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AGE-RELATED CHANGES OF RUNNING STRIDE KINEMATICS IN 7 TO 18 YEAR - OLD YOUTH

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Abstract

The research deals with cross-section analysis of ontogenetic characteristics of basic kinematic parameters of the running stride in terms of age and gender from 7 to 18 years of age. There were monitored: average velocity, stride frequency and length, duration of support and flying phase, as well as other derived indicators at 10 m with 15 m flying start. Sample consisted of 1299 male and 1288 female students of elementary and high schools in Bratislava. Authors determined high age dependency of running speed and stride length on age. On the other hand, there was high ontogenetic stability of the indicators (stride frequency, duration of support and flying phase) in the population of 7 to 18 year-old youth. Ontogenetically stable parameters deteriorated partially in prepubescent and at the beginning of the pubescent period in the age 11 – 15. This relates to rapid growth of body height and weight and deterioration of biomechanical and coordination conditions of an organism. Those finding lead the authors to the conclusion, that ontogenetically stable indicators comprise so called dispositional factors in evaluating the rate of talent for running speed.

Keywords: running, kinematics parameters, maximal speed, ontogenesis

Introduction

Running speed belongs to those human motor capabilities, which are difficult to develop. They are substantially conditioned by hereditary factors on CNS level, structure of muscle fibers, energy systems and it is hard to influence them by the process of sports training. Besides, running speed is one of the basic motor capability and it a part of the structure of the sport performance in many sports events. These are the reasons that make early recognition of a talent for fast run and recognition of kinematic parameters that influence it very important. This is why it is necessary to search for such parameters of running speed (predictors), which are relatively independent from age and which demonstrate high ontogenetic stability.

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In the phase of maximum speed both frequency and the length of stride are relatively constant, the proportion between the contact and flight phases of sprinters stride is also stabilized. The zone, where sprinters achieve their absolute maximum speed is very limited. In principle, the best sprinters can sustain this phase for 10 to 20 meters. The zone of maximal speed is located somewhere between 60 and 80 meters in men and between 50 and 70 meters in elite women. Maximal speed is always a product of optimal stride length and the frequency. There are no differences in the length of stride between elite and sub-elite sprinters, with differences existing only in the frequency of stride (Donati, 1996; Mackala, 2007; Seagrave, Mouchbahani, & O`Donnel, 2009).

The studies about the kinematics of sprinting are usually focused on top or high level athletes where they found the most important parameters. The most important generator of sprinting stride efficiency is the execution of the contact phase, especially the ratio between the breaking phase and propulsion part (Čoh, Škof, Kugovnik, & Dolenec, 1994; Alcaraz, Palao, Elvira, & Linthorne, 2008). To ensure maxima sprinting velocity, the force impulse must be as small as possible in the breaking phase, which is possible trough an economic placement of the foot of the push-off leg as close as possible to the vertical projection of the body centre of gravity on the surface.

It seems that the basic kinematic characteristics of running during phase of maximum speed are: momentary and average velocity, frequency and length of the running stride, duration of the support phase and the flying phase and efficiency index, which is defined by duration of the support phase and the running phase ratio. The duration of the support phase in 13 to 16-year-old youth presents a stable factor in terms of ontogenesis (Tabačnik, 1979; Siris, Gajdarska, & Račev, 1983). The period of so-called “sensitive phase” in the development of children (9-13 years), which is very suitable for development of speed potential. Central neural system is being developed, particularly emphasized is formation of myelin nerve sheath, which serves as a transporter of neural impulses from central neural system to active muscles. In this period, particularly the speed of transfer of such impulses, which generate the speed of movement, can be influenced.

The level of the stride frequency during the phase of maximum speed is a stable factor in the population ontogenesis and it can be influenced only by appropriately oriented, specialized sport preparation (Korneljuk & Marakušin, 1977). It was also found the linear independence between the velocity of run and the support phase duration (Bogdanov, 1974; Tjupa, Aleshinsky, Kaimin, & Primakov, 1978; Kampmiller & Koštial, 1986). This finding shows that it is a substantial criterion for determining the maximal running speed of humans.

To determine basic kinematic parameters of the running stride at distance (10m) with 15 – meters approach (flying start) in cross-sectional age samples of male and female students of elementary and high schools in Bratislava (ISCED 2, 3) of 7 – 18 years of age and to point out the ontogenetic stability of frequency and length of the running stride, duration of the support phase and the flying phase. To determine basic measures of location (mean) and of variability (standard deviation) in one-year intervals in samples of boys and girls.

Method

Samples consisted of the 7 to 18 years old students of elementary and high schools in Bratislava. There were 1299 boys and 1288 girls in the samples. Subjects were supposed to run in maximum speed 25 meters long track. There was recorded the velocity of the 10 meters distance after 15 meters flying start by timing gates in standard conditions (gymnasium, sports hall). The run was carried out on a contact platform in combination with a measuring device

"Lokomometer", which by use of computer technology evaluates basic kinematic parameters of the running step (velocity of the 10 meters distance, frequency and length of the running stride, duration of the support phase and the flying phase and efficiency index, which is defined by duration of the support phase and the running phase ratio). Contact platform was 17 meters long and consisted of two conductive layers separated by non-conductive elastic grading. During the contact of a foot with a surface, the contact platform worked as an electric circuit switch, during the flight phase, the circuit was disconnected. Length parameters were measured by "Lokomometer" (Šelinger, Kampmiller, Šelingerova, & Laczo, 1994). Measuring of the time variables was carried out with 0.001 s accuracy, length variables with ± 0.005 m. Body height was determined with ± 0,005 m accuracy and body weight with ± 0.5 kg. Age was determined with 0.1 years accuracy.

We have used no research procedure that may harm the child either physically or psychologically, we take special effort to explain the research procedures also to the parents and be especially sensitive to any indicators of discomfort. As with the child and parents or guardians informed consent requires that the persons interacting with the child during the study be informed of all features of the research which may affect their willingness to participate.

Samples were divided to groups according to age with one-year gap between the groups, in average from 6.5 to 17.5 years old. Means and standard deviations were calculated. Ontogenetic tendencies were represented graphically and by means of significance of difference by two-sample statistical t-test of middle values of interannual increase. Statistical significance was evaluated on 1% and 5% level. In addition there was used correlation analysis in IBM SSP program.

Results

In Table 1 and Table 2 there are basic statistical characteristics of observed parameters. On the Figure1 there is a course of average running speed, which shows parallel and linear growth from 6.5 to 13.5 years of age in both boys and girls. Later on speed in boys increases steeply, meanwhile it stagnates in girls. Similar trend shows on Figure2 (average stride length). The stride frequency (Figure3) shows very stable tendency with slight decrease at the end of observed period. This parameter changes significantly only during prepubescent and at the beginning of the pubescent period (from 10.5 to 14.5 years of age).

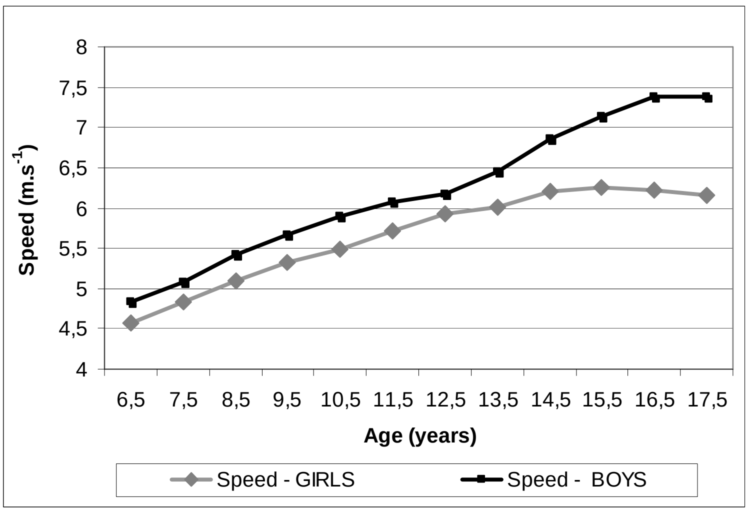

Figure 1 Average running speed of the 10 meters distance after 15 meters flying start

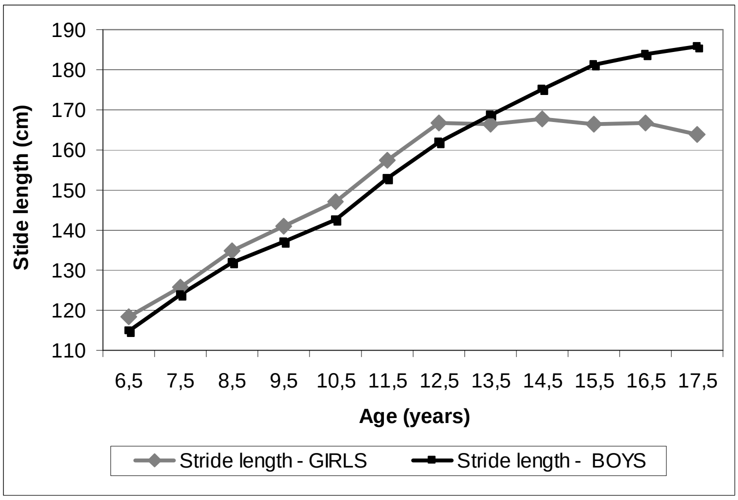

Figure 2 Average stride length of the 10 meters distance after 15 meters flying start

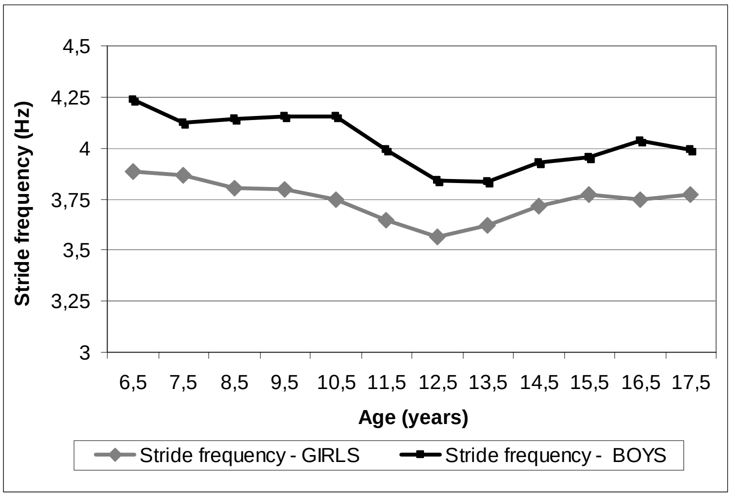

Figure 3 Average stride frequency of the 10 meters distance after 15 meters flying start

Duration of the contact of a foot with a surface (Figure 4) displays similarly stable course as the stride frequency. As a result of biological changes the duration of the contact lengthens between 10.5 and 13.5 years of age and gradually returns to original values in 7 years of age. This parameter of the kinematic structure of the running step also displays high level of ontogenetic stability, which is proved by interannual t-test values in Table 1, 2.

Table 1

Statistical characteristics of age, somatic and kinematic parameters of running stride on the 10 meters distance after 15 meters flying start - BOYS and significance of differences between the variables

Group	Statistic	Decimal age	Body hight	Body weight	Contact time	Flight time	Stride length	Stride frequency	Speed	Relative speed	Relative stride length	tf/tc	Statistic
1	Mean	6.50	122.45	22.79	149.10	89.35	114.80	4.24	4.82	2.15	.94	0.60	Mean
n	Stdev	0.20	4.21	2.86	13.55	14.67	11.81	.33	.40	.30	.09	.11	Stdev
29	t (1-2)	-13.59	-4.34	-2.59	-.60	-1.35	-4.02	1.60	-2.80	1.05	-2.16	-.98	t (1-2)
	Sig	**0.00**	**0.00**	**0.00**	**NS 0.548**	**NS 0.179**	**0.00**	**NS 0.111**	**0.00**	**NS 0.297**	**0.03**	**NS 0.329**	**Sig**
2	Mean	7.50	127.73	25.13	151.00	94.12	123.99	4.12	5.08	2.08	.97	0.63	Mean
n	Stdev	0.39	6.26	4.68	15.75	17.78	11.04	.35	.45	.34	.07	.14	Stdev
137	t (2-3)	-25.28	-7.75	-5.22	1.44	-.76	-5.44	-.39	-6.02	2.49	-1.38	-1.30	t (2-3)
	Sig	**0.00**	**0.00**	**0.00**	**NS 0.150**	**NS 0.449**	**0.00**	**NS 0.695**	**0.00**	**0.01**	**NS 0.169**	**NS 0.21**	**Sig**
3	Mean	8.50	134.07	28.68	148.13	95.67	131.88	4.14	5.43	1.96	.98	0.65	Mean
n	Stdev	0.21	6.79	6.15	15.82	14.54	12.10	.34	.47	.38	.08	1.36	Stdev
118	t (3-4)	-25.00	-5.39	-3.23	.68	-.38	-3.80	-.29	-4.13	1.78	-.94	-.68	t (3-4)
	Sig	**0.00**	**0.00**	**0.00**	**NS 0.497**	**NS 0.707**	**0.00**	**NS 0.73**	**0.00**	**NS 0.077**	**NS 0.348**	**NS 0.499**	**Sig**
4	Mean	9.50	138.17	31.36	146.83	96.34	137.01	4.15	5.66	1.88	.99	0.66	Mean
n	Stdev	0.40	6.06	7.44	16.15	14.85	10.69	.34	.47	.38	.07	.13	Stdev
171	t (4-5)	-22.95	-5.56	-2.71	.72	-.45	-4.18	-.03	-4.07	1.17	-.91	-.61	t (4-5)
	Sig	**0.00**	**0.00**	**0.00**	**NS 0.473**	**NS 0.654**	**0.00**	**NS 0.976**	**0.00**	**NS 0.242**	**NS 0.365**	**NS 0.541**	**Sig**
5	Mean	10.50	142.78	34.13	145.40	97.12	142.64	4.15	5.90	1.82	1.00	0.67	Mean
n	Stdev	0.17	7.10	8.78	14.00	10.88	9.95	.30	.44	.41	.06	.10	Stdev
93	t (5-6)	-22.57	-6.90	-4.06	-2.85	-2.58	-6.62	4.45	-2.86	4.09	-2.48	-.42	t (5-6)
	Sig	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**NS 0.677**	**Sig**
6	Mean	11.50	149.40	39.08	150.71	101.54	152.79	3.99	6.07	1.62	1.02	0.67	Mean
n	Stdev	0.40	6.92	8.99	13.32	13.59	12.06	.25	.41	.33	.07	.12	Stdev
125	t (6-7)	-20.65	-4.56	-2.62	-2.43	-2.61	-5.07	3.87	-1.93	2.23	-2.65	-.77	t (6-7)
	Sig	**0.00**	**0.00**	**0.01**	**0.01**	**0.01**	**0.00**	**0.00**	**NS 0.055**	**0.02**	**0.00**	**NS 0.433**	**Sig**

Table 1 (continued)

Group	Statistic	Decimal age	Body hight	Body weight	Contact time	Flight time	Stride length	Stride frequency	Speed	Relative speed	Relative stride length	tf/tc	Statistic
7	Mean	12.50	154.38	42.44	155.63	106.85	161.88	3.84	6.18	1.52	1.05	0.69	Mean
n	Stdev	0.21	8.52	8.73	15.09	14.88	12.98	.29	.36	.31	.06	.12	Stdev
78	t (7-8)	-19.68	-6.77	-5.37	-1.88	2.31	-3.37	.07	-4.01	4.13	1.84	2.62	t (7-8)
	Sig	**0.00**	**0.00**	**0.00**	**NS 0.062**	**0.02**	**0.00**	**NS 0.947**	**0.00**	**0.00**	**NS 0.068**	**0.01**	**Sig**
8	Mean	13.50	164.02	50.98	160.30	101.92	168.78	3.84	6.45	1.33	1.03	0.65	Mean
n	Stdev	0.41	9.90	11.59	17.18	13.14	13.74	.24	.50	.29	.07	.12	Stdev
95	t (8-9)	-20.04	-3.57	-3.74	1.97	.68	-3.31	-2.35	-5.55	2.61	-.75	-.35	t (8-9)
	Sig	**0.00**	**0.00**	**0.00**	**0.05**	**NS 0.496**	**0.00**	**0.02**	**0.00**	**0.01**	**NS 0.454**	**NS 0.723**	**Sig**
9	Mean	14.51	169.15	57.09	155.53	100.59	175.22	3.93	6.86	1.23	1.04	0.65	Mean
n	Stdev	0.16	8.41	8.97	13.29	11.85	10.79	.26	.45	.17	.07	.10	Stdev
74	t (9-10)	-18.44	-7.32	-5.75	.75	-.07	-3.72	-.65	-4.37	4.39	1.23	-.62	t (9-10)
	Sig	**0.00**	**0.00**	**0.00**	**NS 0.452**	**NS 0.943**	**0.00**	**NS 0.514**	**0.00**	**0.00**	**NS 0.219**	**NS 0.537**	**Sig**
10	Mean	15.51	176.49	64.31	154.03	100.71	181.28	3.95	7.13	1.13	1.03	0.66	Mean
n	Stdev	0.45	6.64	9.06	14.71	12.51	12.10	.27	.43	.16	.06	.11	Stdev
172	t (10-11)	-12.80	-2.07	-3.00	1.39	.60	-1.14	-1.62	-3.21	1.67	-.02	-.46	t (10-11)
	Sig	**0.00**	**0.04**	**0.00**	**NS 0.165**	**NS 0. 551**	**NS 0.254**	**NS 0.107**	**0.00**	**NS 0.096**	**NS 0.980**	**NS 0.648**	**Sig**
11	Mean	16.50	178.98	69.37	150.16	99.32	183.85	4.04	7.38	1.08	1.03	0.67	Mean
n	Stdev	0.11	5.52	9.23	16.25	12.95	12.10	.29	.30	.14	.06	.11	Stdev
35	t (11-12)	-12.54	-1.14	-.85	-1.11	.06	-.85	.88	.11	.90	-.26	.73	t (11-12)
	Sig	**0.00**	**NS 0.025**	**NS 0.395**	**NS 0.270**	**NS 0.955**	**NS 0.395**	**NS 0.380**	**NS 0.913**	**NS 0.369**	**NS 0.793**	**NS 0.468**	**Sig**
12	Mean	17.40	180.26	70.84	153.22	99.18	185.65	3.99	7.37	1.06	1.03	.65	Mean
n = 172	**Stdev**	0.42	6.16	9.29	14.64	13.37	11.23	.28	.41	.14	.06	.11	**Stdev**

Table 2

Statistical characteristics of age, somatic and kinematic parameters of running stride on the 10 meters distance after 15 meters flying start - GIRLS and significance of differences between the variables

Group	Statistic	Decimal age	Body hight	Body weight	Contact time	Flight time	Stride length	Stride frequency	Speed	Relative speed	Relative stride length	tf/tc	Statistic
1	Mean	6.50	121.00	21.74	157.28	102.89	118.51	3.88	4.58	2.13	.98	.66	Mean
n	Stdev	0.17	3.77	2.67	13.89	14.37	8.66	.31	.38	.30	.06	.11	Stdev
46	t (1-2)	-17.07	-6.37	-3.77	.94	-1.32	-4.35	.32	-3.59	1.54	-1.29	-1.71	t (1-2)
	Sig	**0.00**	**0.00**	**0.00**	**NS 0, 347**	**NS 0.188**	**0.00**	**NS 0.751**	**0.00**	**NS 0.125**	**NS 0.198**	**NS 0.089**	**Sig**
2	Mean	7.51	126.50	23.94	154.96	106.51	125.73	3.87	4.83	2.05	.99	.6937	Mean
n	Stdev	0.39	5.41	3.63	14.59	16.56	10.05	.32	.43	.30	.07	.13	Stdev
134	t (2-3)	-23.55	-10.24	-7.05	-.93	-1.16	-6.88	1.47	-4.59	4.23	-1.57	-.43	t (2-3)
	Sig	**0.00**	**0.00**	**0.00**	**NS 0.351**	**NS 0.245**	**0.00**	**NS 0.143**	**0.00**	**0.00**	**NS 0.118**	**NS 0.669**	**Sig**
3	Mean	8.52	133.65	28.04	156.80	108.90	134.79	3.80	5.10	1.87	1.01	.7004	Mean
n	Stdev	0.21	5.15	5.29	15.50	14.22	9.90	.32	.46	.35	.08	.11	Stdev
101	t (3-4)	-23.55	-6.42	-4.47	1.19	-1.34	-4.28	.22	-3.67	2.82	-.87	-1.85	t (3-4)
	Sig	**0.00**	**0.00**	**0.00**	**NS 0.234**	**NS 0.182**	**0.00**	**NS 0. 828**	**0.00**	**0.05**	**NS 0.386**	**NS 0.066**	**Sig**
4	Mean	9.50	138.48	31.60	154.56	111.41	140.94	3.79	5.32	1.75	1.02	.7269	Mean
n	Stdev	0.42	6.47	6.94	14.79	15.52	12.33	.31	.49	.35	.07	.12	Stdev
177	t (4-5)	-12.72	-3.64	-2.65	-.54	-.54	-2.49	.73	-1.72	1.56	-.64	-.36	t (4-5)
	Sig	**0.00**	**0.00**	**NS 0.09**	**NS 0.592**	**NS 0.587**	**0.02**	**NS 0.464**	**NS 0.087**	**NS 0.121**	**NS 0.523**	**NS 0.716**	**Sig**
5	Mean	10.52	143.36	35.46	156.26	113.16	147.16	3.75	5.49	1.64	1.03	.7361	Mean
n	Stdev	0.12	7.41	8.61	19.88	17.59	11.85	.32	.53	.41	.07	.15	Stdev
28	t (5-6)	-11.15	-4.83	-2.76	-1.69	-.40	-3.94	1.96	-2.25	2.32	-.84	.78	t (5-6)
	Sig	**0.00**	**0.00**	**0.00**	**NS 0.093**	**NS 0.693**	**0.00**	**NS 0.051**	**0.03**	**0.03**	**NS 0.402**	**NS 0.437**	**Sig**
6	Mean	11.52	151.48	40.76	161.86	114.42	157.49	3.64	5.72	1.47	1.04	.7153	Mean
n	Stdev	0.47	8.31	9.47	15.37	15.03	12.92	.25	.48	.33	.08	.13	Stdev
153	t (6-7)	-11.44	-4.20	-2.97	-1.15	-1.07	-3.71	1.56	-2.17	2.54	-.90	-.07	t (6-7)
	Sig	**0.00**	**0.00**	**0.00**	**NS 0.250**	**NS 0.286**	**0.00**	**NS 0.120**	**0.03**	**0.02**	**NS 0.370**	**NS 0.941**	**Sig**

Table 2 (continued)

Group	Statistic	Decimal age	Body hight	Body weight	Contact time	Flight time	Stride length	Stride frequency	Speed	Relative speed	Relative stride length	tf/tc	Statistic
7	Mean	12.50	158.19	46.10	165.39	117.56	166.77	3.57	5.92	1.31	1.05	.7171	Mean
n	Stdev	0.12	7.03	7.07	16.41	14.24	11.53	.29	.46	.23	.06	.11	Stdev
31	t (7-8)	-10.91	-2.60	-2.07	-.27	1.70	.12	-.93	-.85	1.41	1.82	1.62	t (7-8)
	Sig	**0.00**	**0.01**	**0.04**	**NS 0.788**	**NS 0.091**	**NS 0.908**	**NS 0.357**	**NS 0.395**	**NS 0.160**	**NS 0.071**	**NS 0.107**	**Sig**
8	Mean	13.51	161.84	49.66	166.27	112.30	166.49	3.62	6.01	1.25	1.03	.6808	Mean
n	Stdev	0.51	6.81	8.77	15.81	15.34	11.54	.29	.51	.24	.07	.11	Stdev
104	t (8-9)	-15.60	-4.45	-3.05	1.77	1.28	-.73	-2.08	-2.58	2.18	1.82	.12	t (8-9)
	Sig	**0.00**	**0.01**	**0.00**	**NS, 0.079**	**NS 0,203**	**NS 0.464**	**0.04**	**0.02**	**0.03**	**NS 0.070**	**NS 0.905**	**Sig**
9	Mean	14.51	166.15	53.35	162.12	109.31	167.80	3.71	6.20	1.17	1.01	.6788	Mean
n	Stdev	0.14	5.01	5.53	13.39	14.02	10.97	.27	.43	.15	.07	.10	Stdev
66	t (9-10)	-18.22	-.20	-2.05	1.61	.78	.90	-1.67	-1.00	1.27	1.11	-.32	t (9-10)
	Sig	**0.00**	**NS 0.839**	**0.04**	**NS 0,108**	**NS 0,434**	**NS 0.367**	**NS 0.097**	**NS 0.318**	**NS 0.203**	**NS 0.267**	**NS 0.747**	**Sig**
10	Mean	15.50	166.31	55.05	159.14	107.87	166.57	3.77	6.26	1.15	1.00	.6834	Mean
n	Stdev	0.44	4.83	6.17	13.54	13.32	9.70	.25	.40	.14	.05	.11	Stdev
279	t (10-11)	-16.38	-.43	-1.44	-1.36	.54	-.10	.70	.64	1.56	.12	1.03	t (10-11)
	Sig	**0.00**	**NS 0,666**	**NS 0.150**	**NS 0.176**	**NS 0.588**	**NS 0.919**	**NS 0.484**	**NS 0.522**	**NS 0.119**	**NS 0.903**	**NS 0.304**	**Sig**
11	Mean	16.50	166.67	56.42	161.89	106.74	166.72	3.75	6.22	1.12	1.00	.6663	Mean
n	Stdev	0.12	4.83	6.94	13.02	15.89	9.88	.23	.36	.14	.06	.13	Stdev
52	t (11-12)	-15.19	-.91	-1.33	.05	.63	1.66	-.66	1.02	1.95	2.25	.63	t (11-12)
	Sig	**0.00**	**NS 0.365**	**NS 0.184**	**NS 0.958**	**NS 0.528**	**NS 0.098**	**NS 0.512**	**NS 0.310**	**NS 0.052**	**.02**	**NS 0.527**	**Sig**
12	Mean	17.47	167.41	57.68	161.79	105.18	163.90	3.77	6.15	1.08	.98	.65	Mean
n=197	Stdev	0.46	5.33	5.76	12.14	15.88	11.14	.25	.42	.13	.06	.11	Stdev

Values of the flying phase duration can be studied on the Figure5. Their course is parallel in both boys and girls with duration lengthening tendency till 12.5 years of age followed by slightly shortening tendency till 17.5 years of age. Similar is also the course of efficiency index on the Figure 6. It is clear that these parameters confirm high level of ontogenetic stability (duration of the support phase and the flying phase, flying phase and support phase ratio and frequency) compared to unstable parameters, such as running speed and stride length, which are dependent on age.

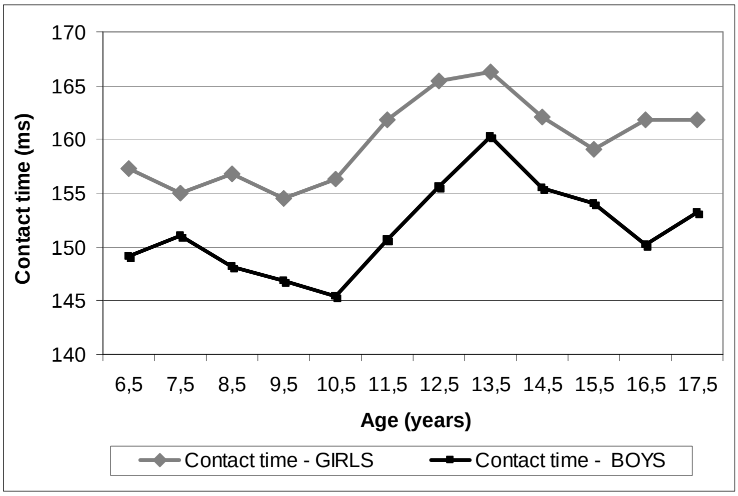

Figure 4 Average contact time of the 10 meters distance after 15 meters flying start

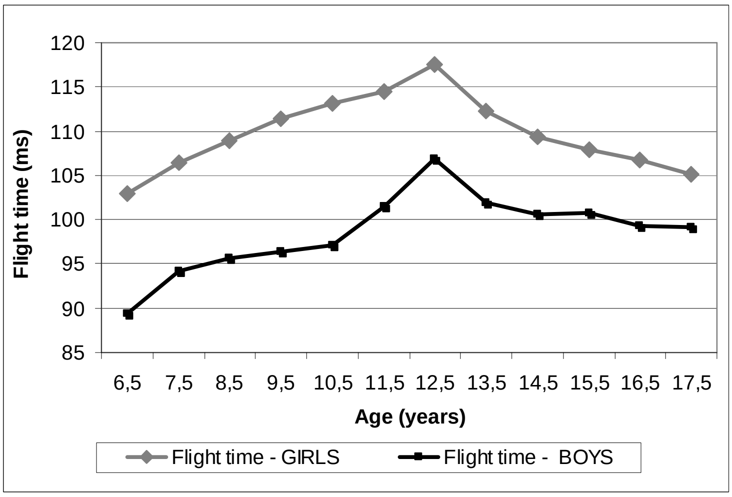

Figure 5 Average flight time of the 10 meters distance after 15 meters flying start

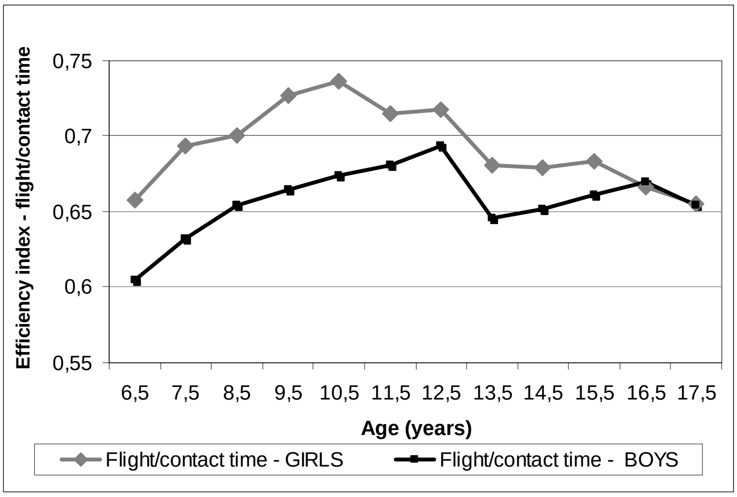

Figure 6 Efficiency index - defined by duration of the support phase and the running phase ratio

Relationship analysis in the form of Pearson correlation coefficients, which are shown in Table3, confirmed statistically significant dependence of running speed, indicators of decimal age, body height, body weight, duration of the support phase and the flying phase, stride length and stride frequency (girls); relative speed, relative frequency and efficiency index (boys). The results showed, for both sexes, that the structure of the sprint stride change drastically in connection to the stride length and frequency, the ratio between the contact and the flight phase sand the vertical pressure on the surface. The correlation coefficients show that the duration of contact, the relative stride frequency and the vertical pressure on the surface are good indicators of the sprinting potential of young runners.

Table 3

Correlation coefficients and their significances of age, somatic and kinematic parameters of the 10 m after 15 m flying start

p <0.01** *p* <0.05*

Upper triangle: BOYS; lower triangle: GIRLS

	Decimal age	Body hight	Body weight	Contact time	Flight time	Stride length	Stride frequency	Speed	Relative speed	Relative stride freguency	Flight/ contact
Decimal age	1	.937**	.889**	.141**	.150**	.885**	-.238**	.878**	-.783**	.304**	.036
Body hight	.909**	1	.934**	.248**	.174**	.911**	-.337**	.851**	-.863**	.243**	.002
Body weight	.882**	.924**	1	.280**	.082**	.820**	-.292**	.773**	-.916**	.157**	-.081**
Contact time	.153**	.257**	.264**	1	.122*	.188**	-.687**	-.159**	-.439**	.042	-.623**
Flight time	-.053*	.001	-.082**	.049	1	.415**	-.628**	.136**	-.096**	.653**	.840**
Stride length	.749**	.839**	.732**	.171**	.315**	1	-.463**	.880**	-.716**	.617**	.214**
Stride frequency	-.089**	-.203**	-.147**	-.674**	-.696**	-.370**	1	.005	.426**	-.448**	-.125**
Speed	.736**	.755**	.681**	-.240**	-.111**	.812**	.235**	1	-.589**	.456**	.182**
Relative speed	-.797**	-.863**	-.928**	-.428**	.001	-.634**	.324**	-.472**	1	.032	.158**
Relative stride freguency	-.082**	-.069*	-.140**	-.106**	.574**	.482**	-.347**	.278**	.229**	1	.522**
Flight/ contact	-.129**	-.138**	-.211**	-.565**	.835**	.160**	-.211**	0.03	.230**	.521**	1

Discussion

The results of the research of kinematic characteristics of the running step in the population of 7 to 18 year-old youth allow us to present following conclusions:

Running speed measured at 10 m long track with 15 m long approach (flying start) has linear growth tendency in the male population till 13 years of age, followed by phase of even steeper increase. In the female population after 14 to 15 years of age there is observable stagnation of the running speed/velocity. Similar age dependence was detected meanwhile assessing the length of the running step.

High level of ontogenetic stability and independence from age was determined in kinematic parameters (stride frequency, duration of the support phase, duration of the flight phase, and partly efficiency index). These indicators can be considered the predictors of the running speed. Partial deterioration of the kinematic parameters occurs in prepubescent and pubescent period.

The stride frequency showed as a very stable parameter, significantly changes are only during prepubescent period, its can be explained by deterioration of coordination, which is a result of increase in body height and weight. Moreover, Čoh, Jošt, Kampmiller, and Štuhec (2000) found that development of maximal speed is not constant, but has certain oscillations, particularly in the adolescence period, when morphological and motor characteristics of youth change. Due to acceleration of longitudinal parameters, frequency and length of stride change. The length of stride increases and the frequency of stride decreases significantly. Frequency does not change only as a result of morphological changes, but also due to disruption of proprio-receptive mechanisms for movement control.

In contradiction with our duration of the contact results are findings of Bračič, Tomažin, & Čoh (2009). They found that the biggest differences in the development of maximal speed of pupils of both tenders occur between the ages of 12 and 14, mainly in boys due to development of strength. The duration of contact phase of sprinters stride in boys is rapidly reduced after the age of 12. However others (Mero, Luhtanen, & Komi, 1986; Mero, Komi, & Gregor, 1992) consider duration of contact phase as one of the main criteria in selecting young sprinters.

These results are comparable to older research Kampmiller and Koštial (1986), which were carried out with smaller samples, and modified methods at school stadiums, where there was not possible to achieve high level of standard conditions of measurements. That is why our results are influenced by new method. For example the support phase is 0.02 s longer than measured in the past, also in comparison with values of kinematic parameters of support phase done by other authors Čoh et al. (1994) where they found the most important kinematic-dynamic parameters, their developmental trend and their influence on the efficiency in maximal sprinting speed for young spinsters of both sexes, from eleven to eighteen years of age. They recorded kinematical and dynamical parameters also with electronic devise - locomometer.

It was also determined that stride length and stride frequency were negatively correlated in maximal speed running which was the result of positive correlation between skeleton dimensionality and stride length, on the one hand, and of negative correlation between skeleton dimensionality and stride frequency. As far as authors know, research demonstrated integrally the mechanism of mutual relationships between subcutaneous fatty tissue, skeleton dimensionality, explosive power and kinematic parameters Babić and Dizdar (2010).

For specific implications into practice, based on our results, we suggest to evaluate the rate of talent for running speed on the basis of stride frequency and support phase duration. If a child achieves above-average values in aforesaid parameters 2 or 3 standard deviations higher than population average, determined in our research, an individual can be considered as talented. Results of our research can be used as background papers for assessment of the rate of talent for running speed. An individual can be considered talented if he or she achieves parameters of two standard deviations above mean values in indicators as stride frequency, duration of the support phase and running speed. It may contribute to a better understanding of the factors responsible for sprint performance in the population of athletes who are not top-level sprinters, i.e. they may be useful to PE teachers, coaches who work with novices in athletics and physical conditioning coaches who work in other sports than athletics, to get a more thorough insight into the sprinting efficiency mechanisms.

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