Mechanisms Underlying the Reduced Performance Measures from Using Equipment with a Counterbalance Weight System

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Abstract

Bench press throws are commonly used in the assessment of upper-body power and are often performed on a Smith machine that uses a counterbalance weight to reduce the net load on the barbell. The use of a counterbalanced Smith machine was recently shown to reduce performance measures, but the mechanisms for this reduction have not been established. The purpose of this study was to determine the underlying physiological and biomechanical causes of the reduced performance measures found when using a counterbalanced Smith machine. Twenty-four men (mean ± SE: age, 23 ± 1 years; weight, 91.0 ± 3.5 kg; height, 178.9 ± 1.2 cm) performed Smith machine bench press throws at 30% of 1-repetition maximum under 4 conditions: (a) rebound movement and counterbalance, (b) rebound movement and no counterbalance, (c) concentric-only movement and counterbalance, and (d) concentric-only movement and no counterbalance. Peak power, peak force, and peak concentric and eccentric velocities were measured using a linear accelerometer, and peak ground reaction force was measured using a force plate. The counterbalance condition produced significantly ($p < 0.05$) lower peak accelerometer-based force (−21.2 and −17.0% for rebound and concentric-only bench press throws, respectively) but increased peak ground reaction force (5.3 and 3.2%). The discrepancy between changes in peak accelerometer-based force and peak ground reaction force suggests that an increase in net external load occurred during the movement. For performance testing of explosive movements, the use of a counterbalance system results in an underestimation of performance capability, likely because of an increase in the net external load during the concentric phase. Therefore, a counterbalance system should not be used for explosive movement performance testing.