THE EFFECTS OF VOLUME AND SKINFOLDS ON SPRINTER SPEED IN 11-12-YEAR OLD CHILDREN

[1]Nikola Radulović, [1]Ilona Mihajlović, [1]Marko Gusić and [2]Ratko Pavlović

[1] Faculty of Sport and Physical Education, Novi Sad
[2] Faculty of Physical Education and Sport, Pale

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Abstract
The study was conducted with the aim of emphasizing certain relations of the conditions of the subcutaneous adipose tissue at reference points of the body and volume with the results in sprint disciplines of primary school pupils. It included a total of 120 subjects (59 boys and 61 girls) aged 11-12 years, primary school "Prva vojvodjanska brigada" in Novi Sad. In the morphological space which included body volume, body mass and subcutaneous adipose tissue, using multivariate analysis of variance, there were statistically significant differences, which could in the individual analysis be observed only in the variable Abdomen circumference with significantly lower values in girls. Results of linear regression analysis indicated that the predictor variable system with sprinter running speed, described Running 30m (criterion) from 28% in girls and 57% in boys of common variability, which suggested the significance of the effect of the predictor system on the criterion variable of Running 30m. By the individual observation, the negative contribution to higher running speed was given by the variable Upper arm skinfold in both analyzed subsamples.

Key words: *sprinter speed, morphology, relations*

Introduction

Particular type of kinesiology activity needs an adequate morphological type of athlete to achieve above-average and excellent results, and on the other hand, perennial subjecting to the training process in a kinesiology activity is created in accordance with the previous selection, genetic base and narrower social environment, a relevant type by which one can recognize that a person deals with that particular kinesiology activity. The maximum speed a man can manifest in any movement depends on many different factors.

These factors are related to morphological and physiological characteristics, energy mechanisms, gender, age, biomotor ability, inter and intra muscular coordination and optimal biomechanics of movement technique. Locomotor speed of sprint type is one of the most important skills that generates the successfulness of people in many competitive situations. From the point of inherent genetic motor program, speed can be classified into primary phylogenetic human movements (Coh and Bosnjak, 2010). In specific sports situations, speed appears in the form of a "three-component model". it consists of speed, strength and coordination. Setting the individual components of this model depends on the specific sports discipline. In terms of motor performance, sprint looks like a simple biomotor activity.

However, sprint is a motor skill, which is very demanding with regard to coordination and it is not very easy to master. The main goal of sprint, i.e. sprinting, is to reach maximum running speed as quickly as possible and keep it as long as possible. The maximum speed that a man can manifest in any move depends on many different factors.

These factors are related to morphological and physiological characteristics, energy mechanisms, gender, age, biomotor ability inter-muscular/intra-muscular coordination and optimal biomechanics of movement technique. This raises an issue of the relationship between morphological characteristics responsible for volume and body mass, condition of subcutaneous fat with a sprint speed in children of different genders before puberty. Between 11-13 years of age girls are in puberty, there is the effect of androgen hormones on changes in body composition, the highest growth acceleration should have passed. In boys, this is the pre-puberty and sometimes puberty period, when morphofunctional changes begin, so it is interesting to examine the relations between body volume and condition of subcutaneous fat and sprint speed as the simplest and fastest type of natural form of movement.

Obesity during childhood and physical activity have increased dramatically worldwide in recent years. Children of low socioeconomic status are particularly at risk.

In general, the overall efficiency of school curricula on the outcomes of the health condition of children is negative, i.e. worrying. In obese children, children with high levels of subcutaneous fat, energy capacities are significantly lower than in children of normal nutritional condition (Maciejzyk at al., 2012) and this applies particularly to aerobic capacities. The last few decades motor skills have been one of the most common subject of study in the field of physical culture. The level of development of motor skills of students is significantly conditioned by their proper growth and development.

Unfortunately, in the last two decades, we have witnessed more pronounced downward trend in children's physical activity whichis happening not only in our country but also in neighboring countries (Siljeg, Zecic, Mrgan and Kevic, 2008; Strel, Bizjak, Starc and Kovac, 2009), as well as in the developed countries (Janz, Dawson & Mahoney, 2000; Tomkinson, Olds & Gulbin, 2003; Wedderkopp, Froberg, Hansen & Andersen, 2004).

There are probably several reasons for this situation, some of which result from the absence of a desire to use physical exercise as a graceful food for human being, which is again a result of complete unfamiliarity with the value of this kind of food, lack of responsibility towards one's own body and neglect of their needs and the fact that through education appropriate for the new era, a man is tied to technological innovations telling him that the need for any kind of movement - exercise is a tedious waste of time and as such - unnecessary.

The results of some studies have shown that socioeconomic status of the subjects affects the level of their motor skills (primarily coordination), which the authors associate with better opportunities for sports activities of the respondents in larger communities (Mikalacki, Hosek Momirovic i-Bala, 2006; Matic and Jaksic , 2007). Changes in motor skills take place in certain socioeconomic conditions that are typical for the environment of an individual or a group of people, consisted of a set of cultural, material, urban and other factors.

The social standard, the cultural level of protection, the place and role of physical education in it, the social status of parents, the social status of pupils, are some of the factors of the social environment which could indirectly affect the development of motor skills of the population in that environment and the level of engagement in sports activities (Gadzic and Vuckovic, 2009; Matic, Kuljic and Maksimovic, 2010).

Based on the aforementioned facts and the results of previous research, this paper is aimed at determining the association between some anthropometric characteristics, such as body volume and subcutaneous adipose tissue, and sprint running speed in children of primary school age, therefore the goal of this study is to determine the effect of subcutaneous adipose tissue and body volumeon the manifestation of sprint speed in male and female fifth-grade pupils of 11-12 years of age.

Method

The sample of this study consists of male and female fifth-graders from Novi Sad, aged 11-12 years, a total of 120 respondents, of which 49% are boys and 51% girls (boys N=59 and girls N=61), of different social status, healthy people with no physical aberrations. For the purpose of this research, there was a battery of tests responsible for the anthropometric characteristics and motor abilities, which gave an adequate sample of variables for the evaluation of volume and body weight: *Body weight* (kg); *Waist circumference* (cm); *Extended upper arm circumference*(cm), and for the evaluation of subcutaneous adipose tissue: *Upper arm skinfold* (mm); *Abdominal skinfold* (mm). These variables constituted the predictor system. For the evaluation of sprint running speeds a standardized test as a criterion variable was applied: *Running 30m* (s).

All measurements were performed by standard procedures with respect of IBP and athletic rules. In both pre-formed sub-samples (male and female pupils) linear regression analysis was applied in order to determine the effects of predictor variables on criterion variables, as well as the individual contribution predictors to defining of the criterion variables.

Results

Analysis of descriptive statistics of variables (Table 1), indicate a remarkable variability in the variables in the assessment of body weight and skin folds (*Body weight, Upper arm skin folds, Abdominal skin folds*). Such results are affected by genetic factors, socio-economic conditions in which children grow and develop.

The level of physical activity of children should not be excluded. The results could also be influenced by a period of growth and development, the impact of androgen hormones, especially in girls because of the effect of puberty on their body in this sensitive period of development. In the variables for the evaluation of skeleton volume, Extended upper arm circumference, Waist circumference, one can see homogenous results (balanced development of these indicators of morphological space).

In the variables for the evaluation of the running speed in both groups of respondents, there is a balanced development of this ability (as seen within each subsample). The respondents were at the similar level of development of sprint speed in the analyzed age and sample of the respondents.

The values of scunis and kurtosis indicate approximately normal distribution of variables. In the variable *Running 30m*in the subsample of girls, the distribution was extremely leptokurtic, which indicate the increased homogeneity of the results.

Table 1. Descriptive statistics of the analyzed variables

Variable	Group	MIN	MAX	AM	S	Sc	Kurt	VC (%)
Body weight (kg)	M	32.40	73.50	45.49	9.94	1.12	1.22	21.85
	F	28.50	66.80	45.17	9.37	0.40	-0.56	20.74
Waist circumference (mm)	M	572	991	684.56	99.03	1.36	1.70	14.47
	F	542	850	642.23	76.54	0.79	-0.50	11.78
Extended upper arm circumference (mm)	M	182	290	224.81	29.14	0.64	-0.60	12.96
	F	180	275	221.18	26.61	0.50	-0.81	12.03
Upper arm skin fold (mm)	M	53	318	137.03	65.31	0.75	-0.48	47.66
	F	70	300	153.56	66.23	0.64	-0.86	43.13
Abdominal skin fold (mm)	M	36	316	118.69	81.17	1.08	-0.08	68.39
	F	46	245	118.31	57.80	0.72	-0.68	48.85
Running 30m (s)	M	4.33	6.78	5.38	0.56	0.41	-0.54	10.41
	F	5.12	8.25	6.10	0.47	1.63	6.30	7.70

Legend: AM–arithmetic mean; S–standard deviation; MIN–minimum measurement values; MAX– maximum measurement values; Sc- scunis (distribution trend), Kurt - kurtosis (elongation of distribution); CV – variation coefficient

Based on Wilks lambda values (Table 2) it can be concluded that there is a statistically significant difference between the respondents of different gender in terms of their morphological characteristics in the value of F=11.62. The individual analysis of each variable suggests that significant differences exist only in the variable *Waist circumference* (p=0.01), whereas lower values were reported in girls (Table 2).

They are distinct by smaller waist circumference than boys of the same age. This variable contributes individually the most to the existence of differences between the sexes, because in other analyzed morphological varijblama statistically significant differences were not observed, so it can be concluded that the boys and girls are of similar body volume and body weight.

Table 2. Differences between the respondents of different gender in the morphological variables

Group	Variable	f	p
Boys Girls	Body weight	0.03	0.86
	Waist circumference	6.89	**0.01**
	Extended upper arm circumference	0.51	0.48
	Upper arm skin fold	1.89	0.17
	Abdominal skin fold	0.01	0.98

F=11,62 P=0,00

Legend: f – univariate f test; p – level of statistical significance of f test; F – multivariate Wilk's F test; P – statistical significance of multivariate F test

Table 3 shows the regression analysis of the predictor system of males on the criterion variable *Running 30m*.

Reviewing this table reported a statistically significant impact of the system of predictor variables on the tested criteria (P=0.00) with the multiple correlation coefficient R=0.76, which explains 57% of common variability (Graph 1), while the remaining percentage can be attributed to other factors that are not included by the given predictor system (stride length, resistance phase, length of the foot contact with the ground, other longitudinal dimensions, cognitive and connative characteristics, condition of muscles, inter and intra muscular coordination).

Considering each individual variable, it is concluded that the variable *Upper arm skinfold* shows a statistically significant negative effect on the criterion (p=0.02). Boys with higher values of the aforementioned skinfold achieved lower results in the test for the evaluation of sprint running speed.
Based on Pearson correlation coefficient, it is concluded that the respondents with higher values of variables for assessing skeleton volume, subcutaneous fat achieved statistically significantly (p≤0.01) worse results in the test for the evaluation of sprint running speed, higher values of these characteristics reduced the running speed at a given age and sample of respondents. The results of the partial correlations from the same table indicate that for the most part running speed at 30m is determined by the variable *Upper arm skinfold* (P_{part}=0.02).

After partialization of this variable, the value of the partial coefficient is the highest and statistically significant. It may be noted that other analyzed variables for assessing volume and body mass, subcutaneous fat, reduce the possibility of achieving better results in boys (after partialization, partial correlation coefficient drastically reduced regarding the Pearson coefficient).

Table 3. Regression analysis*(Running 30m)* in boys

Variable	r	p	r_{part}	p_{part}	Beta	p_{beta}
Body weight	0.65	0.00	0.09	0.52	0.19	0.52
Waist circumference	0.70	0.00	0.14	0.33	0.30	0.33
Extended upper arm skin fold	0.64	0.00	-0.19	0.16	-0.36	0.16
Upper arm skin fold	0.72	0.00	0.31	0.02	0.65	0.02
Abdominal skin fold	0.71	0.00	-0.01	0.99	-0.01	0.99

R=0.76 R^2=0.57 P=0.00

Legend: r –Pearson correlation coefficient; p –level of statistical significance for r; r_{part}–value of partial correlation coefficient; p_{prat}–level of statistical significance for r_{part} Beta –regression coefficient; p_{beta}–level of regression coefficient significance; R – multiple correlation coefficient; R^2 –determination coefficient; P –significance of multiple correlation coefficient

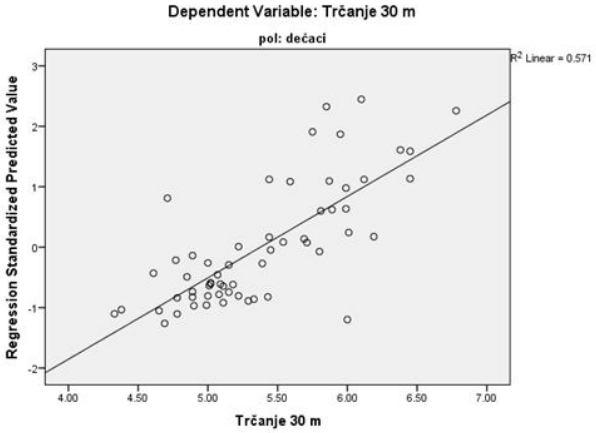

Figure 1. Regression line (Running 30m) in boys

Table 4 shows the regression analysis of the predictor system of females on the criterion variable *Running 30m*. Multiple correlation coefficient values R=0.53 and its statistical significance of P=0.00, indicate that the system of predictor variables is statistically significantly associated with the criterion *Running 30m* in girls, with a common variability of 28% (Graph 2), while

the remaining percentage can be attributed to some other characteristics and abilities that were not a part of this predictor system (stride length, resistance phase, length of the foot contact with the ground, other longitudinal dimensions, cognitive and connative characteristics, condition of muscles, inter and intra muscular coordination, etc.).

As with the boys, a variable for the estimation of subcutaneous fat, *Upper arm skinfold* reported a negative (Beta=1.06) and statistically significant (pbete=0.00) impact on the manifestation of this ability in the evaluated sample of female respondents, which means that this variable contributed most to the entire predictor system being statistically significant. Girls with higher values of subcutaneous fat on the upper arm achieved lower results in the manifestation of sprint speed.

Table 4. Regression analysis*(Running 30m) in girls*

Variable	r	p	r_{part}	p_{part}	Beta	p_{bete}
Body weight	0.24	0.03	-0.14	0.29	-0.36	0.29
Waist circumference	0.24	0.03	-0.03	0.81	-0.06	0.81
Extended upper arm circumference	0.26	0.02	-0.13	0.35	-0.27	0.35
Upper arm skin fold	0.43	0.00	0.39	0.00	1.06	0.00
Abdominal skin fold	0.35	0.00	-0.01	0.93	-0.03	0.93

R=0.53 R^2=0.28 P=0.00

Legend: r – Pearson correlation coefficient; p – level of statistical significance for r; r_{part} – value of partial correlation coefficient; p_{prat} –level of statistical significance for r_{part} Beta – regression coefficient; p_{bete} – level of regression coefficient significance; R – multiple correlation coefficient; R^2 – determination coefficient; P – significance of multiple correlation coefficient

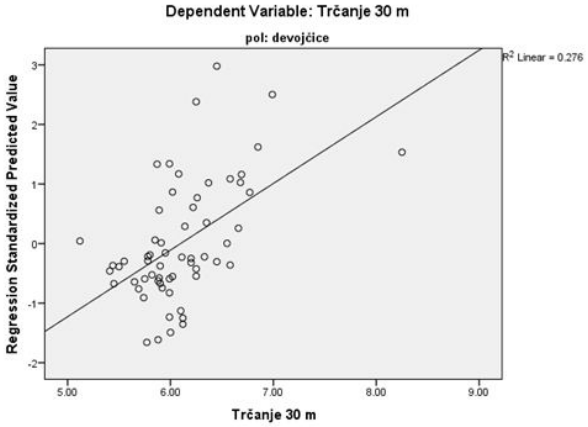

Figure 2. Regression line of Running 30m in girls

Considering the value of the Pearson correlation coefficient in the same table, it can be concluded that all the predictor variables are statistically significantly associated with the criterion, and that with the higher values of body weight, waist and upper arm circumference, as well as higher levels of subcutaneous fat on the upper arm and abdomen, achieve lower results in running at 30m. The values of the partial correlation coefficient for predictor variable *Upper arm skinfold*, indicate that higher body weight, waist circumference, upper arm circumference and higher values of subcutaneous fat reduce the ability of higher running speed in girls. Variable *Upper arm skinfold* mostly determines worse results of sprint speed in girls.

Discussion

Considering the achieved average values of analyzed morphological characteristics of boys and girls, it can be assumed that in terms of these dimensions they are of approximately similar development. There was only a difference in the waist circumference, with the emphasis that the girls had lower values of morphological dimensions than the boys of the same age. Children between 10-12 years of ge belong to the pre-adolescent period or puberty.

The body undergoes a little less change, and the amount of muscles is significantly behind the body weight, and children are not strong and durable enough. Therefore, sprint speed at 30m was chosen as a predictor in the study. The body has no necessary qualities to overcome severe physical and mental effort yet (Pelemis et al., 2012), therefore can easily overcome short-term efforts.

The results of the study suggested that the boys were on average faster than the girls of the same age, i.e. that they manifested higher sprint speed at a given age and sample of respondents.

This phenomenon may be associated with higher levels of testosterone (blood serum levels) in boys (Zatsiorsky and Kraemer, 2009). One should not omit the influence of muscle mass, which in boys begins to develop in the period of between 11 and 12 years of age, i.e. in those boys who "enter" this sensitive stage of development.

Increased muscle mass, higher level of androgen hormones, better inter and intra muscular coordination in boys led to better achieved results of sprint speed. Testosterone is a major hormonal signal of the increased protein synthesis in a muscle, but must bind to the androgen receptor. In boys, the serum level of testosterone in the blood was higher than in girls (so the girls did not achieve the same muscle hypertrophy as the boys during the training - physical exercise).

Growth of the relative strength (explosive power is a part of it) in boys during this period is intense (dicrease is expected between 13 and 15 years of age when a rapid puberty growth begins, and body weight increases). Due to the tendency of growth of the relative strength and the opportunities of rapid relocation of body parts in space among the boys, the higher maximum force needed for better results in sprint running was achieved.

If we assume that in the period of 11-12 years of age, the boys still play different elementary games, that they are more active than girls, then it can be assumed that their inter and intra muscular coordination is better. The boys obviously have higher gradation of total muscle power by the activation of certain motor units (recruitment), the frequency of emptying is better (i.e. changes in frequency of motor units shutter), hence better synchronization, activation of motor units.

The assumption of the correlation between the morphological characteristics responsible for the body weight, volume and subcutaneous adipose tissue with the sprint speed turned out to be true for boys and girls.

The most common variance was observed in the subsample of boys (57%), while that same system described slightly lower variance in the subsample of girls (28%). It can be assumed they had a greater effect on the sprint speed in boys than in girls. Research has shown that subcutaneous adipose tissue on the upper arm (indirectly linked to the level of training, physical activity) adversely affects the manifestation of higher sprint speed in boys and girls.

This variable is pointed out as a variable which mostly influences the running result, considering the given predictor system. With the increase of subcutaneous fat on the upper arm, sprint speed was lower (running speed reduced). Muscle strength is not determined only by the amount of the involved muscle mass, but also the degree of involvement of the individual muscle fibers.

For the demonstration of muscle mass, muscles must be activated appropriately. Coordinated movement of multiple muscle groups is associated with intermuscular coordination. The main characteristic of people who train (especially children in the training process) is better synchronisation of activated muscle fibers in specific muscles and muscle groups.

They have a better intra and inter muscular coordination. Nervous system generates muscle strength in three ways: by activating and deactivating individual motor units, frequency of discharge of motor units and synchronization of motor units.

All three options are based on the existence of motor units, which are the basic elements of the work of the neuro-muscular system. Each motor neuron consists of moto-neuron which is located in the spinal cord and muscle fibers that it innervates.

Motor units are, in terms of contractile properties, divided into fast and slow. Slow motor units are specialized for prolonged use at relatively low speeds. They consist of small motor-neurons of low triggering threshold with a low discharge frequency, and are adaptated to the aerobic activities. Fast muscle units or motor unit or units are specialized for relatively short activities that require demonstration of high speed and a high degree of strength development. They consist of large motor neurons of high discharge frequency threshold, axons with rapid implementation, and muscle fibers adapted to explosive anaerobic activities. Motor units operate according to the law "all or nothing". A motor unit is active or inactive at any time. The highest speed of shortening fast muscle fibers is four times greater than the slow muscle fibers (Zatsiorsky, Kraemer, 2009).

Conclusion

Subcutaneous adipose tissue differentiates to sprint speed in boys and girls as ballast tissue, which reduces the possibility of achieving better results.

It is highly expressed in children who are not physically active, so it can be assumed that they have less developed intramuscular and intramuscular coordination because children are not in the training process, and are more passive in their free time.

Children between 11 and 12 years of age, if not in puberty, have shorter limbs and smaller muscle mass, perhaps more subcutaneous fat if they move less or are not included in sports activities, which results in lower mechanical strength required for the demonstration of maximum movement speed, adding to it a greater amount of subcutaneous fat, poor results can certainly be expected. They also have disproportionately longer legs which means that, in terms of biomechanics, they are off-balance and therefore have potentially worse movement coordination.

Obtained results of the study of the population of primary school fifth-grade children indicate that smaller amounts of subcutaneous adipose tissue and better developed explosive leg strength (higher level of neural adaptation) in both genders enable the achievement of greater maximum running speed, which is consistent with the results of previous studies (Geier, Thepaut-Mathieu & Lehenaff, 1999).

This also confirmed the research of Ms Babic (2005) which in her doctoral dissertation indicated the fact that the subcutaneous adipose tissue had a negative prediction on sprint speed.

Based on the conducted research and testing, we can conclude that the predictor system, consisting of the anthropometric variables statistically significantly affected the running speed in both the male and female subsample.

The variable for assessing subcutaneous fat on the *Upper arm skinfold* was differentiated as a variable that most negatively affected the manifestation of the sprint speed in both analyzed subsamples, so it can be considered the most disturbing factor for speed.

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UTJECAJ VOLUMINOZNOSTI I KOŽNIH NABORA NA SPRINTERSKU BRZINU KOD DJECE UZRASTA 11-12 GODINA

Sažetak

Istraživanje je provedeno s ciljem ukazivanja na pojedine odnose stanja potkožnog masnog tkiva na referentnim točkama tijela i voluminoznosti s rezultatima u sprinterskim disciplinama kod učenika osnovnoškolskog uzrasta. Obuhvaćeno je ukupno 120 ispitanika (59 dječaka i 61 djevojčica) uzrasta 11-12 godina, O. Š. "Prva Vojvođanska brigada" u Novom Sadu. U morfološkom prostoru koji je obuhvaćao voluminoznost tijela, masu tijela i potkožno masno tkivo, primjenom multivarijatne analize varijance utvrđene su statistički značajne razlike, pri čemu se u pojedinačnoj analizi ta razlika uočava samo u varijabli Opseg trbuha sa znatno manjim vrijednostima kod djevojčica. Rezultati linearne regresijske analize ukazali su da je prediktorski sustav varijabli s sprinetrskom brzinom trčanja, Trčanje 30 m (kriterijem) opisivao od 28% kod djevojčica do 57% kod dječaka zajedničkog varijabiliteta, što je dalo značajnost utjecaja prediktorskog sustava na kriterijsku varijablu Trčanje 30m. Pojedinačnim promatranjem, negativan doprinos većoj brzini trčanja dala je varijabla Kožni nabor nadlaktice kod oba analizirana poduzorka.

***Ključne riječi**: sprinterska brzina, morfologija, relacije*

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Correspondence to:
Asocc. Prof. Ratko Pavlović, PhD
Faculty of Physical Education and Sport,
University of East Sarajevo, RS-BIH
Phone: +387 (65) 934-131
E-mail: pavlovicratko@yahoo.com