MODELS PREDICTING VERTICAL JUMP DISPLACEMENT USING THE HIGHEST ATTEMPT

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INTRODUCTION

Kinematic and kinetic outputs derived from the *average* of a series of attempts are commonly used when characterizing performance. However, in some scenarios, this approach may be problematic, as fitness-trained individuals tend to display greater performance variability in some motor skills when compared to their elite-level counterparts. Consequently, averaging across both *good* and *bad* attempts may not accurately reflect the *best* performance characteristics of fitness-trained individuals. For a motor skill like vertical jumping, using only the highest jump from each session might yield more consistent and useful jump performance metrics. Therefore, when attempting to explain the variability in vertical jump displacement, examining performance outputs from the *best* effort may be an appropriate strategy.

PURPOSE

- To maximize the explained variance in countermovement vertical jump (CMVJ) displacement by including kinematic and kinetic output from the highest jump from each of two testing sessions.

METHODS

Healthy fitness-trained adults (31 men, 29 women; 18-35 years) performed three CMVJs using a self-selected depth and constrained arm swing. Right leg kinematic data were captured using a nine-camera 3D motion capture system (240 Hz, Qualisys Inc., Sweden), and vertical ground reaction force (vGRF) data were collected using a force platform (1200 Hz, AMTI, Watertown, MA, USA). Vertical displacement was measured as the change in the center of mass from toe-off to peak vertical position. Velocity (fig.1) and power with concentric work (fig. 2) were calculated using vGRF and center-of-mass data, and both absolute and body-mass normalized values were calculated for power and work. Anthropometric variables (height, body mass, total body fat percentage, and fat-free mass) were measured, with body fat estimated using sex-specific three-site skinfolds. Model construction was constrained to one independent variable per 10 subjects. Bivariate correlations identified variables most associated with CMVJ displacement, and those with low inter-correlations were included in multiple linear regression models using forced-entry methods. Multicollinearity was checked using Tolerance (<4.00) and Variance Inflation Factor (>0.20). Non-significant variables (p<0.05) were excluded from the models.

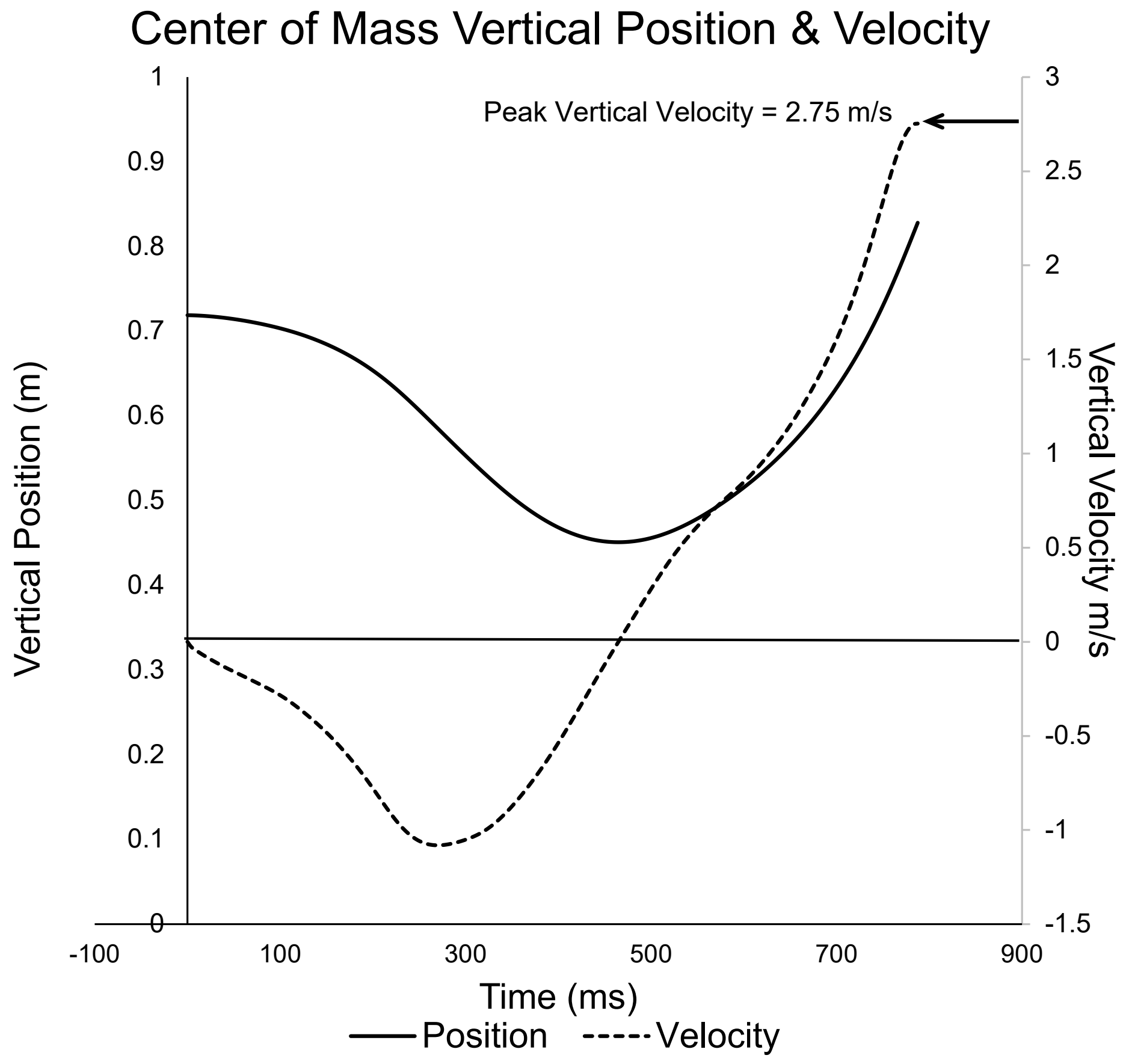

Fig. 1. Sample figure of center-of-mass position and vertical velocity to take-off.

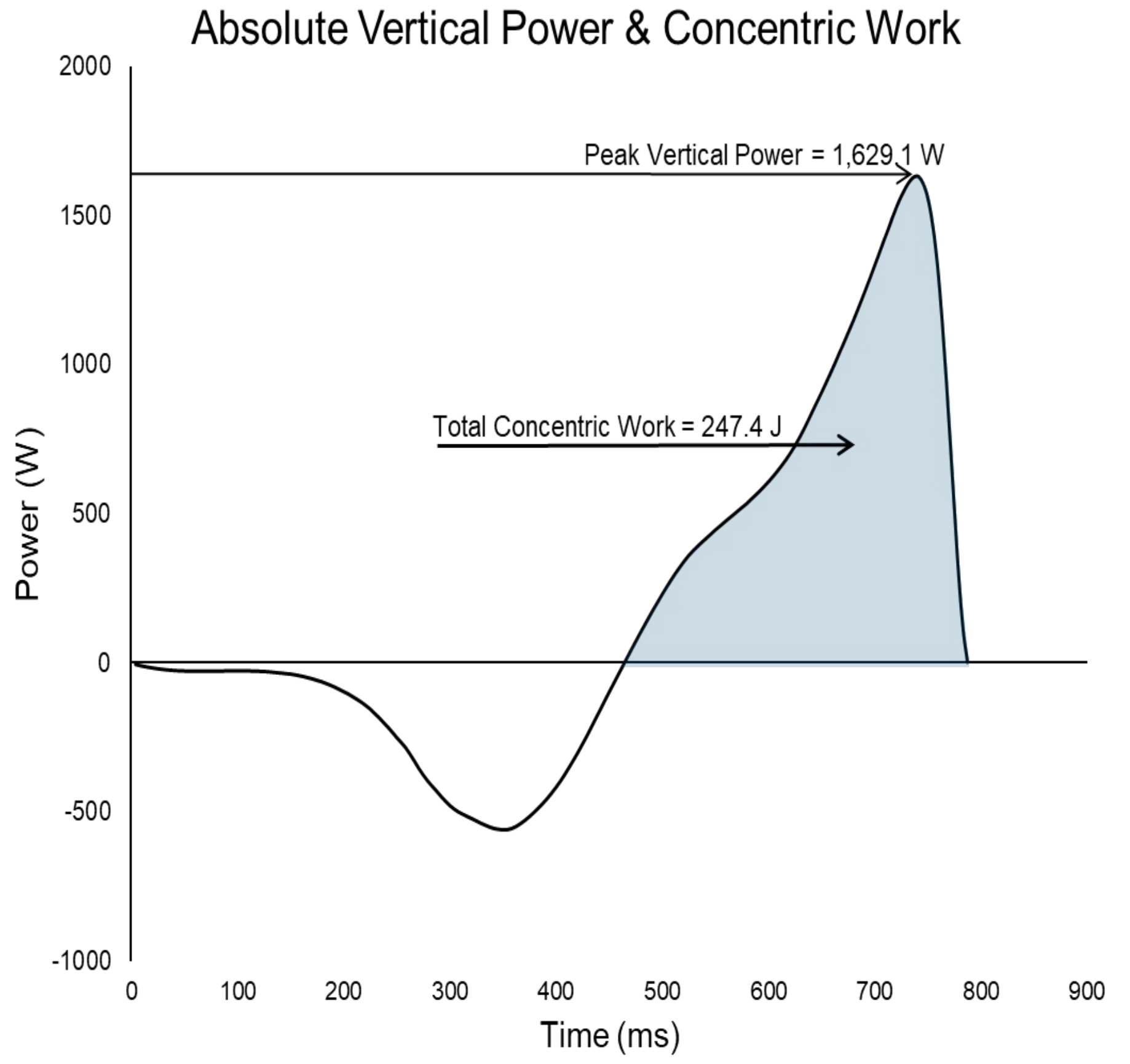

Fig. 2. Sample figure of absolute vertical power with concentric work to take-off.

RESULTS

- Peak center-of-mass vertical velocity and normalized peak power explained 82% and 67% of CMVJ variance, respectively while two- and three-predictor models explained 72% to 84% (Table 1).
- Model order was based on explained variance (R^2) and standard error of the estimate (SEE). Multicollinearity (assessed via tolerance and variance inflation factor) was not observed in these models.

Table 1. Viable models predicting CMVJ displacement for fitness-trained men and women.

Model 1 (n=59)		R=0.91	R^2=0.84	SEE=0.04	F= 142.624 (p ≤ 0.001)
CMVJ =	-0.334	+ 0.197 (PkVz)	+ 0.033 (WorkNorm)		
t =	-8.025	7.809	2.454		
Sig. =	<0.001	<0.001	0.017		
Tol. =		0.344	0.344		
VIF =		2.910	2.910		
Model 2 (n=60)		R=0.91	R^2=0.83	SEE=0.04	F= 137.503 (p ≤ 0.001)
CMVJ =	-0.231	+ 0.215 (PkVz)	– 0.002 (%Fat)		
t =	-2.948	9.192	-1.923		
Sig. =	0.005	<0.001	0.059		
Tol. =		0.419	0.419		
VIF =		2.388	2.388		
Model 3 (n=60)		R=0.90	R^2=0.82	SEE=0.04	F= 259.245 (p < 0.001)
CMVJ =	-0.365	+ 0.250 (PkVz)			
t =	-8.440	16.101			
Sig. =	<0.001	<0.001			
Model 4 (n=60)		R=0.85	R^2=0.72	SEE=0.05	F= 73.505 (p < 0.001)
CMVJ =	0.140	+ 0.010 (PkPzNorm)	– 0.004 (%Fat)		
t =	2.189	5.472	-3.166		
Sig. =	0.033	<0.001	0.002		
Tol. =		0.447	0.447		
VIF =		2.237	2.237		
Model 5 (n=60)		R=0.82	R^2=0.67	SEE=0.05	F= 118.551 (p < 0.001)
CMVJ =	-0.037	+ 0.015 (PkPzNorm)			
t =	-1.101	10.888			
Sig. =	0.276	<0.001			

Table Variables: PkVz- peak vertical velocity, WorkNorm- concentric work normalized, % Fat- total body fat percentage, PkPzNorm- peak vertical power normalized.

CONCLUSIONS

- These findings support using kinematic (velocity) and kinetic (power, work) variables from the highest jump attempt to explain performance by fitness-trained young adults.
- Linear models incorporating peak center-of-mass vertical velocity or normalized peak vertical power explain a substantial amount of vertical jump displacement variability.

PRACTICAL APPLICATIONS

- Cause and effect relationships would be best tested by training individuals to specifically increase their center-of-mass peak vertical velocity or body-mass normalized peak vertical power during a maximum vertical jump and then comparing the predicted versus actual changes in jump displacement.