Muscle Strength, Body Composition, and Performance of an Elite Shot-Putter

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Purpose: Although muscle mass and strength are thought to be closely related to throwing performance, there are few scientific data about these parameters in elite shot-putters. The purpose of this case report was to present longitudinal data for muscle strength and body composition in relation to performance of an elite male shot-putter. Methods: A male national champion with the best rotational shot-put performance of 20.36 m (in 2010) was followed from 2003 to 2011 (current age: 29 y). Data regarding body composition (dual X-ray absorptiometry), as well as 1-repetition-maximum muscle strength (bench press, squat, snatch) and rotational shot-put performance, were collected every February for the last 9 y, 4 wk before the national indoor championship event. Results: The athlete’s personal-best performances in squat, bench press, and snatch were 175 kg, 210 kg, and 112.5 kg, respectively. His peak total lean body mass was 92.4 kg, bone mineral density 1.55 g/cm², and lowest body fat 12.9%. His shot-put performance over these 9 years was significantly correlated with 1-repetition-maximum squat strength \( r = .93, P < .01 \), bench press \( r = .87, P < .01 \), and snatch \( r = .92, P < .01 \). In contrast, shot-put performance was not significantly correlated with any of the body-composition parameters. Conclusions: The results of this case study suggest that elite rotational shot-put performance may not be directly correlated with lean body mass. Instead, it seems that it is closely related with measures of muscle strength.

Keywords: athletic throws, track and field, DXA

Shot put is a track-and-field event that requires the production of increased levels of muscle power. One of the main determinants of muscle power is strength, which is closely related to muscle mass. Shot-put athletes spend a large fraction of their preparation aiming to improve muscle mass and strength. Indeed, there is a close correlation between muscle strength, lean body mass (LBM), and linear shot-put performance. Many contemporary shot-put athletes have adopted the rotational style, which is thought to favor athletes with a greater ability to produce speed after taking the power position. This suggests that power production during rotational shot put might rely more on speed of movement or the rate of force development and less on muscle mass and strength. Indeed, recently it was reported that the correlation between rotational shot-put performance and LBM becomes low and nonsignificant at the winter competition period in shot-putters with moderate to high performance. The purpose of this case report was to describe the longitudinal development of muscle strength, body composition, and performance of an elite shot-putter and further describe the relationship between LBM and rotational shot-put performance.

Methods

Athlete

The Greek national shot-put champion of recent years volunteered to participate (current age 29 y, height 186 cm, body mass 101.5 kg, body-mass index 29.3 kg/m²). His personal-best rotational shot-put performance was 20.36 m (92% of 2011’s world best performance). He is right-hand dominant and started to compete in shot-put events in 1999. During the last 9 years he was in good health, except in 2006 when he suffered from a knee injury; he did not take any medication except from protein and vitamin supplements; and he has never used performance-enhancement drugs (tested 10 times between 2003 and 2011). All procedures were performed in accordance with the Declaration of Helsinki and approved by the university ethics committee.

Shot Put and Muscle Strength

Shot-put performance was measured every year, indoors, in a standard circle, 4 weeks before the annual indoor national championship event (late February), using a 7.260-kg implement (power position and full rotational style). Maximal strength (1-repetition maximum; 1RM) in squat, bench press, and snatch was assessed on 2 different days according to previously described methods.
Briefly, after a short warm-up, the athlete performed incremental submaximal efforts until he was unable to lift a heavier weight. Three minutes of rest were allowed between sets.

**Dual X-Ray Absorptiometry**

A total body scan was performed (DXA model DPX-L, LUNAR Radiation, Madison, WI, USA) and analyzed using the LUNAR Radiation body-composition program. Fat mass, LBM, and bone mineral density were determined for the total body, the arms, the legs, and the trunk.

**Statistical Analyses**

Means ± SDs were used to describe variables. Pearson (r) product–moment correlation coefficient was used to explore the relationships between different variables. P ≤ .05 was used as a 2-tailed level of significance.

**Results**

Shot-put performance remained above 19 m after the year 2004. However, total LBM showed large variations of 84 to 92 kg (Figure 1). A similar trend was found for upper and lower body LBM. Specifically, LBM of the lower extremities ranged from 30.2 to 33.0 kg, while LBM of the upper extremities ranged from 10.3 to 12.5 kg. Bone mineral density ranged from 1.475 to 1.553 g/cm². Body fat ranged from 12.9 to 21.3%. Shot-put performance with the rotational style was significantly correlated with 1RM in squat (r = .93, P < .01), in bench press (r = .87, P < .01, Figure 2), and in snatch (r = .92, P < .01). In contrast, low and nonsignificant correlations were found between all the body-composition parameters and shot-put performance. Shot-put performance from the power position was significantly correlated with total LBM (r = .92, P < .01).

**Discussion**

The main result of this study was that 1RM muscle strength in squat, bench press, and snatch was closely related to the rotational shot-put performance of an elite athlete during the latest 9 years of his career. Similarly, muscle strength has been shown to correlate with both linear² and rotational shot-put performance. In contrast, neither total nor regional LBM correlated with shot-put performance as recently found in shot putters (rotational style).⁴ LBM was significantly correlated with shot-put performance from the power position, as also found in the past.⁴ It seems that when a complex throwing style is adopted (eg, rotational), LBM does not affect performance as it does during a simple throwing technique. This further suggests that other parameters might be more important for rotational shot-putting, such as neuromuscular activation level, level of arousal, and perhaps the proportion of type II muscle fibers.⁶

**Practical Implication**

LBM is not directly linked to rotational shot-put performance and may not be a main training aim for experienced shot-putters performing with the rotational style.

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**Figure 1** — Shot put and lean body mass during an elite shot-putter’s last 9 years of competing with the rotational style.
Conclusion

The results of the current study suggest that muscle strength correlates better than LBM with rotational shot-put performance in elite shot-putters.

Acknowledgments

We wish to thank Mr. Michalis Stamatogiannis for consistent collaboration with our team during the last 11 years.

References