Leg Volume and Mass Scales of Elite Male and Female Athletes in Some Olympic Sports

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Abstract

This study aims to scale average leg volume and mass scales of elite male and female athletes in some olympic sports. A total of 280 elite athletes comprising of 200 males and 80 females studying at School of Physical Education and Sports at University of Kirsehir Ahi Evran voluntarily participated in this study. Frustum and Hanavan methods were used to determine leg volume and mass, respectively. SPSS 22.0 package program for Windows was used for descriptive statistics analysis of the study. The present study found average leg volume and mass scale of male athletes in football, basketball, volleyball, handball, gymnastics and wrestling and female athletes in football, basketball, volleyball, handball, gymnastics, box, taekwondo and tennis. It was observed in the related scale that leg volume of the athletes in the lowest weight classes in weight sports were lower. In other words, leg volume and mass of the athletes were in direct proportion to their weight class. When the scale of female athletes is analyzed, it can be noted that volleyball players have the highest leg volume and mass among team sports players.

Keywords: Leg volume, leg mass, scale

1. Introduction

An athlete needs a certain amount of muscle balance in order to use his/her strength and display a better performance (Baecchle, & Earl, 2000). Muscle balance is related to a muscle or a group of muscles moving in a certain or reverse direction. Strength balance can be considered as a more accurate parameter for sports performance compared to absolute strength because an athlete's absolute strength is equal to his/her muscle or muscle groups with the lowest strength (Astrand *et al.,* 2003).

It is reported in the literature that performance and strength values are positively influenced by leg volume, leg muscle volume and fat-free leg volume. Muscle balance is related to a muscle or a group of muscles moving in a certain or reverse direction (Shumway, & Woollocatt, 2007). Athletes with a higher anaerobic performance are known to have higher muscle mass and cross-sectional area, leg volume and leg mass (Staron *et al.,* 2000). Muscle fibril length, leg volume and muscle mass play an important role in the muscle strength in anaerobic sports (Armstrong *et al.,* 2001; De Ste Croix *et al.,* 2001). Muscle volume, mass and cross-sectional area on the leg affect muscle strength (Ozkan, & Isler, 2010). In this respect, this study aims to contribute to the literature by creating a scale of right and left leg volume and mass of athletes in different olympic sports.

2. Material and Methods

A total of 200 male athletes comprising of 30 football players with 21.46±1.91 years of age, 79.00±5.09 kg and 181.33±6.39 cm, 30 basketball players with 22.56±2.10 years of age, 80.10±5.09 kg and 180±3.50 cm, 30 volleyball players with 22.46±1.91 years of age, 81.00±5.09 kg and 183±5.39 cm, 30 handball players with 23.60±2.26 years of age, 78.10±5.09 kg and 179±5.40 cm, 30 gymnasts with 21.60±1.28 years of age, 75.33±5.25 kg and 176±4.40 cm, 10 wrestlers (freestyle and Greco roman) with 23.20±2.10 years of age, 65.30±5.15 kg and 176±4.40 cm, 10 wrestlers (freestyle and greco roman) with 22.15±1.50 years of age, 70.10±5.30 kg and 176±4.40 cm, 10 wrestlers (freestyle and greco roman) with 22.22±1.20 years of age, 74.25±4.15 kg and 176±4.40 cm, 10 wrestlers (freestyle and greco roman) with 22.22±1.30 years of age, 85.50±6.20 kg and 176±4.40 cm, 5 wrestlers (freestyle and greco

roman) with 21.52±2.10 years of age, 97.46±3.15 kg and 176±4.40 cm, and 5 wrestlers (freestyle and greco roman) with 23.62±1.30 years of age, 125.40±4.15 kg and 176±4.40 cm voluntarily participated in the study. In addition, a total of 80 female athletes comprising of 10 female football players with 20.35±1.20 years of age, 68.12±3.09 kg and 176.11±4.10 cm, 10 female basketball players 20.56±1.20 years of age, 75.20±2.09 kg and 179±3.40 cm, 10 female volleyball players with 21.46±1.90 years of age, 70.10±5.20 kg and 180±2.30 cm, 10 female handball players with 22.60±2.20 years of age, 75.20±4.01 kg and 175±4.37 cm, 10 female gymnasts with 21.20±1.15 years of age, 65.03±2.25 kg and 170±2.40 cm, 10 female boxers with 22.40±1.15 years of age, 70.33±5.25 kg and 172±3.40 cm, 10 taekwondo players with 21.10±1.18 years of age, 72.43±4.25 kg and 179±2.40 cm, and 10 tennis players with 22.10±1.13 years of age, 74.08±6.20 kg and 172±6.40 cm participated in the study, too. Frustum and Hanavan methods were used to determine leg volume and mass, respectively.

2.1 Calculation of Leg Volume and Mass

Femur, calf and feet were measured in order to calculate leg volume. The distance between tibial point and inguinal fold was calculated to find the femur volume. After this distance was measured for each 10 percentile of total length, as defined by frustum sign model method, volumes for each 10 percentile and volumes of all other parts were summed to calculate total femur volume. In order to find calf volume, the distance between tibial point and medial malleolus point was first calculated. After this distance was measured for each 10 percentile of total length, as defined by frustum sign model method, volumes for each 10 percentile and volumes of all other parts were summed to calculate total calf volume.

2.1.1 Calculation of Foot Volume

Foot volume was measured using medial malleolus (Ozkan, & Kin Isler, 2010; Sukul *et al.,* 1993). While the elliptic surface of cross section area (Si) in each part is calculated using, volumes of other consecutive parts between the lines were calculated using Frustum model. When calculating foot volume, hi, i+1 is the distance between consecutive foot parts, and h value, which is L3/2, is the height between line 1 and foot sole, and it varies depending on the foot. h value between the third and fourth part is L1/2, which varies depending on the foot. The volume of fifth part is calculated using elliptic parabolic Formula 6, while total foot volume is calculated by summing volumes of all parts (Mayrovitz *et al.,* 2005).

The foot volume was defined by drawing lines between foot sole and medial malleolus point, volumes of different foot parts were calculated as mentioned above, and, finally, volumes of all parts were summed to calculate total foot volume.

2.1.2 Calculation of Leg Mass

Femur, calf and feet were measured in order to calculate leg mass. The distance between tibial point and inguinal fold was calculated for the femur. The distance between tibial point and medial malleolus point was calculated for the calf. Finally, the foot was first measured using medial malleolus, and later Havanan model method (Kwon, 1998). "Leg Volume and Mass Calculation Program" developed by Marangoz and Ozbalci (2017) was used for calculation.

2.2 Statistical Analyses

SPSS 22.0 package program for Windows was used for descriptive statistics analysis of the study.

3. Findings

Leg volume and mass of elite male athletes in some olympic sports are given in Table 1. The findings here suggest that the lowest leg volume and mass are observed in gymnasts (right leg volume: 10739.20±877.74; left leg volume: 10476.40±773.71; right leg mass: 11.84±.68; left leg mass: 11.55±.97), while the highest leg volume and mass are observed in wrestlers. When leg volume and mass values in wrestling, which is a weight sport, are analyzed, the lowest leg volume and mass are observed in 57-61 kg males (right leg volume: 12010.12 ±844.59; left leg volume: 11985±921.12; right leg mass: 11.80±.72; left leg mass: 11.41±.56), while the highest leg volume and mass are observed in 125 kg male wrestlers (right leg volume: 21500±576.40; left leg volume: 21350±526.00; right leg mass: 18.50±.50; left leg mass: 18.40±.10).

Table 1. Leg Volume and Mass Scale of Elite Male Athletes in Some Olympic Sports

	Volume (ml)		Mass (kg)	
	Right	Left	Right	Left
Football	10817.80±844.59	10563.73±757.10	11.93±.72	11.76±.83
Volleyball	10819.20±844.99	10567.40±773.78	11.91±.73	11.97±.69
Basketball	11006.80±926.52	10719.06±919.84	11.88±.68	11.62±.93
Handball	10756.66±861.08	10471.53±776.69	11.87±.66	11.42±.97
Gymnastics	10739.20±877.74	10476.40±773.71	11.84±.68	11.55±.97
Wrestling 57-61 kg	12010.12 ±844.59	11985 ±921.12	11.80±.72	11.41±.56
65-66 kg	13501.05±956.27	13348.05±753.27	11.75±.52	11.65±.24
70-71 kg	14850.02±847.19	14750.02±895.20	12.25±.66	12.10±.66
74-75 kg	14500±877.74	14320±573.74	13.94±.68	13.85±.93
85-86 kg	16500±926.52	16350±856.44	14.50±.80	14.40±.40
97-98 kg	17850±760.18	17650±450.10	16.50±.52	16.40±.56
125 kg	21500±576.40	21350±526.00	18.50±.50	18.40±.10

Table 2. Leg Volume and Mass Scale of Elite Female Athletes in Some Olympic Sports

	Volume (ml)		Mass (kg)	
	Right	Left	Right	Left
Football	11941,53±650,50	11720,32±640,10	11,81±,30	11,78±,60
Volleyball	14514,27±645,18	14000,76±630,14	13,16±,60	13,23±,56
Basketball	13510,20±520,45	13654,43±450,40	13,16±,68	13,13±,40
Handball	13807,16±620,42	13654,43±420,31	13,16±,56	13,13±,23
Gymnastics	13350,20±650,20	13230,20±557,52	14,01±,46	13,50±,20
Boxing 48-51 kg	11159,39±620,34	10802,38±510,42	10,814±,56	11,149±,56
57-60 kg	13160,84±520,40	12737,14±521,14	13,187±,50	12,998±,74
71-75 kg	17184,06±425,42	17116,31±475,23	15,369±,46	15,198±,34
Taekwondo 46-49 kg	11727,18±587,43	11227,97±429,29	11,064±,50	10,742±,44
49-53 kg	12195,29±523,44	11688,96±538,39	11,506±,51	11,134±,42
53-57 kg	14844,55±562,42	14207,49±548,40	13,162±,52	13,472±,52
63-67 kg	15059,20±524,40	15487,90±547,14	13,073±,49	13,097±,51
Tennis	11131,14±478,60	11069,15±489,55	11,35±,41	11,05±,20

Leg volume and mass of elite female athletes in some olympic sports are given in Table 2. While the lowest leg volume and mass are observed in tennis players (right leg volume: 11131.14±478.60; left leg volume: 11069.15±489.55; right leg mass: 11.35±.41; left leg mass: 11.05±.20), while the highest leg volume and mass are observed in boxers. In addition, the highest leg volume and mass are observed in 71-75 kg female boxers (right leg volume: 17184.06±425.42; left leg volume: 17116.31±475.23; right leg mass: 15.369±.46; left leg mass: 15.198±.34).

4. Discussion

The finding in this study were used to create a scale of right and left leg volume and mass of elite male and female athletes in different olympic sports. The scale demonstrates that leg volume and mass of athletes in the lowest weight class were lower and that weight was in direct proportion to leg volume and mass. The scale of elite female athletes

indicates that volleyball players had the highest leg volume and mass, whereas basketball players had the highest leg volume and mass values among the male athletes.

Temfemo *et al.* (2009) conducted a study on some anthropometric values and vertical jump performances in adolescent males and females, and reported that leg length and leg mass values of 14, 15 and 16-year-old males were higher compared to females. However, average ages of females and males participating in this study are 21 and 22, respectively. Although no significant differences were observed between leg volume and mass of female and male athletes, it was found out that male wrestlers had higher leg volume and mass compared to other female athletes.

Visser *et al.* (2002) compared leg mass and composition and lower extremity performance in black males and females aged between 70 and 79, and observed a smaller leg area and more fat infiltration along with a poor lower extremity performance. This study demonstrates that a lower leg volume and mass decreases performance, irrespective of age.

Janssen *et al.* (2000) analyzed skeletal muscle mass of lower and upper extremity in males and females in different age groups and reported that males had a higher skeletal muscle mass on their lower and upper extremities compared to females. In addition, skeletal muscle mass of the lower extremity decreased in proportion to ageing in both males and females. On the other hand, the present study found out that leg volume and mass of lower extremity in female and male athletes were closer to each other, which may be related to the fact that the participants were elite athletes.

Zorba *et al.* (2010) indicated in their study on the relationship among leg volume, leg mass, anaerobic performance and leg strength in wrestlers that leg volume and mass played a decisive role in anaerobic performance.

Ozkan *et al.* (2010) demonstrated that fat-free body mass, leg volume and leg mass played an important role in the determination of anaerobic strength and capacity. Thus, it was underlined that body mass, leg volume and leg mass contributed to anaerobic performance in various sports.

Winter, Brooks and Hamley (2007) carried out a study on the relationship between maximal exercise performance and fat-free leg volume of males and females and reported that maximal exercise performance and leg volume of males were higher compared to females.

5. Conclusion

The above-mentioned studies indicate some differences between leg volume and mass of males and females as well as their strength values. The present study, too, revealed difference between leg volume and mass scale of males and females. However, it was observed that the difference was not remarkable and that females in some sports had a higher leg volume and mass compared to males. The reason for this lies in the fact that males and females participating in the present study were elite athletes and their respective olympic sports. In addition, right and left leg volume of male and female athletes in the scale did not yield the same results. Therefore, all athletes are recommended to train their both legs and strengthen their weaker leg in order to display a better performance. For future studies, we recommended to study upper extremity volume and mass and indicate the differences between upper and lower extremity volume and mass both females and male.

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