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EFFECT OF ACCENTUATED ECCENTRIC LOADING TEMPO ON POST ACTIVATION PERFORMANCE ENHANCEMENT DURING A BACK SQUAT

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INTRODUCTION

Accentuated Eccentric Loading (AEL) during resistance training is becoming an increasingly popular way to train to enhance lower body power output. Evidence for this training has mostly been demonstrated by using supramaximal eccentric loads and moderate to heavy concentric loads. The ability to generate force during the eccentric action has been linked to enhanced performance and reduced injury risk amongst a wide array of populations.

AEL back squats have been demonstrated to increase eccentric work and eccentric rate of force development (RFD) when the eccentric portion of the movement was loaded with 105% 1-RM and the concentric portion was loaded with 80% 1-RM in trained male subjects (Wagle et al., 2018). In male powerlifters AEL back squats have been shown to increase countermovement jump height when an eccentric load of 110% 1-RM and a 55% 1-RM concentric load was used compared to the eccentric only and control groups (Perenc et al., 2024).

Tempo of the eccentric portion of a back squat has also been shown to influence lower body power (Lu et al., 2023). This may be due to a difference in time under tension. However, to our knowledge, no research has investigated the effect of tempo during an AEL back squat and the acute effect on lower body force output during a countermovement jump.

PURPOSE

The purpose of this study is to examine the effect of tempo during an AEL back squat with a light concentric load on lower body power output while performing a 5x3 AEL back squat protocol.

METHODS

Experimental Design

- 15 male participants (Age: 23.5 ± 4.3 years; Relative 1RM Back Squat: 1.7 ± 0.2 kg/kg) participated in a cross-over design study that was separated by a minimum of seven days between testing sessions

Inclusion Criteria

- Resistance training regularly (3x/week) for one year
- Performing the back squat on average every other week or more for the past 3 months
- Free of musculoskeletal injury for the past six months that prevented them from resistance training

Testing Procedures

- Following a dynamic warm-up, participants performed two countermovement jumps arms akimbo to determine baseline measures on the testing day.
- The participants completed a 5x3 back squat protocol with 100% 1RM on the eccentric portion and 40% 1RM during the concentric portion of the movement with a 1 second eccentric (1S) or 3 second eccentric tempo (3S). The following week, participants performed the opposite condition.
- After each set, the participant passively rested for three minutes and then performed two countermovement jumps arms akimbo.

Countermovement Jumps

- Jumps were performed on force plates (AMTI, BMS400600)and were analyzed using a customized Excel spreadsheet to extract jump height (JH), peak power output (PPO), concentric and eccentric impulse, reactive strength index-modified (RSImod), and time to takeoff (Chavda et al., 2018).

Statistical Analysis

- A two-way repeated-measures ANOVA was performed to determine differences between tempo and across sets. Alpha level was set a $p < 0.05$.

RESULTS

Table 1. Comparisons Between Tempo Across Sets for CMJ Performance

Variable	Set	1 Sec Ecc. (FT)	3 Sec Ecc. (ST)
Jump Height (m)	Baseline	**0.41 ± 0.07***	**0.42 ± 0.08***
	Set 1	0.39 ± 0.08	0.41 ± 0.08
	Set 2	0.39 ± 0.08	0.40 ± 0.08
	Set 3	0.40 ± 0.08	0.40 ± 0.08
	Set 4	0.39 ± 0.08	0.40 ± 0.08
	Set 5	0.40 ± 0.08	0.40 ± 0.08
Relative Peak Power (W/kg)	Baseline	**59.45 ± 7.68***	**59.67 ± 7.67***
	Set 1	56.99 ± 7.98	57.81 ± 8.00
	Set 2	56.92 ± 7.56	57.81 ± 7.94
	Set 3	56.72 ± 8.37	57.14 ± 7.69
	Set 4	56.31 ± 7.86	57.21 ± 7.58
	Set 5	56.28 ± 8.27	57.09 ± 7.72
Braking Rate of Force Development (N/s)	Baseline	6018.3 ± 2653.1	6564.2 ± 2430.8
	Set 1	6139.7 ± 2261.2	6471.0 ± 2396.2
	Set 2	6136.0 ± 2739.5	6532.0 ± 2139.7
	Set 3	6060.9 ± 2284.9	6616.4 ± 2391.2
	Set 4	6469.4 ± 3130.2	6669.8 ± 2613.0
	Set 5	6416.2 ± 2625.1	6320.2 ± 2462.1
Braking/Propulsive Duration Ratio (au)	Baseline	**1.98 ± 0.19***	2.00 ± 0.25
	Set 1	1.90 ± 0.20	1.87 ± 0.14
	Set 2	1.87 ± 0.17	1.91 ± 0.16
	Set 3	1.88 ± 0.22	1.84 ± 0.20
	Set 4	1.89 ± 0.20	1.86 ± 0.19
	Set 5	1.87 ± 0.20	1.87 ± 0.21
Braking/Propulsive Impulse Ratio (au)	Baseline	0.45 ± 0.07	0.46 ± 0.06
	Set 1	0.47 ± 0.06	**0.49 ± 0.06†**
	Set 2	**0.47 ± 0.05†**	0.47 ± 0.05
	Set 3	0.46 ± 0.05	0.48 ± 0.07
	Set 4	**0.47 ± 0.06†**	0.47 ± 0.05
	Set 5	**0.48 ± 0.05†**	0.46 ± 0.05
Time To Takeoff (s)	Baseline	0.79 ± 0.10	0.79 ± 0.11
	Set 1	0.77 ± 0.09	0.76 ± 0.08
	Set 2	0.76 ± 0.08	0.76 ± 0.09
	Set 3	0.77 ± 0.08	0.75 ± 0.09
	Set 4	0.76 ± 0.09	0.75 ± 0.08
	Set 5	0.76 ± 0.08	0.76 ± 0.07
Braking Impulse (Ns)	Baseline	103.41 ± 22.15	106.86 ± 22.25
	Set 1	106.95 ± 25.46	110.98 ± 21.89
	Set 2	106.31 ± 20.47	**106.90 ± 19.83‡**
	Set 3	105.05 ± 23.15	107.95 ± 19.03
	Set 4	105.94 ± 20.79	**105.99 ± 18.37‡**
	Set 5	**108.49 ± 20.42†**	**104.13 ± 19.08‡**
Propulsive Impulse (Ns)	Baseline	**223.78 ± 42.26***	233.91 ± 42.61
	Set 1	227.21 ± 40.12	**228.25 ± 42.23†**
	Set 2	227.27 ± 45.09	**227.80 ± 42.16†**
	Set 3	227.13 ± 41.00	**228.05 ± 42.58†**
	Set 4	225.73 ± 46.37	228.17 ± 43.17
	Set 5	226.19 ± 43.03	**227.44 ± 40.04†**

† = Different than baseline
‡ = Different than set 1
* = Baseline different than all conditioned sets

- Eccentric/Concentric Duration Ratio is the time spent in the eccentric phase divided by the time spent in the concentric phase
- Eccentric/Concentric Impulse is the net eccentric impulse divided by the net concentric impulse

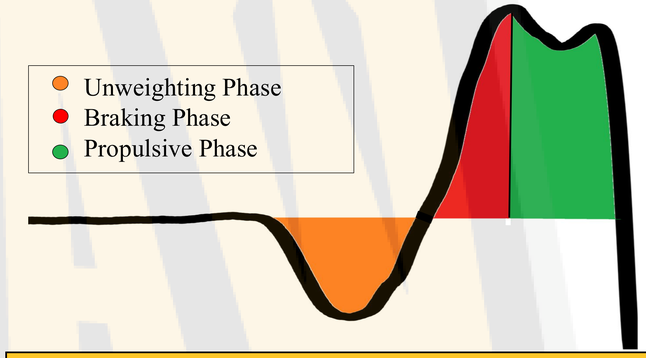

Figure 1. Force-Time Curve of a CMJ

RESULTS, Cont'd

Both FT and ST conditions led to decreases in jump height and relative peak power. FT led to a decrease in Braking/Propulsive Duration Ratio (less time in the braking phase relative to propulsive). Sets 2, 4 and 5 FT and Set 2 ST saw increases in braking to propulsive impulse ratio (more impulse in propulsive relative to braking) compared to baseline. Set 5 FT had higher braking impulse than baseline. Sets 2, 4 and 5 ST had lower braking impulse than set 1. All FT sets saw decreases in propulsive impulse. Sets 1, 2, 3 and 5 ST saw decreases in propulsive impulse.

CONCLUSIONS

Based on the results of this study, overloaded eccentric back squats are detrimental to jump height and peak power with 3 minutes of rest. This may be due to the eccentric phase being the most fatiguing part of the back squat.

PRACTICAL APPLICATIONS

The data from this experiment should inform practitioners that overloading the eccentric phase of a back squat, will decrease CMJ height and power if rest time is < 3 minutes, in trained individuals.

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