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LEAN BODY MASS AS A PREDICTOR OF PERFORMANCE OF YOUNG IRANIAN ELITE WEIGHTLIFTERS

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ABSTRACT

The aim of this study was to evaluate the relationships of body composition and anthropometric variables with the performance of young Iranian elite weightlifters. Forty-two subjects (age 16.21±3.22 years) volunteered to participate in the study. All subjects competed at the Iranian National Championship. Body composition and anthropometric variables including lean body mass (LBM), body mass index (BMI), percentage body fat (%BF), height, shoulder circumference, chest circumference, waist to hip ratio (WHR), as well as the performance of the weightlifters (snatch; clean & jerk; front squat; back squat), were measured. The results showed a strong correlation between LBM and the performance of the weightlifters ($p \leq 0.001$). Moderate correlations between the remaining body composition variables and the performance of the weightlifters were obtained. However, low negative correlations were found between the performance of the weightlifters and the %BF and WHR values. It can be concluded that there was a relationship between LBM and weightlifting performance. However, weak negative relationships existed among %BF and WHR with the performance of weightlifters. Therefore, LBM was the major determinant in weightlifting, while %BF played a very small role in the determination of weightlifting performance.

Key words: Weightlifting performance; Body composition; Elite weightlifters.

INTRODUCTION

Success in performing professional sport depends on motor skills, psychological conditions and body composition variables (Pietraszewska *et al*., 2015). Body composition variables refer to the relative amounts of fat and fat free mass (FFM) (muscle, bone and water) (Newman *et al*., 2006; Ayan *et al*., 2012; Martín-Matillas *et al*., 2014). Basically the human body is composed of fat mass (FM) and FFM (Baumgartner & Jackson, 1998; Wang *et al*., 2001; Siahkouhian *et al*., 2006; Siahkouhian & Hedayatnejad, 2010).

FM which is expressed as a %BF, referred to as relative body fat, is obtained by dividing the FM by the total body mass. The average %BF is 15% for men and 23% for women (Jackson & Pollock, 1985). Exact %BF cannot be precisely determined, but multiple methods (formula, skin fold thickness and bioelectrical impedance calculations), are used to estimate %BF (Adeyemi *et al*., 2009; Martín-Matillas *et al*., 2014).

On the other hand, LBM (Lean Body Mass) is a theoretical value developed by Behnke (1985). LBM is considered as an in vitro entity relatively constant in water, organic matter

and mineral content. The terms LBM and FFM are often incorrectly used interchangeably. FFM contains no lipids, whereas LBM includes approximately 2 to 3% and 5 to 8% fat, for men and women respectively (Heyward & Wagner, 2004; Buśko & Lipińska, 2012). Behnke (1985) points out that FFM refers to an in vitro entity appropriate for body analysis. The literature indicates considerable variations in the LBM of different athletes, with values ranging from a low of 48.1kg in some jockeys to over 100kg in football linemen and field-event athletes. Seven elite sumo wrestlers had an average LBM of 109kg (Skinner *et al*., 2014).

It has been established that the relationship between body mass and lifting performance is not linear in Olympic weightlifters. This relationship has been frequently studied in Olympic weightlifting (Cleather, 2006). To determine the extent to which age and body mass of elite Olympic weightlifters are related to and predictive of indirect estimates of absolute and relative muscular power, Ploutz-Snyder (2003) showed that all predictor variables were significantly ($p<0.05$) predictive of the dependent variables, but the magnitude of associations and extent of predictive ability were significantly ($p<0.05$) higher among males than females. According to these results, Ploutz-Snyder concluded that the extent to which age and body mass explain differences in muscular power, differs between female and male weightlifters, but the rate of decline in power with advancing age is similar and is in agreement with previous reports for world record holders (Ploutz-Snyder, 2003). On the other hand, Stone *et al*. (2005) indicated that independent of body mass and height differences, maximum strength is strongly related to weightlifting performance.

Problems in comparing the performances of Olympic weightlifters arose from the fact that the relationship between body mass and weightlifting results was not linear. Therefore, Kauhanen *et al*. (2002) examined this relationship by using a nonparametric curve fitting technique of robust locally weighted regression on relatively large data sets of weightlifting results from top international competitions. These results have shown that existing formulas commonly used in normalising the performances of Olympic weightlifters did not yield satisfactory results when applied to the present data. It was concluded that the devised formulas may provide objective means for the evaluation of male weightlifter's performances, regardless of their body mass, age or performance levels (Kauhanen *et al*., 2002).

To assess factors that limit human muscle strength and growth, Ford *et al*. (2000) examined the relationship between performance and body dimensions in the world weightlifting champions between 1993 and 1997. Their findings suggest a nearly constant fraction of body mass is devoted to muscle in lighter lifters and a lesser fraction in heavier lifters. Analysis also suggests that contractile tissue comprises ~30% less body mass in female champions (Ford *et al*., 2000).

PURPOSE OF THE STUDY

Despite a wide variety of studies (Byers *et al*., 2008; Koley *et al*., 2010; Tysz, 2010; Giatsis *et al*., 2011; Muhumbe & Van Gent, 2014; Ammar *et al*., 2015), there is no comprehensive data about Iranian World and Olympic weightlifting champions. Due to a lack of data regarding body composition and anthropometric variables and its relationships to the performance of young elite weightlifters, the purpose of this study was to evaluate the

relationships of body composition and anthropometric variables with the performance of young Iranian elite weightlifters.

METHODOLOGY

Experimental design and subjects

Young elite male weightlifters (N=42), who volunteered to participate in the study signed an informed consent document prepared and approved by the Board for Protection of Human Rights affiliated at the University of Mohaghegh Ardabili. They were healthy volunteers with no history of cardiovascular disease, orthopaedic problems or other medical conditions that would contra-indicate exercise (age 17.56±2.78 years; height 169.43±6.36cm; mass 71.08±16.39kg). All the subjects were professional weightlifters with an average of 4 years lifting experience in the weightlifting championships. Snatch, clean and jerk, front squat and back squat attempts of the weightlifters were measured during the last pre-competition micro-cycle.

Procedure

All of the subjects completed a 15-minute warm up at 60 to 75% of their personal records, before physical test protocols were performed. Each training session was conducted and monitored by the researchers. The subjects were encouraged to exert maximal effort on all tests. Following the initial evaluations, subjects were instructed to maintain the same level of physical activity (PA).

Anthropometric and body composition measurements

The %BF was predicted by the 3 points skinfold measurement (chest, abdomen and thigh), which was taken on the right side. Measurements were taken when the skin was dry and not sweaty. To eliminate inter-observer variability, only 1 highly trained investigator performed these procedures. The Lafayette standard calliper was used to measure the skinfold thickness in millimetres. Relative body fat was calculated using the Siri equation (Siri, 1961). All anthropometric and body composition variables were measured 14 hours after the last training session. Pollock and Wilmore methods were used to measure anthropometric values (Jackson *et al*., 1978). All subjects were encouraged to use a balanced fluid intake before the body composition measurements.

Height was measured to the nearest centimetre using a Seca stadiometer. To measure the height, the subjects stood erect with their backs touching the stadiometer, their arms held laterally by their sides and their feet closely together. The mass of each subject was measured to the nearest kilogram using a Seca scale. The body mass index (BMI) was calculated using the height (m) and mass (kg) measures [mass/height^2]. The shoulder, chest, waist and hip circumferences were measured to the nearest centimetre using a measuring tape, while the subject was standing erect (Siahkouhian & Hedayatnejad, 2010).

Lifting performance measurements

During normal training, consisting of 2 workouts per day, each weightlifter warmed-up for 15 to 20 minutes and the recording process followed. All lifting exercises were performed under supervision of 3 international level judges.

Statistical analysis

The data were analysed using descriptive and inferential statistics for anthropometric, body composition and performance variables. Pearson correlation coefficient (R) was applied for understand the overall relationship between body composition, anthropometric and performance variables. All data were tested for normality using Kolmogorov-Smirnov test.

RESULTS

The mean values of the anthropometric and body composition characteristics of the subjects are listed in Table 1.

Table 1. **CHARACTERISTICS OF THE SUBJECTS: ANTHROPOMETRIC, BODY COMPOSITION AND PERFORMANCE MEASURES**

Variables	Mean±SD
Age (year)	17.56±2.78
Height (cm)	169.43±6.36
Mass (kg)	71.08±16.39
Body fat (%)	19.47±9.75
Lean body mass (kg)	51.91±13.49
Waist to hip ratio	0.79±0.069
Body Mass Index (kg/m^2)	23.91±4.85
Shoulder circumference (cm)	111.45±18.25
Chest circumference (cm)	95.11±16.22
Snatch record (kg)	79.85±25.71
Clean & Jerk record (kg)	98.23±23.47

Analyses by means of the Pearson correlation revealed significant positive high correlations of LBM with the snatch, clean and jerk, front squat and back squat records (Figure 1). On the other hand, weak negative relationships among %BF and WHR with the performance of the weightlifters were found. The results also revealed moderate relationships of body composition and anthropometric variables with the performance of the weightlifters (Table 2).

DISCUSSION

A low %BF has been shown to improve performance in endurance activities, while a large muscle mass is important during strength and power events (Heyward & Wagner, 2004). Despite low negative %BF and WHR correlations with the performance of the weightlifters, except for LBM, results revealed moderate significant positive correlations of body composition and anthropometric variables with the performance of the weightlifters. The strong positive correlation between the performance of the weightlifters and LBM implies that this parameter is the major determinants in the weightlifting.

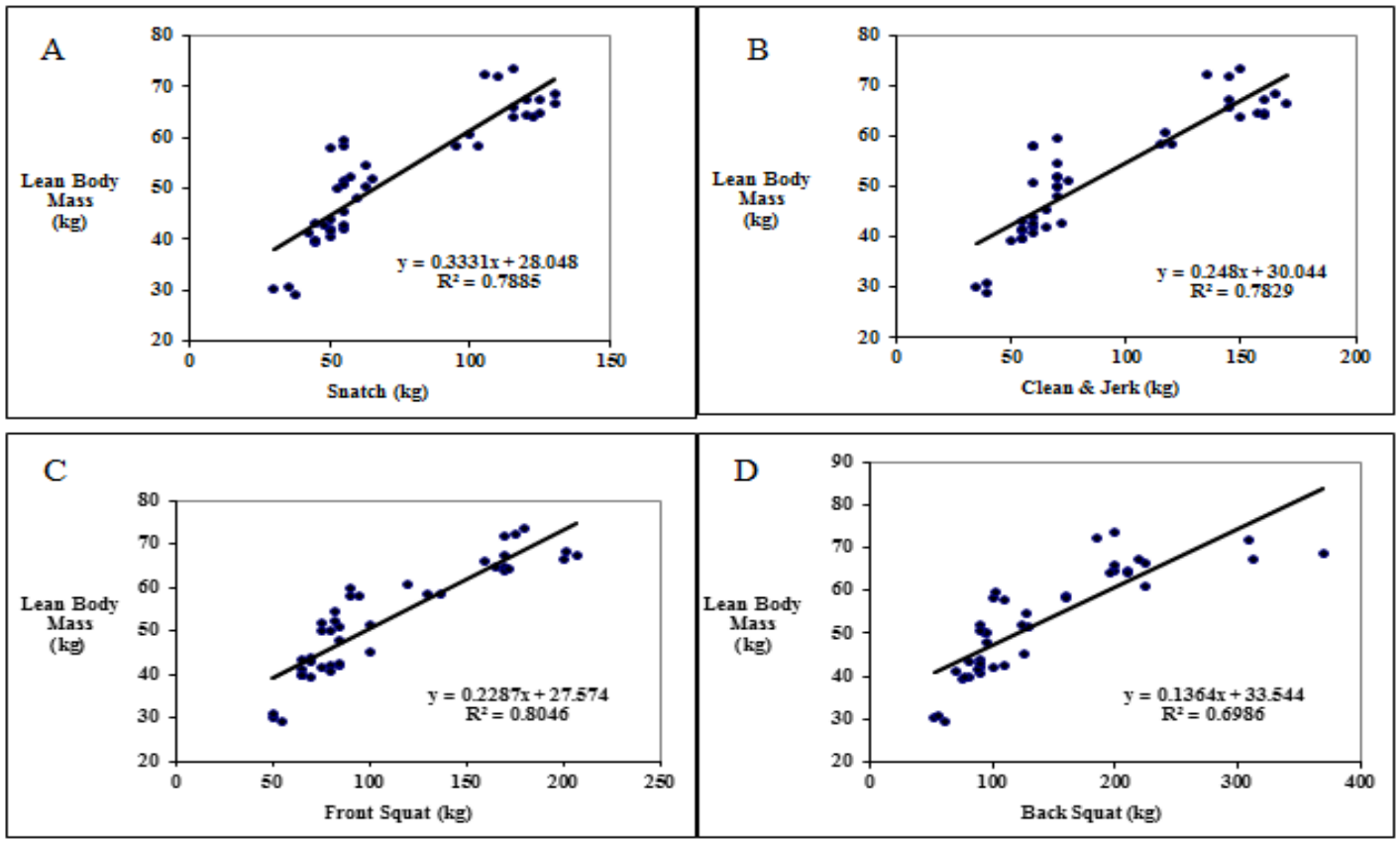

Figure 1. **PEARSON CORRELATION COEFFICIENT OF LBM WITH THE SNATCH (A), CLEAN & JERK (B), FRONT SQUAT (C) AND BACK SQUAT (D) RECORDS**

Table 2. **CORRELATION AMONG ANTHROPOMETRIC, BODY COMPOSITION AND PERFORMANCE VARIABLES**

Variables	Snatch	Clean & jerk	Front squat	Back squat
Body Fat (%)	-0.244	-0.235	-0.180	-0.183
WHR (%)	-0.220	-0.194	-0.148	-0.142
Mass (kg)	0.450**	0.459**	0.511***	0.465**
BMI (kg/m^2)	0.375*	0.374*	0.442**	0.393**
Shoulder circumf. (cm)	0.544***	0.544***	0.741***	0.674***
Chest circumf. (cm)	0.544**	0.544***	0.571***	0.507***

WHR=Waist to Hip Ratio BMI=Body Mass Index Circumf.=Circumference
Significance: * $p \leq 0.05$ ** $p \leq 0.01$ *** $p \leq 0.001$

Negative correlations of %BF and WHR were observed regarding the performance of the weightlifters. This result was in contrast with findings of Stone *et al*. (2005), who assessed the relationship of maximum strength to weightlifting ability using established scaling methods. Their results indicated that maximum strength is strongly related to weightlifting performance, independent of body mass and height differences. Also, regarding the relationship between body mass and weightlifting abilities, Kauhanen *et al*. (2002) showed that the devised formulas may provide objective means for the evaluation of performances of the male weightlifters, regardless of their body mass, age or performance ranks.

These findings, while not congruent with those obtained by Kauhanen *et al*. (2002) and Stone *et al*. (2005), correspond with the findings of Ford *et al*. (2000), who revealed that maximum mass lifted by elite weightlifters varied almost exactly with height squared. This suggests that muscle mass scaled almost exactly with height cubed and that muscle cross-sectional area was closely correlated with body height, possibly because height and the number of muscle fibres in a cross-section are determined by a common factor during maturation. The ratio of mass lifted to a mean body cross-sectional area was approximately constant for body-mass classes of ≤83kg for men, which decreased abruptly for higher mass classes. The findings suggest a nearly constant fraction of body mass devoted to muscle in lighter weightlifters and a lesser fraction in heavier weightlifters.

Insignificant negative relationships of %BF and WHR with the performance of the weightlifters are notable. These relationships may be due to the relatively small sample and magnitude of standard deviations. It should also be noted that weightlifting is a power and strength-based sport and it is obvious that increased power and strength result in increased performance. Similarly, strong positive relationships between weightlifters' performance and LBM indicate the importance of LBM in the weightlifters' performance predictions.

CONCLUSION

According to the results, it could be concluded that there is a relationship between LBM and weightlifting performance. However, weak negative relationships exist among %BF and

WHR with the performance of the weightlifters. Therefore, LBM is the major determinant in weightlifting, whereas %BF plays a very small role in the determination of weightlifting performance.

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