INTERCORRELATIONS OF MULTIPLE INDICES OF RATE OF FORCE DEVELOPMENT DURING VERTICAL JUMPING

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

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

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INTRODUCTION

Rate of force development (RFD) conceptually appears to reflect speed strength. It may be calculated as a slope in which delta force from a designated anchor point on the force-time curve to a designated point on the curve is divided by the corresponding elapsed time. However, alternative iterations of RFD have been suggested. In 1995, Vladimir Zatsiorsky proposed four indices of RFD including 1) starting gradient (S-gradient: 50% of peak force / elapsed time to reach it), 2) acceleration gradient (A-gradient: 50% peak force / elapsed time from that point to peak force), 3) index of explosive strength (IES: peak force / time to peak force, and 4) reactivity coefficient (RC: peak force / (time to peak force x body mass). Five slope-based iterations of the force-time curve might be considered as additional RFD indices including 1) full RFD to peak force, 2) early-stage RFD, and 3) late-stage RFD with the point of demarcation between early and late stages being either 1) 50% of the time to reach peak force (temporally based or t) or 2) 50% of delta force to peak (kinetically based or k). Indices not highly associated with each other would be considered as displaying unique or independent features while those highly associated with each other might be considered as displaying redundant characteristics.

PURPOSE

- To determine the association between nine proposed iterations of RFD during vertical jumping in recreationally trained biological men and women.

METHODS

Sixty young adults (31 men, 29 women), 18-35 years of age, performed three CMVJs on two occasions. 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. The designated anchor point for RFD measurements was at the first sign of a positive slope (beginning of the eccentric phase) of the force time curve. Each of the nine proposed indices of RFD were extracted from the highest CMVJ displacement on each of two testing days and were subsequently averaged. Associations were based on bivariate correlations. Indices of RFD having at least 50% shared variance ($r \geq 0.71$) were deemed redundant. Indices of RFD having less than 50% shared variance ($r < 0.71$) were deemed unique.

RESULTS

- For significant ($p \leq 0.05$) correlations (See Table 1), shared variances ranged from 11% to 98%.

Table 1. Association (*r*) of nine indices of RFD obtained during countermovement vertical jumps (n=59) based on two-day averages from the jump with the greatest displacement for each day. The first sign of a positive slope of the force-time curve (beginning of the eccentric phase) was considered the anchor point for RFD calculations.

RFD Indices	S-grad.	A-grad.	IES	RC	Full RFD	Early RFD_t	Early RFD_k	Late RFD_t	Late RFD_k
Start Gradient	--								
Acceleration Gradient	0.33*	--							
Index of Explosive Strength	0.40**	0.76**	--						
Reactivity Coefficient	0.22	0.65**	0.93**	--					
Full RFD	0.65**	0.76**	0.63**	0.47**	--				
Early-Stage RFD_t	0.74**	0.21	0.41**	0.25	0.74**	--			
Early-Stage RFD_k	0.78**	0.44**	0.57**	0.41**	0.84**	0.93**	--		
Late-Stage RFD_t	0.43**	0.91**	0.61**	0.48**	0.91**	0.38**	0.56**	--	
Late-Stage RFD_k	0.35**	0.99**	0.77**	0.65**	0.78**	0.24	0.47**	0.92**	--

* $p \leq 0.05$
** $p \leq 0.01$

CONCLUSIONS

- Considering that redundant and unique RFD variables exist over a continuum rather than as a dichotomy, the nine proposed indices of RFD appear to be associated with each other over a wide spectrum.

PRACTICAL APPLICATIONS

- Interchanging any of these nine RFD indices should be done cautiously for recreationally trained men and women.
- Highly redundant variables appear to be A-gradient with Late-Stage $RFD_{t \text{ and } k}$, IES with RC, and Late-Stage RFD_t with A-gradient, RFD, and Late-Stage RFD_k.