PREDICTION OF RUNNING SPEED IN GIRLS ON THE BASIS OF STRENGTH

PREDIKCIJA BRZINE TRČANJA DEVOJČICA NA OSNOVU SNAGE

Nikola Radulović[1], Ilona Mihajlović[1], Ratko Pavlović[2], Milan Šolaja[1] and Mila Vukadinović[1]

[1] Faculty of sport and physical education, University of Novi Sad, Serbia
[2] Faculty of Physical Education and Sport, University of East Sarajevo, Bosna i Hercegovina

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Correspondence author:
Nikola Radulović
Faculty of Sport and Physical Education
University of Novi Sad
Serbia
nikolaradulovicfsfv@gmail.com

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SUMMARY

The aim of this study was to examine connection between the motor ability strength and the achievement of results in sprinting in order to define strength tests to perform selection in physical education classes, at the age of early puberty. The sample consisted of 88 female subjects aged 12 years (± 6 months). The batery of four tests was used for evaluation of the motor ability strength, prescribed in the curriculum for the subject Physical Education of the Pedagogical Association of Vojvodina: variables of explosive strength - standing broad jump (cm), throwing medicine ball from lying position (m), variable of repetitive strength - sit-ups (number of successful attempts) and variable of isometric strength - bent arm hang (s). For evaluation of the motor ability speed, the standardized test was applied, which represented the criterion variable - the result obtained in 60 m run (s). The relationship between the system of predictor variables and the criterion variable is calculated by linear regression analysis, and the results showed that, on the basis of the results of the predictor variables system, the level of sprinting speed can be statistically significantly predicted. By observing the individual variables, it can be seen that the variables standing broad jump (p=0.00) and sit-ups (p=0.00) achieve statistically significant prediction of 60 m run speed. By analyzing the results of regression analysis, it can be assumed that the result of the 60 m run in selected subjects can be predicted based on manifestation of explosive leg strength and repetitive strength of torso.

Key words: *sprint speed, strength, girls, explosive strength, repetitive strength.*

INTRODUCTION

Running is a natural form of movement and the basis of every exercise which is the foundation of many sports (Findak & Mraković, 2003). In addition to being a basis of every movement and many sports, it can be said that running has a very significant impact on overall health if practiced in natural and healthy conditions (Janković, 1998). Running is defined in the central nervous system, and its efficiency and speed depend on a number of inherent functions (Babić & Čoh, 2010). It is believed that functional and motor abilities are among the most responsible for success in short distance running (Homenkov 1977, Milanović 2007, Mihajlović & Tončev, 2008), and good technique, speed of alternative movements, explosive strength and maximum force of attempted movements are considered the most important factors in achieving high results on short tracks. The maximum speed that a human can manifest in any motion depends on a variety of factors which are related to morphological and physiological characteristics, energy mechanisms, gender, age, biomotor abilities, inter- and intramuscular coordination and optimal biomechanics of movement techniques (Čoh & Bošnjak, 2010). When talking about running for children, it referes to "natural biological development of sprint speed" (Babić & Čoh, 2010) that are most influenced by body height and weight, development of motor abilities and formation of motor stereotypes. Success of a child in sprinting disciplines depends, inter alia, on the period when the child begins to train - it is desirable that the child starts speed training before puberty, because this period is characterized by a balanced and proportionate development, and functional maturation (Bompa, 2000). Since the sprint type speed is a very important ability which causes success of an athlete in a number of situations during their sports career (Babić & Čoh, 2010), this paper will be focused on that activity. Sprinting is the fastest form of natural movement of human and it consists of repeating racing steps (Ibid.), more precisely, it represents a series of explosive jumps incorporated into a single coherent whole, whose basic task is to achieve maximum running speed as fast as possible and to preserve the achieved speed as long as possible (Marinković, 1977). In quick terminal sprint type movements, the development of force is a crucial factor in the efficiency of the movement, in which the variables of motor programme are the maximum force of agonist muscles, maximum force of antagonist muscles, delay time of antagonist muscles, time to reach maximum force of antagonist muscles, coactivation of muscles in the function of the position of kinetic chain, length of the movement, terminal position, starting position, duration of the movement and movement speed (Ilić, 1999). Since faster movement is more appropriate for children, such movements are very beneficial and in harmony with a young organism (Ibid.), and mastering the proper sprinting technique is important for prevention of injuries and uncontrolled falls caused by poor running performance and poor coordination of movements which is not compatible with the running speed. It is known that the most important abilities and features for engaging in athletic disciplines are best developed in certain, sensitive stages of life (Sozanski, 1981; Zeličenok, 1998), and it is assumed that the largest increase in running speed can be achieved if the training begins before puberty. In that period, the speed is naturally developed: from 7th to 11th and from 13th to 14th year in girls and from 7th to 10th and from 15th to 16th year in boys (Sozanski, 1981). Vraneković, Tkalčić & Horvatin-Fučkar (2008) studied the relations between anthropometric dimensions and 60 m running on a sample of 345 students aged 13 years ± 6 months. The results have shown that anthropometric variables in both manifest and latent space have significant impact on the outcome of sprinting. Given the necessity of timely orientation of children for athletic disciplines, it is important to be able to perform effective and applicable

verification of those abilities and characteristics that have contribution in achievement of better results in sprinting. Therefore, the objective of this study was to examine the connection between motor ability strength and achievement of results in sprinting in order to define strength tests to perform selection in physical education classes, at the age of early puberty.

METHODS

The study was of transversal character, conducted during two weeks at physical education classes, where, after adequate preparation through introductory and preparatory part of the class, the value of the variable speed was determined during the main part of the first class, and the variable strength was determined at the second class. The sample consisted of 88 girls (12 years ± 6 months) in the fifth grade, selected by random choice method. A systematic review has found that they were healthy and without injuries of the locomotor apparatus. Also, they were not involved in a training process, engaged in organized recreational activities and they were not prepared for the research by some exercise program.

The batery of four tests was used for evaluation of the motor ability strength, prescribed in the curriculum for the subject Physical Education of the Pedagogical Association of Vojvodina: variables of explosive strength - standing broad jump (cm), throwing medicine ball from lying position (m), variable of repetitive strength - sit-ups (number of successful attempts) and variable of isometric strength - bent arm hang (s). For evaluation of the motor ability speed, the standardized test was applied, which represented the criterion variable - the result obtained in 60 m run (s).

The SPSS 20.0 statistical program was used to calculate basic statistical parameters (arithmetic mean and standard deviation), whereas the linear regression analysis was applied to pre-formed sub-sample of girls, in order to determine connectivity and prediction of the system of predictor variables with the criterion variable.

RESULTS

Table 1 Descriptive statistics of analyzed variables

Variable	AM	SD	KS-test
Standing broad jump	177.20	24.310	0.13
Throwing medicine ball from lying position	5.73	4.18	0.73
Sit-ups	39.54	7.129	0.18
Bent arm hang	53.08	26.529	0.49
60 m run	12.30	3.993	0.32

Legend: AS-arithmetic mean; SD-standard deviation; KS-test Kolmogorov-Smirnov test

Table 1 shows central and dispersion parameters. Based on them, it can be concluded that the highest values of standard deviations are observed in the tests standing broad jump and bent arm hang, which indicates the fact that the results of these tests deviated the most from the average value of this sample of subjects. This can be attributed to a variety of daily physical activities of children in their spare time. When talking about the homogeneity of the results, it

can be concluded that the highest homogeneity of the results, around arithmetic mean, was obtained in 60 m run and throwing medicine ball from lying position.

Table 2 shows the results of regression analysis of motor abilities, that is, the analysis of the prediction of the system of predictor variables on the criterion variable, that is, on the result obtained in the 60 m run in girls.

Table 2 Regression analysis

Variable	r	p	r_{part}	p_{part}	Beta	p_{bete}
Standing broad jump	0.67	0.00	0.08	0.001	-0.576	0.001
Throwing medicine ball from lying position	0.62	0.00	0.02	0.523	0.156	0.523
Sit-ups	0.64	0.00	-0.11	0.000	-0.135	0.000
Bent arm hang	0.59	0.00	0.24	0.397	-0.123	0.397
R=0.633		**R^2=0.492**		**P=0.000**		

Legend: r - Pearson correlation coefficient; p - level of statistical significance for r; r_{part} - partial correlation coefficient; p_{prat} - level of statistical significance for r_{part};Beta - regression coefficient; pbete - level of significance of regression coefficient; R - multiple correlation coefficient; R2 - determination coefficient; P - significance of coefficient of multiple correlation

After examining this table, it was determined that the results of the examined criterion can be statistically significantly predicted based on the results of the system of predictor variables (p=0.00) at the value of multiple correlation coefficient R=0.633, which explains 49.2% of the common variability, while the other percentage may be attributed to some other factors which are not included in the given predictor system, and are directly connected with the efficiency of sprinting technique and achievement of the results (stride length, phases of resistance, duration of foot contact with the ground, other longitudinal dimensions, cognitive and connative characteristics, condition of the muscles, inter- and intramuscular coordination). Likewise, by observing the individual results of some of the variables, it can be concluded that the results of criterion variable can be statistically significantly predicted based on the results of variables standing broad jump (p=0.00) and sit-ups (p=0.00). Girls with higher values of the said predictor system of variables have achieved better results in the test for assessing the running speed, which means that more detailed and further training for manifestation of explosive leg strength and repetitive torso strength could contribute to improved results in the 60 m run in these subjects. Also, based on the Pearson correlation coefficient, it can be concluded that subjects with higher values of the variable for motor ability strength have achieved statistically more significant ($p \leq 0.01$), better results in the test for assessing the sprinting speed.

The results of partial correlation from the same table indicate that, for the most part, the result of the 60 m run is determined by the variables standing broad jump (p_{par}=0.001) and sit-ups (p_{part} p= 0.000). It can be noted that other analyzed variables for assessing other forms of strength - explosive arm strength (throwing medicine ball from lying position) and strength endurance (bent arm hang), diminish the possibility of achieving better results in this sample of subjects (after partialisation, the coefficient of partial correlation was significantly reduced compared to the Pearson coefficient).

DISCUSSION

The study showed a relatively equal prediction of criterion variable results on the basis of results of a set of predictor variables that have analyzed various forms of strength, which clearly indicates the importance of determining the factors associated with sprinting. Zagorac (1984) researched the association of motor abilities, but in 600 m run (among other tests), and he proved that motor abilities are strongly and positively associated with the running result, which means that development of motor skills can improve the running results in children 11-13 years old. Mihajlović & Tončev (2008) argue that decisive parts of technique for top performance in the future competition are being adopted at the age of 14 to 19 years, and therefore they believe that a very important fact is to start with the development of motor skills and improvment of their level two years before that, so the technique can later be perfected and the best results reached. The research project MZOS RH, conducted in 2003/2004, contained a study which referred to children of primary school age, and it examined motor abilities along with the attendance of athletics, sprint running, as additional physical activity. The results were that motor abilities were improved thanks to attendance of athletic in the form of sprinting. This means that, in addition to development of motor abilities in order to improve results in short distance running, the short distance running technique has to be exercised in order to improve the running result. Most of the researchers argue in their studies that the inborn coefficient is responsible for the level of speed as motor ability 95%, while possible improvement of the same by exercising can be only 5% (Wilmore & Costill, 1994). Due to complexity of anatomical and physiological structure of the movement apparatus and different structure of muscle fibers and dimensions of particular segments of human body, it is difficult to determine the ideal model of movement of short distance runners. This is why scientific literature and training practice deal mostly with the issues of general laws of muscle contraction and mutual influence of particular groups of muscles while executing maximum quick movements. Researches of Opavski (1975) indicate that short distance running speed is shown in the last support period, while the additional factors are the swing of the swinging leg and the swing of the opposite arm. Because of the greater mass and greater amplitude of movement, including a technical detail such as the swing of the swinging leg, which represents a significant part of the basic factor that in the last support (resistance) period, the side of swinging leg moves faster than the side of stepping leg. Runners should attempt to place the front part of the foot closer to the vertical projection of the center of gravity of the body (in accordance with the speed of movement), to shorten the amortization phase. At the end of the racing section there is a speed reduction. The cause of this phenomenon is a constant task of researchers, but most likely the cause is the change in the functional state of the central nervous system and local fatigue of actual muscle groups (Bompa, 2006).

Given that the aim of this study was to determine which of the tests for prediction of strength, as prescribed by the syllabus for subject Physical education, can be used to assess predispositions for short distance running in early age of girls, and with respect to all of the above, it can be concluded that this sample showed direct correlation of two forms of strength - explosive leg strength and repetitive torso strength with the result of 60 m run. Developing the maximum speed requires a very subtle intermuscular coordination of muscle groups of the lower extremities, of which the most important role is played by the following muscles: m. gluteus maximus, m. tibialis anterior, m. soleus, m. gastrocnemius, m. rectus femoris, m. biceps femoris, m. vastus lateralis (Čoh & Bošnjak, 2010), which is associated with the obtained results of this study, since the specified muscles provide explosive leg strength and, together with abdominal

muscles (which provide repetitive torso strength), are part of the chain of movement required for efficient short distance running. Therefore, it was determined that, for this sample of subjects, it was possible to make selection for short distance running on the basis of the results obtained in these strength tests, and that these two tests are usable in estimating the motor value of speed, and that it is necessary for them to continue to be implemented within the curriculum of Physical Education.

CONCLUSION

With reference to the results obtained in this study, it can be concluded that the running speed as the motor ability, which was analyzed by 60 m run test in girls aged 12 years, can be statistically significantly predicted on the basis of the results of some tests that assess various aspects of strength as a motor ability, as confirmed by research (Babić, 2005; Strel, Bizjak, Starc & Kovač, 2009; Vraneković, Tkalčić & Horvatin-Fučkar, 2008), who, on a similar sample of subjects, have proved that motor abilities are positively associated with the result in 60 m run. The obtained study results showed that not all the variables had demonstrated statistical significance. The variables that were distinguished as those that contribute most to the improvement of manifestation of speed as motor ability are standing broad jump and sit-ups, and that increasing their values leads to improvement in manifestation of speed measured by 60 m run test. The importance of research of this nature is reflected in the improvement of sports science, because it allows for understanding of sport talent, and therefore predicting the sport achievements. The existence and availability of such researches clarifies the issue of finding talents and eliminates subjectivity of sports experts in selection. Knowing the abilities and features that are critical for success in sports is important for the proper selection and orientation of potential athletes, and especially for programming and implementation of teaching and training process and for monitoring the results of these processes. Analysis of the obtained ability results can offer specific and optimal solutions and therefore the loss of time and wrong orientation can be avoided.

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Correspondence author:
Nikola Radulović
Faculty of Sport and Physical Education
University of Novi Sad
Serbia
nikolaradulovicfsfv@gmail.com

SAŽETAK

Cilj istraživanja bio je da se ispita povezanost motoričke sposobnosti snage sa postizanjem rezultata u sprinterskom trčanju radi definisanja testova snage kojima se može vršiti selekcija na časovima fizičkog vaspitanja u uzrastu ranog puberteta. Uzorak je činilo 88 ispitanika ženskog pola uzrasta 12 godina (± 6 mjeseci). Za procenu motoričke sposobnosti snage korištena je baterija od četiri testa koji su propisani nastavnim planom i programom predmeta Fizičko vaspitanje Pedagoškog saveza Vojvodine: varijable eksplozivne snage - skok u dalj iz mesta (cm), bacanje medicinke iz ležanja na leđima (m), varijabla repetitivne snage - podizanje trupa (broj uspešnih pokušaja) i varijabla izometrijske snage - izdržaj u visu zgibom (s). Za procenu motoričke sposobnosti brzine primenjen je standardizovani test koji je predstavljao kriterijumsku varijablu - rezultat postignut u trčanju na 60 m (s). Povezanost sistema prediktorskih varijabli sa kriterijumskom varijablom izračunat je linearnom regresionom analizom, a rezultati istraživanja su pokazali da se na osnovu rezultata prediktorskog sistema varijabli statistički značajno može predvideti nivo sprinterske brzine trčanja. Pojedinačnim posmatranjem varijabli može se uočiti da varijable skok u dalj iz mesta (p=0,00) i podizanje trupa (p=0,00) ostvaruju statistički značajno predviđanje brzine trčanja na 60 m. Analizirajući rezultate regresione analize, može se pretpostaviti da se rezultat u trčanju na 60 m kod selektovanih ispitanica može predvideti na osnovu manifestacija eksplozivne snage nogu i repetitivne snage trupa.

***Ključne riječi**: sprinterska brzina, snaga, devojčice, eksplozivna snaga, repetitivna snaga.*