germany).

Isokinetic muscle strength

Isokinetic dynamometer Cybex II Norm (Lumex and Co, Ronkonkoma, New York, USA) was used to examine the knee flexion and extension isokinetic muscle strength. Participants performed a standardized warm-up on a Monark cycle Ergometer for five minutes. The participant was seated on the dynamometer in an adjustable chair; the upper body was stabilized with straps secured diagonally across the chest and the hips. Maximal isokinetic strength was recorded as the torque of the quadriceps and hamstring muscles throughout the whole range of motion (ROM) at angular velocities of 60°, 180° and 300°·sec⁻¹. Peak torque was measured using a speed-controlled isokinetic dynamometer with a specially designed program, which included torque comparison adjusted for the weight of the leg. Gravity correction was performed for the tested leg. The knee to be tested was positioned at 90 degrees of flexion (0 degrees corresponding to fully extended knee) and the axis of rotation of the dynamometer was aligned with the nearest knee joint axis of rotation (lateral femoral condyle). The length of the level arm was individually determined and the resistance pad placed proximal to the medial malleolus. The non-tested leg was hanging freely. Knee extension started when the knee positioned at 90 degrees of the flexion while the knee flexion started when the knee was in full extension (0°). Subjects were instructed to cross their arms over their chest and to kick strongly and rapidly for a complete ROM. Three repetitions were carried out at each angular velocity and the best torque value was used. A 30-second rest period was taken between each trial and 60-second rest period was taken between each velocity measurement. During these procedures subjects always performed maximal voluntary contractions in which verbal encouragement was given to them throughout the contractions. The concentric strength ratio between knee flexors and extensors (hamstrings/quadriceps H/Q) was expressed as the ratio between the peak torque values at each velocity. A convention H/Q ratio, determined maximal hamstring moment (H) divided by maximal quadriceps moment (Q) was calculated separately for each velocity and contraction mode.

Vertical jump

To measure the height of the jump we used the “Myotest - PRO” (Myotest SA, Switzerland) device which is a portable, accurate and quick test. Myotest calculates the power, the velocity and the force of an athletic movement using a three-dimensional accelerometer. Subjects performed three maximal voluntary vertical jumps at each of the two tests, which were counter movement (CMJ) and squat jump (SJ). In CMJ the subjects started in standing position with their hands on their hips looking straight ahead and standing still. At the short “beep” they had to make a free lunge movement (bending their knees) and jump as high as they could while keeping their hands on their waist. After landing smoothly and softly they had to return to the standing position awaiting the next “beep” before repeating the jump. After five repetitions the double beep signaled the end of the test.

On the other hand, in SJ the participants also started in standing position with their hands on their hips looking straight ahead and standing still but this time they had to bend their knees to 90° degrees. At the short “beep” they had to jump as high as possible without any counter-movement lunge while keeping their hands on their waist. After a smooth and soft landing they had to return to the previous position with their knees flexed at 90° degrees awaiting for the next “beep” before repeating the jump. In both tests we took the average of the three best repetitions.

Statistical analysis

Data are expressed as mean ± standard deviation (mean ± SD). All data were checked for homogeneity and the assumption for normality was examined with Shapiro Wilk test (n<50). One-way ANOVA and post hoc analysis using a Scheffé test was used to determine differences of parameters between measurements. The statistical analysis was performed via SPSS (version 17.0, Chicago, Illinois, USA). Statistical significance was accepted at p<0.05.

Results

Anthropometric characteristics of the subjects are demonstrated in Table 1. Significant differences were found in weight ($F(2,74) = 28.544$; $p < 0.01$; $2 = 0.774$; Power = 0.89) and lean body mass, ($F(2,74) = 36.213$; $p < 0.001$; $2 = 0.882$; Power = 0.97). No differences were found among the three groups concerning height and body fat.

Table 1. Physical and anthropometric characteristics of the subjects (mean $\pm$ SD).

Variables	Group		
	Professional n=29	Under-21 n=26	U-17 n=22
Age (yrs)	27.06 $\pm$ 6.53	19.7 $\pm$ 0.071***	16.81 $\pm$ 0.58†††
Training age (yrs)	18.10 $\pm$ 2.4	10.6 $\pm$ 1.80***	9.70 $\pm$ 1.2†††
Height (cm)	180.75 $\pm$ 6.53	179.69 $\pm$ 6.18	176.81 $\pm$ 6.17
Weight (kg)	79.46 $\pm$ 7.00	72.99 $\pm$ 6.50**	69.09 $\pm$ 6.59†††
Body fat (%)	11.22 $\pm$ 2.83	11.03 $\pm$ 2.24	10.94 $\pm$ 1.80
LBM (kg)	70.54 $\pm$ 6.80	64.93 $\pm$ 6.35**	61.53 $\pm$ 6.47†††

** $p < 0.01$, Professionals vs U-21

*** $p < 0.05$, Professionals vs U-21

††† $p < 0.05$, Professionals vs U-17

Cardiorespiratory values during maximal exercise testing are presented in Table 2. The results of our study showed that VO_{2max} in terms of ml/min were higher in professionals compared to U-21 ($F(2,74) = 32.123$; $p < 0.05$; $2 = 0.796$; Power = 0.87) and U-17 ($F(2,74) = 35.644$; $p < 0.001$; $2 = 0.971$; Power = 0.98), respectively. However, the relative values of VO_{2max} (ml/kg/min) did not differ between groups. No differences were found among the three groups concerning time to exhaustion, VO_{2AT} , HR_{max} , VE_{max} and RER. However, there was a significant difference between professionals and U-17 in blood lactate values.

Table 2. Cardiorespiratory and anaerobic threshold values of the subjects.

Group			
Variables	Professional n=29	Under-21 n=26	U-17 n=22
HRrest (b/min)	63.71 $\pm$ 9.38	64.88 $\pm$ 13.22	66.22 $\pm$ 9.67
BPsystolic (mmHg)	126.25 $\pm$ 8.37	122.80 $\pm$ 9.77	127.40 $\pm$ 12.71
BPdiastolic (mmHg)	65.96 $\pm$ 6.65	64.46 $\pm$ 10.41	62.50 $\pm$ 5.04
Exhaustion time (min)	8.22 $\pm$ 0.81	8.16 $\pm$ 0.54	7.97 $\pm$ 0.60
VO2max (ml/min)	4620 $\pm$ 371.86	4328.38 $\pm$ 444.34*	4014.04 $\pm$ 433.20†††,\$
VO2max (ml/kg/min)	57.97 $\pm$ 3.01	59.40 $\pm$ 3.72	58.48 $\pm$ 5.80
HRmax (b/min)	198.40 $\pm$ 7.37	199.20 $\pm$ 5.96	198.81 $\pm$ 4.64
RER	1.13 $\pm$ 0.04	1.10 $\pm$ 0.05	1.12 $\pm$ 0.06
HRAT (b/min)	168.07 $\pm$ 3.92	169.73 $\pm$ 4.36	169.0 $\pm$ 5.99
UAT (km/h)	14.14 $\pm$ 0.67	14.17 $\pm$ 0.54	14.06 $\pm$ 0.66
VEmax (l/min)	143.15 $\pm$ 14.23	132.03 $\pm$ 18.20*	131.81 $\pm$ 18.32
BLa (mmol/min)	9.82 $\pm$ 1.94	9.13 $\pm$ 1.83	8.22 $\pm$ 2.05†

* $p < 0.05$, Professionals vs U-21

† $p < 0.05$, Professionals vs U-17

\$ $p < 0.05$, U-21 vs U-17

††† $p < 0.05$, Professionals vs U-17

Significant differences were found between the three groups where professionals and U-21 had exhibited higher peak torque values at all angular velocities of knee extensors and flexors compared to U-17 ($0.05 < p < 0.001$). More specifically, in extension $60^{\circ} \cdot \text{sec}^{-1}$ U-17 presented 11.6% lower isokinetic muscle strength than professionals and U-21. U-17 obtained 12.1% lower isokinetic muscle strength than U-21 and 17.4% than professionals in $180^{\circ} \cdot \text{sec}^{-1}$. Finally, U-17 showed 11.6% lower isokinetic muscle strength than U-21 and 15.5% lower than professionals at $300^{\circ} \cdot \text{sec}^{-1}$ (Figure 1).

Figure 1. Knee extension values at 3 angular velocities for the determination of peak torque. Values represent means $\pm$ SD. †: $p < 0.05$, Prof vs U-17, \$: $p < 0.05$, U-21 vs U-17, \$\$: $p < 0.01$ U-21 vs U-17, †††: $p < 0.05$, Prof vs U-17.

Significant differences were reported in knee extension peak torque values between professionals vs U-17 ($F(2,74) = 25.446$; $p < 0.05$; $2 = 0.773$; Power = 0.831), U-21 vs U-17 ($F(2,74) = 24.679$; $p < 0.05$; $2 = 0.767$; Power = 0.842), U-21 vs U-17 ($F(2,74) = 36.078$; $p < 0.01$; $2 = 0.870$; Power = 0.933) and professionals vs U-17 ($F(2,74) = 31.823$; $p < 0.05$; $2 = 0.763$; Power = 0.819). U-17, in flexion $60^{\circ} \cdot \text{sec}^{-1}$, presented 8.2% lower values in muscle strength than U-21 and 6.5% lower than professionals. In $180^{\circ} \cdot \text{sec}^{-1}$ U-17 showed 14.3% lower values than U-21 and 19.1 lower than professionals. Finally, in $300^{\circ} \cdot \text{sec}^{-1}$ U-17 presented 19.5% lower values in isokinetic muscle strength than U-21 and 24.4% lower than professionals (Figure 2).

The results showed differences between U-21 vs U-17 ($F(2,74) = 30.156$; $p < 0.05$; $2 = 0.780$; Power = 0.853), U-21 vs U-17 ($F(2,74) = 29.563$; $p < 0.01$; $2 = 0.795$; Power = 0.901), Professionals vs U-17 ($F(2,74) = 26.440$; $p < 0.05$; $2 = 0.768$; Power = 0.807).

Figure 2. Knee flexion values at 3 angular velocities for the determination of peak torque. Values represent means $\pm$ SD. \$: $p < 0.05$, U-21 vs U-17, \$\$: $p < 0.01$ U-21 vs U-17, †††: $p < 0.05$, Prof vs U-17

Peak torque ratio of H/Q in all angular velocities are presented in Figure 3. The results showed that ratio did not differ between groups and the percentage of the H/Q relationship reflected normal ratio (Figure 3).

Figure 3. Peak torque ratios of H/Q at 3 angular velocities for the determination of peak torque. Values represent means $\pm$ SD. H/Q ratio values presented no significant differences between three groups

Jumping ability values in SJ and CMJ are shown in Figure 4. Our results presented that professionals had significantly higher values of SJ and CMJ compared to U-21 by 11.3% and 10.5% and U-17 by 10.5% and 9.4%, respectively ($0.01 < p < 0.001$).

Figure 4. Jumping ability values at 2 tests. Values represent means $\pm$ SD. CMJ: countermovement jump, SJ: squat jump. ††: $p < 0.01$, prof vs U-17, ***: $p < 0.05$, prof vs U-21

Discussion

In the present study, anthropometric and physical characteristics profiles were compared across three level categories in soccer players of the same club. Our data supports clearly that professional were significantly heavier and presented higher LBM compared to U-21 and U-17. Additionally, maximal oxygen uptake and pulmonary ventilation were significantly higher in professionals compared to U-21 and U-17 as well as quadriceps and hamstrings isokinetic peak torque.

Our results revealed that professionals were older and had significantly higher professional experience than semi-professionals and amateurs. Previous findings on anthropometric characteristics of soccer players suggest that they vary widely in body size (Rico-Sanz, 1998; Shephard, 1999). Thus, these parameters are not essential factors for success in soccer; moreover, they might determine the playing positional role (Reilly, 1996).

It is widely reported that the aerobic system is the main source of energy production during soccer game and the average values of VO_{2max} for elite soccer players tend to be high (Tumilty, 1993; Reilly, Bangsbo, & Franks., 2000). Concerning the cardiorespiratory endurance of our participants, our results demonstrated that the at VO_{2max} variations rates among the different groups are due to the increased body weight of the professional soccer players compared to semi-professionals and amateurs since no differences have been found in relative values of VO_{2max} and all the rest parameters that have been examined in our study. The VO_{2max} values of the three groups are similar to those observed in previous studies (Bangsbo and Linguist, 1992; Ekblom, 1994; Wisloff et al., 1998; Reilly et al., 2000; Krstrup et al., 2003; Impellizzeri et al., 2005; Metaxas et al., 2005; Metaxas et al., 2009).

It is well known that the average VO_{2max} for international level male soccer players has been reported to range between 55 and 68 ml/kg/min, with individual values of more than 71 ml/kg/min having been recorded (Davis, Brewer, & Atkin, 1992; Reilly, 1996; Wisloff et al., 1998). These values are similar to those reported for other team sports, but substantially lower than those for elite performers in endurance sports, where values near to 90 ml/kg/min have commonly been recorded. Maximal oxygen uptake expressed in ml/kg/min/ implies linearity between oxygen cost and body mass, which is not the case (Bergh et al., 1991). When expressing VO_{2max} in ml/kg/min, work capacity is overestimated in light individuals (e.g. endurance sport athletes) and underestimated in heavy individuals. The opposite is true when evaluating the oxygen cost of running at submaximal workloads. Consequently, several studies (Bergh et al., 1991; Helgerud, Ingjer, & Stromme, 1990; Hoff & Helgerud, 2004; Wisloff et al., 1998) have concluded that comparisons between individuals of different body mass of oxygen uptake determined when running should be expressed ml/kg/min.

The concentration of lactate in blood is often used as an indicator of the anaerobic lactic acid energy production in soccer. Mean blood lactate concentrations for professionals, semi – professionals and amateurs are similar to those obtained previously (Agnevic, 1970; Ekblom 1986; Metaxas et al., 2009) and higher than those reported by Gerish et al. (1988). Reilly et al. (2000) reported that the relatively poor anaerobic capacity in children is reflected in low lactate production during intense exercise bouts and suggests a low glycolytic rate. There is especially limited potential in the prepubescent child for developing the anaerobic system. Recent evidence from magnetic resonance spectroscopy has confirmed that children are less able than adults to effect ATP rephosphorylation in aerobic pathways during high intensity exercise (Zanconato et al., 1993). Pre-adolescents accumulate lower lactate concentrations in their blood than adults during high intensity exercise, but they recover much faster than men following short-term (30s) intense exercise (Hebestreit et al., 1993). Anaerobic capacity increases progressively during maturation until reaching that of adults after the teenage years.

On the other hand, the results of our study concerning isokinetic dynamometry and vertical jump values presented that professional soccer players obtained higher values in muscle strength as well as in jumping ability compared to semi-professional and amateur soccer players. This may be due to the fact that there's an increase in training intensity while the playing category increases. However, no significant differences have been reported between professional and semi-professional. CMJ values for professionals (40.40 ± 3.79 cm), U-21 (36.16 ± 3.91 cm) and U-17 (36.16 ± 3.91 cm) are in agreement with previous data (Thorlund et al, 2009), as well as the isokinetic dynamometry and vertical jump values (Metaxas et al, 2009). These findings can be attributed to age, training experience and specific strength training program.

While soccer performance is based on many aspects of physiological profile, the present results suggest that certain fitness assessment data are important in determining whether already highly selected soccer players are successful or not in acceding to higher standards of play. Such measures may not be sensitive enough to be used reliably on their own for selection purposes. Therefore, future analyses could embrace areas such as players' mental and technical skills or practice history profiles to provide an even more comprehensive model for defining the prerequisites for evaluation the professional and/or amateur soccer.

Conclusions

The players' training program during the preparation period contributes significantly to the formation of the results during competitive season, so it is important to be carefully planned. It can result to the improvement of the soccer players' performance regardless of their age. Moreover, it is suggested that the application of a specific training program in professional soccer players followed by a balanced diet can lead to

improved levels of cardiorespiratory performance and body composition in elite players compared to younger ones of the same team.

Finally, we concluded that professional players present significantly higher values in muscle strength and jumping ability compared to U-21 and U-17. This may be due mainly to the training experience and to the specifically strength training program. On the other hand, cardiorespiratory values ($\text{VO}_{2\text{max}}$) do not differ between groups, although professionals present higher absolute values (ml/min) compared to the U-21 and U-17. This may be due to the different high intensity aerobic training program and to the increased weight and lean body mass values of professionals.

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