MULTI SET STRENGTH COMPARISON IN BRAKING AND PROPULSIVE FORCE-TIME CHARACTERISTICS DURING ACCENTUATED ECCENTRIC LOADING BACK SQUATS

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Introduction

Eccentric training has grown in popularity both in research and practice in recent years (1-4). There are various eccentric training methods available to practitioners. One such method is accentuated eccentric loading (AEL), which can be defined as a training method which applies a greater load during the eccentric (braking) phase of a movement compared to the concentric (propulsion) (5). The weight released during the transition must cause minimal disruption to the natural mechanics of the movement. AEL has demonstrated an ability to elicit positive physiological changes in muscle architecture properties, strength, power, speed, and overall performance (3, 6). Some research examining the role of strength in AEL have shown that stronger individuals may require a greater eccentric loads to maximize concentric performance compared to weaker individuals (7). Further research is required to examine the impact of relative strength on braking and propulsive characteristics during AEL. The purpose of this study was to examine differences in braking and propulsive force-time characteristics across multiple sets of AEL back squats between stronger and weaker men.

Methods

- 15 resistance-trained men were separated into stronger (n = 8, age = 25.1 ± 5.2 years, height = 172.8 ± 5.6 cm, body mass = 80.2 ± 11.0 kg, relative one repetition maximum [1RM] back squat = 2.24 ± 0.12 kg/kg) and weaker (n = 7, age = 23.6 ± 1.7 years, height = 182.9 ± 6.2 cm, body mass = 91.4 ± 12.4 kg, relative 1RM back squat = 1.76 ± 0.13 kg/kg) groups based on if they were able or unable to back squat twice their body mass.
- Each subject participated in three separate testing sessions over the course of one week. After obtaining the back squat 1RM of the subjects in the first testing session, they were also familiarized with AEL squats using weight releasers.
- The stronger group (S) was defined as a relative strength >2.0 body mass and the weaker group (W) <2.0 body mass.
- All testing sessions for both conditions took place on a force plate and a linear position transducer velocity device was attached to the barbell.
- During sessions two and three, the subjects performed three sets of three back squat repetitions using weight releasers on the first repetition of each set. The final two testing sessions had the subjects perform AEL back squat with 100% 1RM eccentrically on the first repetition and either 60 (100-60) or 80% (100-80) 1RM concentrically for the first and remaining repetitions.
- Force data analysed included net braking mean force (BMF), braking duration (BD), net propulsive mean force (PMF) and propulsive duration (PD).
- The braking phase was identified as the point in which force exceeded system mass (body mass + concentric barbell load) following the unweighing phase (8)
- The end of the braking phase was identified as the lowest point of the squat (measured by linear position transducer) and where the greatest braking force was produced.
- The propulsive phase of the back squat was then identified as the force produced above system mass following the end of the braking phase and the highest barbell position.
- Hedge's g effect sizes were calculated between groups to examine the magnitude of the differences**.**

Results

Table 1: Accentuated eccentric loading (AEL) multi-set strength comparison in braking and propulsive characteristics in the back squat (mean ± standard deviation)

Condition	Group	Set	BMF ($N \cdot kg^{-1}$)	BD (s)	PMF ($N \cdot kg^{-1}$)	PD (s)
AEL 100-60	Stronger	1	6.70 ± 0.63	0.55 ± 0.10	4.72 ± 0.74[#a]	0.66 ± 0.10[a]
		2	6.77 ± 0.81	0.56 ± 0.09	4.93 ± 0.47	0.63 ± 0.08
		3	6.61 ± 0.48	0.56 ± 0.08	4.88 ± 0.49[#]	0.63 ± 0.08
	Weaker	1	5.55 ± 0.62	0.58 ± 0.09	3.83 ± 0.48	0.75 ± 0.01
		2	5.73 ± 0.54	0.55 ± 0.05	4.04 ± 0.69	0.72 ± 0.07
		3	5.76 ± 0.55	0.54± 0.05	4.27 ± 0.57	0.72 ± 0.06
Effect Size (g)*			1.41 – 1.73	0.12 – 0.28	0.63 – 1.47	0.15 – 1.18
AEL 100-80	Stronger	1	4.90 ± 0.47	0.70 ± 0.11	3.48 ± 0.58	0.96 ± 0.10
		2	5.06 ± 0.57	0.66 ± 0.09	3.30 ± 0.46	0.99 ± 0.09
		3	5.07 ± 0.54	0.66 ± 0.10	3.24 ± 0.48	1.02 ± 0.14
	Weaker	1	4.24 ± 0.39	0.69 ± 0.06	2.66 ± 0.41	1.15 ± 0.18
		2	4.41 ± 0.44	0.67 ± 0.09	2.76 ± 0.40	1.16 ± 0.17
		3	4.35 ± 0.63	0.71 ± 0.12	2.67 ± 0.33	0.72 ± 0.24
Effect Size (g)*			0.96 – 1.46	0.01 – 0.36	1.18 – 1.59	0.86 – 1.36

BMF = Braking mean force, BD = Braking duration, PMF = Propulsive mean force, PD = Propulsive duration, #Within subject statistical significance between set 1 and set 3 ($p=<0.05$), [a] A within subject statistically significant ($p<0.05$).*Effect size ranges comparing the stronger and weaker groups

Figure 2.Starting position of the participant on the force platform with linear transducer attached and weight releasers on the barbell

Figure 3. Weight releasers fall off at the bottom of the back squat reducing absolute barbell load for the propulsion phase

Conclusions

- The stronger group produced greater BMF and PMF across sets in both the 100-60 and 100-80 condition compared to the weaker group.
- There was no difference for BD across groups in both conditions.
- The stronger group also performed the propulsive phase over shorter durations in both conditions.

Practical Applications

Stronger and weaker groups can complete multiple sets of AEL BS; however, the S group may respond to the stimulus better than their W counterparts. Because the S group appear to enhance concentric performance to a greater extent than the W group, relative strength may be a limiting factor for AEL prescription in the BS.

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