ASSOCIATION OF THE ECCENTRIC RATE OF FORCE DEVELOPMENT WTH VERTICAL JUMPING PERFORMANCE

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INTRODUCTION

The rate of force development (RFD) has been used to reflect speed strength; a characteristic assumed to be high in better vertical jumpers. It may be calculated as the change in force output from designated initial and ending points divided by the elapsed time over which the force change occurred. Although this seems particularly relevant during the isometric and concentric phases of jumping, the contribution of the eccentric rate of force development (ERFD) is less clear. During the countermovement phase of jumping, elastic energy is stored in the contractile and connective tissues for release during the concentric phase. However, people employ different strategies to attenuate their descent during the countermovement phase and it is unclear if an association between countermovement jumping performance and the ERFD exists.

PURPOSE

- To determine the association of ERFD during vertical jumping with vertical jump displacement in combined and separate groups of men and women

METHODOLOGY

Sixty young 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. The slope representing the ERFD began at the point at which force started to increase during the countermovement phase and ended when the lowest center of mass was attained. The ERFD was based on a two-day average and expressed both as an absolute and normalized for body mass. Associations were calculated using bivariate correlations.

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RESULTS

Average jump displacements were as follows (mean ± SD): all subjects, 37.8 cm ± 10.5; men, 44.7 cm ± 10.5; women, 30.4 cm ± 6.6. Average two-day absolute ERFD values were as follows: all subjects, 2,038.2 N · s^{-1} ± 916.1; men, 2,431.1 N · s^{-1} ± 1,017.3; women, 1,616.2 N · s^{-1} ± 551.2. Average two-day normalized ERFD values were as follows: all subjects, 28.4 N · s^{-1} · kg^{-1} ± 1.04; men, 30.2 N · s^{-1} · kg^{-1} ± 1.15; women, 26.5 N · s^{-1} · kg^{-1} ± 8.9. Bivariate correlations are presented in Table 1 below.

Table 1. Association (r) of absolute and normalized (for body mass) expressions of the eccentric rate of force development (ERFD) with CMVJ displacement.

Variables	CMVJ All Subjects n = 60	CMVJ Biological Men n = 31	CMVJ Biological Women n = 29
CMVJ	---	---	---
ERFD Absolute	0.44**	0.36	-0.19
(95% CI)	(0.20- 0.63)	(-0.01- 0.64)	(-0.53- 0.21)
ERFD Normalized	0.23	0.34	-0.19
(95% CI)	(-0.04- 0.46)	(-0.03- 0.63)	(-0.53- 0.20)

** $p \leq 0.01$

CONCLUSIONS

- For all subjects and men-only, ERFD accounted for 5% to 19% of the variability in vertical jump displacement via a positive association.
- For women, ERFD accounted for 4% of the variability in vertical jump displacement via a negative association.
- Normalizing the ERFD for body mass did not enhance correlations with vertical jump displacement.

PRACTICAL APPLICATIONS

- Absolute and normalized expressions of the ERFD as measured herein have little association with countermovement vertical jump displacement.
- Women appear to have a unique inverse and low association of the ERFD with countermovement vertical jump displacement.
- The use of unilateral force output during vertical jumping was a study limitation that may have affected the findings.