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Effect of different types of loads on the force-velocity relationship obtained during the bench press throw exercise

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INTRODUCTION:
The relationship between the velocity (V) of muscle contraction and the force (F) that it can produce is one of the main muscular properties (1). Therefore, it is not surprising that the F-V relationship has been frequently used to assess muscular function (2). The most standard type of load that has been used to assess muscular function has two main components: weight (mass × gravity) and inertia (mass × acceleration). However, it can be modified to provide almost exclusively gravitational (W) or inertial (I) type of loads. Therefore, the aims of this study were: (I) to evaluate the degree of linearity of the force-velocity (F-V) relationship across different types of loads (W, I and W+I), (II) to compare the magnitude of the F-V relationship parameters (maximum values of force [F0], velocity [V0] and power [Pmax]) between the different types of loads (W, I and W+I), and (III) to explore the concurrent validity of F0 with traditional measures of maximal strength.
METHODS:
The F-V relationships of 15 physically active men (age: 20.9±2.0 years, bench press 1-repetition maximum [1RM] relative to body mass: 1.20±0.10 kg·kg-1) were determined during the bench press throw (BPT) exercise (the load magnitudes: 40, 50, 60, 70 and 80 kg) using predominantly gravitational (W), inertial (I) and combined (W+I) loads. The type of load was manipulated by combining the extended rubber bands with the weight plates added to the barbell. The bench press maximal isometric force (Fiso) and the 1RM were also assessed. All tests (BPT, Fiso and 1RM) were performed on a custom-made Smith machine.
RESULTS:
The individual F-V relationships were highly linear regardless of the type of load considered (median r [range] = 0.98 [0.94, 1.00]). The W+I load provided the largest value of F0 (972±45 N; 6.0% and 14.6% higher than W and I, respectively), the I load the largest value of V0 (2.99±0.34 m·s-1; 40.4% and 20.1% higher than W and W+I, respectively), and the W load the lowest value of Pmax (501±46 W; -22.7% and -17.1% lower than I and W+I, respectively). The F0 obtained from the W load presented the highest association with Fiso and 1RM values (r > 0.90).
CONCLUSION:
The F-V relationship was highly linear regardless of the type of load considered. The comparison of the F-V relationship parameters revealed that the W+I load provided the largest F0, the I load the largest V0, and both W+I and I loads provided comparable values of Pmax. Therefore, practitioners should consider using W+I and I loads over W loads for the development of Pmax, being preferable to apply a W+I load to stimulate F0 development and an I load to develop V0 capacity. The F0 obtained from the F-V relationship modelled with a W load should be recommended to assess maximal strength capacity since it provided the highest correlation with Fiso and the 1RM.
1) Hill, A. Proc R Soc B Biol Sci, 1938.
2) Jaric, S. Int J Sports Med, 2015.

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