Slavenko Likić[1], Nusret Smajlović[2], Ivan Hmjelovjec[2] and Nedeljko Vidović[3]

Prediction of Achivement in Athletic disciplines 60m running, 60m Hurdles and Triple Jump by Means of Some Morphological and Motor Dimensions

Key words: **sprint and jump athletic disciplines, basic motor abilities, specific coordination qualities**
Ključne riječi: **Sprintersko-skakačke atletske discipline, osnovne motoričke sposobnosti, specifične koordinacijske kvalitete**

Abstract
On a sample of 54 male students (age 19 – 21) of sport studies at the Teachers' Faculty in Mostar, the multiple regression analysis – Stepwise method, determined the predictive general and partial contribution of some morphological and motor variables in achieving successful results in the sprint and jump athletic disciplines (60m running, 60m running with hurdles and triple jump) being discussed. Cross-correlation analysis was used in order to find out relations between predictor morphological and motor variables and criteria variables. The results of this research proved that these speed and jump abilities are the most important factor in achieving efficient results in all sprint and jump athletic disciplines, and that a successful result in these athletic disciplines is the expression of a high synergy between motor abilities and movement coordination

Sažetak
Predikcija postignuća u atletskim disciplinama trčanje na 60m, trčanje na 60m prepone i troskok pomoću nekih morfoloških i motoričkih dimenzija
Na uzorku od 54 studenta starosti od 19 - 21 godinu studija sporta na Nastavničkom fakultetu u Mostaru primjenom višestruke regresione analize - metodom Stepwise utvrđivan je prediktivni opći i parcijalni doprinos nekih morfoloških i motoričkih dimenzija u ostvarivanju rezultatske uspješnosti u tretiranim sprintersko - skakačkim atletskim disciplinama (trčanje na 60m, trčanje 60m sa preponama i troskok). Kros-korelacionom analizom je ostvaren uvid u relacije tretiranih sprintersko - skakačkih atletskih disciplina sa morfološkim i motoričkim varijablama.
Potvrdili su se rezultati mnogih dosadašnjih istraživanja sa sličnom problematikom da su ove brzinsko – skakačke sposobnosti najvažniji faktor u ostvarivanju rezultatske efikasnosti u svim sprinterskim – skakačkim disciplinama, te da je rezultatska uspješnost u ovim atletskim disciplinama izraz visoke sinergije motoričkih sposobnosti i koordinacije pokreta.

Introduction

Athletics is a very complex multidisciplinary sport branch. Athletic disciplines belong to the group of mono-structural movement of cyclical, encyclical or compound type. In athletics, i.e. in athletic disciplines that define it, there is typically a great number of different types, i.e. structures of movement, mostly including take-offs, swings, falls, landings, and consequently a very complex system of demanding values in the morphological and particularly motor abilities space with respect to result efficiency in individual athletic disciplines. The basis of successful results in sprint and jump athletic disciplines of 60m running, 60m hurdles and triple jump is made up both of primary motor abilities of speed-cyclic character and specific coordination qualities.

Running in short athletic disciplines (60, 100, 200 and 400m) belongs to cyclic exercises of maximum intensity, and is characterized by relatively short action 6.5 – 50 seconds (phosphate – glykolitic work). General time of running over the track depends on several factors, the ability to respond fast to the starter's signal, the quality of start acceleration (how fast they reach the appropriate running speed), and the athletes ability to maintain the same speed to the end of track without significant decrease while running (Petrovski, Sadovski, 1977). Running speed is also determined by step length and step frequency. While running along distance, the most favorable ration between these two factors' values is determined by the runner's anthropometric characteristics and motor abilities. Step frequency is closely related to the duration of contact phase (Mero, Komi and Gregor, 1992). The shorter the contact time, the bigger the running step frequency. Duration of contact also shows the level of explosive strength of lower extremities' muscles during take-off (Luhtanen and Komi, 1980; Komi, 1984). According to numerous researches (Komi, 1984; Čoh, 1988; Kampmiller et al., 1996), duration of step contact phase is one of the most important predictors of sprint running efficiency.
Hurdles' running belongs to compound and coordinated technical athletic disciplines with cyclical, speed-power movement. The major problem of the technique in running with hurdles is crossing athletic hurdles with the so-called hurdle-step. The analysis of motor abilities which lie in the basis of the runner's successful result reveals a need for a broad range of various abilities. Top results in athletic disciplines with hurdles require above-average coordination, sense of rhythm, speed, strength, flexibility, endurance on the track and good technique (Smajlović & Babić, 1998). Still, regardless of the hurdler's technical skill, he should always have a high level of speed on the track and use the speed efficiently in negotiating hurdles. Without strength, particularly the specific one, success in running with hurdles is inconceivable. Flexibility is a necessary motor ability of hurdle-runner for improvement in the technique of negotiating hurdles.
Triple jump is technically a compound athletic discipline, where phases of support and flight in 'hop'. 'step', and 'jump', i.e. the first, second and third jump alternate with the speed of 10.5 m/sec. The length of a triple-jumper's flight depends on the starting speed of flight, angle and height of body gravity center after each take-off (Krejer, 1977). With respect to a triple jump successful result and creating an efficient movement form, the level of triple-

[1] Teachers' Faculty of University 'Džemal Bijedić' of Mostar
[2] Faculty of Sport and Physical Education, University of Sarajevo
[3] Buildings Faculty, University of Sarajevo

jumpers specific movement coordination and level of speed and strength motor abilities has a decisive influence (Krejer, 1977).
Since the basis of successful results in sprint and jump disciplines of 60m running, 60m hurdles and triple jump consists of both primary motor ability of speed-cyclic character and specific coordination qualities, the problem of this research was to determine relations of these motor qualities through a system of predictive variables relative to the three discussed sprint and jump athletic disciplines as criteria variables. A great number of researches dealt with relations of individual anthropological areas to successful results in individual athletic disciplines.
The goal of this research is to evaluate predictive general and partial contribution of the variables representative of contents that are typically used in methodological approach to teaching and improving the technique of the discussed athletic disciplines, as well as the content for developing motor abilities that form the basis of successful results in sprint and jump athletic disciplines (Smajlović, Babić, 1998).

Methods

Sample of the examined

The sample of respondents consisted of 54 male students (age 19 – 21) of sport studies at the Teachers' Faculty of University "Džemal Bijedić" in Mostar, who were attending the course in Athletics in accordance with the curriculum.

Sample of variables

The sample of variables in this research consisted of 20 predictive and three criteria variables. The Logic of the predictive variables choice was based on contents typically used in methodological procedure of teaching and improving the technique of discussed sprint and jump athletic disciplines, as well as the content for developing motor abilities that form the basis of successful results in these athletic disciplines (Smajlović, Babić, 1998). The sample of predictive variables consisted of three variable groups.
The first group consisted of three predictive variables for estimating anthropometric dimensions: stature (ATVIS), body mass (ATMASA), lower extremities' length (ADUZNO). Body mass index (ABMI) joined the group of anthropometric variables.
The second group consisted of ten predictive variables for estimating basic motor abilities: a) variables for estimating speed-strength abilities of body: strength of abdominal muscles (MSTRB), strength of back muscles (MSLED), strength of side abdominal muscles – left hip (MSBOCL), strength of side abdominal muscles – right hip (MSBOCD); b) variables for estimating the speed of locomotion: 7,5-meter running (MBL7), 15-meter running (MBL15), 30-meter running (MBL30); c) variables for estimating speed-strength abilities of jumping type: high jump from the spot (MBSM), high jump from the spot with landing from a 33cm-high stool (MBSS), and quintuple jump from the spot (MBSP).
The third predictive group of variables consisted of six variables for estimating respondents' specific coordination ability: flamingo test with closed eyes (KOFLA), dosing–control of neuromuscular excitation in long jump from the spot (KDOSM), dosing–control of neuromuscular excitation in triple-step jump (KODOTR), coordination in space (KOPRO), movement decomposition (KODEK), long jump from the spot backwards (KODSUN).
The criteria sample of variables included variables for estimating successful results in the taught athletic disciplines: 60m running (REZ60), 60m running with hurdles (REZ60PR), and triple jump (REZTRO).

Data processing methods

Predictive general and partial contribution of variables of morphological and motor area to the successful results in discussed sprint and jump athletic disciplines was estimated by means of multiple regression analysis. The Stepwise method was used. Stepwise is a successive procedure of the selection of introducing variables into a regression equation. Cross-correlation analysis was used in order to gain insight into the level of variable relations in the discussed sprint and jump athletic disciplines with morphological and motor abilities variables.

Results and Discussion

Results of this research successively singled out three variable of the greatest statistical predictive significance for the dependent variable of 60m running (table 1). The greatest predictive value for the result of 60m running is attached to the result of 30m running (MBL30) with the determination coefficient .031. The logical determinant for the result of 60m running with the variables 30m running and quintuple jump from the spot results from the fact that acceleration in 30m running is achieved by means of multiple explosive feet take-offs, which are characteristic of the locomotion structure of the variable quintuple jump from the spot. Variable body coordination in space (KOPRO) additionally determines the prediction of the 60m running result with the determination coefficient of .02. The predictive significance of the variable body coordination in space (KOPRO) is probably conditioned because this variable perceives fast coordination of movement in space. These three variables together determine the prediction of 60m running variable with 75 per cent.

Results of research successively singled out two variable of the greatest statistical predictive significance for the dependent variable of 60m hurdles (table 2). The greatest statistically significant prediction of the athletic discipline of 60m hurdles is possessed by the variable of 30m running (MBL30) with the determination coefficient of .64, which points to a more rational way of negotiating hurdle which, in turn, implies running across them with a less vertical oscillation of the trajectory of the body gravity center above the hurdle. Variable quintuple jump from the spot (MBSP) participates in the prediction of the result in 60m running with hurdles with the determination coefficient of .0638, which in turn confirms the significance of multiple repeated take-offs (5) necessary in take-off and attack on hurdles.

Table 1.
Multiple regression analysis – dependent variable 60 m running (REZ60)

Variables in the Equation						
Variables	R Square ch.	B	SE B	Beta	T	Sig. T
MBL30	.71819	1.197523	.219502	.613639	5.456	.0000
MBSP	.03070	-.171266	.067789	-.284240	-2.526	.0147
KOPRO	.02029	.072121	.034400	.142677	2.097	.0411
(constant)		3.911758	1.847333		2.118	.0392

Research analysis successively singled out two variables of the greatest statistical predictive significance for successful results in triple jump (table 3). Variable quintuple jump from the spot has the predictive value with a partial determination coefficient of .67, and the variable body-mass index (ABMI) has a manifest predictive determination coefficient at .036 level. The impact of this variable is negatively manifest by the value of B coefficient (-.077). Contribution of variable quintuple jump results from the almost identical locomotion structure with the variable of taught athletic discipline – triple jump. The negative contribution of body mass index (ABMI) for the result in triple jump can be explained by fact that respondents which have bigger values of body mass index has bigger ballast body mass, and because of that have more difficulties in performing triple jump than respondents which have thin body constitution.

Research results of Cross-correlation Analysis, used in order to gain insight into the level of relations of criteria variables of sprint and jump athletic disciplines with morphological and motor predictive variables, are shown in table 4.

Results in 60m running are determined by variables of basic motor abilities of the strength of left and right side of abdominal muscles (MSBOCL and MSBOCD) at the significance level of $p<.01$. All the other variables of basic motor abilities have correlations at the level of $p<.001$. The highest level of correlation with the result in the athletic discipline of 60m running is possessed by variables of 30m running (MBL30, $r=.8475$) and variable quintuple jump from the spot (MBSP, $r=.7812$). Logical link between the result in 60m running with the variable 30m running and quintuple jump from the spot stems from the fact that in 30m running, start acceleration is achieved by multiple explosive feet take-offs, which is characteristic for the locomotion structure of variable quintuple jump from the spot. 60m running correlates with only one variable of specific coordination ability – long jump from the spot backwards (KODSUN) at the significance level of $p<.01$.

The result of 60m hurdles has correlation with the anthropometric variable – lower extremities' length (ADUZNO) at the significance level of $p<.01$. This connection stems from the fact that a greater length of legs has a significant impact on the efficiency of hurdle negotiation technique. The variable of basic motor ability of the strength of the side part of abdominal muscles (MSBOCL) is significantly related to the result of running with hurdles at the level of $p<.01$ ($r=.4128$). It is assumed that this connection is due to the synergic impact of the strength of abdominal side muscles during the swinging leg attack on the hurdle. Same as in 60m running, all the other variables of basic motor abilities are significantly related to the results in 60m running with hurdles at the $p<.001$ level. The 60m hurdles is also related to a single variable of the specific coordination ability – long jump from the spot backwards, at the $p<.01$ level ($r=.3455$).

The result in the athletic discipline of triple jump is determined by the anthropometric variable of the lower extremities length (ADUZNO) at the significance level of $p<.001$. This is the highest level of determination of this variable with respect to all observed athletic disciplines ($r=.4609$), and can be considered logical, having in mind the selective factor of achieving higher results in jumping athletic disciplines. The variable of basic motor ability of the strength of abdominal side muscles (MSBOCL) is significantly related to the result in the athletic discipline of triple jump at the level of $p<.01$, due to the nature and sequence of triple jump take-offs (left – left – right). The other variables of basic motor abilities are related to the results in the athletic discipline of triple jump at the significance level of $p<.001$. The greatest contribution is manifested by the variable quintuple jump from the spot (MBSP, $r=.8184$), followed by the variable 30m running (MBL30, $r=.7383$). Results of the discipline of triple jump are related with the variable of specific coordination ability – decomposition of movement by a long jump from the spot backwards (KODSUN) at the significance level of $p<.01$.

Conclusion

Research results of regression analysis determined the highest predictive value on the result in 60m running are possessed by the variable result in 30m running (MBL30), variable quintuple jump from the spot (MBSP), and the variable coordination in space (KOPRO). The dominant predictive value on the result in 60m hurdles is also possessed by the variable 30m running, which indicates a more rational way of negotiating hurdles, which in turn implies their crossing with as small vertical oscillation as possible of the trajectory of the body gravity center above the hurdle. Statistically greatest predictive significance for the result in the dependent variable of triple jump is possessed by variable quintuple jump from the spot (MBSP) and variable body mass index (ABMI). The contribution of the variable quintuple jump stems from the almost identical locomotion structure with the variable of athletic discipline triple jump.

Cross-correlation analysis was used in order to gain insight into the level of relations of sprint and jump athletic disciplines as criteria variables with morphological and motor predictive variables.

Table 2.
Multiple regression analysis – dependent variable 60m hurdles (REZ60PR)

Variables in the Equation						
Varijabla	R Square ch.	B	SE B	Beta	T	Sig. T
MBL30	.64020	1.454844	.393028	.466769	3.702	.0005
MBSP	.06386	-.402560	.121349	-.418314	-3.317	.0017
(constant)		9.041699	3.270820		2.764	.0079

Table 3.
Multiple regression analysis – dependent variable triple jump (REZTRO)

Variables in the Equation						
Varijabla	R Square ch.	B	SE B	Beta	T	Sig. T
MBSP	.66980	.904070	.082387	.838246	10.973	.0000
ABMI	.03583	-.076870	.030852	-.190328	-2.492	.0160
(constant)		.155057	1.159557		.134	.8942

Results of 60m running, 60m hurdles and triple jump have correlations with all basic motor variables for estimating the speed of locomotion and variables for estimating speed-strength abilities of jumping type at the significance level of $p<.001$. The highest level of connection with the criteria variables of 60m running (REZ60) and 60m hurdles (REZ60PR) are possessed by the variable 30m running (MBL30) and variable quintuple jump from the spot (MBSP). The greatest contribution with criteria variable of triple jump (REZTRO) is possessed by variable quintuple jump from the spot (MBSP), followed by the variable 30m running (MB30). The result in the athletic discipline of triple jump is determined by the anthropometric variable length of lower extremities (ADUZNO) at the significance level of $p<.001$. All three criteria variables are correlated only with a single variable of the specific coordination ability – long jump from the spot backward (KODSUN), at the significance level of $p<.01$. It again proved the results of numerous previous researches dealing with similar issues, that these speed and jump abilities are the most important factor in achieving efficient results in all sprint and jump athletic disciplines, and that a successful result in these athletic disciplines is the expression of a high synergy between motor abilities and movement coordination.

Table 4.

Cross-correlation of results of athletic disciplines and results of morphological and motor variables

Cross – correlations	REZ60	REZ60PR	REZTRO
ATMASA	-.1395	-.0970	.0822
ADUZNO	-.2852	-.4006 *	.4609 **
ABMI	-.0732	.0248	-.1030
MSTRB	-.2888	-.2365	.2119
MSLED	-.0404	-.1723	.1914
MSBOCL	-.3785 *	-.4128 **	.3405 *
MSBOCD	-.3289 *	-.2287	.2419
MBL7	.5623 **	.5214 **	-.4949 **
MBL15	.6443 **	.6459 **	-.5078 **
MBL30	.8475 **	.8001 **	-.7383 **
MBSM	-.5277 **	-.4676 **	.5680 **
MBSS	-.5107 **	-.4823 **	.5151 **
MBSP	-.7812 **	-.7903 **	.8184 **
KOFLA	.0136	.0207	.0655
KDOSM	-.0594	-.0868	.1702
KDOTR	-.0567	-.0654	.0701
KOPRO	.1899	-.0529	-.1453
KODEK	-.0294	.1559	-.0366
KODSUN	-.3372 *	-.3455 *	.3615 *

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