RELIABILITY & PRECISION OF THE ECCENTRIC RATE OF FORCE DEVELOPMENT DURING COUNTERMOVEMENT VERTICAL JUMPING

Lawrence W. Weiss, Douglas W. Powell, Max R. Paquette, Lindsey A. Massey, Hailey J. Daugherty

Musculoskeletal Analysis Laboratory, The University of Memphis, Memphis, TN, USA

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INTRODUCTION

Eccentric actions occur during the countermovement phase of vertical jumping when the musculature is engaged to decelerate and eventually stop the body's descent. Different strategies are used to accomplish this that are analogous to the myriad approaches used to stop a moving vehicle at a stop sign. During this phase, elastic energy is stored in the connective and contractile tissues for use during the concentric phase. The timing of force generation during the countermovement phase may be represented by the *eccentric rate of force development* (ERFD). The ERFD is calculated as a slope based on the change (delta) in force from a designated initial point to a designated final point divided by the corresponding delta time. If eccentric strategies are implemented inconsistently reliability and precision would be negatively impacted.

PURPOSE

- To determine the stability reliability and precision of the ERFD during countermovement vertical jumping in biological men and women

METHODOLOGY

Sixty young, active adults (31 men, 29 women), 18 to 35 years of age, performed three vertical jumps (CMVJ) on two occasions using a self-selected countermovement depth and constrained arm swing. A nine-camera 3D motion capture system (240 Hz, Qualisys Inc., Sweden) and force platform (1200 Hz, AMTI, Watertown, MA, USA) were used to collect 3D marker position data and vertical ground reaction force (vGRF) data for the right side of the body, respectively. Unilateral ERFD was computed from vGRF data and expressed both as an absolute and normalized for body mass. Stability reliability was determined using an intraclass correlation coefficient (ICC, two-way random model), and precision using both the standard error of measurement (SEM) and the coefficient of variation (CV%). Statistical analyses were performed for all subjects, as well as separately for men and women.

RESULTS

Study findings are presented in Table 1 below.

Table 1. Summary of descriptive, reliability, and precision findings for absolute and normalized expressions of the ERFD during countermovement vertical jumping.

Variables	Sample Size	Mean	Std. Dev.	ICC (*95% CI*)	SEM	CV%
<u>Men & Women Combined</u>						
ERFD Day1 Absolute ($N \cdot s^{-1}$)	60	1960.69	943.73	0.90	294.72	20.6
ERFD Day2 Absolute ($N \cdot s^{-1}$)	57	2090.13	907.54	(0.85 – 0.94)		
ERFD Day1 Normalized ($N \cdot s^{-1} \cdot kg^{-1}$)	60	27.2	1.07	0.86	4.1	21.4
ERFD Day2 Normalized ($N \cdot s^{-1} \cdot kg^{-1}$)	57	29.3	1.06	(0.78 – 0.90)		
<u>Biological Men</u>						
ERFD Day1 Absolute ($N \cdot s^{-1}$)	31	2359.70	1050.79	0.91	312.68	18.4
ERFD Day2 Absolute ($N \cdot s^{-1}$)	29	2452.34	1014.16	(0.85 – 0.95)		
ERFD Day1 Normalized ($N \cdot s^{-1} \cdot kg^{-1}$)	31	29.1	11.9	0.89	4.0	19.1
ERFD Day2 Normalized ($N \cdot s^{-1} \cdot kg^{-1}$)	29	30.5	11.8	(0.81 – 0.94)		
<u>Biological Women</u>						
ERFD Day1 Absolute ($N \cdot s^{-1}$)	29	1518.94	548.80	0.80	266.38	23.3
ERFD Day2 Absolute ($N \cdot s^{-1}$)	28	1714.98	595.67	(0.64 – 0.89)		
ERFD Day1 Normalized ($N \cdot s^{-1} \cdot kg^{-1}$)	29	25.0	9.0	0.81	4.1	21.9
ERFD Day2 Normalized ($N \cdot s^{-1} \cdot kg^{-1}$)	28	28.1	9.3	(0.67 – 0.90)		

CONCLUSIONS

- Stability reliability was attained for absolute and normalized expressions of ERFD for all subjects, men only, and women only.
- Precision was more problematic for ERFD measurements, regardless of absolute versus normalized expressions or biological sex.

PRACTICAL APPLICATIONS

- Due to the marginal measurement precision, the average of multiple sessions is recommended for representing ERFD performance during countermovement vertical jumping in populations like the ones used in this study.