MJSS

Akdeniz Spor Bilimleri Dergisi

Mediterranean Journal of Sport Science

ISSN 2667-5463

Body Composition As Indicators of Upper and Lower Limp Anaerobic Power in Men and Women Weightlifters

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DOI: https://doi.org/10.38021asbid.1250064

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Abstract

The aim of this study was to investigate the relationship between anaerobic power and body composition in weightlifters. A total of 58 weightlifters, 28 females and 30 males, actively competing in national and international competitions participated in the study. Body composition of the weightlifters was determined by bioelectrical impedance analysis method and upper and lower extremity anaerobic power was determined by Wingate test. Data normality was verified using the Kolmogorov-Smirnov test**.** A preliminary bivariate correlation analysis was used to assess the association between body composition, lower and upper PP(W), body composition and upper and lower absolute anaerobic power variables were compared using the independent t-test to control within the values of men and women. Gender-specific multiple regressions evaluated whether the body composition was associated with the upper and lower absolute anaerobic power. The alpha level was set at $p<0.05$ for all the analyses. According to the results of the analysis, there was a difference between the peak power values of men and women. There is a different level (medium-high) relationship between body composition and lower and upper extremity peak power in both men and women. According to linear regression analysis, women and men have high predictive values for lower body peak power and low predictive values for upper extremity. In conclusion, it was determined that men and women use different variables effectively in peak power production. According to research results, monitoring body composition may contribute to the improvement of weight lifters' weight lifting performances.

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Key Words: Weightlifters, Anaerobic Power, Body Composition, Gender.

Erkek ve Kadın Haltercilerde Üst ve Alt Ekstremite Anaerobik Gücün Göstergesi Olarak Vücut Kompozisyonu

Öz

Bu çalışmanın amacı haltercilerde anaerobik güç ile vücut kompozisyonu arasındaki ilişkinin incelenmesidir. Çalışmaya ulusal ve uluslararası müsabakalarda aktif olarak yarışan 28 kadın 30 erkek olmak üzere toplam 58 katılımcı dahil edilmiştir. Haltercilerin vücut kompozisyonu değerleri biyoelektrik empedans analiz yöntemi, üst ve alt ekstremite anaerobik güç değerleri ise Wingate testi ile belirlenmiştir. Elde edilen verilerde homojeniteyi tespit etmek amacıyla Kolmogorov-Simirnov testi kullanılmıştır. Anaerobik güç ile vücut kompozisyonu arasındaki ilişki için korelasyon analizi, cinsiyetler arasındaki farkı incelemek için t-testi, cinsiyetler arası alt ve üst ekstremite anaerobik güç ile vücut kompozisyonu arasındaki ilişki için ise çoklu regresyon analizi kullanılmıştır. Tüm analizler için anlamlılık değeri $p<0.05$ olarak belirlenmiştir. Yapılan istatiksel analizler sonucunda göre kadın ve erkeklerin zirve güç değerleri arasında farklılık görülmüştür. Vücut kompozisyonu ile alt ve üst ekstremite zirve güç arasında hem kadınlarda hem de erkeklerde farklı düzeyde (orta-yüksek) ilişki vardır. Doğrusal regresyon analizine göre kadınlar ve erkeklerde alt vücut zirve gücün tahmin edilmesinde yüksek, üst ekstremite için ise düşük tahmin değerlerine sahip olduğu görülmektedir. Sonuç olarak zirve güç üretiminde kadın ve erkeklerin farklı değişkenleri etkin olarak kullandığı belirlenmiştir. Araştırma sonuçlarına göre, kadın ve erkek haltercilerin vücut kompozisyonunun takip edilmesi ağırlık kaldırma performansların geliştirilmesine katkı sağlayabilir.

Received: 13.02.2023

Accepted: 04.05.2023

Online Publishing: 28.12.2023

Anahtar Kelimeler: Halter, Anaerobik Güç, Vücut Kompozisyonu, Cinsiyet.

Introduction

Weightlifting has been a significant element of the modern Olympic Games for a long time and its global participation is continuously increasing. The snatch and jerk are two movements in weightlifting. The snatch and the jerk are complex whole-body movements performed using a series of high-intensity muscle movements (Storey and Smith, 2012a). Weightlifting causes rapid muscle fatigue, significant energy expenditure, and high force and power output over a short period, as an example of a dynamic strength and power sport (Ammar et al., 2020). The anthropometric characteristics of the athletes vary significantly because there are eight male and seven female body weight divisions in professional weightlifting. Athletes in other strength and power sports with equivalent body mass have similar body compositions to weightlifters. However, weightlifters' lower stature and shorter limb lengths give them mechanical benefits while lifting large objects since they require less vertical displacement of the barbell and less mechanical torque. Furthermore, shorter body dimensions are associated with a greater mean skeletal muscle cross-sectional area for improved weightlifting performance (Storey and Smith, 2012b).

Weightlifters are characterized by very big trunk and limb girths, high body and fat-free mass per unit of height, and medium to below average height (Brechue and Abe, 2002). When comparing results between research, care should be given due to variations in data collection and processing methods. Due to the potential for differing anthropometric characteristics of various ethnic groups, it is also critical to evaluate nation-specific data in order to use it for the identification of athletes with potential and the monitoring of training programs (Palma-Lafourcade et al., 2019). Even while the amount of fat-free/lean mass may be the primary anthropometric factor determining maximal strength, a range of other anthropometric parameters may also have an impact on powerlifting performance (Brechue and Abe, 2002; Mayhew et al., 1993). Male weightlifters' anthropometric characteristics have received substantial research male weightlifters who are light to medium weight (between 56 and 85 kg) are classified as predominantly ectomorphic or mesomorphic by somatotype and have body fat percentages between 5 and 10% (Stone et al., 2006; Storey and Smith, 2012b). Despite having less complete anthropometric data, female weightlifters may have body fat percentages that are twice as high as male weightlifters of equal body mass (Haff et al., 2008). However, elite male and female weightlifters have a lower body fat percentage than lower competitors with the same total body mass. As a result, the variations in lean body mass constitute a significant component in the disparities in neuromuscular reactions between males and females and elite and non-elite weightlifters (Fry et al., 2006; Haff et al., 2008; Stone et al., 2006).

There needs to be more research on weightlifting than there is on other Olympic sports. It appears that gender and ethnicity may have an influence on anthropometric attributes (Vidal Perez et al., 2021).

Weightlifting movements require a high level of explosive power, which is primarily derived from the anaerobic energy system. This system provides energy for short bursts of intense activity, such as a heavy snatch or clean and jerk. Anaerobic power is critical for generating high power outputs during weightlifting movements, and developing this type of power requires specific training exercises (Ammar et al., 2020; Crenshaw et al., 2023; Moscatelli et al., 2023). Studies on weightlifting are scarce, but there are few in the population of Turkey. The research on its relationship with limb and segment length, linked to the performance of weightlifting athletes, becomes interesting, given that anaerobic power is a crucial component of weightlifting. In order to evaluate the significance of anthropometric characteristics in performance, this research aimed to identify potential relationships between body composition and anaerobic power in weightlifting.

Materials and Methods

Participants

58 weightlifters (28 women and 30 men) who have competed in national and international competitions and who regularly train and participated voluntarily in this study. Weightlifters were free of any musculoskeletal disorders and had at least five years of training and competition experience. Participants signed a written informed consent form after being given information about the study's objectives, potential risks, and procedures. Additionally, they were told not to exercise vigorously for 24 hours before to the testing. The Non-Interventional Clinical Research Ethics Board granted approval for this study (Protocol no:2023/6), and it adhered to the Declaration of Helsinki's principles.

Bioelectrical Impedance Analysis (BIA)

After a 12-hour fast, the athletes' body composition values were assessed using the bioelectrical impedance analysis method (BIA; MC 980, Tanita Corp., 1000 kHz, Japan). The device's hand and foot electrodes work along with the electric current flowing through the body to provide a thorough study of the body. Weightlifters were instructed to empty their bladders right before measurements and to abstain from alcohol, caffeinated beverages, and other diuretics 12 hours beforehand in order to reduce mistakes associated with hydration status. Additionally, athletes were instructed to arrive at the facility for testing after an overnight fast in a typically hydrated state. Before testing, a 24-hour dietary recall was taken. From the data obtained as a result of this measurement, Body weight (kg), Body Mass İndex (kg/m^2), Body fat (%), Muscle Mass (kg), Trunk (kg), Left Arm (kg), Right Arm (kg), Left Leg (kg), Right Leg (kg) values were used in the study.

Anaerobic Power Tests

The weightlifters performed 30-second Wingate anaerobic tests in their legs and arms on a movable Monark cycle ergometer to gauge their anaerobic strength and capacity (Model 894-E, and Model 891-E Stockholm, Sweden). In the Wingate leg test, each subject was required to cycle to their maximum capacity while standing against a resistance load of 75 g/kg^{-1} body mass, while in the wingate arm crank test, they were required to cycle to their maximum capacity while standing against a resistance load of 55 g/kg^{-1} body mass. Before each test, the cycle set was calibrated in accordance with the manufacturer's instructions. The first phase of the warm-up consisted of five minutes of cycling at 60 to 70 rpm, followed by three all-out sprints in the final five seconds of the third minute. After then, the participants received a 5-minute passive rest period. The 30-second wingate testing was completed. Subjects were instructed to fast reach their maximum pedaling speed and then instructed to start pedaling against the predetermined workloads at the order "start"(Galán-Rioja et al., 2020). The cadence speed was monitored and simultaneously recorded while the subjects could look via the monitor during the experiments. The peak power (PP) in watts was determined as the highest measured power in any 5-second period.

Statistical analysis

The data were analysed using SPSS 21.0 (IBM Corp, Armonk, NY, USA), and the results were presented as mean ± standard deviation. Data normality was verified using the Kolmogorov-Smirnov test**.** A preliminary bivariate correlation analysis was used to assess the association between body composition, lower and upper PP(W), body composition and upper and lower absolute anaerobic power variables were compared using the independent t-test to control within the values of men and women. Gender-specific multiple regressions evaluated whether the body composition was associated with the upper and lower absolute anaerobic power. The alpha level was set at 0.05 for all the analyses. Effect sizes for the paired t-test were calculated by Cohen’s d and were classified according to Hopkins.

Results

Table 1
Body Composition, Absolute Upper and Lower Limb Anaerobic Power Test

Variables	Men	Women	p	d
	Mean-SD	Mean-SD		
n	30	28		
Age (yrs,)	21.70±1.9	20.37±2.1	0.060	0.60
Experience (yrs,)	8.283.2	7.15±2.1	0.060	0.62
Height (cm)	170.65±5.9	156.54±5.5	0.000	2.48
Body weight (kg)	69.71±8.2	57.76±9.1	0.000	1.39
BMİ (kg/m^2)	23.9±2.2	23.52±3.1	0.656	0.15
Body fat (%)	14.88±3.6	24.35±5.6	0.000	2.01
Trunk (kg)	30.47±3.3	24.27±2.9	0.000	1.99
Left Arm (kg)	3.17±0.6	1.97±0.5	0.000	2.17
Right Arm (kg)	3.18±0.6	1.90±0.5	0.000	2.31
Left Leg (kg)	9.59±1.1	6.54±1.3	0.000	2.53
Right Leg (kg)	9.89±1.1	6.68±1.3	0.000	2.67
Lower Limp Absolute PP (W)	1054.20±182.2	620.78±132.1	0.000	2.72
Upper Limp Absolute PP (W)	777.05±159.3	404.75±77.1	0.000	2.97

PP:Peak Power, BMİ: Body Mass İndex

Body composition, absolute upper and lower limb anaerobic power test are shown in table I. All parameters were different except the age, training experience and BMİ of men and women ($p < 0.01$). Men have upper and lower limb anaerobic power than women ($p< 0.01$).

Table 2

The Matrix of Correlations Body Composition, Lower and Upper Limp PP(W)

Group		Height (cm)	BMİ (kg/m^2)	Body fat (%)	Trunk (kg)	Left Arm (kg)	Right Arm (kg)	Left Leg (kg)	Right Leg (kg)
Men	Lower Limp PP(W)	0.597*	0.490*	0.192	0.715*	0.472*	0.404*	0.641*	0.656*
Women		0.547*	0.630*	0.308	0.740*	0.460*	0.408*	0.494*	0.530*
Group		**Height (cm)**	**BMİ (kg/m^2)**	**Body fat (%)**	**Trunk (kg)**	**Left Arm (kg)**	**Right Arm (kg)**	**Left Leg (kg)**	**Right Leg (kg)**
Men	Upper Limp PP(W)	0.324*	0.528*	0.140	0.564*	0.464*	0.431*	0.515*	0.496*
Women		0.487*	0.599*	0.152	0.648*	0.686*	0.628*	0.692*	0.660*

*$p < 0,05$ PP:Peak Power,

The matrix of correlations body composition, lower and upper limp PP(W) variables is shown in table II. Body composition and phase angle were differentially (medium-high) associated lower and upper limp PP(W) in both men and women ($p<0.05$), wheras no correlation was found body fat (%) all group (Table 2.)

Table 3

Linear Regression Analysis Independent Variables And Lower and Upper Limp PP(W)

PP(W)		Height (cm)	BMİ (kg/m^{2})	Body fat (%)	Trunk (kg)	Left Arm (kg)	Right Arm (kg)	Left Leg (kg)	Right Leg (kg)	Adjust R^2
Lower Limp	Model 1	-1.14	-1.75	1.11	2.33	0.30	0.17	0.06	1.09	0.43
	Model 2	3.49	4.23	-1.58	-2.22	-4.19	0.42	5.20	-4.45	0.63
Upper Limp	Model 1	2.21	2.65	-1.06	-1.27	-1.00	0.69	1.85	-3.21	0.23
	Model 2	1.28	1.19	0.12	-1.19	-1.76	0.51	4.74	-3.36	0.05

All values represent standardized β's,
Model 1 men
Model 2 women

According to the results of linear regression analysis (Table 3), The adjusted R^2 values in the regression models created for men and women at lower limp PP values, men and women have high prediction rates. In contrast, they have low prediction scores at upper limp PP values. According to this finding, the predictor variables considered with the predicted variable of lower limp PP have a significant effect. It is concluded that low R^2 values in the upper limb are not effective in predicting PP values. Especially in women, the variables considered have very low effect values for Upper limp PP. According to the standardized regression coefficient, the trunk (kg) has the highest effect in men, and the left leg (kg) has the highest effect in women for lower limp PP. For upper limp PP, the right leg (kg) in men and the left (kg) in women were found to have the highest effect.

Discussion

The purpose of the current research was to determine whether there might be differences in the lower and upper limp anaerobic power of competitive male and female Turkish powerlifters according on their body types and sexes. As anticipated, both male and female powerlifters showed a significant link between their lifting abilities and their body types.In addition, it was also found that women and men were affected differently by the parameters considered in revealing the PP variable. At the same time, the left leg (kg) was more effective in women's PP values, the trunk (kg) was adequate for lower limp PP, and the right leg (kg) was effective for limp upper PP in men. As a result, it was determined that different variables were used effectively by men and women in determining PP. The five factors that have been found to accurately classify elite men and women weightlifters—body mass index, vertical jump height, relative fat, grip strength, and torso angle during an overhead squat—are particularly relevant. These factors are indicators of muscular strength, flexibility, lower body power, body composition, and kinesthetic awareness (Fry et al., 2006; Kipp, 2022; Musser et al., 2014).

Athletes competing in events with weight restrictions frequently train at a body mass 5–10% higher than the weight class they must compete in (Hasan et al., 2021; Rogozkin, 2000). Limiting fluid intake and eating a low-residue diet the week before a competition may be utilized to produce a minor drop in body mass (e.g., a loss of 1-2 kg), although this can impair performance. When lifting maximal loads, these anthropometric characteristics have two mechanical advantages: first, the shorter lengths of the resistance lever arms reduce the mechanical torque required to lift a given load, and second, the reduced vertical displacement of the barbell reduces the amount of muscular work required to lift a given load (Keogh et al., 2007; Keogh et al., 2009). Furthermore, the performance of weightlifting is improved because the shorter body dimensions are correlated with a more significant mean skeletal muscle cross-sectional area (Ford et al., 2000). In addition, compared to other power athletes, the reported PP of male weightlifters is 13–36% higher during workout tests that include the lower body (such as clean pulls and different leaps) (Stone et al., 2003; Stone et al., 2008; Storey and Smith, 2012b). However, it was demonstrated that there are no absolute or relative PP differences between weightlifters and handball players during upper body-only activity (Chiu and Schilling, 2005; Izquierdo et al., 2002).

These results emphasize the lower body's crucial role in weightlifters' ability to produce power. Additionally, given that handball players must repeatedly perform high-intensity upper body motions (such as throwing) in competition, they may be explained by the specialization of training. On the other hand, during the snatch and clean&jerk, a weightlifter's upper body muscles are comparatively less important than their legs (Bai et al., 2008; Izquierdo et al., 2002). Men's weightlifters' anthropometric traits have received substantial research Men light to medium weightlifters (between 56 and 85 kg) are classified as predominantly ectomorphic or mesomorphic by somatotype (Orvanová, 1990) and have body fat percentages between 5 and 10% (Fry et al., 2006; Katch et al., 1980; Lovera and Keogh, 2015; Orvanová, 1990). According to the study, male weightlifters had mean body weights of 69 kg and body fat percentages of 14.88%, while female weightlifters had mean body weights of 57 kg and 24.35%, respectively. Despite the fact that there is less anthropometric data available for women weightlifters, their body fat percentages may be twice as high as that of men of equivalent body mass (Haff et al., 2008; Stone et al., 2006). The results of this study are supported by data on the body fat percentages of women weightlifters.

Elite weightlifters, both men and women, have lower body fat percentages than inferior competitors who have the same total body mass. Thus, changes in lean body mass are mostly to blame for the varying anaerobic power responses observed between men and women and elite and non-elite weightlifters (Ford et al., 2000; Fry et al., 2006). Women weightlifters may have a higher body fat percentage than men with equivalent body mass. (Stone et al., 2006). In contrast to other strength and power competitors, Olympic weightlifters benefit from having short limb segments and broad bi-acromial breadths (Fry et al., 2006). Elite Olympic lifters, according to Fry et al., exhibited shorter humerus, tibia, and trunk lengths as well as higher levels (moderate to large effect size) of fat-free mass as compared to non-elite junio lifters.(Fry et al., 2006). Additionally, it's been demonstrated that taller male weightlifters have lower limbs that are shorter than average (Marchocka and Smuk, 1984; Vidal Perez et al., 2021).

Success in weightlifting is impacted by barbell kinematics, which can also be affected by an athlete's anthropometric characteristics and anaerobic power. Some of the kinematic aspects of weightlifting exercises that have historically been studied include the trajectory, velocity, and acceleration of the barbell during the various pull stages of the snatch or clean&jerk (Kauhanen, 1984; Kipp and Harris, 2015; Vidal Perez et al., 2021). The barbell's acceleration and velocity profiles reveal the lifter's technical prowess. Nevertheless, there is little research linking barbell kinematics to anthropometric measurements and anaerobic power in weightlifters. In this regard, it is well known that the minimum horizontal barbell displacement is regarded as a crucial component of the best lifting technique (Isaka et al., 1996; Kipp, 2022), and at least one study reported a weight class-dependent relationship between the horizontal barbell displacement and some anthropometric variables (such as lower limb length).

In previous study found a positive correlation between anaerobic power and competition results in both snatch and clean and jerk, indicating that higher anaerobic power was associated with better sport performance. and also found that weightlifters with a more muscular and mesomorphic somatotype tended to have higher levels of anaerobic power (Pilis et al., 1997). Overall, the study suggests that anaerobic power and somatic variables are important factors that contribute to elite weightlifting performance. The findings may be useful for weightlifters and coaches in developing training programs that focus on improving anaerobic power and optimizing somatic variables for better performance in competition (Crenshaw et al., 2023; Pilis et al., 1997).

Conclusion

It is well known that a large muscle mass enhances performance in strength and power activities, so the estimation of the optimal bodyweight category is essential for coaches. Additional factors, such as body mass loss, influence athletes' outcomes. There is—however, surprisingly little research examining this effect in weightlifting. The strong link between body composition and excellent performance in weightlifting is not something that can be hypothesized about. This information is further supported by the study's findings, which show that lower and upper limp PP(W) were differentially (medium-high) related to body composition in both men and women. İn this study it was determined that different variables were used effectively by men and women in PP. Monitoring body composition analyses may therefore help to enhance lifting performance.

Ethics Committee Permission Information

Ethics review board: Yalova University Human Research Ethics Committee

Date of ethics assessment document: 23.01.2023

Issue number of the ethics evaluation document: 2023/6

Statement of Researchers' Contribution Rates

All authors contributed equally at all stages of the research.

Conflict of Interest

The authors cannot make a statement of conflict regarding the research.

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