48 - SELECTED TIME SPACE CHARACTERISTICS IN FEMALE POLE VAULT

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Abstract
This research is stressed at time and space characteristics (centre of gravity movements) in female pole vault. Kinetic parameters were gained by two-dimension analyser Consport Motion Analysis System (CMAS). There are involved 19 female pole vault jumpers with sport performance 380 – 483 cm, divided on 2 different groups; higher and lower level from the point of sport performance.
We found that in time parameters reached better results high performance level jumpers in phases hanging and lifting. It is coursed by better transmission on pole after take-off and by better work on the pole. As for the centre of gravity the jumpers of higher performance reached higher growth in all phases. The most significant difference can be seen in phase of lifting. Comparison of time and space characteristics enable to show the way for technique improvement in female pole-vault.

Key words: female pole vault, rhythm of the jump, centre of gravity height

Introduction

Pole vault is the only athletic event in which the performance is reached with use of tool. The pole use put this event away from fundamental locomotion and adjoins it to complex athletic events. The movement activity is realised in two basic parts; the first is approach ended with take-off and the second is the movement of jumper on the pole. The approach has cyclical movement structure and it is influenced with both arm holding, bearing and displacing pole. The movement activity on the pole has on the contrary acyclic character and it represents the structure of shifting movements in front and upside position at parallel rotation round horizontal and vertical body axes and round pole and that is performed at optimal time sequence – rhythm BOJKO - NIKONOV, 1989; GRABNER, 1997; McGINNIS, 1997; KRŠKA – KOŠTIAL, 2000; KRŠKA, 2008.

Pole vault sport performance structure is relatively very complicated from the point of view of biomechanical parameters. On the bases of two-dimension (2-D) analyse of group of female pole vault jumpers, KRSKA (2008) prepared by multiple correlation and regression analysis, where 76 variables were entering into process, the model of sport performance structure (fig 1).

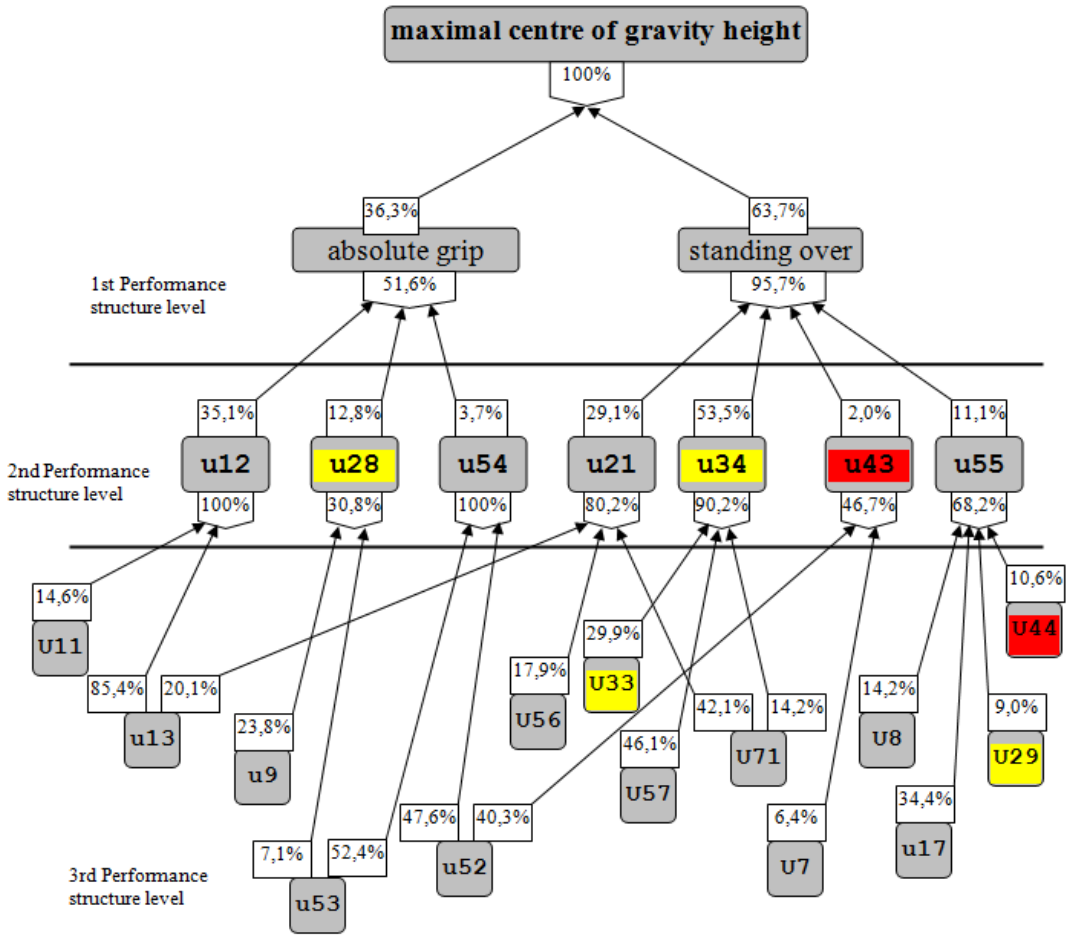


Fig 1 Female pole vault sport performance structure (Krska, 2011)
Legend: Time parameters Space parameters

We can see that 1st level is formed by two decisive variables: absolute grip (distance between bottom of the pole and hand grip of upper arm) and standing over (it means distance of the centre of gravity over hand grip). In the 2nd and 3rd level we can find mostly speed, angle, time (duration of single jump phases) and centre of gravity movement (space) parameters (tab 1). Those are the most usable factors from the point of technique improvement in training process.

Tab 1 Selected speed, angle, time and centre of gravity movement parameters in sport performance structure

Horizontal speed of centre of gravity at moment of	
u11	Tread-down on take-off
u12	End of take-off
u13	Speed lost during take-off
Vertical speed of centre of gravity at the end of	
u17	Hanging position
u21	Pull with turn
Angle Parameters	
u52	angle of tread-down of take-off
u53	angle of take-off
u54	operating angle during take-off

u55	climb angle
u56	angle between body and vertical line at moment of straightening up end
u57	angle between body and vertical line at moment of pull with turn end
Centre of gravity height at moment of end of	
u28	Take-off
u29	Hanging
u33	Pull with turn
u34	Lifting
Time duration of	
u43	Take-off
u44	Hanging

In this contribution we will analyse parameters of time duration and centre of gravity movements of single jump phases.

Objectives

In this contribution we want to analyse selected time and space female pole vault characteristics on two different sport performance level groups and thus reveal relations between sport performance and technique mastery.

Material and methods

This research was performed in on the meetings Golden spiked shoes in Ostrava, Czech Republic. Our kinematic parameters were gained by two-dimension analyser Consport Motion Analysis System (CMAS). There are involved 19 female pole-vaulters with the sport performance 380 – 483 cm. All watched top-level female pole-vaulters (group S) were divided on 2 smaller groups; lower sport performance group (S1) and higher sport performance group (S2). Fundamental statistical characteristics can be seen in table 2.

Tab 2 Statistical characteristic of kinetic parameters of involved groups S, S1 ans S3

Whole group S; sport performance 380 – 483 cm; n=19		[unit]	x	x_{max}	x_{min}	s
u 1	Maximal centre of gravity height	[cm]	448.03	490.50	408.10	23.07
u 2	Absolute height of upper arm grip	[cm]	403.11	420.00	385.00	10.86
u 3	Standing over (peak height)	[cm]	44.92	70.50	11.20	16.24

Lower sport performance group S1; 380 – 430 cm; n=9		[unit]	X	x_{max}	x_{min}	s
u 1	Maximal centre of gravity height	[cm]	428.36	441.14	408.10	12.28
u 2	Absolute height of upper arm grip	[cm]	395,89	406.00	385.00	6.81
u 3	Standing over (peak height)	[cm]	32.47	49.10	11.20	10.83
Higher sport performance group S2; 440 – 483 cm; n=10		[unit]	x	x_{max}	x_{min}	s
u 1	Maximal centre of gravity height	[cm]	465.73	490.50	449.30	13.98
u 2	Absolute height of upper arm grip	[cm]	409.60	420.00	395.00	9.79
u 3	Standing over (peak height)	[cm]	56.13	70.50	33.30	11.35

In this contribution we analyse all technique pole-vault phases (take-off, hanging, swinging, roll up, straitening up, pull with turn, lifting and bar crossing) that were assessed from the point of their time durations and of centre of gravity (CGv) motions. For better clearness we used bar charts in absolute eventually in relative values with distinctive colours. In order to be able to follow all decisive phases we also use illustrative figures with border positions (fig 2 – 9) and diagram created by 3-D analysis (fig 10).

Fig 2 Border positions of take-off phase

Fig 3 Border positions of hanging phase

Fig 4 Border positions of swinging phase

Fig 5 Border positions of roll up phase

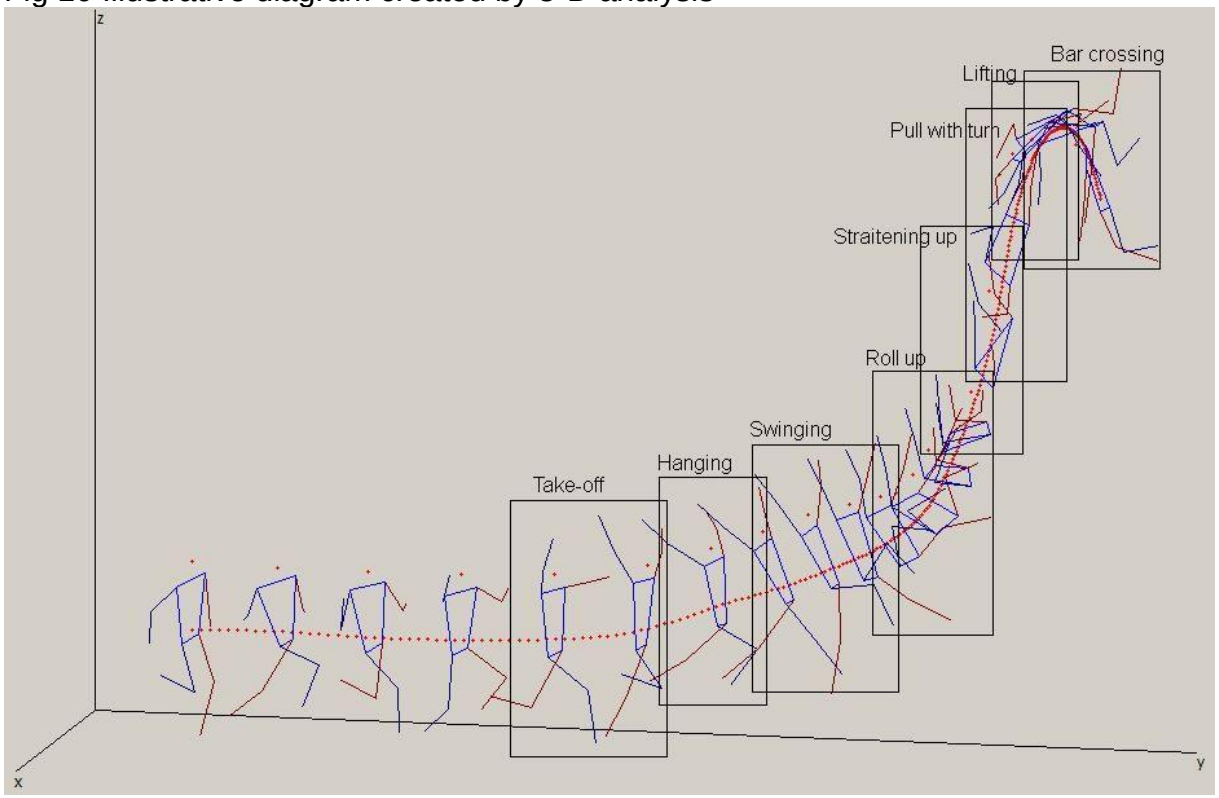
Fig 6 Border positions of straitening up phase

Fig 7 Border positions of pull with turn phase

Fig 8 Border positions of lifting phase

Fig 9 Border positions of bar crossing phase

Fig 10 Illustrative diagram created by 3-D analysis



For pedagogical interpretation we used logical methods, mostly analyse, comparison, deduction and generalisation.

Results

Absolute and relative time duration of single phases can be seen in fig 11 and 12.

Fig 11 Comparison of single phases during jumps

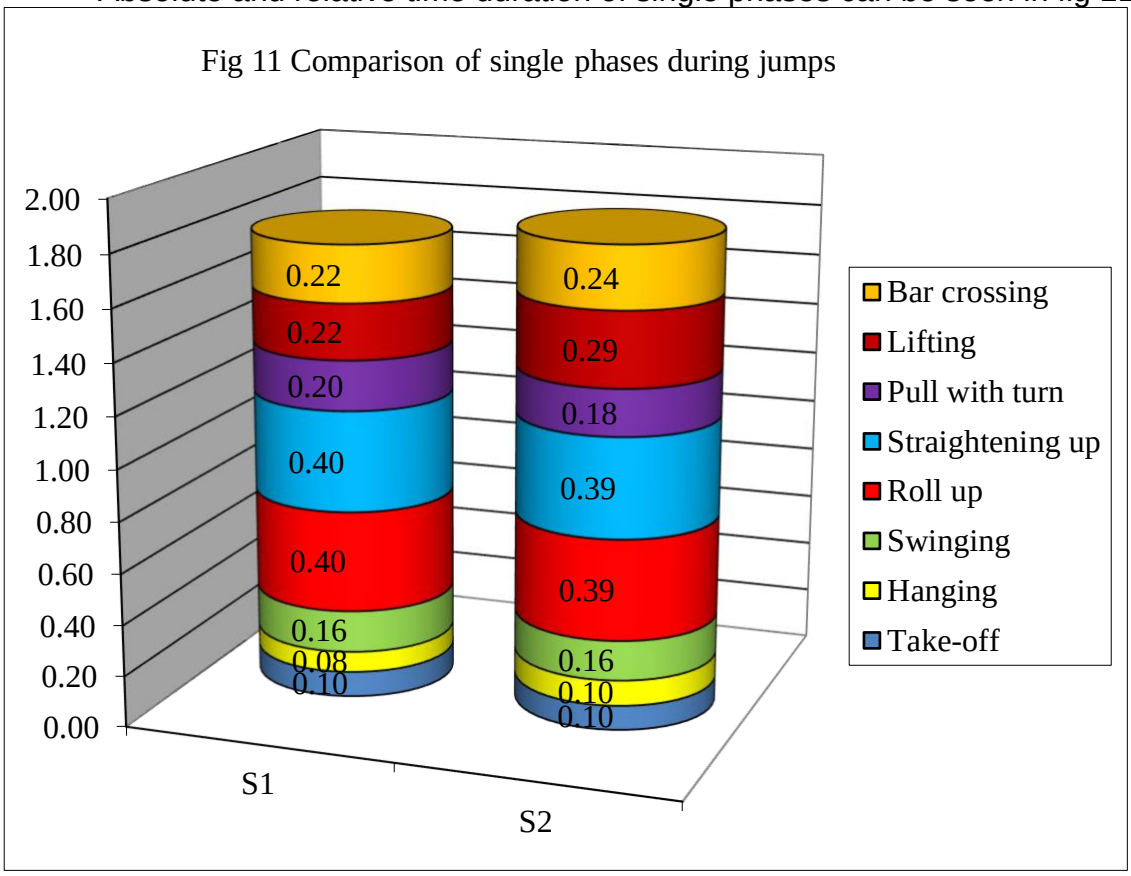
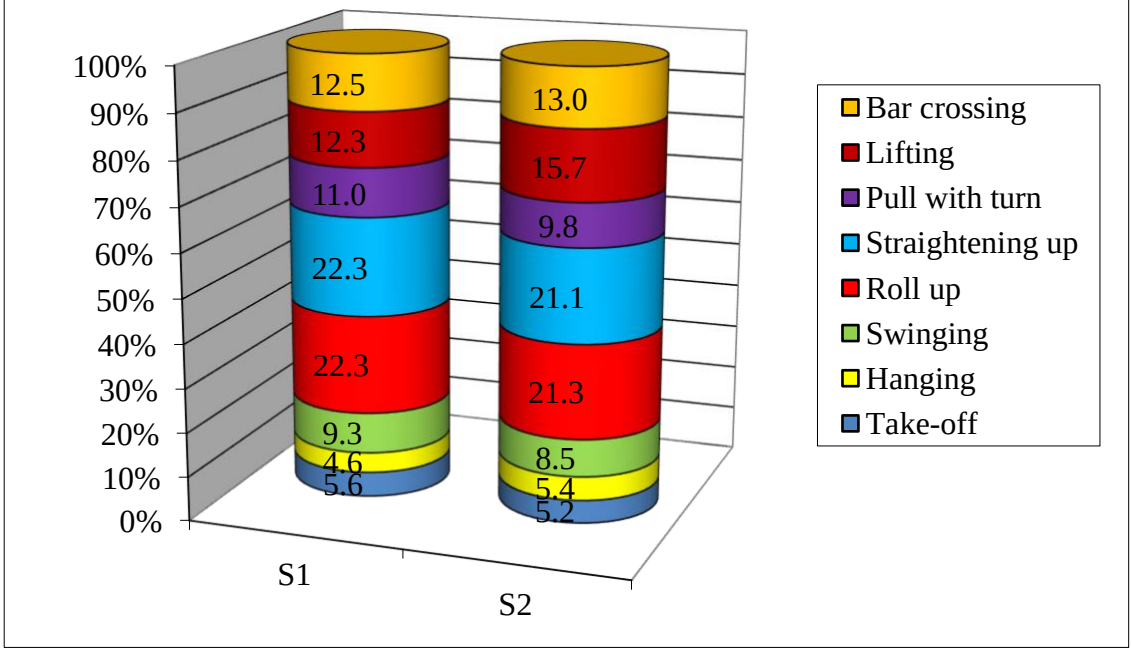


Fig 12 Percentage comparison of time phases duration during jumps



Our female pole-vault jumpers needed in average 1.68s in S1 and 1.75s in S2 group, in order to perform movement activity on pole from the end of take-off till crossing bar plane with the whole body. The average total time was slightly different in favour higher

sport performance level group – S2. The total time is up to certain level also influenced with suitable stands setting.

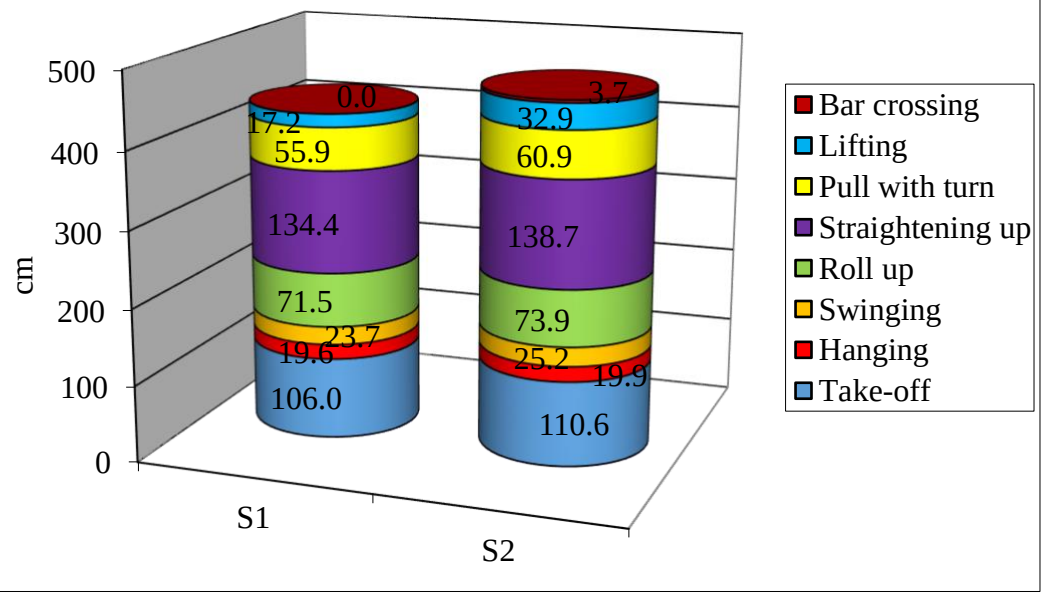
Comparison of single phases of our two groups S1 and S2 shows that there are only few differences, though the average sport performance difference is relatively great – over 37 cm. The first substantial difference according our view is in the phase of hanging, in which the difference is 0.02 s (relatively 0.08%) in favour of S2 group. These 0.02s of longer duration in hanging phase enables to bend over the pole stronger and thus use better the potential of pole elasticity and accumulate in this phase more kinetic energy in pole bending that can be availed during following phases of jump.

Further differences are watched mainly in phases pull with turn, lifting and bar crossing. In the phase pull with turn we can see that S1 group has longer duration time; together with the lower centre of gravity increase (CGv) in this phase (fig 13) we can state that here in this phase is already manifested faster and stronger pole straightening that courses faster centre of gravity vertical speed (KRSKA – SEDLACEK – KOSTIAL, 2014) of S2 group; higher CGv speed courses shorter pull with turn phase duration. The greatest difference in time duration can be seen in the phase of lifting in favour of S2 group. The average difference is 0.07 s. This longer time phase duration we consider like positive for longer and higher centre of gravity standing over (CGv gets over upper arm hand grip); the longer you are lifting your CGV, the higher you can get it. Also in the latest phase there is a difference in favour of S2 group – 0.02 s. Mainly in these two last phases lifting and bar crossing the group of higher sport performance level (S2) shows their higher technique mastery for they are able to use better accumulated energy in pole, when pole straightens and this enables to work longer on it, mainly during these two phases.

From the point of jump rhythm we can state that the most important phases from the point of view of sport level difference are phases of hanging and lifting. Higher sport performance group (S2) here shows better transmission on pole and higher use of kinetic energy accumulated in the pole.

In the fig 13 can be seen centre of gravity changes during jump phases of S1 and S2 groups.

Fig 13 Comparison of centre of gravity growth during phases



Discussion

We can state that in average can be seen the same increase tendency of centre of gravity height in both watched groups; with higher increase of higher performance level group (S2) in all phases. At take-off end is average CGv height 106.0 cm in group S1and 110.6 cm in group S2; it is more likely coursed by higher body height of S2 like by technique mastery. In the phase of hanging we measured nearly identical CGv growth (19.6 cm resp. 19.9 cm). In the phase of swinging reached jumpers of S2 1.5 cm more in CGv height like S1 group. In the phase of roll up gained S2 jumpers another 2.4 cm comparing S1 group. After pole bending end and its next straitening the CGv difference in vertical direction between both groups increase in favour of S2 group; this is also coursed by better S2 group work on pole (higher technique mastery) during following phases. In the phase of straitening reached S2 more 4.0 cm like S1 group. In the phase pull with turn more about 5,0 cm; in the phase lifting again more about 15.7 cm and in phase bar crossing more about 3.7 cm, while S1 jumpers here in this last phase did not reach any increase.

Conclusions

1. In female (just like male) pole vault technique assessment plays biomechanical analyse decisive role. Sport performance structure contains mostly kinetic parameters of speed, angle, time and space characteristics.
2. Time parameters show that mostly in phases hanging and lifting is manifested technique mastery of higher sport performance female jumpers; while during hanging phase, which them lasts longer this S2 group better transmit on pole, then during lifting phase they are able to use more pole elasticity and reach higher vertical CGv growth.
3. Centre of gravity increase during single phases shows that higher performance group (S2) reaches higher gains comparing S1 mostly in second part of jump, in more vertical CGv jump direction. This is of course connected with technique mastery and better use of pole elasticity.
4. We recommend in technique training improvement to use regularly 2-D or if possible also modern 3-D analysis systems. This enables to precise technique details, which can be decisive from the point of sport performance level increase.

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