IMPACT OF SOME SPECIFIC KINEMATIC PARAMETERS ON THE 60M HURDLES RESULT

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Abstract

The aim of this paper was to determine the impact of some specific kinematic parameters on the result in 60 m hurdles. For this purpose, the sample included 7 female hurdlers aged 11-12 years who ran several times and each result was treated as a separate entity, with the total of 15 entities. All subjects are competitors in the hurdles event. A set of two specific kinematic parameters was applied. The first set describes start and initial acceleration, and the second set describes clearance of the first hurdle. Regression analysis was applied, which, from the first variable set, isolated Time to the first hurdle as a variable with significant impact, whereas in the second variable set, the isolated variables were Total first hurdle stride length, Flight time over the first hurdle, and Body inclination. The obtained results indicate that a more efficient mastering of the hurdles running technique is necessary to achieve better results in 60 m hurdles.

Key words: *kinematics, younger cadets, hurdles.*

Introduction

Hurdles is one of the most complex athletic disciplines in terms of motor and technical skills, and is characterised by cyclic, quick and powerful movement. The main problem in hurdles is hurdle clearance, which requires high level of technical skill. Elite hurdlers must have good flexibility, speed, power, mental stability, and high technical preparedness.

Top results in this discipline necessarily involve high level of technique, coordination, rhythm, speed, equilibrium, and power (Babić et al, 2015), in addition to flexibility, which is crucial, particularly in the hip area. There are ten or five hurdles, depending on the discipline (60 m, 100 m, 110 m, 400 m). Hurdles are crossed by hurdle steps. Hurdle running is predominated by movement speed and explosive power.

The main goal of hurdle running is the economy of movement with the minimum loss of speed. Hurdlers should be observed from different angles to detect errors which cannot be seen if an athlete is observed only from one side. Every athlete has her unique style of hurdle running which can be further developed, but not at the cost of losing speed.

To introduce the hurdle running technique and for the purpose of easier analysis, the hurdle run may be observed in the following segments: start, running to the first hurdle (initial acceleration), clearance of the first hurdle (initial acceleration), running between hurdles (running on the track), and finish (crossing the finish line).

In hurdle running, low start is performed in more difficult conditions than in sprint disciplines. A hurdler must achieve maximum speed over a limited distance from start to the first hurdle.

The characteristics of hurdle running are as follows:

a) In a hurdle start, at the command "set", hips are raised a bit more than in a 100m run start;
b) After the start – earlier stretching and lifting the upper trunk in vertical position in order to take a favourable position before attacking the first hurdle;
c) Earlier transition to a full-swing step.

The distance from start to the first hurdle is normally covered in 7-8 strides. The eight or the ninth stride is the hurdle clearance stride. The last stride before the hurdle must be shorter than the previous one. It is a mistake to make this step longer since it makes it more difficult to perform the take-off, attack and hurdle clearance correctly.

Efficient running to the first hurdle involves optimum rhythm, body opening as soon as possible, the take-off step being shorter than the preceding stride, efficient hurdle start progression, stepping on the optimal take-off point before attacking the hurdle.

After the take-off and hurdle attack, a hurdler reaches the flight phase - moving over the hurdle. At this stage, the lead leg is completely extended in the knee and directed forward, and its extending starts at the moment when the knee reaches the height of the hurdle bar. At the same time, the body is even more bent.

The plantar flexion of the foot of the lead leg, extended knee, and the most favourable body tilt, enable a hurdle clearance with minimum body OCT and good conditions to quickly lower the lead leg on the track. When the take-off is done, the take-off leg lags far behind the lead leg. However, after the lead leg is extended, the trail leg quickly catches up. Most previous studies have dealt with kinematics on senior population so there is only a small number of studies on younger cadets hurdlers.

Many studies have investigated the problem of impact of different factors on the hurdle race outcome (Čoh, 1988; Foreman, 1989; Gollhofer & Kyrolainen 1991; Čoh, 2003; Likić et al., 2008; Čoh et al., 2010).

The hurdles discipline is complex and difficult to study due to its structure and specificity. Previously published data of biomechanical analyses of certain athletic disciplines published in scientific research projects by IAAF (1988, 1997, 2009 and 2011) focused on the importance of a stable model of competition activity, particularly in achieving the best results.

The aim of this study was to determine some important kinematic parameters (start and clearance of the first hurdle) and result efficacy in 60 m hurdles among younger cadets hurdlers. To obtain as relevant results as possible, the study was conducted on a competitive population of female cadets hurdlers.

Methods

Subject sample
The subject sample of this study included 7 female track-and-field athletes, competitors in the 11-12 age group, competing in hurdles disciplines.

Variable sample
The variable sample included specific kinematic parameters of hurdle running, represented by start and initial acceleration to the first hurdle, and clearance of the first hurdle, whereas the criterion variable was represented by the 60 m hurdles result.

1. Variables for start and initial acceleration were as follows: Reaction time, Time to the first hurdle, Number of steps to the first hurdle, Speed and Length of the take-off step.

a) Reaction time – Time-interval between the starter's signal and the moment the subject is able to exert a certain amount of pressure on the starting blocks (**R60RT)**
b) Time to the first hurdle – Time interval between the starter's signal and the first hurdle (**R601H)**
c) Number of steps to the first hurdle – The number of steps necessary for a subject to reach the first hurdle (**NS1H**)
d) Speed of the take-off step – Speed of the last step before take-off and attack on the hurdle**(STS**)
e) Length of the take-off step – Length of the last step before take-off and attack on the hurdle(**LTS**)

2. Variables for clearance of the first hurdle were as follows: Total hurdle stride length, Flight time over the hurdle, Body inclination on the hurdle, Body mass centre height, and Lead leg knee angle during hurdle clearance.

1. Total first hurdle stride length – Distance from the take-off point to the hurdle during attack and from the first hurdle to the landing point of the lead leg behind the first hurdle (**T1HSL**)
2. Flight time over the first hurdle – Time necessary for hurdle clearance from the moment of the last contact of the take-off leg before the first hurdle to the first contact of the lead leg behind the first hurdle (**FT1H**)
3. Body mass centre height **–** Vertical distance from the horizontal surface to the top of the iliac crest at the moment of flying over the first hurdle when the body reaches maximum vertical height **(MCH1H**)
4. Body inclination – Minimum body inclination at hurdle clearance is the angle formed bythe horizontal line (body mass center and clavicula) parallel to the surface (**BI1H**)
5. Lead leg knee angle – Angle of intersection of two lines. The first line is determined by two points: knee and foot, whereas the second line is determined by knee and iliac crest (**LLKA1H**)

To assess the kinematic parameters, the following equipment was used:six sets of photocells for measuring movement dynamics on the competition track, Opto jump – an optical measurement system for determining kinematic parameters in running, the electronic starting block for measuring the start reaction time, SVHS 100HZ camcorders. A

nalysis was performed by Kinovea movement structure analysis software. The camcorder was positioned vertically onto the first hurdle at a 5-m distance on a 1.20-m tripod. The analysed space was calibrated by a reference framework (180x180x180 cm).

Methods of data analysis
Statistica ver. 12 software package (StatSoft, Inc., TULSA, USA) was used to analyse the obtained data. In accordance with the objectives of the study, the following methods were used:

- basic descriptive parameters were calculated for all variables,
- normality of variable distribution was tested by Kolmogorov-Smirnov test,
- multiple regression analysis was used to determine the impact of kinematic parameters on the 60 m hurdles result.
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Results and discussion

Basic descriptive statistical parameters for all the observed variables are presented in Table 1: arithmetic mean (AM), minimum (MIN) and maximum (MAX) result, standard deviation (SD), measures of asymmetry (Skew) and flatness (Kurt).

Kolmogorov-Smirnov test showed all variables had normal distribution.

Table1. Basic descriptive statistical parameters of kinematics parameters.

	N	AM	MIN	MAX	SD	Skew	Kurt
R60	15	10.65	9.61	11.79	0.541	0.114	0.636
R60RT	15	0.27	0.107	0.64	0.180	1.413	0.517
R601H	15	2.72	2.47	2.92	0.131	-0.213	-0.774
NS1H	15	8.33	7.00	9.00	0.617	-0.312	-0.404
STS	15	7.05	6.43	7.75	0.472	0.208	-1.624
LTS	15	157.13	140.00	192.00	15.165	0.893	0.519
T1HSL	15	288.60	257.34	327.27	19.342	0.175	-0.290
FT1H	15	0.476	0.38	0.55	0.049	-0.331	-0.327
MCH1H	15	120.65	114.96	126.82	3.924	0.097	-1.203
BI1H	15	46.53	34.00	61.00	9.156	0.282	-1.477
LLKA1H	15	157.80	134.00	176.00	11.509	-0.987	0.680

AM (arithmeticmean), MIN (minimum result), MAX (maximum result),
SD (standard deviation), Skewness (measure of asymmetry), Kurtosis (measure of flatness)
Minimum and maximum results, as well as their means, are presented in the table. However, due to the lack of previous studies dealing with this problem, these values cannot be compared.

Table 2. Regression analysis.

	b*	t	p-value
R601H	0.58	2.59	0.029
R60RT	0.12	0.54	0.601
NS1H	-0.09	-0.34	0.744
STS	-0.23	-1.24	0.245
LTS	-0.33	-1.33	0.217

R = 0.87; R^2 = 0.76; Adjusted R2= 0.63; F (5.9) = 5.76;
p < 0.012; Std. Error of estimate: 0.33; b*- unstandardized regression coefficient;
t – value used to test the significance of regression coefficients; p- level of significance

The regression analysis results reveal significant amount of mutual information of the variable set of 5 predictor variables and the 60 m hurdles result. Total of 76% of the explained variance was isolated, with multiple correlation coefficient of R=87 (Table 2).

In the predictor variable set, the variable with the greatest impact on the criterion variable was Time to the first hurdle, with coefficient b=0.58. The results are similar to those obtained on the senior sample in previous studies. This seems logical considering that time to the first hurdle determines the dynamics of the race, i.e., clearance of other hurdles. Studies conducted on Olympic medal winners have shown that, to achieve result efficacy in hurdles, the most balanced rhythm possible is required, with the smallest possible loss of speed. Since the subject sample in this study involved younger cadets , which have not yet been sufficiently investigated, the comparison with senior hurdlers yielded only Time to the first hurdle as a significant effect variable, whereas neither Speed nor Length of the take-off step were confirmed as significant parameters, neither was the Number of steps to the first hurdle, which has had significant effect in the senior sample (Winckler, 1994; Šnajder, 1997; Čoh, Kastelić & Pintarić, 1997; Tončev, 2001; Iskra & Čoh, 2006; Krzeszowski et al. 2016). These results may be explained by the subjects' age and by the fact that they have not yet mastered the hurdles technique in the best possible way, and have still not reached their maximum development, in neither morphological characteristics, nor motor skills.

Table3. Regression analysis.

	b*	t	p-value
T1HSL	-0.96	-4.72	0.001
FT1H	0.75	3.13	0.012
MCH1H	-0.23	-0.98	0.354
BI1H	0.42	2.28	0.048
LLKA1H	-0.30	-1.51	0.165

R = 0.86; R^2 = 0.74; Adjusted R2= 0.59; F (5.9) = 5.16;
p < 0.016; Std. Error of estimate: 0.34; b*- unstandardized regression coefficient;
t - value used to test the significance of regression coefficients; p - level of significance

The regression analysis reveals significant effect of the variable set of 5 predictor variables on the criterion variable(60 m hurdles result). Total of 74% of the explained variance was isolated, with coefficient of multiple correlation of R=0.86 (Table 3). In the predictor variable set, the variable with the greatest impact on the criterion variable was Total first hurdle stride length, with coefficient b=0.96, followed by Flight time over the first hurdle with coefficient b=0.75, and Body inclination variable with b=0.42. The obtained results are congruent with previous studies conducted on senior samples.The regression analysis results showed that the subjects in this phase should work on their technique to achieve better results, whereas in seniors, the significance of these variables is explained by their best possible performance and reaching a constant, i.e., in hurdle clearance, the loss of time is minimal and flight time is optimal, regarding the take-off distance and landing distance. This variable (Body inclination), interpreted with the other two variables, indicates that those hurdlers who have a smaller angle of deflection body to the horizontal achieve better results, which would mean they have a better technique of hurdle clearance.

Conclusion

The aim of this study was to determine the effect of specific kinematic parameters on 60 m hurdles result in younger cadet hurdlers (11-12 age). A set of 10 kinematic parameters was applied, divided into a set describing start and initial acceleration, and a set of parameters describing clearance of the first hurdle. For the criterion variable, the parameter was the 60 m hurdles result. The measurement was performed on the 7 best cadets in the Republic of Croatia. The results were analysed by multiple regression analysis which revealed a correlation between the predictor variable set and the criterion. Regression analysis of the first variable set (Time to the first hurdle, Reaction time, Number of steps to the first hurdle, Speed and Length of the take-off step) showed that Time to the first hurdle variable had the greatest effect. Regression analysis of the second set of kinematic parameters (Total hurdle stride length, Flight time over the hurdle, Body inclination, Lead leg knee angle) yielded three parameters as significant for success in 60 m hurdles: Total hurdle stride length and Flight time over the hurdle, along with the Body inclination variable. The results are congruent with previous findings obtained on senior subjects. The results provide an insight into the movement structure of younger cadetshurdlers running and can be used as guidelines for planning and programming training, as well as better selection.

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