Single Leg Lateral and Horizontal Loaded Jump Testing: Reliability and Correlation With Long Track Sprint Speed Skating Performance

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Background

- In the 500 m sprint event, the opening 100 m acceleration accounts for a large proportion of the explained variance in the overall race time[1]. Here, skaters transition between a running phase and a gliding phase that require two distinct techniques[2].
- To optimize performance during the start, skaters must produce force through varied contact times and postures[1,2,3], and basic muscle properties such as the force-velocity and force-length relationships may contribute to performance[4].
- Traditional tests of neuromuscular power implemented with speed skating athletes have lacked movement and load specificity with the running and gliding phases of on-ice acceleration[5,6].
- **Research Objective: (1)** establish the intra-day reliability of peak velocity (PV) measurements obtained during a single leg lateral jump (JumpLat) test and a singe leg horizontal jump (JumpHorz) test with 3 external loading conditions; **(2)** assess the relationship between single leg jump PV and 500 m long track speed skating performance in highly trained long track speed skaters; **(3)** examine the feasibility of a linear modelling approach by determining the intra-day reliability of load-velocity (LV) parameters for each loaded jump protocol.

Methods

Figure 1. Experimental set-up and start position for the $Jump_{Lat}$ and $Jump_{Horz}$

- Highly trained (n=26), national level athletes performed single leg jumps with a horizontal robotic resistance across three external load conditions (10 N, 7.5% of body mass, 15% of body mass) using their dominant limb. Jumps were performed in both the horizontal ($Jump_{Horz}$) and lateral ($Jump_{Lat}$) direction. A commercial robotic resistance device (1080 Sprint, 1080 Motion) was used to conduct the multi-planar loaded jump testing. Subjects completed two consecutive trials of the same jump protocol to examine the intra-day reliability of the peak velocity (PV) achieved for each loading condition.
- Intrasession reliability was assessed using the coefficient of variation (CV), intraclass correlation coefficient using a two-way mixed effects model (ICC 3,1) and Bland-Altman analysis to determine the 95% limits of agreement (LOA) (Table 1). Pearson correlation coefficients were used to examine relationships between jump outcomes and on-ice split times (Figure 2).

Results

Table 1. Test-Retest Reliability of the peak velocity (m/s) recorded from different jumps and load conditions.

Jump Type	*ICC (95% CI)*	*CV*	LOA (m/s)
$Jump_{Lat}$ *(10N)*	0.82 (0.68-0.9)	3.0%	-0.03 ± 0.24
$Jump_{Lat}$ *(7.5%BW)*	0.84 (0.71-0.92)	2.7%	0.03 ± 0.19
$Jump_{Lat}$ *(15% BW)*	0.9 (0.81-0.94)	2.6%	0 ± 0.19
$Jump_{Horz}$ *(10N)*	0.9 (0.82-0.95)	3.5%	-0.04 ± 0.34
$Jump_{Horz}$ *(7.5%BW)*	0.91 (0.83-0.95)	3.4%	0.04 ± 0.29
Jump *(15%BW)*	0.92 (0.82-0.96)	3.1%	0.03 ± 0.23

Table 2. Test-Retest Reliability of LV parameters recorded from different jumps and load conditions.

LV Parameter	*M ± SD*	*ICC (95% CI)*	*CV%*
L_0 ($Jump_{Horz}$)	61.46 ± 8.46	0.44 (0.07-0.70)	14.6%
Slope ($Jump_{Horz}$)	-0.06 ± 0.01	0.44 (0.06-0.70)	15%
L_0 ($Jump_{Lat}$)	103.65 ± 28.9	0.47 (0.11-0.72)	40%
Slope ($Jump_{Lat}$)	-0.04 ± 0.01	0.50 (0.15-0.74)	20%

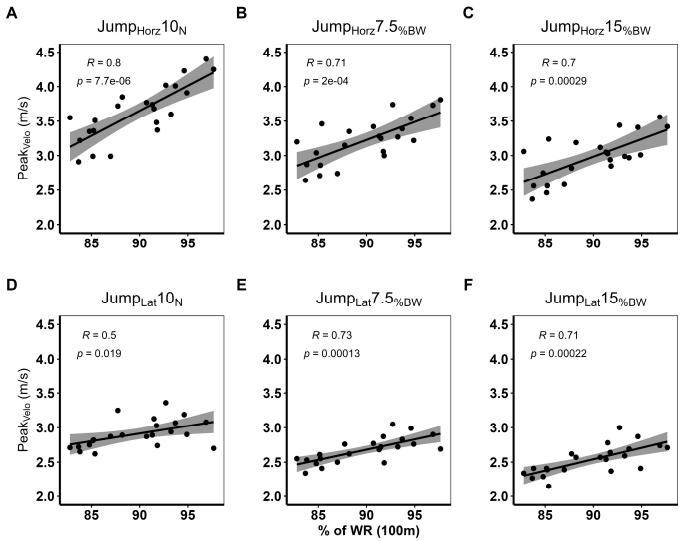

Figure 2. Relationship between unilateral jump peak velocity (m/s) and 100m race split time (%WR)

Conclusions

- PV as measured during the $Jump_{Lat}$ and $Jump_{Horz}$ is sufficiently reliable for routine off-ice testing in highly trained speed skaters and displayed strong interrelationships with competition performance.
- The relationship between PV and performance varied across loading conditions, which may be indicative of training induced adaptations to the multi-joint force velocity relationships of skating athletes.
- Despite PV at each load being stable, linear load-velocity profile (LVP) parameters exhibited poor reliability for the $Jump_{Horz}$ and $Jump_{Lat}$.

Practical Applications

- The loaded $Jump_{Lat}$ and $Jump_{Horz}$ are both sufficiently reliable for performance testing and warrant consideration in a neuromuscular test battery for skating athletes.
- Practitioners seeking to use linear modelling approaches during resisted unilateral jumping must determine how to sufficiently load the jump without degrading movement kinematics or focus on PV across load conditions as an outcome measure rather than relying on LV parameters..
- Future work may seek to implement these tests the utility of these tests with other skating populations.

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