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A Three-Dimensional Assessment of Push-Pull Power Ratios Across Various Loads

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Capturing a true assessment of power in upper body motions is problematic owing to difficulty reproducing a testing environment that matches kinematic profiles performed in sport. New technology permits more accurate reflections of three-dimensional power in isotonic environments. **PURPOSE:** To quantify power ratios of single-arm press and pull exercises across various loads. **METHODS:** 64 subjects performed a total of 1,145 sets on Proteus (Boston Biomotion, Inc.): 570 sets of single-arm horizontal presses and 575 sets of single-arm horizontal rows. All subjects performed both exercises. Three-dimensional magnetic resistance was applied at 5, 10, 15, 20 and 25lb. ANOVA tested the subjects' kinematic profile across loads. **RESULTS:** On average, across all sets, maximum power per set was 175.2 ± 103.0 for presses and 183.6 ± 108.5 for pulls. For mean power throughout a set, subjects achieved 159.5 ± 96.3 for presses and 168.2 ± 102.5 for pulls. The different loads had significant differences for maximum ($p<0.001$) and mean ($p<0.001$) power; the higher the load, the higher the value in each measurement. At a 5lb load, maximum power (presses and pulls combined) was 31.7 ± 10.8; at a 25lb load, it was 366.4 ± 96.0. Similarly, for mean power, at 5lb, subjects achieved 26.8 ± 10.2 while at 25lb, it was 335.1 ± 92.0. Dominant and non-dominant arms were similar in maximum ($p=0.497$) and mean power ($p=0.530$) although overall, pulling was stronger than pushing. Across all sets and loads, push-to-pull ratio was 0.95:1 for both maximum and mean power. This ratio changes at different loads. For peak power, at 5lb, the push-to-pull ratio was 1.22:1. At 10lb, it was 0.99:1. At 15lb, it was 0.98:1. At 20lb, it was 0.95:1. At 25lb, it was 0.94:1. For mean power, the same pattern, though slightly more extreme, was found. **CONCLUSIONS:** Numerous investigations have quantified ideal force ratios of the knee while similar assessments of the upper limbs have received relatively little attention. New technology provides a systematic approach to measure strength ratios of the shoulder and elbow in three-dimensional space. In this context, strength ratios change with load; push power exceeds pull power at low loads whereas the inverse is true at higher loads. These strength ratios may be considered for sport application and recognition of risk for upper limb injury.