Vault Run Speeds

1999 John hancock U.S. Gymnastics Championships - Women

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The gymnastics vault run has been studied by several investigators (4, 9, 10). Sands and Cheetham (9) studied the velocity of the vault run using high speed film, and noted a high relationship between peak run speed and vault score in a variety of vaults. Sands and McNeal studied men's vault runs using infrared interval timers and noted a weaker relationship between maximum speed and score (10).

Mechanics of the vault indicate that a high speed run is advantageous to vaulting in that a gymnast needs sufficient momentum to direct into a high and long post flight. Takei, in particular, has done considerable analysis of vaulting for both men and women with extensive models of vault performance (11-16). In spite of training emphasis on maximizing run-up speed, gymnasts probably do not require an absolute maximum running speed. More importantly, the gymnast should strive to attain the highest speed that the athlete can control (7). Maximum running speed is further constrained by the short run-up distance allowed in competition. Henry and Trafton (1) showed, as early as the 1950s that a sprinter could reach only approximately 95% of maximum speed within approximately 20 meters. Observation of vault runs quickly show that gymnasts run poorly and do not appear to devote much attention to running technique (3, 5, 8). However, the basic question of how much one might improve vaulting by running faster remains largely unanswered.

In order to study the maximum vault run speeds of top American female gymnasts, run-ups were recorded during the 1999 John Hancock U.S. Gymnastics Championships in Sacramento, Calif. Because of the constraints of a live event, spectators, television, and so forth, radar was chosen to study the vault run-ups during training and warm ups using a radar gun (Radar Sales, Inc.). The radar gun was capable of recording the movement of an object in 0.1 mile per hour (0.045 m/s) increments with a sampling rate 20 Hz (20 samples/s). The radar gun allowed data collection to occur while standing at the start of the vault run way and recording vault run-up speeds without interacting with the gymnast. Because the training and warm ups of the gymnasts were not under my control, I could not dictate the number of trials nor the type of vault performed by the gymnasts, although each was recorded. Multiple trials of the same vault were then averaged. Because of the nature of the competition rules, two different vaults were required for each athlete.

Results

The performances of the athletes could be divided into the following categories:

a. Junior
b. Senior
c. forward/handspring-type vault
d. Yurchenko-type vault
e. Tsukahara-type vault

The descriptive statistics of these vaults are shown in Table 1.

Table 1 - Descriptive Statistics Speeds (m/s)

Variable	Mean	SD	Min	Max	n
All Athletes/All Vaults					
Handspring-Type	7.28	0.39	6.48	7.91	23
Yurchenko-Type	7.21	0.40	5.99	7.75	67
Tsukahara-Type	7.36	0.34	6.48	7.87	9
Senior Athletes					
Handspring-Type	7.64	0.22	7.33	7.91	7
Yurchenko-Type	7.36	0.35	5.99	7.75	43
Tsukahara-Type	7.51	0.51	6.48	7.87	6
Junior Athletes					
Handspring-Type	7.18	0.36	6.48	7.73	23
Yurchenko-Type	6.93	0.34	6.30	7.47	24
Tsukahara-Type	7.19	0.23	7.05	7.53	4

Table 2 shows the comparison of all vault run speeds between Juniors and Seniors. Note that the results showed Seniors were significantly faster than Juniors ($t(105) = 5.9$, $p < .001$).

Table 2 - Junior vs Senior (Speeds m/s)

Variable	Mean	SD	n
Senior Vaults	7.41	0.36	56
Junior Vaults	7.06	0.36	51

The correlations between score and maximum vault run speed are shown in Table 3. Data are presented for Junior gymnasts only due to loss of Senior vault scores for each vault. Correlations were calculated on the subsets of first and second vaults with no correlation reaching statistical significance (all $p > .05$). First and second Junior vault scores were combined for the analysis shown in Table 3.

Table 3 - Vault Speed vs Vault Type (Juniors)

Variable	r	Significance
All Vaults with Scores (n=51)	.102	.48
Handspring-Type with Scores (n=23)	.258	.23
Yurchenko-Type with Scores (n=24)	.127	.55

Discussion

The present analysis indicates that maximum vault run speed is not significantly related to score. However, this conclusion should not be generalized to all vaulting performances. The small population used for this analysis consisted of only Junior gymnasts at the 1999 John Hancock U.S. Gymnastics Championships-surely a very select and relatively homogeneous group. If a similar analysis was performed using these elite athletes and perhaps a number of Junior Olympic athletes, the resulting analysis would probably show a higher relationship between speed and score as younger, smaller, and slower athletes would likely score lower than their Junior Elite counterparts.

Takei (13) found a significant correlation (r=.74) in a study of the handspring compulsory vaults of female gymnasts at the Pan American Games between take off velocity and score. Note that the take off velocity from the board may differ significantly from the maximum run-up velocity. For example, analysis of two female gymnasts from the 1984 Olympic Games showed that horizontal component board touchdown velocity of the gymnasts following a round off entry was 5.1 to 5.5 m/s and the board take off horizontal velocity decreased further to 3.1 to 3.6 m/s (6). Clearly, the round off prior to board contact will result in considerable slowing of the gymnast's overall run-up speed. The reduction in horizontal component velocity during the hurdle and take off has been demonstrated (6).

Nelson *et al.*, found the average horizontal component velocity of gymnasts at the 1984 Olympics at board contact was 6.5 m/s. A study by Sands and Cheetham (9) found the average run-up velocity of female gymnasts was 7.25 m/s on a variety of vaults. Sands and Cheetham also showed a high correlation between vault run-up speed and score ($r(9) = .953$, $p < .05$). Krug et al. (2), using a laser speed measurement system found that handspring-type vaults averaged 7.3 m/s, Yurchenko-type vaults averaged 6.98 m/s, and Tsukahara-type vaults averaged 7.28 m/s. The highest run-up speed recorded by Krug *et al.*, for a female gymnast was 7.9 m/s.

The results of this analysis show that promising areas for vault score improvement among these gymnasts are more likely to lie with aspects of vault performance other than the maximum run-up speed. Scores are not calculated from run-up speeds directly, rather from the result of the gymnast's entire effort. Moreover, aspects of form, landings, and so forth are not highly dependent on maximum speed, while the score is highly dependent on these performance characteristics. Future research should include observations of the magnitude of speed decline from the peak of the run to the board contact and take off. Individual gymnasts in particular may benefit from such analysis.

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