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Original Article

The Examination of Relationship Between Anthropometric Measurement Values of Lower Extremity and Weightlifting Performance of Olympic Style Weightlifting Athletes

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Abstract

The study aims to determine the relationship between some anthropometric measurement values of lower extremity of athletes in olympic style weightlifting and weightlifting performance. Male (n= 35, age: 18.43±1.07, height: 1.72±.07 m, body weight: 74.70±14.63 kg, body muscle index: 25.12±4.05 kg/m^2) and female (n= 20, age: 21.20±3.49, height: 1.66±.08 m, body weight: 66.25± 15.12 kg, body muscle index: 23,98±3.96 kg/m^2) athletes in olympic style weightlifting participated in this study. Anthropometric measurements of right-left thigh and lower leg length, right-left thigh and calf girth of male and female athletes were obtained. One repetition maximum of snatch and clean and jerk performances of the athletes was recorded. A symmetry was observed between length and girth values of right-left lower extremity of athlete groups. Right-left thigh length, thigh and calf girth of female athletes were found be correlated both with snatch and with clean and jerk performance. Right-left lower leg length of both male and female athletes was not correlated with weightlifting performance. Consequently, it might be stated that anthropometric measurement values of length and girth of lower extremity of female athletes in olympic style weightlifting are correlated with their snatch and clean and jerk performances.

Keywords: Anthropometric measurement, Olympic style weightlifting, Snatch, Clean and jerk

Olimpik Stil Halter Sporcularının Alt Ekstremite Antropometrik Ölçüm Değerleri ile Halter Performanslarının Arasındaki İlişkilerin İncelenmesi

Öz

Bu çalışma, olimpik stil halter sporcularının alt ekstremitelerine ait bazı antropometrik ölçüm değerleri ile halter performansları arasındaki ilişkilerin belirlenmesini hedeflemiştir. Araştırmaya erkek olimpik stil halter sporcuları (n= 35, yaş: 18.43±1.07, boy: 1.72±.07 m, vücut ağırlığı: 74.70±14.63 kg, vücut kitle indeksi: 25.12±4.05 kg/m^2) ve kadın olimpik stil halter sporcuları (n= 20, yaş: 21.20±3.49, boy: 1.66±.08 m, vücut ağırlığı: 66.25± 15.12 kg, vücut kitle indeksi: 23,98±3.96 kg/m^2) katıldı. Erkek ve kadın sporcuların sağ-sol uyluk ve baldır uzunluk, sağ-sol uyluk ve baldır çevrelerine ait antropometrik ölçümler gerçekleştirildi. Sporcuların koparma ve silkme tekniklerinde tek tekrar maksimalleri tespit edildi. Sporcu grupların sağ-sol alt ekstremitelerine ait uzunluk ve çevre ölçüm değerleri arasında simetri gözlendi. Kadın sporcuların sağ-sol uyluk uzunlukları, uyluk ve baldır çevreleri ile koparma ve silkme performansları arasında bir korelasyon belirlendi. Hem erkek hem de kadın sporcuların ise sağ-sol baldır uzunlukları ile halter performansları arasında korelasyon tespit edilmedi. Sonuç olarak kadın sporcuların alt ekstremitelerine ait uzunluk ve çevre ölçümü antropometrik değerlerinin koparma ve silkme performanslarıyla ilişkili olduğu ifade edilebilir.

Anahtar Kelimeler: Antropometrik ölçüm, Olimpik stil halter, Koparma, Silkme

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INTRODUCTION

Since its first appearance in Olympic Games, weightlifting sport has been called "olympic style weightlifting". Olympic style weightlifting is a sport performed through two categories: snatch and clean and jerk (Calhoon and Fry, 1999; Garhammer and Takano, 1992; Erdağı, 2019). Snatch is to lift the bar over the head through a single move without any pause (Garhammer and Takano, 1992). Clean and jerk, on the other hand, is a coordinated process, in which clean is to lift the bar to the shoulders in a single move and jerk is to lift the bar over the head in a single move when hands are straight upward (Erdağı, 2019; Öztürk, 1992; Yazıcı, 1997). In weightlifting tournaments, athletes are given three trials for both techniques and they attempt to lift maximal, 1 repetition maximum (Erdağı, 2019). Anthropometry is a systematic method that uses specified measurement methods and classifies objective characteristics of a human body depending on their size and structural characteristics (Özer, 1993). Anthropometric characteristics of athletes affect athletic performance and are of primary importance in success in some sports and necessary for an upper level performance of athletes (Bayios et al., 2006; Duncan et al., 2006). It's known that each sport requires unique characteristics. Physical structures of athletes with requirement of the sport are known to be effective in athletic feat in tournaments (Claessens et al., 1994; Slater et al., 2005). To have an idea about the physical characteristics of successful athletes might be accepted as a model during the selection of the athletes depending of their skills. To do so, anthropometric measurements such as height and girth length are essential (Claessens, 1999). Especially, physical structure plays a critical role in performance. In a study, the anthropometric characteristics of olympic style weightlifting athletes are reported to be important to weightlifting performance (Akkuş, 1994). However, the number of studies in literature regarding the relationship between anthropometric characteristics and weightlifting performance of olympic style weightlifting is restricted.

Purpose: The study aims to determine the relationship between anthropometric characteristics of lower extremity and weightlifting performance of male (MWL) and female (FWL) athletes in olympic style weightlifting.

METHODS

Participants

The study included two groups consisting of male (MWL, n= 35) and female (FWL, n= 20) athletes in olympic style weightlifting. Demographic data including age, height, body weight, body muscle index (BMI), years of training, maximal weight in one repetition [(snatch (1 RM snatch) and clean and jerk (1RM clean and jerk)] was recorded for each participant and the results are shown in Table 1. 65% percent of female and 25.7% of male athletes in the study were athletes that accomplished international olympic style weightlifting championships successfully (European Championship, World Championship, Mediterrenean Games). 35% of female and 74.2% of male athletes of the rest were successful athletes in championships in Turkey. During the time of anthropometric measurements, female athletes were chosen from those attending the preparation camp of Senior European Championship in the city of Antalya and male athletes were chosen from different Olympic Preparation Centers located in different cities of Turkey. The participants in the study are athletes that train six days a week and at least four hours a day regularly and that have attended national and international tournaments actively at least for the last four years. The study complies with the Declaration of Helsinki and the ethical approval of the study was obtained from the University of Necmettin Erbakan, Meram Medical Faculty (approval number: 2020/ 2439).

Measurements

Anthropometric Measurements and Weightlifting Performance

A non-elastic tape was used to measure lower extremity length and girth. Thigh girth: The

athletes were asked to stand and open their legs as far as the length of their shoulders. The measurement was made from the largest part closest to the groin (at m.quadriceps extension). Calf girth: The athletes were asked to stand and open your legs slightly and the measurement was made from the largest part of the calf when body weight was equal on both feet. Thigh length: The distance between trochanter major and patella (from the center) was measured. Lower leg length: The distance between tibial condyle and medial malleoli was measured (Norton et al., 1996; Özer, 1993; Zorba and Ziyagil, 1995). Anthropometric measurements were taken on day/days when the athletes did not train. One repetition maximum weight data of the athletes that they lifted through snatch and clean and jerk in national and international competitions in 2019 and 2020 was collected from the results screen of the website of Turkey Weightlifting Federation (Turkey weightlifting federation, 2020). For both groups, the athletes under 18, with lower extremity problems, those not having trainings or sport activities for a month or those actively using their left foot were excluded in the study.

Statistical analysis

Prior to basic statistics, descriptive statistics regarding demographic variables were studied. To study whether anthropometric and demographic values of lower extremity of male and female athletes differ depending on gender, a series of Independent Samples t-Tests were conducted. To compare anthropometric values of right and left lower extremity of the groups, Paired Samples t-Tests were carried out. Moreover, as the study included many different comparisons, using Benforroni correction was thought to be useful (Olejnik et al., 1997). Furthermore, the correlation between 1RM snatch and clean and jerk variables and other variables of the study was examined by Pearson correlation analysis. Statistical significance value was set at $p< 0.003$ for Independent Samples t-Tests, $p< 0.006$ for Paired Sample t-Test and all statistical procedures were conducted using the SPPS 25 (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.).

RESULTS

Table 1. Demographic and anthropometric characteristics, weightlifting performance and training years of the athlete groups in the study.

	MWL		FWL			
Features	Mean	Std. Deviation	Mean	Std. Deviation	t	p
Age (years)	18.43	1.07	21.20	3.49	-4.38	.000
Height (m)	1.72	.07	1.66	.08	3.35	.002
Body weight (kg)	74.70	14.63	66.25	15.12	2.04	.047
BMI (kg/m^2)	25.12	4.05	23.98	3.96	1.01	.315
Training years	4.66	1.75	8.15	2.46	-6.14	.000
Right thigh length (cm)	42.34	1.61	40.80	2.61	2.72	.009
Left thigh length (cm)	42.34	1.61	40.80	2.61	2.72	.009
Right lower leg length (cm)	44.26	1.62	42.35	2.43	3.49	.001
Left lower leg length (cm)	44.23	1.63	42.35	2.43	3.43	.001
Right thigh girth (cm)	54.06	8.60	54.20	6.01	-.07	.948
Left thigh girth (cm)	54.26	8.92	54.50	6.03	-.11	.914
Right calf girth (cm)	38.80	5.02	35.85	3.84	2.27	.027
Left calf girth (cm)	38.74	4.87	36.05	3.94	2.11	.040
1 RM snatch (kg)	110.09	16.92	87.25	11.44	5.37	.000
1RM clean and jerk (kg)	133.06	19.69	111.65	14.31	4.26	.000

MWL: Male athletes in olympic style weightlifting, FWL: Female athletes in olympic style weightlifting BMI: Body muscle index, 1 RM: One repetition maximal, $p < 0.003$

Table1 shows anthropometric and demographic characteristics, training years and weightlifting performances of the athlete groups. From the findings of t-Tests for independent groups, a difference in favor of FWL was found in age (t (53)= -4.38, p< 0.001) and training years (t (53)= -6.14, p< 0.001). A significant difference was present in favor of MWL in body height (t (53)= 3.35, p < 0.003), right lower leg length (t (53)= 3.49, p < 0.001), left lower leg length (t (53)= 3.43, p < 0.001), 1 RM snatch (t (53)= 5.37, p < 0.001) and 1RM clean and jerk (t (53)= 4.26, p < 0.001). However, no statistical difference was observed in body weight, BMI, right- left thigh length, right-left thigh girth and right-left calf girth values of FWL and MWL groups (p>0.05).

Table 2.The comparison of anthropometric values of right and left lower extremity of MWL and FWL.

Gender	Anthropometric values	Mean	Std. Deviation	t	P
MWL	Right thigh length (cm)	42.34[a]	1.608	-	-
	Left thigh length (cm)	42.34[a]	1.608		
	Right lower leg length (cm)	44.26	1.615	-1.484	.147
	Left lower leg length (cm)	44.23	1.629		
	Right thigh girth (cm)	54.06	8.602	.495	.624
	Left thigh girth (cm)	54.26	8.922		
	Right calf girth (cm)	38.80	5.016	1.000	.324
	Left calf girth (cm)	38.74	4.865		
FWL	Right thigh length (cm)	40.80[a]	2.608	-	-
	Left thigh length (cm)	40.80[a]	2.608		
	Right lower leg length (cm)	42.35[a]	2.434	-	-
	Left lower leg length (cm)	42.35[a]	2.434		
	Right thigh girth (cm)	54.20	6.005	-1.453	.163
	Left thigh girth (cm)	54.50	6.031		
	Right calf girth (cm)	35.85	3.843	-1.285	.214
	Left calf girth (cm)	36.05	3.940		

a. The correlation and t cannot be computed because the standard error of the difference is 0.

Table 2 shows the comparisons of right-left lower extremity length and girth values of the athlete groups. No asymmetry was observed in length and girth values of right-left lower extremity of both MWL and FWL groups (p> 0.05).

The correlations between weightlifting performance of MWL-FWL and their age, demographic characteristics, lower extremity length, girth values are shown in Table 3. It was found that training years and left calf girth values of male athletes are correlated with their both snatch and clean and jerk performances (p< 0.01, p< 0.05, respectively), however, right calf girth value is only correlated with clean-and-jerk performance (p< 0.05). For FWL, the values of height (except 1RM clean and jerk), body weight, BMI, right-left thigh length, right-left thigh girth, right-left calf girth were observed to be statistically correlated with their snatch and clean-and-jerk performances (p<0.05).

Table 3. The correlations between weightlifting performance, anthropometric values of lower extremity of the athletes and other variables of the study.

Variable	MWL		FWL	
	1 RM snatch (kg)	1RM clean and jerk (kg)	1 RM snatch (kg)	1RM clean and jerk (kg)
Age (years)	.155	.163	.124	.181
Height (m)	.212	.178	.478*	.419
Body weight (kg)	.286	.327	.712***	.676**
BMI (kg/m^2)	.239	.297	.692**	.684**
Training years	.484**	.505**	.246	.304
Right thigh length (cm)	.056	-.047	.586**	.506*
Left thigh length (cm)	.056	-.047	.586**	.506*
Right lower leg length (cm)	.042	-.084	.399	.291
Left lower leg length (cm)	.015	-.117	.399	.291
Right thigh girth (cm)	.022	.113	.811***	.825***
Left thigh girth (cm)	.019	.110	.798***	.815***
Right calf girth (cm)	.314	.366*	.867***	.796***
Left calf girth (cm)	.334*	.381*	.850***	.796***
1 RM snatch (kg)	1	.968***	1	.949***
1RM clean and jerk (kg)	.968***	1	.949***	1

*p < .05, **p < .01, ***p< .001

DISCUSSION

As well as normal growth and development processes, anthropometric methods can also be used for the effects of trainings on physical characteristics and the determination of different physical body structures in different types of sports (Kurudirek, 1998). In studies conducted to increase athletic performance and success, it was reported that having certain body characteristics is advantageous for the development of certain skills and a close relation is present between athletic performance and body type (Taşucu, 2002; Kurudirek, 1998). Kılınç (2008), studied the relationship between rowing performance and anthropometric characteristics of male adolescents and reported that participants with a higher level of rowing performance have longer and larger lower extremity values. Moreover, the researcher stated that physical structure is important in rowing performance of male adolescents and that length and girth values of lower extremity, in particular, have positive effects on athletic performance. In a study on anthropometric and physiological characteristics of national and international 200m skiing athletes, Van Someren and Palmer (2003), reported that anthropometric values are sensitive indicators of success in 200 m skiing competitions. Yıldırım and Özdemir (2010), studied the effects of anthropometric characteristics of elite level male handball athletes on vertical and horizontal jumping distances and reported that body height, overall body fat percentage, the girth length of chest, lower back, thigh and calf, biiliac diameter, hand wrist diameter, thigh length, calf length, leg force and flexion are quite essential factors in vertical jumping distance. Furthermore, the researchers mentioned that forearm girth length and calf length are highly important to horizontal jumping distance. To determine absolute and proportional anthropometric differences in stronger power lifters and weaker lifters, Keogh et al., (2009), stated that stronger power lifters tended to have significantly greater levels of muscle mass per unit height and have larger muscular girth than less successful lifters. In addition, the same researchers expressed that athletes with a larger amount of muscle mass and muscular girth per unit height and with relatively shorter length seem to possess a more remarkable competitive advantage. Keogh et

al., (2008), carried out a study to find out anthropometric characteristics of male and female athletes participating in national and international powerlifting tournaments, it was stated that successful male and female powerlifters have similar proportional characteristics. The researchers consider this finding means that similar anthropometric characteristics affect performance and that all powerlifters regardless of gender might require such characteristics to get elite status (Keogh et al., 2008). Pekel et al., (2006), studied the relationship between anthropometric characteristics and proper physical structure values regarding performance of children selected and trained for athletics and reported that both in girls and boys, anthropometric measurements of diameter, girth length and height have statistically positive correlations with test performances of speed, power and force. To examine the relationship between anthropometric characteristics and some performance values of boys playing basketball in junior groups, Ulusu et al., (2018), reported that longer leg and hand length in boys mean an increase in the distance that they could jump forward while standing. Regarding the relationship between anthropometric characteristics and bio-motor skills and success of elite level wrestlers, it was mentioned that statistically significant correlations exist between both in anthropometric characteristics and in bio-motor skills and athletic success (Ziyağil, 1991). In a study on correlations of snatch and clean and jerk levels, which are critical for success in weightlifting, with anthropometric characteristics, physiological parameters and bio-motor skills, Akkuş (1994), studied elite level weightlifting athletes participating in national and international tournaments and reported that thigh length was 40.35±2.7cm, calf length was 41.31±2.4cm, thigh girth was 58.53±6.02cm and calf girth was 36.26±3.39cm. The researcher declared that weightlifting athletes with different weight have different values in girth and length from each other and girth (except head circumference) and length values have significant correlation with snatch and clean and jerk performance ($p<0.01$). It was found in our study that total training years of FWL was longer than that of MWL ($p<0.003$). No difference was observed in the anthropometric measurements of right-left thigh length, thigh girth and calf girth of MWL and FWL, however, right-left leg length of MWL was statistically found to be longer than that of FWL ($p<0.003$). We consider that the lack of difference in anthropometric values of thigh and calf girth of MWL and FWL seems to be correlated due to the hypertrophic effect occurred in lower extremity of FWL caused by longer training years of FWL. Although all athletes participated in our study declared that they dominantly preferred their right foot, no asymmetry was found in right-left anthropometric measurements of lower extremity of both athlete groups. From the viewpoint that olympic style weightlifting is one of the symmetric types of sports, we consider that the observation of no asymmetry in anthropometric measurements of thigh and calf is due to the fact that during the time in which maximal weight is lifted, loads on both feet are distributed equally. Kılınç (2008); Van Someren and Palmer (2003); Yıldırım and Özdemir (2010); Keogh et al., (2009); Keogh et al., (2008); Pekel et al., (2006); Ulusu et al., (2018); Ziyağil (1991) and Akkuş (1994), reported in their studies that a significant correlation exists between some anthropometric characteristic measurement of lower extremity and athletic performance of athletes. Our study, similarly, showed that some anthropometric characteristics of lower extremity are closely related to weightlifting performance of MWL and especially FWL. The main limitation of our study was the low number of MWL that participate in olympic style weightlifting tournaments at international level. The majority of the MWL were competitors in championships in Turkey.

The findings of our study might be expanded by anthropometric measurements with a wider number of participants and by different performance evaluation criteria. Then, the data to be obtained in this way might be useful to estimate performance and to evaluate skills of weightlifting athletes. Moreover, the reference data of our study data might be useful for athlete selection, talent

identification, training schedule development and other disciplines of study into olympic style weightlifting. Consequently, it might be said that anthropometric measurement values of calf girth of MWL and thigh length, thigh girth and calf girth of FWL are related to weightlifting performance.

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Conflict of interest
There are no conflicts of interest.

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