Evaluation of the maximum speed in a 30-metre sprint among young Argentine football players

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Summary

Introduction: the objective of this study was to compare in young federated soccer players, the speed in a sprint of 30 meters in different ages. The times used in two phases were also compared (0 to 10 meters and 10 to 30 meters) was analyzed according to age.
Material and method: 505 male soccer players were measured with the 30-meter test, in an age range between 11,0 and 16,9 years. They were divided into 5 groups per chronological age. Anthropometric measurements (body weight and size) were analyzed. To measure the 30-meter test, three pairs of infrared synchronizations beam lamps (photocells) placed at; 0,0 m, 10,0m and 30,0 m from the starting line.
Results: group 1 (11 years) traveled the distance of 30 meters in 5,48±0,36 s, group 2 (12 years) in 5,17±0,42 s, group 3 (13 years) in 4,94±0,44 s, group 4 (14 years) in 4,64±0,29 s, group 5 (15 years) in 4,56±0,28 s, and group 6 (16 years) in 4,42±0,22 s.
Conclusion: The older youth, on average, traveled the distance of 30 meters in less time, although they only varied significantly between 11,5 and 14,5 years (p>0,01). During the segment o to 10m, the same trend was also observed, being significantly at all ages, except for 12,5 years (p>0,01).

Key words:
Sprint. Anaerobic power. Children. Field test. Soccer.

Evaluación de la velocidad máxima en un esprint de 30 metros en jóvenes futbolistas argentinos

Resumen

Introducción: El objetivo de este estudio fue comparar en jóvenes futbolistas federados, la velocidad en un esprint de 30 metros en diferentes edades. También se compararon los tiempos empleados en dos fases (segmentos 0 a 10 metros y 10 a 30 metros), de acuerdo a la edad.
Material y método: 505 futbolistas masculinos fueron medidos con el test de 30 metros, en un rango de edades entre 11,0 y 16,9 años. Fueron divididos en 5 grupos de acuerdo a la edad cronológica. Se realizaron mediciones antropométricas (peso corporal y talla parada). Para medir el test de 30 metros se utilizaron tres pares de lámparas de haz de sincronización por infrarrojos (fotocélulas) colocadas a; 0,0 m, 10,0 m y 30,0 m de la línea de salida.
Resultados: El grupo 1 (11 años) recorrió la distancia de 30 metros en 5,48±0,36 s, el grupo 2 (12 años) en 5,17±0,42 s, el grupo 3 (13 años) en 4,94±0,44 s, el grupo 4 (14 años) en 4,64±0,29 s, el grupo 5 (15 años) en 4,56±0,28 s, y el grupo 6 (16 años) en 4,42±0,22 s.
Conclusión: Los jóvenes de mayor edad, en promedio, recorrieron la distancia de 30 metros en menor tiempo, aunque solo variaron significativamente entre los 11,5 a 14,5 años (p>0.01). Durante el segmento 0 a 10 m, también se observó la misma tendencia, siendo significativamente en todas las edades, a excepción la de 12,5 años (p>0,01).

Palabras clave:
Esprint. Potencia anaeróbica. Niños. Prueba de campo. Fútbol.

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Introduction

During a football game, players cover an average distance of 10,000 to 12,000 metres, depending on the position they play.[1] These distances are classified, depending on the displacement speed. Speeds over 23 km·h^{-1} are known as a "sprint".[1] During a sprint, a player covers a distance of 20 metres, accumulating a total between 200 and 400 metres.[1,2]

Although, when compared to the total distance covered in a match, these actions only represent 5% on average, sprints play an important role. Faude *et al*[3] looked at the German league and observed that, out of 360 goals, 60% were the result of linear sprints, 9% came from a sprint with changes in direction, 22% from a jump, and only 8% from other types of actions, concluding that sprints play an important role.[3] According to this study, 69% of goals involved a sprint. For this very reason, physical trainers assess, monitor and train this quality in their athletes.[4-6]

One simple way of evaluating a sprint is to measure the time taken to run in a straight line, at the maximum speed that the players can reach.[7] The devices used are photocells or a video camera. In general, these distances are between 30 and 50 metres.[7,8] These distances are used to assess two phases: a first phase known as acceleration speed (AS) and another known as maximum speed (MS).[9] According to the bibliography, the distances to cover in each of the aforementioned phases can vary.[4-11] Distances of 5, 10, 15 and 20 metres are used to evaluate the AS, while distances over 20 metres are used to assess the MS.[4-11] Another way of pinpointing the MS is to use several photocells (or a video camera) to measure the time taken in several 10-metre segments.[11] For instance, after measuring a 40-metre sprint, the average is calculated for the time taken in each segment, 0-10, 10-20, 20-30 and 30-40 metres, and the MS is located in one of the segments (generally the 20-30 or 30-40 segment[11]). This method is widely used nowadays.[11] Buchheit *et al*[11] worked with trained football players to demonstrate that 70% of boys aged under 14 years old reached the MS in the 20-30 m segment, and 30% achieved it in the 30-40 m segment.[11] However, between 15 and 18 years old, 60% reached the MS in the 30-40 m segment and 40% in the 20-30 m segment.[11] Consequently, it is important to monitor this quality during the training period.

Football is one of the most widely-played sports in Argentina.[12] Although it is widely known that physical trainers assess and train this skill, it is difficult to find studies run on young Argentine players. Consequently, the aim of this study was to compare the time taken in the 30 m test for males aged between 11.0 and 16.9 who took an active part in federated football in Neuquén. The second aim was to observe the relationship between the two phases being measured: the 0-10 m segment and the 10-30 m segment, by age. This knowledge will provide useful information for trainers to assess and monitor progress among their athletes in the training stages.

Material and method

Study Design

The study was carried out in the facilities of each club involved, in September and October. The measurements were taken in training hours, between 3 and 5 pm. In all the measurements, the subjects wore sports clothing (shorts, t-shirt and boots). The field assessments took place on the playing field. The subjects did not do intense physical exercise 48 hours before the assessments.

Subjects

The sample was made up of 505 males. All subjects were federated football players belonging to Alto Valle de Río Negro and Neuquén and they were in the playing season (tournament). Subjects were only included if they met the following characteristics: a) have taken part in the activity for at least 6 months; b) no neuromuscular and/or cardiorespiratory injury; c) aged over 11.0 years old and under 17.0 years old; d) have experience in speed tests and e) experience in speed training. The study was clearly explained to all subjects, including the risks and benefits of taking part. Informed consent was obtained from their parents because they were minors. Furthermore, the study was endorsed and approved by LIFUNE (Neuquén football league). For analysis, they were divided into 6 groups, according to their decimal age: group 1 (between 11.0-11.9 years old), group 2 (between 12.0-12.9 years old), group 3 (between 13.0-13.9 years old), group 4 (between 14.0-14.9 years old), group 5 (between 15.0-15.9 years old) and group 6 (between 16.0-16.9 years old).

Assessments

Anthropometry: Body mass (BM) and foot size (FS) were measured. The measurements were taken, according to the International Society for Kinanthropometry Progress (ISAK)[13]. The Body Mass Index (BMI kg/ m^2) was calculated by dividing the body weight of the subject by their height expressed in square metres.

Equipment

Three pairs of infrared synchronised beams (Winlaborat equipment with a sampling speed of 14 us of photocells and software sampling rate of 1,000 Hz, Argentina) were used with a beam height of 0.9 m from the ground. They were placed 0.0 m, 10.0 m and 30.0 m from the start line. The terrain used for the tests was grass and all the subjects wore football boots.

Procedures

Following the anthropometric measurements, participants completed a general warm-up consisting of 10 minutes of light jogging and dynamic stretching. This was followed by a warm-up with specific exercises for the speed test.

The subjects lined up behind the start line and the initial light beam to avoid any odd premature movement breaking the beam at 50 cm. The position was held with one foot forward and the other behind (Split start) as recommended in the bibliography.[10] On the command of "go", the subjects began to run. They were instructed to run as fast as possible over a distance of 30 metres. The speed was measured with an accuracy of 0.01 seconds, taking the fastest speed of the two attempts. Between attempts, the subjects rested between 5 and 7 minutes.

The distances of 10 m and 30 m were shown to be valid[16] and reliable[17] (r= 0.90 and 0.95), as was the technical measuring error (1.3% and 0.5%), respectively.[18]

Statistical analysis

The data was analysed using the IBM SPSS 18.0 statistics package. The Kolmogorov-Smirnov test and the Levene test checked for the presence of normality and homoscedasticity in the study sample. Descriptive statistics were subsequently applied to calculate the frequencies, mean and standard deviation, maximum and minimum value. The ANOVA one way test was used to determine the statistically significant differences between the BM, FS, BMI and the time taken in the 30-metre test. The Scheffé test was applied to find the difference between the average of the groups. The ratio between the various speed phases was calculated using the Pearson correlation coefficient, with the following criteria: 0.1 very low; 0.1-0.3, low; 0.3-0.5, moderate; 0.5-0.7, good; 0.7-0.9, very good; and 0.9-1.0, perfect.[14] In all cases, an alpha $p<0.05$ was accepted.

Results

Table 1 shows the anthropometric characteristics of the samples distributed by ages and the time used in the 30-metre test.

Differences were found between the groups in the anthropometric measurements.

The MC for group 1 was significantly lower than groups 3, 4, 5 and 6. Group 2 was significantly lower than groups 4, 5 and 6. Group 3 was significantly lower than groups 5 and 6. No difference in BM was observed between groups 4, 5 and 6.

The FS for group 1 was significantly lower than all groups. Group 2 was significantly lower than groups 3, 4, 5 and 6 and higher than group 1. Group 3 was significantly lower than groups 4, 5 and 6 and higher than groups 1 and 2. No difference in FS was observed between groups 4, 5 and 6.

Concerning BMI, the only statistically significant difference was between groups 1 and 6.

Figure 1 shows the times taken in the section from 0.0 to 10.0 meters (A), the section from 10.0 to 30.0 metres (B) and the section from 0.0 to 30.0 metres in the different groups.

Table 2 shows the correlations obtained in the different phases of the 30-metre sprint.

Figure 2 shows the percentage representation of the maximum speed achieved in each group, taking the oldest group as a reference. The curves correspond to the maximum speed in both segments (0-10 m and 10-30 m).

Table 3 is constructed by using the following quartiles, where the 0-25 quartile is low performance, 26-50 is low-moderate performance, 51-75 is moderate-high performance and 76-100 is high performance. This table aims to give the physical trainer some reference points to assess their athletes.

Discussion

For the first time, a large number of young Patagonian footballers were measured using the 30-metre test, in both segments: acceleration speed (0-10m) and maximum speed (10-30m).

According to the results obtained, the older subjects, on average, cover the 30 m distance in less time, although they only vary significantly

Table 2. Correlations between the two 30-metre sprint phases, in the different age groups.

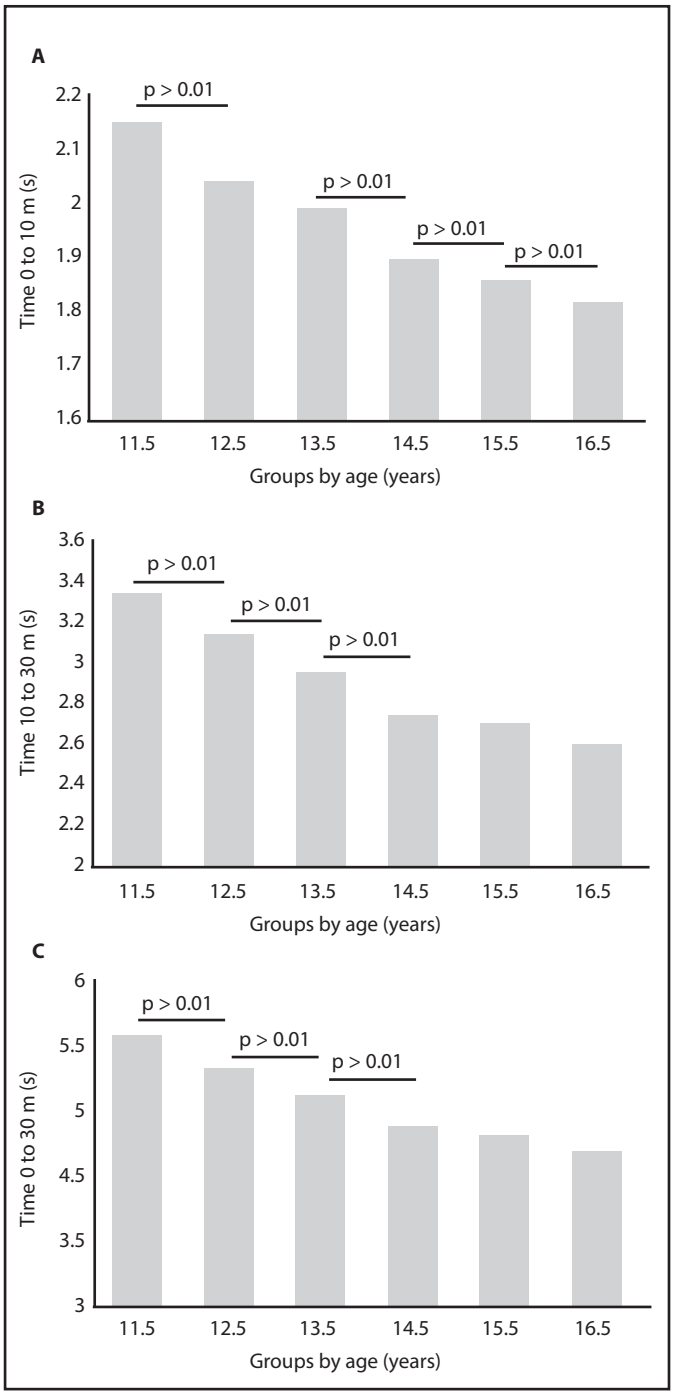
Groups	Phases	10-30 m	0-30 m
11 to 11.9 years old	0-10 m	r = 0.83	r = 0.92
12 to 12.9 years old	0-10 m	r = 0.74	r = 0.88
13 to 13.9 years old	0-10 m	r = 0.78	r = 0.91
14 to 14.9 years old	0-10 m	r = 0.65	r = 0.86
15 to 15.9 years old	0-10 m	r = 0.68	r = 0.88
16 to 16.9 years old	0-10 m	r = 0.48	r = 0.77

Table 1. Anthropometric characteristics of the young players and the time taken in the 30-metre test.

Units Sample	Age (years)	BM (Kg)	FS (cm)	BMI (kg·m²)	Time taken (s)			Speed (km/h) *		
					0 to 10 m	10 to 30 m	0 to 30 m	0 to 10 m	10 to 30 m	0 to 30 m
G1 (n=28)	11.5± 0.3	44.3;12.1	148.1;7.6	19.8± 3.7	2.15;0.13	3.33;0.25	5.48;0.36	16.8;1.0	21.7;1.6	19.7;1.2
G2 (n=106)	12.5;0.3	49.4;10.2	155.2± 9.0	20.4± 3.3	2.04;0.16	3.13;0.29	5.17;0.42	17.7;1.4	23.2;2.0	21.0;1.7
G3 (n=138)	13.4;0.3	53.8;11.9	161.5± 8.7	20.4± 3.4	1.99;0.16	2.95;0.30	4.94;0.44	18.2;1.5	24.6;2.4	22.0;1.9
G4 (n=85)	14.5;0.3	59.7;10.7	168.6± 7.0	21.0± 2.9	1.90;0.13	2.74;0.20	4.64;0.29	19.0;1.3	26.4;1.8	23.3;1.4
G5 (n=81)	15.6;0.3	63.7;12.7	170.9± 6.4	21.5± 3.9	1.86;0.12	2.70;0.18	4.56;0.28	19.5;1.3	26.9;1.7	23.9;1.4
G6 (n=67)	16.4;0.3	63.8;7.8	171.0± 6.3	21.9± 2.5	1.82;0.10	2.60;0.16	4.42;0.22	19.7;1.0	27.5;1.6	24.3;1.2

BM: Body mass FS: foot size in bare feet. BMI: body mass index. m: metres. s: seconds
*The speed was calculated; distance/time used.

Figure 1. Time taken in the different segments according to age, A: 0-10 m segment; B: 10-30 m segment; C: 0-30 m segment.



between 11.5 and 14.5 years old (p>0.01). This finding is similar to other studies. Mathisen and Pettersen applied a 20-metre sprint in young players aged between 10 and 16 years old.[15] They compared the times used by each age group in the segments: 0-20 m, 0-10 m, and 10-20 m. As age increased, the time used fell significantly in all segments.

Bucheitt *et al*[11] applied a 40-metre sprint among young players aged between 13 and 18 years old.[4] Between groups, they compared the

Figure 2. Evolution of the speed, according to age.

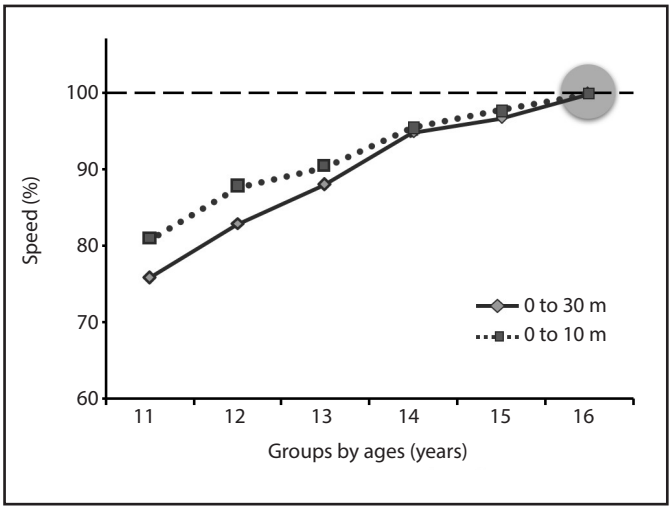
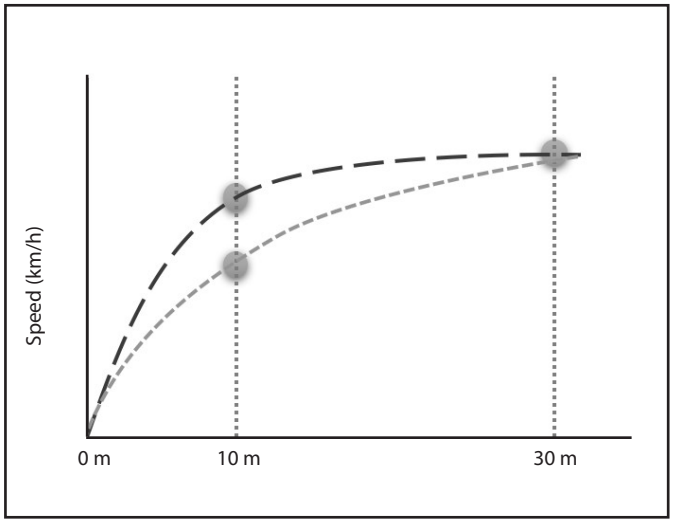


Figure 3. Example of the two study cases, that take the same time over 30 metres, but different times in the 0-10m segment.



acceleration speed (0-10 m segment) and the maximum speed (locating it in one of the other segments (10-20, 20-30 and 30-40). As the players' age rose, the time used fell in both phases; acceleration and maximum, although they were significant between 13 and 15 years old. Meyers *et al* assessed the maximum speed with a 30-metre sprint among school children aged between 11 and 15 years old.[18] In the same way as other studies, they found that, as the age increased, the speed was greater between the groups, although this was only significant between 11 and 14 years old. The differences were attributed to the length of the stride, the frequency of steps and the contact time with the ground, ruling out the flight time as no differences were seen in any group.

To get a better understanding of the discrepancies found between the ages, Figure 2 shows the differences expressed as a percentage, tak-

Table 3. Proposal to assess the performance in the 2 segments of the 30-metre sprint.

Age (years)	Time taken from 0 to 10 metres (s) Low	Low-Mod	Mod-High	High
11	≥ 2.24	2.23 - 2.14	2.13 - 2.09	≤ 2.08
12	≥ 2.15	2.14 - 2.03	2.02 - 1.93	≤ 1.92
13	≥ 2.10	2.09 - 1.98	1.97 - 1.89	≤ 1.88
14	≥ 2.0	1.99 - 1.90	1.90 - 1.83	≤ 1.82
15	≥ 1.93	1.92 - 1.85	1.84 - 1.77	≤ 1.76
16	≥ 1.90	1.89 - 1.84	1.83 - 1.78	≤ 1.77
Age (years)	**Time taken from 10 to 30 metres (s) Low**	**Low-Mod**	**Mod-High**	**High**
11	≥ 3.49	3.48 - 3.32	3.31 - 3.17	≤ 3.16
12	≥ 3.30	3.29 - 3.09	3.08 - 2.94	≤ 2.93
13	≥ 3.10	3.09 - 2.92	2.91 - 2.76	≤ 2.75
14	≥ 2.84	2.83 - 2.71	2.70 - 2.61	≤ 2.60
15	≥ 2.79	2.78 - 2.67	2.66 - 2.56	≤ 2.55
16	≥ 2.71	2.70 - 2.60	2.59 - 2.53	≤ 2.52

ing the speed obtained by the oldest group (group 6) as the reference value (100%). The speed achieved over the 30 metres by the 15-year-old group represents 96.8%, the 14-year-old group 95.0%, the 13-year-old group 88.2%, the 12-year-old group 83.0% and the 11-year-old group 76.5%. This same trend is seen for values measured in the 0.0 to 10.0 metre segment (AS): for the 15-year-old group it represents 97.8%, the 14-year-old group 95.6%, the 13-year-old group 90.6%, the 12-year-old group 87.0% and the 11-year-old group 81.2%. Papaiakovou *et al*[19] found similar percentages to our study among school children.19 The authors found that among 11-year-old children, the speed obtained in the 0-30 metre segment represented 85% of the speed of the 18-year-olds, and this increased, reaching 98% in 16-year-olds and 100% among 18-year-olds. To sum up, as the boys grow, the time they take to complete both phases of the test drops, because they are maturing biologically: their muscle mass increases, their fat tissue drops, their muscular strength increases, their male hormones rise, the length of their stride increases, their jumping height increases and the jump becomes longer, their mechanical efficiency improves, among other aspects, even when they are not in a training programme.[6,18,20-26] Therefore, if the point is to monitor and/or improve speed in training stages, the physical trainer should consider other variables as a whole for a correct comprehensive interpretation of their athletes' performance.

Another point to be discussed concerns the correlations obtained between the 0-10 and 0-30 m segments. The boys who are the fastest over the first 10 metres are also the fastest over 30 metres (range between r=0.92 and r=0.77). However, this does not happen when correlating the segments separately, 0-10 and 10-30. The correlation drops considerably (from r=0.83 to r=0.48) as the boys grow. The fastest subject over the first 10 metres is not necessarily the fastest over the 10-30 m segment. One of the reasons is each player's capacity for acceleration and the peak time in which the maximum running speed is reached in this segment.[6] The less time their foot is on the ground, the shorter the time they take to cover the first 10 metres.[6] To understand this concept better, Figure 3 presents 2 cases that obtain the same final speed over 30 metres, although they accelerate differently. This is the main reason why there is a strong relationship between the measured segments.

As opposed to athletics, in this sport it is important to know the football players' ability to accelerate over short distances, as most plays are resolved over distances under 30 metres.[1,2,6] Consequently Anselmi6 proposes filming the first 3 steps during the assessment with the photocells or, as far as possible, filming all the steps in the 0-10 metre segment.[6] This would differentiate the 10-metre segment better.

To round off, we would like to highlight two limitations: 1) no biological maturing was assessed (Tanner stages) and 2) the players' positions were not differentiated. Although this can influence the outcomes, the football federations and associations organise categories by chronological age, and so this is the real-life situation for the physical trainers. Future research must confirm the results obtained among football players from other regions or provinces.

Conclusions

The older boys, on average, cover the 30-metre distance in less time, although they only vary significantly between 11.5 and 14.5 years old (p>0.01). During the acceleration phase (0 to 10 m), the same trend was seen, significant in all ages, with the exception of 12.5 years old (p>0.01).

Practical application

Table 3 can be used to assess both speed phases, in populations that meet similar characteristics.

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Conflict of interest

The authors do not declare any conflict of interests.

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