

Effects of maximal squat exercise testing on vertical jump performance in American college football players

Dear Editor-in-chief,

Maximal strength and power testing are common assessments that are used to evaluate strength/power athletes. The validity and reliability of these tests have been well established (Hoffman, 2006), however the order of testing may have a profound effect on test performance outcome. It is generally recommended that the least fatiguing and highly-skilled tests are performed first, while highly fatiguing tests are performed last (Hoffman, 2006).

Recent research has demonstrated that maximal isometric contractions and maximal or near-maximal dynamic exercise can augment the rate of force development, increase jump height and enhance sprint cycle performance (Chiu et al., 2003; French et al., 2003). The use of a maximal or near-maximal activity to enhance strength and power performance has been termed "muscle postactivation potentiation", and appears to be more common in the experienced resistance-trained athletes than in the recreationally-trained population (Chiu et al., 2003). It is believed that postactivation potentiation can enhance muscle performance by increasing the neural signal that activates the muscle (Hamada et al., 2000). Since heavy loading in a similar movement pattern of exercise appears to enhance maximal strength and power performance in the experienced resistance-trained athlete, it may be hypothesized that the postactivation potentiation associated with heavy loading has the potential to augment subsequent performance of tests utilizing similar motion. Therefore, consideration of an appropriate sequence of athletic performance testing in strength and power athletes is warranted. We would like to share our experience on the effect of performing a maximal lower body strength test on vertical jump performance in experienced resistance-trained strength/power athletes.

We examined 64 NCAA Division III American collegiate football players (age = 20.1 ± 1.9 yr; body mass = 97.5 ± 17.8 kg; height = 1.80 ± 0.12 m). All testing was performed on the first day of pre-season training camp. All athletes provided their informed consent as part of their sport requirements consistent with the college's Institutional Review Board's policies for use of human subjects in research. They were familiar with all testing protocols and had performed these assessments for the previous 2 – 6 years.

All athletes reported to the athletic training facility for strength and vertical jump testing and performed a 5-min warm-up (pedaling at 60 rpm at $300 \text{ kg}\cdot\text{m}\cdot\text{min}^{-1}$ interspersed with five all-out sprints during the last 5-s of each minute) on a cycle ergometer prior to testing. Following the warm-up the athletes performed two countermovement vertical jumps. The higher of the two trials was

recorded. The athletes then performed a 1-RM strength test for the barbell back squat exercise. Following a 5-minute rest interval, each athlete performed an additional countermovement vertical jump trial.

The 1-RM squat test was performed using methods previously described by Hoffman (2006). Each athlete performed a warm-up set using a resistance that was approximately 40-60% of his perceived maximum, and then performed three-to- four subsequent trials to determine the 1-RM. A 3 – 5 minute rest period was provided between each trial. The squat exercise required the athlete to place an Olympic bar across the trapezius muscle at a self-selected location. The athlete then descended to the parallel position which was attained when the greater trochanter of the femur reached the same level as the knee. The athlete then ascended until full knee extension. Trials not meeting the range of motion criteria were discarded.

The counter-movement vertical jump height was measured using a Vertec™ (Sports Imports, Columbus, OH). Prior to testing, each athlete's standing vertical reach height was determined. Vertical jump height was calculated by subtracting the standing reach height from the jump height. Power outputs were calculated based upon the formula of Harman and colleagues (1991).

Statistical evaluation of the data was accomplished with dependent t-tests. Significance for data analysis was set at $p \leq 0.05$. All data are reported as mean \pm SD.

Performance of a 1-RM squat (167.8 ± 32.1 kg) resulted in a significant 3% increase in vertical jump height (1.7 ± 4.4 cm). Significant improvements in vertical jump height (59.8 ± 10.5 cm versus 61.6 ± 10.3 cm) and peak power (9034 ± 575 W versus 9143 ± 575 W) were seen between PRE and POST, respectively.

Results indicated that vertical jump and power performance were significantly improved by prior maximal squat performance. Improvements in vertical jump and power performance appear to occur within 5-min of maximal squat testing. Whether this postactivation muscle potentiation occurs immediately after 1-RM squat testing, or how long it is sustained following maximal squat testing is not clear from this examination. Previous work by Chiu and colleagues (2003) have suggested that recreationally trained individuals or athletes may exhibit fatigue within the first 5-min following an acute heavy resistance exercise stimulus, but the potentiation effect may be sustained for more than 18-minutes following the exercise stimulus. This is supported in part by studies that have shown no potentiation effect in upper-body power performance 4-min after the completion of a high intensity upper-body resistance training session (Brandenburg, 2005).

Our findings do support previous studies that have demonstrated the positive effect of postactivation muscle potentiation (Chiu et al., 2003; French et al., 2003; Hamada et al., 2000). This has important implications for the sequencing of athletic testing protocols. Based upon these findings it is recommended that performance of the 1-RM squat precede vertical jump assessment to maximize vertical jump height and power output in resistance-trained athletes.

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References

- Brandenburg, J.P. (2005) The acute effects of prior dynamic resistance exercise using different loads on subsequent upper-body explosive performance in resistance-trained men. *Journal of Strength and Conditioning Research* **19**, 427-432.
- Chiu, L.Z.E., Fry, A.C., Weiss, L.W., Schilling, B.K., Brown, L.E. and Smith, S.L. (2003) Postactivation potentiation response in athletic and recreationally trained individuals. *Journal of Strength and Conditioning Research* **17**, 671-677.
- French, D.N., Kraemer, W.J. and Cooke, J.B. (2003) Changes in dynamic exercise performance following a sequence of preconditioning isometric muscle actions. *Journal of Strength and Conditioning Research* **17**, 678-685.
- Hamada T, DG Sale and JD McDougall (2000) Postactivation potentiation in endurance trained male athletes. *Medicine and Science in Sports and Exercise* **32**, 403-411.
- Harman, E.A., Rosenstein, M.T., Frykman, P.N., Rosenstein, R.M. and Kraemer, W.J. (1991) Estimation of human power output from vertical jump. *Journal of Applied Sports Science Research*. **5**, 116-120.
- Hoffman, J.R. (2006) *Norms for fitness, performance and health*. Champaign, Ill: Human Kinetics.

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