The effect of a six-week plyometric intervention on handspring vault performance in competitive female gymnasts

Emma Hall & Daniel C Bishop, School of Sport and Exercise Science, University of Lincoln, UK

Introduction

The handspring vault (HV) is of paramount importance for a gymnast's vaulting development, and requires both technical skill and power production to achieve success. Plyometric Training (PT) has been established as a valuable strategy for enhancing the force-generating potential of explosive-reactive movements such as the HV (Protach and Chu, 2008). In addition recent literature has also demonstrated the effectiveness of PT to improve power development in adolescents (Bishop *et al*., 2009). However despite the huge amount of force exerted by both the upper and lower extremity musculature in gymnastic vaulting (Mohamed, 2010) and the importance of moves such as the HV in a gymnasts development, there is scant research investigating the benefits that PT can induce. The purpose of this study was to determine the effects that PT can have when added to habitual training on HV performance in female adolescent gymnasts.

Methods

Participants - Twenty female competitive gymnasts (mean ± SD: age 12.5 ± 1.7 years; stature 1.46 ± 0.11 m; mass 40.5kg ± 9.7 kg) volunteered to partake in this study.

Experimental Design -The study was granted institutional ethics and used a between-group pre-post design with two independent variables with participants randomly assigned to two independent groups. The experimental Plyometric Training Group (PTG) pursued a six-week plyometric program, consisting of two additional 45 minute sessions a week, alongside their habitual training. The PT programme was appropriately adapted from Radcliffe and Farentinos (1999) and consisted of lower body exercises (for example: squat jumps, bunny hops) and upper body exercises (for example, MB sit up throw, push up clap). Whilst the control group (CG) maintained their regular habitual training.

Data & Statistical Analysis - Videography was used (120 Hz) in the sagittal plane, both pre and post training intervention, to assess key performance indicators attributed to the technical performance and competence required to execute a successful HV (see figure 1). In addition, participants completed a countermovement vertical jump (CMJ) as an assessment of lower body power.

Data were analysed using two-tailed independent and dependent *t*-tests to determine the between and within group effects of the PT programme.

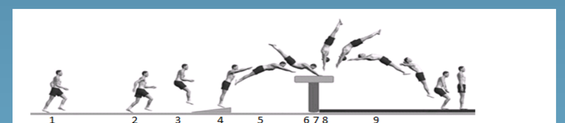

Figure 1. Key HV Variables 1-Run up velocity; 2- Velocity 2-steps before take-off ; 3- Take-off distance from springboard; 4- Duration of board contact; 5- Duration of first flight; 6- Shoulder angle on vault; 7-Hip angle on vault 8-Duration of hand contact on table; 9- Duration of Post Flight

Adapted from Atikovis, 2012

Results

Following the PT intervention the PTG demonstrated significant between group differences over the CG (see table 1) for run-up velocity, take-off velocity, distance from take-off to springboard, duration of foot contact on board, duration of hand contact on vault, duration of post flight and CMJ height. However, no significant differences were found between groups for first flight time, shoulder angle or hip angle on the vault. Furthermore, the CG demonstrated no significant improvement for within group differences for the handspring vault measures or CMJ height.

Table 1. Handspring Vault Measures (mean ± SD) for the PTG and CG pre and post the 6-week PT intervention

	Plyometrics Training Group (PTG)			Control Group (CG)		
Performance Variable	Pre Intervention	Post Intervention	Percentage change (%)	Pre Intervention	Post Intervention	Percentage change (%)
Run up velocity (ms^{-1}) **	6.54 ±0.43	6.87 ± 0.42	4.9††	6.72 ± 0.61	6.79 ±0.58	1.1
Velocity 2-steps before take-off (ms^{-1}) **	5.36 ± 0.80	6.07 ±0.48	13.3††	5.47 ±61	5.65 ±0.65	3.2
Take-off distance from spring-board (m)*	2.17 ±0.28	2.36 ±0.26	8.4††	2.24 ±0.26	2.27 ±0.28	1.7
Duration of first flight (s)	0.26 ±0.04	0.28 ±0.04	4.7	0.30 ±0.05	0.30 ±0.06	2.7
Duration of post flight (s)**	0.43 ±0.11	0.45 ±0.10	4.6†	0.43 ±0.10	0.42 ±0.10	1.9
Duration of board contact (s)*	0.12 ±0.01	0.11 ±0.01	4.7†	0.12 ±0.01	0.12 ±0.01	0.0
Duration of hand contact on table (s)*	0.32 ±0.08	0.30 ±0.09	8.0†	0.35 ±0.09	0.35 ±0.10	1.2
Shoulder angle on vault (^{o})	154 ±15	153 ±13	0.4	153 ±12	152 ±11	-0.8
Hip angle on vault (^{o})	141 ±19	148 ±15	4.3	157 ±18	159 ±17	0.8
CMJ Height (cm)*	43.5 ±6.1	45.3 ±5.8	4.1†	45.0 ±5.75	45.35 ±5.5	0.6

*/** = A significant (*= P < 0.05) (** = P < 0.01) difference was observed between pre-intervention and post-intervention trial change scores between groups
†/†† = A significant (†= P < 0.05) (†† = P < 0.01) difference was observed between pre intervention and post intervention trial variables within groups

Summary and Conclusion

The present study confirms that the implementation of sports specific PT provided significant improvements in the power development (CMJ height) in adolescent gymnasts over a six-week period and is in line with the findings of previous studies (Bishop *et al*., 2009; Vassal and Bazanovk, 2010). The results indicate that performers were able to demonstrate significant improvements in the capabilities of the muscles to generate increased force over a reduced time in the key variables associated to successful HV performance, namely run-up/take-off velocity, foot and hand contact time and duration of post flight time.

Considering the practical importance of the HV in a gymnasts development, the current study found that the inclusion of a suitable PT programme had a positive impact on adolescent performance.

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