Comparison of Metabolic Rate Between Concentric and Eccentric Muscle Actions

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PURPOSE: Previous studies have reported the energy cost of eccentric exercise to be approximately 1/7 to 1/4 that of concentric exercise, but no study has directly compared concentric-only versus eccentric-only resistance exercise. Therefore, we compared energy expenditure between squats performed with concentric versus eccentric muscle actions.

METHODS: 7 apparently healthy, college-aged men (20.5±0.53 yrs) with a body mass index (BMI) < 26 performed three exercise protocols once per week designed to compare energy expenditure between different muscle actions; concentric (CON), eccentric (ECC), and a trial incorporating both concentric and eccentric muscle actions (BOTH). Subject’s 1-RM was determined using a plate-loaded squat machine. Each energy expenditure protocol was randomly assigned in a counterbalanced order and required subjects to perform 4 sets of 10 repetitions with 50% of 1-RM. Repetition speed (2 sec), ROM, and rest intervals were identical across all protocols. Expired air was collected continuously before (15 min), during (~12 min), and after (30 min) each exercise protocol, using a Parvo TrueOne 2400 Metabolic cart. Data were analyzed using a two-way repeated measures ANOVA, with Tukey honest significant difference (HSD) post hoc analyses wherever appropriate. RESULTS: Rates of energy expenditure (kcal/min) during sets 1-4 of CON (4.47±0.44, 4.65±0.57, 4.60±0.65, and 4.50±0.58, respectively) and BOTH (4.43±0.66, 3.60±0.46, 4.26±0.59, and 3.67±0.43, respectively) were significantly greater (p≤0.05) compared to ECC squats (3.34±0.33, 3.10±0.34, 3.10±0.35, and 3.05±0.27, respectively), with the exception of Set 2 for BOTH versus ECC, which was not significantly different. There were no significant differences in energy expenditure between CON, ECC and BOTH during identical warm-up sets. CONCLUSION: When squats are performed with 2 sec CON or ECC muscle actions and 50% of 1-RM, the energy cost of eccentric exercise was 2/3 to 3/4 that of concentric exercise. While our findings show a greater energy cost from eccentric squats relative to concentric, it may be that slower muscle actions (i.e., 2 sec per muscle action) enhance the overall contribution to energy expenditure from eccentric muscle actions due to increased time under tension during resistance exercise.