PREDICTIVE VALUE OF KINEMATIC PARAMETERS ON THE RESULTS OF THE LONG JUMP WITH STUDENTS

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Abstract

The aim of the research is to determine predictive value of kinematics' parameter variable value of a long jump affecting effecting jump length. The research was conducted on the sample of 50 students I year of Faculty of physical education and sport. The sample of variables presented 9 kinematics parameters variables (as predictor variable system) and one variable effective long jump length (as criteria variable). In order to determine predictor set of variables and criteria variable of a long jump we applied regression analysis. Appliance of regression analysis we obtained that the coefficient of multiple correlations (R) of predictor set of data with criteria variable KPEDSK (effective long jump length). 806, with total variability (R Square) .646 on the level of significance .000, According to analysis of individual partial regression correlation of predictor variable kinematics parameters affecting criteria variable KPEDSK, we can conclude that the biggest and statistically significant influence had three variables as follows; KPBZ5M – speed in last 5 meters (.465 Beta), then KPVTTO variable – body gravity height at bounce (.556 Beta) and variable KPVTTL – body gravity height in the highest stage of a flight (.673 Beta). We assume that the results of the research can help further planning and programming of education, curriculum and training.

Key words: *athletics, ballistic movement, biomechanics, regression analysis*

INTRODUCTION

According to biomechanics characteristics, long jump belongs to a group of complex spatial movement and according to motor activity character belongs to a group of natural locomotion without usage of technical accessories. Long jump as athletic discipline consists of 4 divided phases: phase of approach, phase of bounce off, phase of leap and landing. (Hay, 1986). It is also familiar as "horizontal jump" an attempt to leap as far from the take-off point as possible.Long jump is determined by official lenght and it is measured from a foul line to a mark made in the sand by a jumper

It is necessary to emphasize that for the research purposes we use two measures while analyzing the long jump as follows:

- Official long jump length – according to IAAF athletic rules, and
- Effective long jump length – presents horizontal distance from the fingertips in the moment of bounce off to a mark made in the sand (this distance if usually longer then official long jump length).

Many researches are based on biomechanics indicator determination that confirms success and the form of long jump performance and we usually talk about kinematics analysis. Relations between speed of approach and jump distance are clear and cross-study (Hay 1993). Many jumpers use their maximal speed of approach combined with technique (optimal technique is used to achieve as bigger speed while sprinting as possible and to bounce off as much as possible) hoping to achieve the longest possible distance(Bridgett, A., Gallowayl. M., P. Linthorne, 2002). Some previous studies (A. Lees, A., Fowler N., Derby, D., 1993; Hay, J. G., Miller, J. A. 1985) also researched the time of leg contact with the base and the phase of take off during long jump and tried to research correlation between variables.

Different variables of a long jump were used in a range of correlations and multiple regression analysis. Relation between variables that correlated was small. However, when the multiple regression analysis was conducted, series of variables were identified as the ones that support the general rules from the model. These variables could be interpreted as a condition of speed, technique and power (Graham-Smith, P & A. Lees, 2005). Discoveries about kinematics and dynamic long jump

parameters were concentrated and synthesized through discoveries that the phase of a take off is one of the most important phases in long jump discipline. Besides take off phase, speed projection, angle projection, current angle and bounceoff present the most important long jump characteristics. While approaching, the jumpers regulate acceleration using their visual regulation in the last three steps (Glize, D., Laurent, M.1997). The place they will put their leg on the board, could obstruct the way of a jump. First thing to do is to decrease the loss of horizontal speed, (its reduction) and secondly encourage the development of vertical velocity. There is a cooperation between speed projection and angle projection that range 15° to 27° (Koutsioras, I.,Panagiotis, T. & Tsiokanos, A. 2008). The phase of a flight is limited by angle impulse. Without quantity angle momentum reduction in early landing the jump distance reduction will occur. Most of biomechanics long jump studies is connected with kinematics characteristics, and in the future researches should be focused on kinematics and dynamics young athlete characteristics. (Koutsioras, I.,Panagiotis, T. & Tsiokanos, A. 2008). This research is just a shift in this direction presenting actuation for annual planning of curriculum and sports training.

METHODS

Participants

The research was conducted on the sample of 50 students, age from 18 to 21, Faculty of physical education and sports. Respondents graduated in Athletics I and II exercises according to Faculty of physical education and sports, University of Tuzla curriculum.

Instruments

The measuring instruments of this research were kinematics long jump parameters (9 variables) as predictor set of variables and criteria variable (1 variable) effective long jump length.

Variables to estimate kinematics parameters (predictor set of variables)

Predictor's set consists of 9 variables for kinematics parameter estimation presented in table 1 as follows:

Table.1 The variables' names, marks and measurement unit

Variable	Marking	Measurement unit
Speed in the last 5 meter	**KPBZ5M**	m/s
Speed TT at the time of arrival for a take off	**KPBTTD**	m/s
Speed TT during take off phase	**KPBTTO**	m/s
Time of foot contact with base while taking off	**KPVKSP**	ms
Angle of knee joint of the bouncing leg approaching	**KPUDNG**	degree
Angle of knee joint of the bouncing leg taking off	**KPUONG**	degree
Angle of take off TT	**KPUUTT**	degree
Height TT in the phase of bounce off	**KPVTTO**	cm
Height TT in the highest phase of flight	**KPVTTL**	cm

Criterion variable sample

For the purpose of this research as criteria variable we choose effective long jump length

Effective long jump length - **(KPEDSK)**

Data gathering

The measuring was conducted on stadium "Tušanj" that meets all the measuring requirements. The space was adequate to all criteria and conditions for long jump, suitable for equipment setting, but primarily camera with enough light which increased video quality. Temperature was around 25 şC which helped respondents to have good preparation for the jump and to remain prepared which could impact the measuring results. Respondents, before the measuring, had a chance for a trial attempt and later three jumps that were analyzed for this research.

Video gathering

Video acquisition necessary for kinematics analysis was made with one digital camera, 50 pictures per minute and 1/500 ISO. Camera was set at angle of 90^0 on the 8 m distance. Before the actual recording preparation of area calibration with calibration frame (200 x 200 cm) was performed in order to enable accurate area calibration during analysis. After data gathering and taken recordings we conducted data processing (the longest jump for each respondent) through phases required for

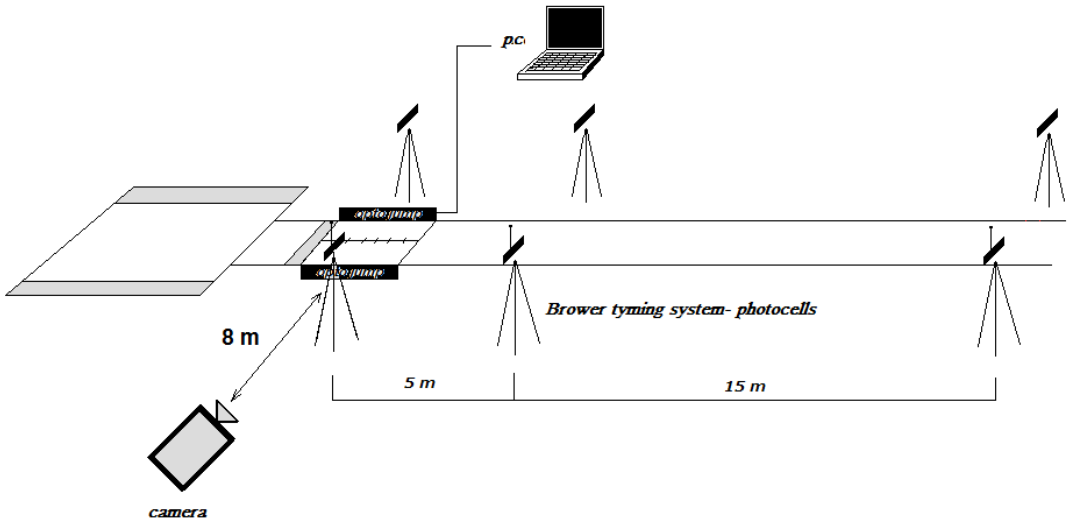
program package Contemplas (Professional motion analysis software):
This includes:

- Frame gradding
- Digitalization
- Filtering
- Kinematics measures calculation
- Data presentation

In order to gather data for this research, besides using camera for video acquisition we also used optical measurement system "Optojump" made in Italy by Microgate and we measured the time of contact with basis during bounce off and Browing timing system with three pairs of photocells that measured speed in the last 5 meters.

In the figure No.1 is shown a way of positioning of the equipment on the premises where the jump was performed

Figure 1
Schematic picture of kinematics measures polygon



RESULTS

Data obtained in this research were processed with program package SPSS 17.0, a data processing was conducted on Faculty of physical education and sports, University of Tuzla. In order to establish influence of predictor set of variables of kinematics parameters affecting criteria variable regression analysis was applied.

With regression analysis applying (Table 2) we obtained that multiple correlation coefficient (R) of predictor data set with criteria variable KPEDSK (effective long jump length) .806, with total variability (R Square) .646, on the level of significance .000. This means that predictor kinematics parameter set of variables describes given criteria with 64% while the rest 36% belongs to other anthropological characteristics that we did not include in this research.

Table 1
Kinematics parameter predictor system and criterion variable KPEDSK regression analysis

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	**,806[a]**	**,649**	,570	27,776	,649	8,229	9	40	**,000**

a. Predictors: (Constant), KPVTTL, KPBTTO, KPUDNG, KPUONG, KPVKSP, KPUUTT, KPBZ5M, KPBTTD, KPVTTO

Table 2
ANOVA[b]

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	**Regression**	57139,359	9	6348,818	8,229	**,000[a]**
	Residual	30861,221	40	771,531		
	Total	88000,580	49			

a. Predictors: (Constant), KPVTTL, KPBTTO, KPUDNG, KPUONG, KPVKSP, KPUUTT, KPBZ5M, KPBTTD, KPVTTO

b. Dependent Variable: KPEDSK

According to analysis of individual partial regression correlation coefficient impact (Table 3), predictor variable kinematics parameters on criteria variable KPEDSK, we can conclude that the biggest influence have three variables as follows: KPEDSK – speed in the last 5 meters (.465 Beta), on the level of significance .001, then variable KPVTTO – body gravity height at bounce (.556 Beta) on the level of significance .005 and variable KPVTTL - body gravity height in the highest stage of a flight (.673 Beta) on the level of significance .003.

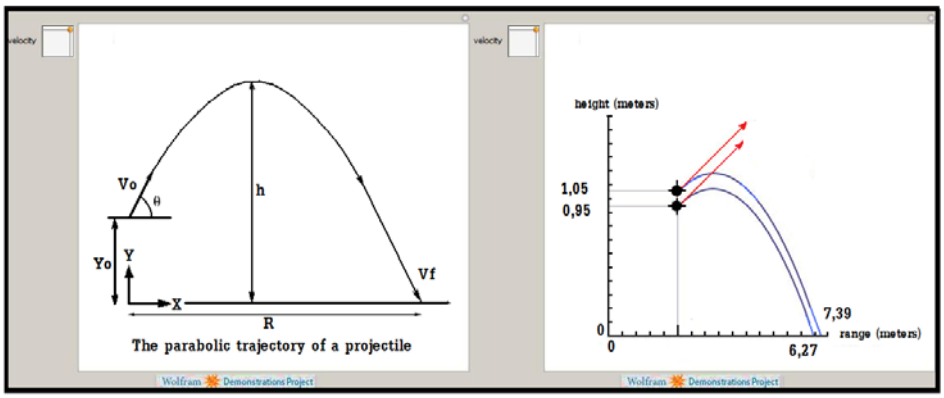
Table 3
Influence of individual regression correlation coefficients of predictor variable kinematics parameters and criteria variable KPEDSK

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-171,280	610,589		-,281	,781
KPBZ5M	42,567	11,906	,465	3,575	**,001**
KPBTTD	1,781	8,523	,032	,209	,836
KPBTTO	15,313	10,511	,213	1,457	,153
KPVKSP	-74,935	236,088	-,037	-,317	,753
KPUDNG	-,800	,792	-,098	-1,010	,319
KPUONG	,733	1,249	,070	,586	,561
KPUUTT	,770	3,314	,032	,232	,817
KPVTTO	-2,929	,986	,556	2,971	**,005**
KPVTTL	2,922	,933	,673	3,131	**,003**

DICUSSION

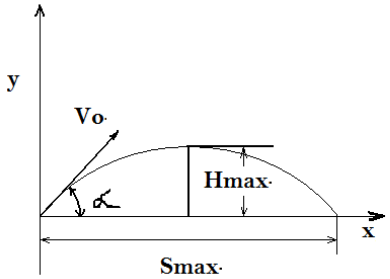
Considering variable KPBZ5M (Speed in the last 5 meters) and its influence on criteria variable KPEDSK (effective long jump length) we can attribute to mechanics rules and parameters that determine range of a skew sling. In fact, respondents that achieved bigger speed of the approach and bigger horizontal body gravity speed (TT) at the point of arrival to the place of a take off were able to use it and achieve better jump result. Similar research results we find in Voroviev's and Co (1991), Fukasiro and Wakayama (1992) who analyzed jumps of Lewis and Powel, when both jumpers broke world record in long jump discipline. Variable KPVTTO is proportional with variable KPEDSK (effective long jump length), in other words the respondents whose body gravitation, during take off, was higher achieved better results which can be explained with laws of mechanics skew sling. In our case, respondent that "launched" TT from a higher starting point, i.e. height of their body gravity during their last contact with basis was higher, according to laws of skew sling and projectile movement parameters achieve higher value in long jump length. This is presented in Figure 4 which shows differences in "projectile" range depending on "launching" height differences.

Figure 2 Variations between two levels of ejection



Impact of variable KPVTTL (body gravity height in the highest stage of flight) can be described by laws of mechanics, in other words factors that influence skew shot range. Observing trajectory of TT jumper in a long jump according to that trajectory we can conclude that body gravity is moving along skew shot trajectory. According to that fact, students that achieved higher height TT in a flight phase (we noted that variable KPVTTO has impact), were able to achieve further distance. We can calculate this with mathematical formula:

Vo- initial velocity
x,y - coordinates
Smax- maximum range
Hmax- maximum height
∠ - angle between Vo and x



CONCLUSION

According to results obtained, on the sample of respondents, 50 students age from 18 to 21, Faculty of physical education and sport, certain kinematics long jump parameters were determined that influence the effective jump length. Kinematics parameters included in this research have treated long jump kinematics parameters that include trail TT, height TT from the take off point and in the highest stage of a flight, the angle of a leap TT, angles of knee joint and time of contact with the ground.

Results obtained indicate that variables from predictor set of kinematics parameters participate in criteria variable success variability (effective length of a jump). The possibility of success prediction, i.e. achieving better results in a long jump can be confirmed according to this research. We should emphasize that introducing new technologies in sport and apparatus that is currently on the market and could be used for this research, can represent good basis for better understanding of a long jump as athletic discipline and possible success predictor. Also, the results of this research can give basis for a long jump biomechanics description so the research discovery can be implemented in creating and correcting current curriculum in athletics and sports education and training.

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PREDIKTIVNA VRIJEDNOST KINEMATIČKIH PARAMETARA NA REZULTAT PRI SKOKU U DALJ STUDENATA

Originalni naučni rad

Sažetak

Cilj rada je da se utvrdi prediktivna vrijednost varijabli kinematičkih parametara skoka u dalj na efektivnu dužina skoka. Istraživanje je sprovedeno na uzorku od 50 studenata I godine Fakulteta za tjelesni odgoj i sport. Uzorak varijabli je predstavljalo devet varijabli kinematičkih parametara (kao prediktorski sistem varijabli) te jedna varijabla, efektivna dužina skoka u dalj (kao kriterijska varijabla). U cilju utvrđivanja uticaja prediktorskog skupa varijabli i kriterijske varijable skok u dalj bila je primjenjena regresiona analiza. Primjenom regresione analize dobijeno je da je koeficijent multiple korelacije (R) prediktorskog skupa podataka sa kriterijskom varijablom KPEDSK (efektivna dužina skoka) .806 , sa ukupnim varijabilitetom (R Square) .646 , na statistički značajnom nivou .000. Na osnovu analize uticaja pojedinih parcijalnih regresionih koeficijenata korelacije kinematičkih parametara prediktorskih varijabli na kriterijsku varijablu KPEDSK, može se zaključiti da su najveće i statistički značajne uticaje imale tri varijable, i to: KPBZ5M- brzina zadnjih 5 metara (.465 Beta), zatim varijabla KPVTTO – visina težišta tijela kod odraza (.556 Beta), te varijabla KPVTTL – visina težišta tijela u najvišoj fazi leta(.673 Beta). Smatramo da rezultati istraživanja mogu služiti u svrhu kvalitetnijeg planiranja i programiranja kako nastave i nastavnih sadržaja tako i treninga.

Ključne riječi: *atletika, kosi hitac, biomehanika, regresiona analiza*

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