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Original Article

Anthropometric characteristic and running parameters: speed performance of children

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Abstract:
This contribution deals with speed abilities of the pupils in short-distance runs in athletics. In scientific literature there are lots of studies that analyze speed performance in adults. These studies showed the correlation between speed and anthropometric measurements and between performance and indicators of speed (acceleration, frequency and length of steps). The aim of our study was the description of speed performance about children to verify similar relation as found in adults. We investigated speed abilities using the 50 m sprint test with standing start. The sample of subject consisted of 90 male and female pupils (45 male and 45 female) aged between 6 and 8 years old: beginner in athletic practice. We analyze performance with chronometers and photocells and we collected for each subject the anthropometric measurements (weight, height, torso and lower limb length), total time, intercepts every 10 meters and frequency of the step every 10 meters. The Anova 1 Way and Tukey-Kramer post hoc test was used to verify if the results were statistically significant among intercepts. In general, boys run faster than girl, total time decrease as the age increase and the interpretation and management of the effort in sprint change in the different age. Furthermore, the correlation between speed and anthropometric measurements were not always verified and the 20 meter cut-off was the general point where the run decreased. In conclusion, the performance in children could be improved using technical exercises about the support phases and educational approach to extend the effort.
Key words: children, speed, sprint.

Introduction

The sprint performance is defined as a cyclical motor activity that consists in the rapid repetition of steps and is determined by the capacity of acceleration and the ability to maintain the maximal reached speed (Babic & Blažević, 2011). Indeed, from a technical point of view the speed decreases in the second half of the path (Maćkała, 2015) while high mean frequency steps (Marchall, 2004) positively affects the performance (Paruzel-Dyja et al., 2006).

Moreover, other studies evaluated the influences of anthropometric measurements: for example, Majumdar & Robergs (2011) showed that taller men were faster than the smallest peers while the fastest women were shorter and with high value of BMI. These evaluations are very useful for trainers but similar information are lacking in case of young sprinter and, in particular, if they are children in full growing path.

Indeed, the anthropometric characteristics in this period of life change in rapid succession (Stratz et al., 2004) and affect the motor request and the general arrangement of coordinative skill: this is very strong in the case of sprint performance of growing children.

Thus, the aim of this study was the analysis of sprint (speed, step frequency/step length) in primary school students according to their anthropometric measurements to provide useful information for Physical Education teacher/trainer during their didactic decision or when implicated in sport promotion.

Materials and methods

Participants

The subjects of this study were 90 children (45 boys and 45 girls) aged between 6 to 8 years freely recruited (n= 15 for each group of age) in starting athletic classes during physical education curricula. All children were healthy where "Healthy" was defined as having no history of any illness considered likely to affect growth on the basis of the reported medical information (overall, neurologic and/or orthopedic affection).

Informed consent from the parents (legal guardian) was obtained before data collection while all children confirmed their participation and could interrupt the participation to the study at any time. All procedures were conducted in accordance with the ethical standards presented in the Declaration of Helsinky as revised in 1983 and permission was granted by the dean of the primary school (drlo-1617-4) where the PE teacher carried out all phases of the protocol.

Procedure

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Anthropometric measurements of height and weight were taken according to the standard procedures described by the International Society for the Advancement of Kinanthropometry (Clarys et al., 2006). Height was measured with a stadiometer to the nearest 0.1 centimeter (cm) while the weight was measured to the nearest 0.1 kilogram (kg) with an electronic scale. In particular BMI was calculated with the equation BMI= mass(kg)/height^2(m^2).

Moreover, other measurements about lower limbs and trunk were collected to obtain additional parameters to define the growing path of children. These last measures were the distance between the seventh cervical vertebra (C7) and the fifth lumbar's (L5) as an indicator of body growth and the lengths between the great trochanter (GT) and the lateral malleolus (LM) and between the head of fibula (F) and LM as the references for lower limbs.

After the anthropometric measurements, all subjects were assessed during a speed 50 meters long performance. Before the test all subjects followed 15 minutes of warm up (low pace running, hopping and technical mobility exercises).

All subjects performed the sprint individually on a official athletics track (www.iaaf.org) in the same condition: acoustic signal with whistle, start position in standing arrangement (as prescribed by the international rules for this age class; www.iaaf.org) while four marks were fixed on the ground (10 meters of distance between each other). The teacher asked to children to perform their best while the time was detected by 1/10s accuracy chronometer (ONstart 310, Geonaute) while an independent operator recorded the sprint performance with Canon Legria HF-G25 to better define, in post-vision, the total time, the five intercepts time and then the relative step frequency/amplitude.

Data analysis / Statistical analysis

The anthropometric characteristic and the results of the test were stratified according to age (6, 7 and 8 years) and sex. The data were presented with descriptive statistic (mean and SD) while the relations between anthropometric measurements and intercept and total time were calculated with Pearson correlation. The 1-way Anova was applied to verified, within sex, significant differences among the three-different class of age (6, 7 and 8 years) about the total time and among the performance collected at each five intercepts. The Tukey-Kramer Test (post hoc analysis) was, eventually, performed to locate the pair-wise differences. The significance level was, at priori, set to 5%.

Results

In general, girls improved of 6 cm between 6 and 7 years and 9 cm between the next year while the weight increased of 4 kg every year (tab.1). In particular, the total gain was reached with similar growth path between upper body (column; 1.5 cm for year) and lower limb (2 cm for year). The boys, instead, growth of 5 cm between 6 and 7 years while in the next year of 9 cm. The weight increased of 3 kg every year (tab. 1) while the column increased in total of 2.5 cm in the similar way of lower limbs (3 cm). In general, all children were classified in normal weight category as proposed by Cole et al. (2000; 2007).

Table 1: Anthropometric characteristic

Age	Sex	Height (cm)	Weight (kg)	BMI (kg/m^2)	C7-L5 (cm)	GT-LM (cm)	F-LM (cm)
6	M	121.3 ± 3.7	26.07 ± 6.5	17.56 ±1.4	33.47±2.17	54.13±5.45	24.67±2.19
	F	117.8±6.1	22.7±3.8	16.5±2.1	31.80±2.00	57.13±4.03	26.07±1.9
7	M	126± 4.6	29.35 ± 4.4	18.53 ±3.1	34.67±2.19	57.67±3.96	26.73±2.19
	F	124±5.1	26.9±4.4	17.4±2.3	33.47±2.31	58.87±3.6	26.93±1.83
8	M	134.1±9.2	31.97 ± 4.4	17.56 ±3.9	36.67±1.95	61.67±4.15	28.27±1.79
	F	133.7±4.0	31.5±4.6	17.5±2.0	36.07±1.94	61±3.11	28.93±1.44

Considering the sprint performance at the first fraction the speed was similar between sex and age group (fig.1 and 2). In general, within girls, seven and eight years old groups were similar while the boys revealed better performance in the oldest group.

In general, 6-year boys increased their own speed only on the second fraction (20m), 7-year boys up to 30m while 8-year boys showed a trend similar to adult athlets (they increase the speed up to 40m; fig. 2). Instead for girls, 6 and 7-years increase speed up to 20 meters while 8-years increase up to 30 meters, in the oldest group the decreament of speed is less than the others (fig. 1).

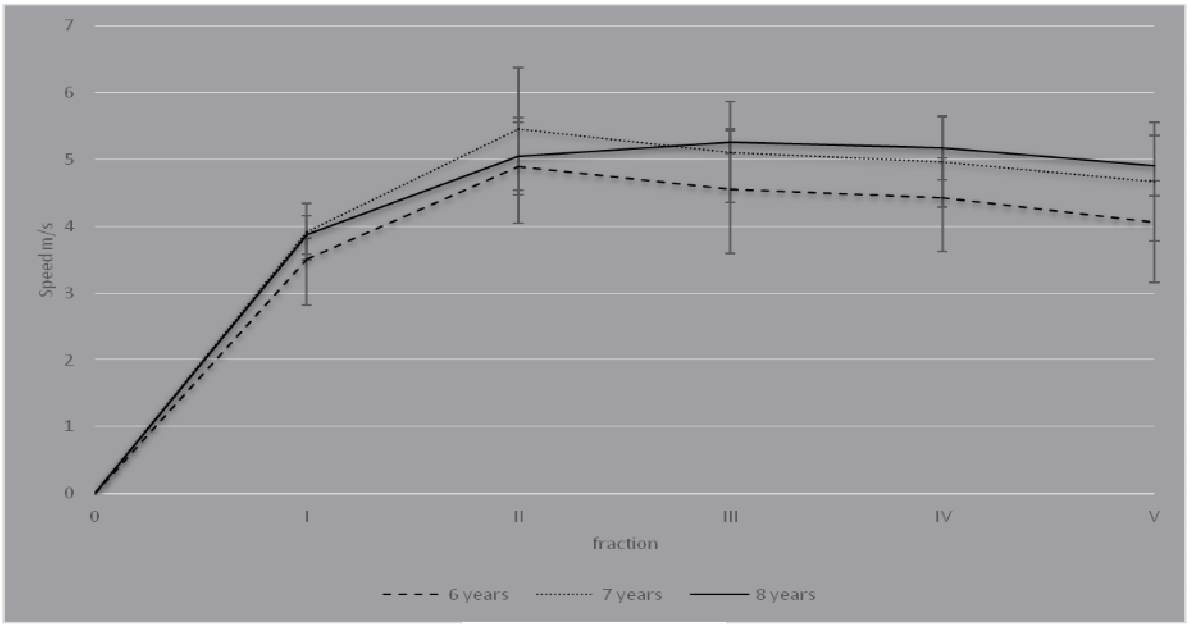

Fig.1. Girls performance

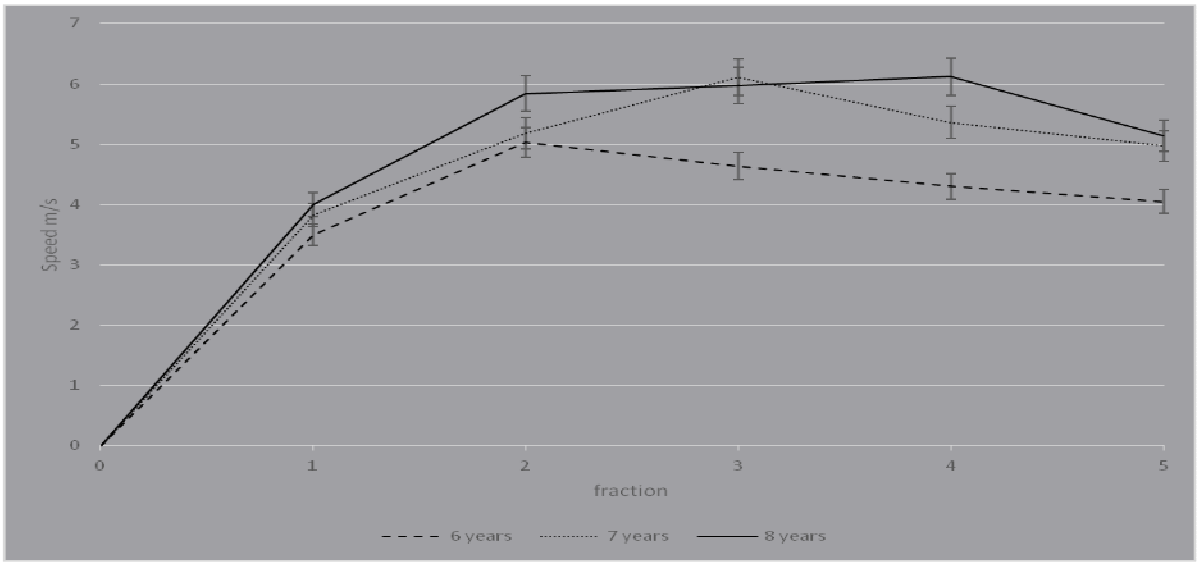

Fig.2. Boys performance

In particular, the One Way Anova among the total time obtained by the boys was significative where the Tukey Kramer post hoc test showed difference between six-year boys (12.31s) and other two groups (none differences between seven and eight years group: results close to 9.90 sec.). The girls, instead, revealed that eight years old group was the fastest (10.51s) while the six years's was the lowest (12.09s). Considering, the fraction within age class, the One Way Anova and the subsequent post hoc analysis revealed significant differences in all comparison except for the last two fraction of the 6 years old boys. For the girls, the significant differences was in the last fraction of the six years old. On average, in the first fraction the boys reached an acceleration of 41.7% while the girls of 37%. The speeds achieved by males and females in the various intervals are showed in table 2 where eight years boys and seven years female showed the best results.

Table 2. Speed on each intercepts for boys and girls

		Speed(m/s)				
		fraction				
Age	Sex	0-10	10-20	20-30	30-40	40-50
6	M	3.50	5.03	4.64	4.30	4.05
	F	3.50	4.89	4.55	4.43	4.05
7	M	3.83	5.18	6.11	5.36	4.97
	F	3.92	5.46	5.11	4.97	4.67
8	M	4.00	5.84	5.97	6.12	5.14
	F	3.87	5.05	5.26	5.17	4.91

The highest value of steps frequency, instead, were reached on 20m by the seven years old boys and by six years old female (table 3).

Table 3. Steps frequency determined in post vision on each intercepts for boys and girls

		Frequency (Hz)				
		Fraction				
Age	Sex	0-10	10-20	20-30	30-40	40-50
6	F	3.55	4.49	3.85	3.70	4.06
	M	3.40	4.15	3.92	3.95	4.09
7	F	3.55	4.23	4.44	4.17	4.28
	M	3.46	4.19	3.78	3.83	4.09
8	F	3.38	4.39	4.05	4.18	4.09
	M	3.20	3.53	3.72	3.60	3.79

No significative correlation were found between anthropometric characteristics and performance data.

Discussion

This study tried to describe the speed evolution during 50m sprint performance in children. Indeed, the author considered this period very important to better define the skill coordination that is affected by the natural growing. Our first outcome revealed that the period between seven and eight years where we verified an important increasement of the lower limb correspond to the best performance in children. Indeed, as demonstrated in adults (Paruzel-Dyja, 2008; Maćkała, 2013) when the pick of height depended on the evolution of the column (C7-L5 length) the speed decreased. This event, indeed, could be consider one of the phenomenon that negatively affects the performance from a skill point of view. The second consideration regarded lack of correlation between performance and anthropometric measurements: this statement suggests that hypothesis on the performance are hard to define because the anthropometric characteristics are in constant evolution and positive results could be disregarded in a brief period. In general, as showed in adults (Korhonen, 2003; Maćkała, 2007) and youth (Čović et al., 2015), the speed performance drops in the last meters of the sprint but this occurred after the 20m (excluding the eight years old boys that decreased after the 30m; Hiroyuki et al. 2011). These interpretations of the performance suggest an hardous but important aim in our didactic proposal: the modulation of the effort along all the path. Indeed, the velocity peak coincided with the frequency peak that is not a effective athletic modulation. Thus, the stimulation of the acceleration until the 25-30m become an important strategic task to reach. From a technical pint of view, we could suggest motor task focused on run technique (avoiding start-phase arrangement stimulation) and on the contact/take-off phases of the foot to correct the lower limb movements of the children that are usual to have heavy and noisy support arrangement.

Finally, the fastest children (eight-year boys) are those who have a greater average amplitude (trend confirmed also in adults Maćkała et al, 2013) but analysis related to the relation amplitude/steps frequency is hardous to realize as discovered in adults that reached at the maximum speed when performed the greater amplitudes (Paruzel-Dyja, 2008). In conclusion, the growth path is a golden period to improve the technique, the competence to modulate the effort and the attitude to force forward the acceleration phase.

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