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ORIGINAL

PHYSICAL FITNESS AND TECHNIQUE EVALUATION IN YOUNG SOCCER PLAYERS

VALORACIÓN DE LA CONDICIÓN FÍSICA Y TÉCNICA EN FÚTBOLISTAS JÓVENES

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ABSTRACT

The aim of this study was to asses both physical and technical condition of 256 soccer players aged 10-17, through specific and unspecific tests. Countermovement jump (CMJ), repeated sprint ability (RSA), goal shooting test, and technique and shooting accuracy test were performed to establish the differences between age and playing position. Significant differences were revealed between age and both physical and technical tests except for technique and accuracy test. No significant differences were found in playing position, with the exception of goal keepers.

KEY WORDS: soccer players, youth, physical and ability testing, field position, age

RESUMEN

El objetivo de este estudio es valorar la condición física y técnica a futbolistas de 10 a 17 años mediantes tests inespecíficos y específicos y establecer diferencias entre las diferentes edades y la posición que ocupan en el campo. En este estudio participaron 256 jugadores de fútbol con edades comprendidas entre los 10 y los 17 años. Se midió el salto vertical (CMJ), sprints repetidos (RSA), la velocidad de desplazamiento específico con balón y la velocidad, técnica y precisión en el lanzamiento a portería. Los resultados más relevantes indican diferencias significativas en función de la edad en las pruebas físicas y técnicas analizadas, excepto en la conducción. No hay diferencias significativas en función de la demarcación, excepto en los porteros.

PALABRAS CLAVE: futbolistas, jóvenes, pruebas físicas y técnicas, demarcación, edad.

INTRODUCTION

In many sports, among them soccer, performance is the result of a combination of different factors: genetic endowment, training and the health of the athlete (Viru & Viru, 2001). Through a physical and physiological evaluation these factors can be analyzed in order to describe the players' profile, and be compared, and repeated to evaluate progress and apply suitable training strategies.

The demands of soccer vary with age group, competitive level, playing position and style of play (Ekblom, 1999). For this reason it is normal to find different profiles and fitness levels even within the same team (Carbonell, Aparicio, & Delgado, 2009).

A fitness evaluation is therefore the most suitable way to determine the current fitness level of the player and his or her future possibilities and the results can be applied to planning training in an individualized manner.

Soccer consists of periods of high intensity exercise alternating with periods of low intensity exercise and is therefore considered an intermittent sport. Many physical, technical, tactical and psychological abilities are needed to practise soccer (Dauty, Bryand, & Potiron-Josse, 2002; Mercé, 2003). From a physical and physiological point of view soccer requires players to be competent in several aspects of fitness like aerobic and anaerobic power, muscle strength, speed, flexibility and agility (Ekblom, 1986; Reilly & Doran, 2003; Reilly & Thomas, 1976). It also requires that these physical aspects be applied in the development of the technical and tactical facets.

Explosive power and velocity which depend on strength are determinant for sports performance in soccer players (Le Gall, Beillot, & Rochcongar, 2002).

Therefore it is of fundamental importance to evaluate these parameters to determine the current situation of the players and be able to plan their improvement and development. Furthermore, explosive strength and speed are related to the speed with which the players carry out their own play actions. In this sense Vittori (1990) states that speed is only a capacity which derives from strength whereas strength is a unique quality which determines the speed which bodies acquire as they move. Explosive strength in soccer has usually been related to the performance of technical-physical actions like jumping, passing or kicking (Masuda, Kikuhara, Demura, Katsuta, & Yamanaka, 2005; Winkler, 1993). And speed is not only important in itself but also when applied to action with the ball.

The evaluation of explosive elastic power using the countermovement jump (CMJ) has been widely used in many studies (Bosco, Luhtanen, & Komi, 1983; Izquierdo, Aguado, González, & Hakkinen, 1999; Saez de Villareal, Kellis, Kraemer, & Izquierdo, 2009) in order to evaluate the ability to use elastic energy in jumping.

Furthermore, as in a soccer match it is necessary for the players to be able to repeat sprints of several seconds with brief recovery periods, the RSA test in which repeated sprint ability is tested, has proved another very valid and useful tool (Bishop & Edge, 2006; Ferrari Bravo, Rampini, & Impellizeri, 2007; Ferrari Bravo, Rampinini, & Impellizzeri, 2006; Ferrari Bravo et al., 2005; Rampinini et al., 2007). It has also shown good reproducibility (Ferrari Bravo et al., 2005) and is relatively sensitive to specific training (Ferrari Bravo et al., 2006). It has also been observed to be a good indicator of physical aptitude in soccer players (Chaouachi et al., 2010).

Few studies have been carried out with regard to the evaluation of soccer players in actions with the ball (Juárez et al., 2008; Mercé, 2003; Mercé, González, Mayo, Pardo, & Sorli, 2004; Seabra, Maia, & Garganta, 2001), in spite of the great importance of this aspect in soccer.

There is a predominance of studies on the physical fitness of young soccer players (Abrantes, Macas, & Sampaio, 2004; Casáis, Crespo, Domínguez, & Lago, 2004; Mercé et al., 2004; Seabra et al., 2001) compared with those that involve technical (Mercé, 2003; Rösch et al., 2000; Seabra et al., 2001) or psychological aspects (Boixadós & Cruz, 1999; Boixadós, Cruz, Torregrosa, & Valiente, 2004).

Mercé and colleagues (Mercé et al., 2004) evaluated 55 infant and cadet players and concluded that unspecific physical tests, although necessary, were not sufficient and that specific tests related to soccer should be used.

Casais and colleagues (Casáis et al., 2004) evaluated 328 infant, cadet and juvenile soccer players using anthropometric measures and strength and velocity tests. The results showed the relation among the variables and were

different according to the age group, which demonstrates that there are appropriate moments for training these factors. These authors also point out the error of using the values found in professional soccer players to evaluate performance at younger ages, as there is a great deal of difference between the values obtained in the present study and those which refer to professional soccer players.

Abrantes and colleagues (Abrantes et al., 2004) carried out a study in which they compared the performance of 146 soccer players of between 12 and 26 years of age in a test of 7 repeated sprints, and found that the effects of fatigue were accentuated between the fifth and sixth sprint and that the u-12 and u-14 players were the ones who needed more time to complete the sprints. Juárez and colleagues (Juárez, López de Subijana, Mallo, & Navarro, 2010) studied ball kicking performance and the vertical jump in 21 young soccer players with an average age of 16.1 ± 0.2 years and found that there was no correlation between jump height and ball kicking which suggests that explosive strength training should be specific to improve each of these actions and attempt to optimize performance.

The physical demands of competition increase with the age and the level of the subjects. It is possible to obtain more information about the characteristics of the soccer players through the evaluation of their abilities in order to improve their training. Thus different tests like the RSA can be used to evaluate the specific physiological components of soccer performance (Calahorro, Torres-Luque, Lara, & Zagalaz, 2011).

These evaluations will contribute information on the future possibilities of a young player and help us use it to design more individual training programmes.

OBJECTIVES

The purpose of this study was to evaluate the physical and technical condition of young soccer players from 10 to 17 years of age, using unspecific tests like the vertical jump (CMJ) and repeated sprints (RSA), and specific tests like speed with ball control, and speed, technique and accuracy when shooting at goal; and to establish differences among the different age groups and the playing position occupied.

MATERIAL AND METHODS

Design

A descriptive design was used for this study to evaluate the technical and physical abilities of the soccer players in order to determine, analyze and describe their physical fitness. The dependent variables measured were the vertical jump (CMJ) which allowed us to measure explosive strength in their lower limbs, speed and the fatigue index in repeated sprints (RSA), speed with

ball control and technique, speed and accuracy when shooting at goal. The independent variables were age and playing position. The following age groups were established: 10-11, 12-13, 14-15 and 16-17.

Participants

Two hundred and fifty-six male soccer players of between 10 and 17 years of age, with a mean age of 13.77 (sd= 1.85), who were attending a technical soccer campus organized by the Real Madrid Foundation in July 2010, took part in the study.

Table 1. Participants by age group

Age	Frequency	Percentage
10-11	37	14.5
12-13	68	26.6
14-15	99	38.7
16-17	52	20.3
Total	256	100.0

Six participants were excluded from the research as their playing position was unknown and this was an independent variable in the study. Another participant was excluded from the ball control test after making two invalid attempts.

All the subjects knew the research objectives, voluntarily accepted to take part, were informed about the experimental procedures which would be carried out and that they could withdraw from the study at any moment. The study was carried out with the consent of the parents and/or guardians. All procedures were according to the Declaration of Helsinki and the Public General Act on the Protection of Data of a personal Nature (LOPD).

Procedure

The subjects performed the tests in just one day. The CMJ test was performed on an ErgoJump Bosco system force platform (Bosco et al., 1983), and flight time was registered for the better of two jumps. They then carried out the ball control test. Cones of 30 cm height were placed 2 m apart over a distance of 10m. The players had to move with the ball in a zigzagging trajectory out and back without touching the cones. They made two attempts and the better time was recorded. The player stood with his forward foot behind the start line and two researchers recorded his time, starting at the moment when the player lifted his back foot from the floor. Timing stopped when his trunk crossed the line at the end. The mean of the times recorded by the two researchers was calculated. Then the players did the goal shot test. The players had to run 5 m kicking the ball, had to dodge an obstacle (a 30 cm height cone) and then shoot at goal in front of the goal area. Velocity and accuracy were recorded. To

evaluate velocity the time was taken from when the player began moving with the ball from the cones, until he kicked the ball at goal (Figure 1). As in the case of the test of moving with the ball, two attempts were registered and the mean time was calculated. To obtain the accuracy of the kick, zones were marked out in the goal in terms of difficulty as is shown in Figure 1.

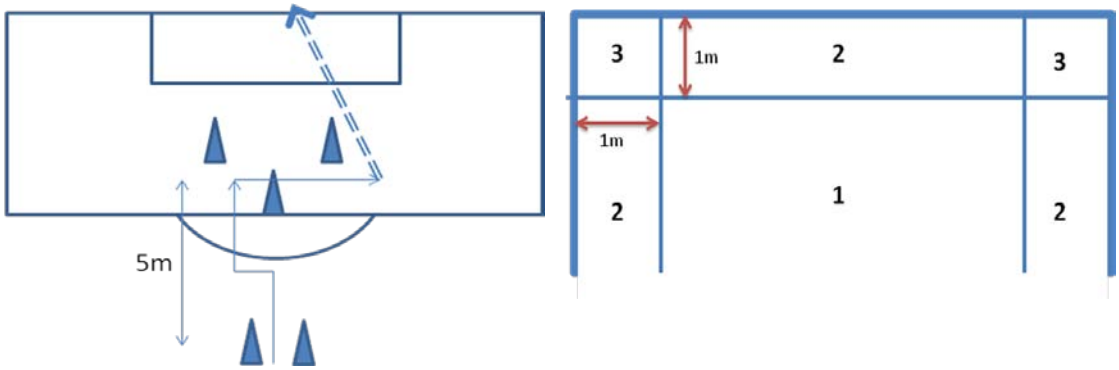

Figure 1. Diagram of the goal shooting test.

Lastly they performed the repeated sprint test (RSA) of 6x40m (20 +20m) with 20 seconds rest between sprints. The time taken for each sprint was recorded as well as the fatigue index. To find this index the method proposed by Fitzsimons et al (1993) was used by applying the following equation:

$$Fatigue\ index = \left(\frac{\sum \text{times}}{t_{best} \times n^{o}\ of\ sprints} \times 100\right) - 100 = \%$$

Statistical analysis

A descriptive analysis was performed for all the measured variables in each of the age groups and for each playing position. Anovas were performed (with the Tukey or Games-Howell post hoc tests depending on the similarity or lack of similarity of the variants respectively) for the parametric variables and the Kruskal-Wallis test for the non-parametric variables, to establish the differences in the variables among the age groups and playing positions.

RESULTS

There were significant differences among the age groups in the CMJ with the exception of the 14-15 and 16-17 groups (Table 2)

Table 2. ANOVA of the CMJ by age group

				95% confidence interval for mean		
	Mean	Standard deviation	Standard error	Lower limit	Upper limit	ANOVA
10-11 (1)	0.244	0.036	0.006	0.232	0.256	P=0.000 1-2;1-3; 1-4; 2-3; 2-4
12-13 (2)	0.282	0.051	0.006	0.269	0.294	
14-15 (3)	0.332	0.056	0.006	0.320	0.343	
16-17 (4)	0.354	0.053	0.007	0.339	0.368	
Total	0.310	0.064	0.004	0.302	0.318	

There were no significant differences among the age groups in relation to the ball control test (Table 3).

Table 3. ANOVA for ball control test by age group

				95% confidence interval for mean		
	Mean	Standard deviation	Standard error	Lower limit	Upper limit	ANOVA
10-11	4.70	0.97	0.16	4.37	5.02	
12-13	4.59	0.89	0.11	4.37	4.81	
14-15	4.27	1.07	0.11	4.05	4.48	P=0.185
16-17	4.49	0.92	0.13	4.23	4.74	
Total	4.46	0.99	0.06	4.34	4.58	

With regard to shooting accuracy, there were significant differences in the time taken to carry out the test between the youngest and oldest age groups with the oldest group being the fastest in completing the test. On the other hand, the youngest group showed the greatest accuracy, revealing significant differences with the rest of the groups.

Table 4. Time taken in goal shooting test by age group

	Mean	Standard deviation	Standard error	95% confidence interval for mean		ANOVA
				Lower limit	Upper limit	
10-11 (1)	3.54	0.35	0.06	3.42	3.66	P=0.013 1-4
12-13 (2)	3.38	0.55	0.07	3.25	3.51	
14-15 (3)	3.33	0.42	0.04	3.24	3.41	
16-17 (4)	3.22	0.46	0.06	3.10	3.35	
Total	3.35	0.47	0.03	3.29	3.41	

Table 5. Shooting accuracy by age group

	Mean	Standard deviation	Standard error	95% confidence interval for mean		ANOVA
				Lower limit	Upper limit	
10-11 (1)	2.14	0.78	0.13	1.88	2.39	P=0.022 1-2;1-3; 1-4
12-13 (2)	1.72	0.85	0.10	1.51	1.92	
14-15 (3)	1.73	0.85	0.09	1.56	1.90	
16-17 (4)	1.61	0.91	0.13	1.35	1.86	
Total	1.76	0.86	0.05	1.65	1.87	

There were significant differences among the age groups in the time taken to complete each one of the sprints (except between the 14-15 and the 16-17 age groups). With regard to the fatigue index the average was 4.7% with no significant differences among the different age groups.

Figure 2. Time taken in RSA by age group

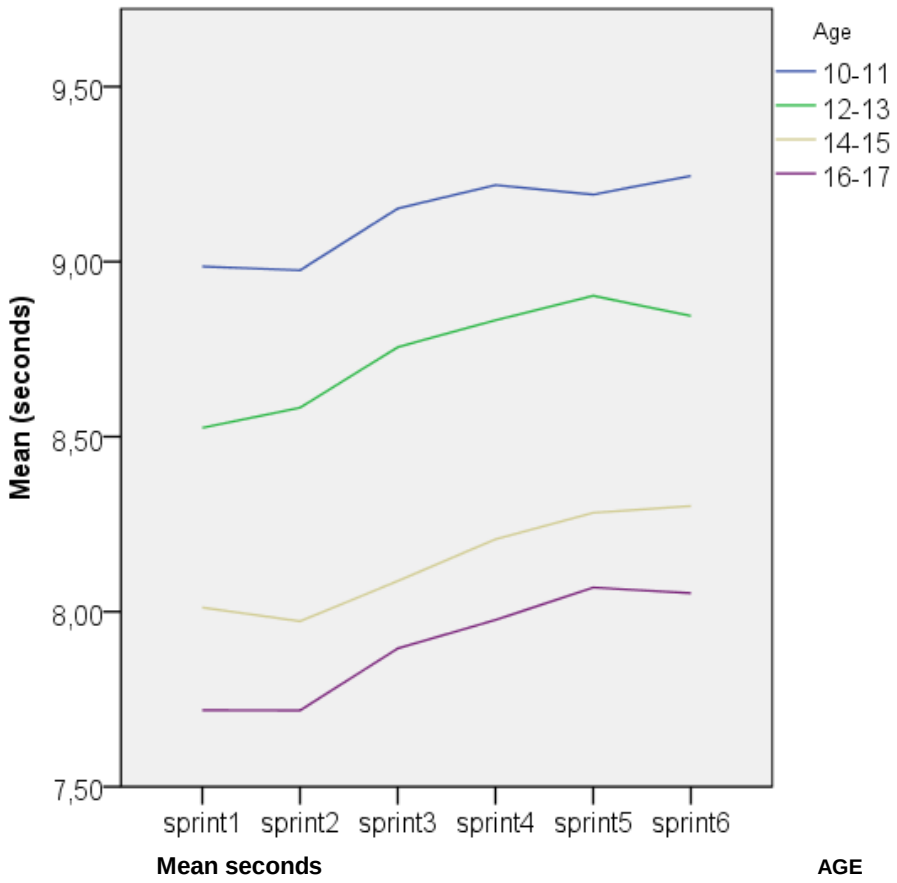

Table 6. Fatigue index (in percentage) by age group

	Mean	Standard deviation	Standard error	95% confidence interval for mean		ANOVA
				Lower limit	Upper limit	
10-11	4,58	2,45	0,41	3,74	5,42	
12-13	4,95	3,07	0,38	4,19	5,70	
14-15	4,62	2,38	0,24	4,14	5,10	P=0.840
16-17	4,54	3,21	0,44	3,65	5,44	
Total	4,69	2,76	0,17	4,34	5,03	

By playing position

No significant differences were found among playing positions in the CMJ (p=0.067), shooting accuracy (p=0.409), time in the shooting accuracy test (p=0.266) nor in the fatigue index (p=0.073). However, there were differences in the ball control test where the goalkeepers had a worse result than the rest of the groups. Similarly in the RSA, the goalkeepers had worse results than the right and left backs (sprints 2 to 6), forwards (sprints 3 to 6), centres (sprints 4

to 6) and wings (sprint 6). There were no significant differences among any of the rest of the groups in any of the tests.

Table 7. Jump (m) by playing position

Jump	N	Mean	Standard deviation	Standard error	95% confidence interval for mean		ANOVA
					Lower limit	Upper limit	
Goalkeeper	17	0.29	0.08	0.02	0.25	0.33	0.067
Centre Back	32	0.31	0.06	0.01	0.29	0.33	
Right/Left back	45	0.33	0.06	0.01	0.31	0.35	
Centre	75	0.30	0.06	0.01	0.29	0.32	
Wing	24	0.30	0.06	0.01	0.27	0.32	
Forward	57	0.31	0.06	0.01	0.30	0.33	
Total	250	0.31	0.06	0.00	0.30	0.32	

Table 8. Ball control (s) by playing position

Ball control	N	Mean	Standard deviation	Standard error	95% confidence interval for mean		ANOVA
					Lower limit	Upper limit	
Goalkeeper	17	5.49	1.11	0.27	4.92	6.06	0.000
Centre Back	32	4.61	0.55	0.10	4.42	4.81	
Right/Left back	45	4.43	0.62	0.09	4.25	4.62	Goalkeeper vs
Centre	75	4.61	0.85	0.10	4.41	4.80	Rest of the
Wing	24	4.31	0.46	0.09	4.12	4.51	groups
Forward	56	4.37	0.63	0.08	4.20	4.54	
Total	249	4.56	0.77	0.05	4.46	4.65	

Figure 3. Time taken in RSA by playing position

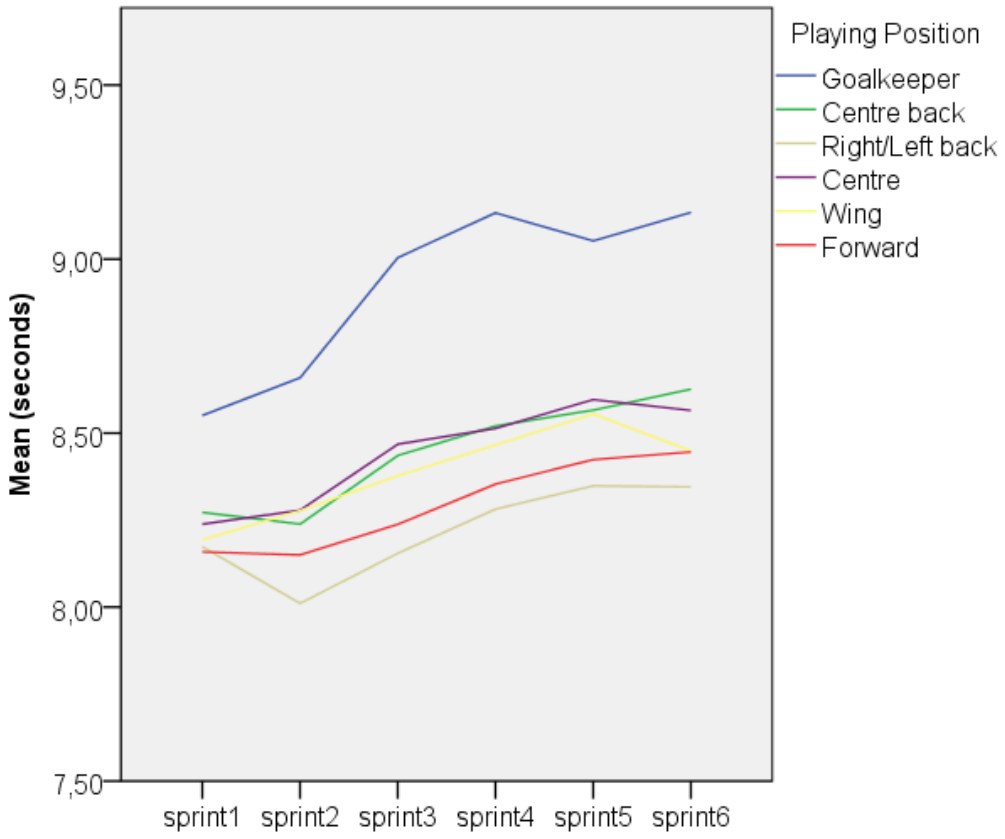

Table 9. Fatigue index (in percentage) by playing position

Fatigue Index	N	Mean	Standard deviation	Standard Error	95% confidence interval for mean		ANOVA
					Lower limit	Upper limit	
Goalkeeper	17	5.81	2.93	0.71	4.31	7.32	0.073
Centre Back	32	5.46	3.59	0.63	4.17	6.76	
Right/Left back	45	4.01	2.33	0.35	3.31	4.71	
Centre	75	4.29	2.78	0.32	3.64	4.94	
Wing	24	5.00	2.09	0.43	4.11	5.88	
Forward	57	4.82	2.60	0.35	4.12	5.51	
Total	250	4.68	2.76	0.18	4.34	5.03	

DISCUSSION

CMJ

The mean for all the players was 30 cm. If we consider the age groups, the players who jumped the highest were the older age groups (15-17 years). Significant differences could be observed among all the age groups ($p<0.05$), except between the 10-11 and 12-13 age groups. The mean for the 10-11 age group was 24 cm, 27 cm for the 12-13 age group, 31 cm for the 14-15 age group and 35 cm for the 16-17 age group. These data are lower than those found in the study by Casais et al. (2004) in infant, cadet and juvenile players.

With regard to the 16-17 age group, our data (35 cm) are a lot lower than those from another study carried out in Spain with 16 year old soccer players when a mean of 41 cm was recorded (Juárez, López de Subijana, De Antonio, & Navarro, 2009).

In the study by Mercé et al. (2004) with players from a soccer school with a mean age of 15 years, the result for the CMJ was 27 cm and therefore was lower than that recorded in the present study in the same age group (31 cm).

In the study by Carbonell et al. (2009), the mean CMJ result in 23 cadet players with a mean age of 14 years was 30.80 cm, a value which was also very similar to the one recorded in our study for the same age group: 31cm.

The differences with the data from other studies are basically due to the characteristics of the sample, the age and the level of specialization of the soccer players. The sample in the present study came from players who belonged to base level soccer schools, where training cycles are not established and whose specialization is less well developed than the players analyzed in other studies. In the study by Casáis et al. (2004) and the one by Juárez et al. (2009), the subjects were the top soccer players in their categories, which could explain the differences with the results of the present study. Furthermore, the data collection in the present study was carried out during the summer period, which may also have influenced the results as it was a period of rest from competitions.

With regard to the different playing positions, no significant differences were found in jump height among any of the positions analyzed, although the left and right backs were the players who jumped the highest (33 cm) and the goalkeepers the ones who jumped the lowest (28cm).

Ball control

With respect to the ball control test, the mean time for the 256 soccer players was 4.45 s. No significant differences were found in this test among the different

age groups. We could only find one other study which used the same test with the same protocol (Mercé, 2003; Mercé et al., 2004) with 55 players with a mean age of 15 years. Their mean time was 3.18 s and thus a better result than the one in the present study.

With reference to ball control among the different playing positions, significant differences ($p<0.05$) were only observed between the goalkeepers and the rest of the players. The goalkeepers were the slowest of all with a mean time of 5.4 s. The best times were recorded by the wings (4.31 s) and the forwards (4.37 s).

Shooting at goal

The mean time taken by the subjects up to the goal shot was 3.29 s and the accuracy mean value was 1.7 points. With regard to the time for the shot there were only significant differences between the 10-11 age group and the 16-17 age group. With respect to shooting accuracy the age group which was the most accurate was the 10-11 age group showing significant differences with all the other groups. The least accurate age group was the 16-17 one. This is due to the fact that the 10-11 age group shot with less power and aimed at the higher scoring goal areas. However, the 16-17 age group were more interested in power and for that reason showed less accuracy. This statement is the result of the direct observations of the group of researchers who were present during the tests. It is true that the older players covered the course prior to the goal shot at greater speed (see Figure 1). When the moment came to shoot their speed was not high, due to the need to dribble past the cone. The older players performed their shot at goal with greater power and aimed at the area which scored the most, while those of the younger ages aimed at the bottom of the goalposts which implied a lower score but an easier shot. Thus the older players ran the risk of making two shots with 0 points if they failed in their attempts.

When we compare these data among the different playing positions no significant differences are revealed either in time taken or in shot accuracy.

RSA

In a study of elite soccer players (Impellizzeri et al., 2008), the players obtained a mean time of 7.2 s in this test. The mean for all the sprints in our players was 8.39 s. If we only consider the oldest players, we can see that there was not a large difference as they revealed a mean of 7.90 s. This coincides with the assertions of Impellizeri et al. (2008) and Ferrari Bravo et al. (2007), when they say that professional soccer players record faster times in the RSA than amateurs.

The increase in time from the first to the last sprint in all players was 0.29 s. These data are similar to those found in previous studies using the RSA by

(Bishop & Edge, 2006; Edge, Bishop, Hill-Haas, Dawson, & Goodman, 2006; Glaister et al., 2006; Heredia, Chirosa, Roldá, & Chirosa, 2009).

There were significant differences among the age groups in the time taken for each of the sprints (except between the 14-15 and the 16-17 age groups). The fastest in all the sprints were the players in the oldest age group: the mean for all the sprints in the 10-11 years ago group was 8.05 s and the mean was 7.1 s for the 16-17 age group, in accordance with their greater physical development. Therefore older players showed greater speed without (RSA) and with the ball (the approach in the goal shot).

With regard to playing position significant differences were only found between the goalkeeper and the rest of the positions in the last 4 sprints. In the study by Ferrari Bravo et al. (2007) significant differences were observed among the playing positions, with the left and right backs and midfielders recording better times in the RSA than the centres (7.20 v 7.38 s respectively). Although in the present study no significant differences were observed, the positions with the best times in the RSA were the forwards, wings and left and right backs. In the same way, in the study by Kaplan (2010) there were no significant differences among positions in the mean time or in the best time for the RSA.

In relation to the fatigue index, the mean was 4.7% without any significant differences among the age groups. These data are lower than those found by other authors like Dawson, Fitzsimons and Ward (1993) and Fitzsimons et al. (1993) in which they used a protocol of 6 × 40 m with a rest period of 30 s and obtained means for the IF (Fatigue index) of 5.6 ± 2.7 y 5.3 ± 2.0, respectively. This is because the sample in these studies was made up of professional soccer players, not like the one in the present study where the fatigue index was lower but the sprints were slower. As indicated by Wadley and Le Rossignol (1998) the subjects who do the fastest prints are the ones who record the highest fatigue index. This is because the subjects who do a fast sprint are those who record the highest fatigue index due to the fact that they are able to deplete all their deposits of phosphocreatine (PCr) unlike slower subjects. As the recovery time between sprints is so short the former cannot resynthesize the PCr and begin the subsequent sprints with lower PCr reserves thus raising their level of fatigue. That is to say that the subjects who record the slower sprints have a lower IF (Fatigue Index). Therefore according to Wadley and Le Rossignol (1998) the slower subjects (slower sprint times) do not totally replete their PCr reserves and can perform the next sprint without decreasing their performance, as their deposits of PCr have been largely restored during the recovery time.

With respect to the fatigue index and playing position, no significant differences were found; however the players who recorded a greater fatigue index and therefore the largest decrease in speed between the first and the last sprint were the goalkeepers (5.8%) and the centre backs (5.4%). On the contrary, the right and left backs had the lowest fatigue index (4%). These players as previously mentioned were the highest jumpers and the fastest runners in their

mean time per sprint in the RSA which confirms the relation between explosive strength and speed. Corroborating these data, Kaplan (2010), did not find significant differences in the fatigue index among the different playing positions.

CONCLUSIONS

The most important conclusions of the study are:

- Significant differences have been found in terms of age in the different physical and technical tests analyzed, with the exception of ball control.
- No significant differences were found with regard to playing position, with the exception of the goalkeepers.

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