A COMPARISON OF PRACTICE AND COMPETITION APPROACH VELOCITIES AND THE POSITION OF THE TOP HANDHOLD AT THE POLE PLANT IN POLE VAULTERS

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The purpose of this study was to examine whether university pole vaulters change their approach velocities and the position of the top handhold, during pole plant between practice and competition. Three male and three female pole-vaulters from a NCAA Division I university were videotaped during a practice and at the following competition. The video data was digitized using the Peak Performance Technologies Motion Measurement digitizing system. A dependent t-test was used to test for significant differences in the parameters between practice and competition. Statistically significant differences were found for the height of the top handhold, and the horizontal velocity at the second to last and the last step. An application for coaches is provided, based on the results of the study.

KEY WORDS: pole vault, top handhold

INTRODUCTION: The running velocity is one of the most important components of athletic events where the body is being projected. This is especially true for the pole vault event where the vaulter uses the run up to generate kinetic energy to convert the pole's potential energy into kinetic energy, thus contributing to the maximum height that the pole vaulter can attain. This relationship has been established quantitatively by McGinnis (1995, 1997) for male and female vaulters. Another component of the pole vault technique that is important and has not been the subject of much research, is the height of the top hand at the pole plant It is an indication of how much extension the pole vaulters have in their arm. The coach of the pole vaulters used in this study feels that it is an important aspect and that it often changes from practice to competition. It is a part of the technique that the coach encourages the pole vaulters work on regularly during practice. From a deductive perspective, it follows that the higher the pole vaulter has the top hand hold at the pole plant, the easier it is to convert the pole's potential energy to kinetic energy. The purpose of this study was to compare run up velocity and the height of the top hand hand during practice and subsequent competitive jumps.

METHODS: Three male and three female pole vaulters from a NCAA Division I university were used in this study. One of the male pole vaulters qualified at the national competition level and two of the female pole vaulters are All-American athletes. The pole vaulters were videotaped using a Peak5 two-dimensional video system (Peak Performance, Englewood, CO) at a practice and the next following competition. The system consists of a video camera (Pulnix TM620) and a VCR (Panasonic AG7350P). The camera was set approximately 1.2 meters off the ground and at a 90 degree angle to the runway at approximately 16.8 meters away from the runway. A sampling rate of 120 Hz was used. The Peak Performance Technologies Motion Measurement computerized digitizing system was used to analyze the video data. This study is part of a larger project, therefore, a spatial model was developed using 22 points. The points included the following: the right hand, right wrist, right elbow, right shoulder, left shoulder, left elbow, left wrist, left hand, right toe, right heel, right ankle, right knee, right hip, left hip, left knee, left ankle, left heel and left toe. The left or right ear, (depending on from which side the data is gathered) was also identified. Also included in the model was the top of the pole, the middle of the pole, and a point as close to the bottom of the pole as possible. A coefficient of variation was calculated from some of the video data to determine the reliability of the digitizing procedure. The coefficients were .009 or lower for all 22 points, demonstrating high reliability in the digitizing procedure.
The averages of practice and competition height of the top handhold at pole plant were analyzed. In addition, the horizontal velocities of the athlete's center of mass at the third to the last step, second to last step, and the last step during the support phase, were each

analyzed individually using a dependent t-test. An alpha level of 0.05 was used as the test of statistical significance. In addition a magnitude of effect and an effect size were computed for any parameters that were statistically significant.

RESULTS: The results are presented in Table 1. The calculated magnitude of effect showed that on average the pole vaulters had about 2.2 percent decrease during competition in how high they held their top hand hold during pole plant. Although the magnitude of effect for this parameter was rather small, the effect size was large (4.9) probably due to very low standard deviation. On average, these pole vaulters did not change much in this parameter, however there was one female vaulter who had a top hand hold at pole plant 10.8 cm lower in the competition. As can be seen in Table 1 there were significant differences in the horizontal velocity of the center of mass between the practice and competition for the second to last and the last step during the support phase.

Table 1 Means of Parameters

Parameter	Practice Mean	S.D.	Competition Mean	S.D.	t-value	p
Height of top handhold	1.84 m	.07	1.80 m	.10	1.90	.03
Horizontal velocity at third to last step	7.53 m/s	.67	7.52 m/s	.78	.04	.24
Horizontal velocity at second to last step	7.64 m/s	.62	8.0 m/s	.75	2.02	.02
Horizontal velocity at last step	6.8 m/s	.61	7.23 m/s	.80	2.29	.02

The magnitude of effect was a 4.7 percent increase in the second to last step and a 6.3 percent increase in the last step in the horizontal velocity of the center of mass from practice to competition. The effect sizes were large (.76 and .81) respectively for the second to last and third to last step respectively.

DISCUSSION: Although the statistical results were significant for these pole vaulters for the heights of the top hand hold at pole plant, a 2.2 percent decrease from practice to competition may have little practical importance. The one exception was a female pole vaulter who had a 10.8 cm decrease in the height of her top hand hold. Potentially, this is a sufficient difference to make it more difficult for her to convert the pole's potential energy to kinetic energy.

The results of the horizontal velocity of the center of mass provide some interesting insights. Although there was no significant difference at the third to the last, as the pole vaulters got closer to the pole plant, their horizontal velocity was considerably less during practice than competition. It appears that the pole vaulters continued to accelerate more during competition up to the second to last step. By the last step their horizontal velocity of the center of mass had decreased considerably in practice and competition. However, their horizontal velocity in practice was still significantly slower than in competition at the last step. There could be a variety of reasons for this. Fatigue, thinking too much/working on something in their technique, the lack of excitement that happens during meets, or just not giving as much effort could account for the changes. However, the end result is the same, a slower run up during practice will affect their ability to work on their technique after take-off. A clear indication of this is the number of times the author observed the vaulters stopping a vault during the rock-back phase during practice. The lower horizontal velocity may have resulted in a lowered ability to convert the potential energy of the pole to kinetic energy and affected their technique. This may have been especially true for one male and one female

pole vaulter who had a difference of almost one meter per second in their horizontal velocity at the last step between practice and competition.

CONCLUSIONS: Generally, there does not seem to be a practical decrease in the height of the top hand hold at pole plant, however, there were some statistically significant and practical differences in the pole vaulters' horizontal velocity of the center of mass between practice and competition. This suggests that a coach needs to emphasize the importance for the pole vaulters to aim for maximum horizontal velocity through the entire run-up during practice.

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