COMPARISON OF ANTHROPOMETRIC MEASUREMENTS BETWEEN GRECO-ROMAN AND FREE STYLE WRESTLERS

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ABSTRACT

This study was aimed to comparison of the Greco-Roman and Free style wrestlers' anthropometric characteristics in Turkish National Wrestler team. This study included eighty-one male Turkish national wrestlers (Greco-Roman style, n=46, Freestyle, n=35). The age of the wrestlers ranged between 17 and 20 years and their body mass index (BMI) were 21-36 kg/m^2 (Greco-Roman style mean age:18±1.1 years; Freestyle mean age:18±0.8 years). Anthropometric characteristics of the wrestlers, namely weight, height, knee and elbow diameter were assessed by caliper, calf and biceps brachi circumference by tape measurement, triceps brachii, subscapular, supraspinale and calf subcutaneous thickness by skinfold. Percent adiposity was calculated with Sloan-Weir formula. Heath-Carter anthropometric method was used for somatotype. There were no differences in calf and biceps brachii circumference between the two groups (Greco-Roman:36.9±3.5cm, 32.5±3.3cm; free: 37.3±4.3cm, 31.5±3.9cm, respectively) ($p>0.05$). However, knee and elbow diameters of the Freestyle wrestlers were greater than Greco-Roman style wrestlers (Greco-Roman:9.5±0.7 cm, 6.9±0.5 cm; Freestyle:10.3±1.1 cm, 9.5±0.8 cm, respectively) ($p<0.05$). In addition, percent adiposity in Freestyle wrestlers (15.8±3.3%) were greater than Greco-Roman wrestlers (9.1±2.3%) ($p<0.05$). Endomorphic and mesomorphic values of the freestyle wrestlers were higher than Greco-Roman (Greco-Roman:2.17±0.48, 5.58±1.29; Freestyle:4.21±0.91, 6.92±1.22, respectively) ($p<0.05$). Somatotypes of the Greco-Roman wrestlers were found as balanced mesomorph; however, it was established as endomorphic-mesomorph for Freestyle wrestlers. Freestyle wrestlers had greater joint diameter and percent adiposity than Greco-Roman wrestlers. In our opinion, these differences might be related to Greco-Roman wrestlers adopted heavy isometric exercise in their training program; Freestyle wrestlers adopted a more active and isotonic type of training program.

Keywords: Wrestlers, Anthropometric Measurements, Somatotype, Freestyle, Greco-Roman Style

GREKOROMEN VE SERBEST STİL GÜREŞÇİLER ARASINDAKİ BAZI ANTROPOMETRİK ÖLÇÜMLERİN VE FARKLILIKLARIN KARŞILAŞTIRILMASI

ÖZET

Bu çalışmada Türk Milli Güreş takımında bulunan Grekoromen ve serbest stil güreşçilerin antropometrik ölçümlerini karşılaştırmak amaçlandı. Bu çalışmaya 81 erkek Türk milli güreşçi dahil edildi. (Grekoromen n=46, Serbest stil n=35). Güreşçilerin yaşları 17-20 yılları arasında, vücut kütle indeksleri (VKİ) 21-36 kg/m^2 arasındaydı (Grekoromen ortalama yaş:18±1.1 yıl; serbest stil ortalama yaş:18±0.8 yıl). Güreşçilerin antropometrik özelliklerindeki farklılıklar; vücut ağırlığı, boy uzunluğu, diz ve dirsek genişliği kaliper ile, baldır ve biseps braki çevre ölçümü mezura ile, triseps braki, subskapular, supraspinal ve baldır deri altı yağ kalınlığı ölçümü skinfold ile değerlendirildi. Yağ yüzdesi Sloan ve Weir formülü ile hesaplandı. Somatotiplerin belirlenmesi için Heath-Carter antropometrik metodu kullanıldı. İki grubun baldır ve biseps braki çevre ölçümleri arasında fark yoktu (Sırasıyla, Grekoromen:36.9±3.5 cm, 32.5±3.3 cm; serbest: 37.3±4.3 cm, 31.5± 3.9 cm, ($p>0.05$). Ancak Serbest stil güreşçilerin diz ve dirsek genişlikleri Grekoromen güreşçilerden daha büyüktü (Sırasıyla, Grekoromen:9.5±0.7 cm, 6.9±0.5 cm; Serbest stil:10.3±1.1 cm, 9.5±0.8 cm) ($p<0.05$). Buna ek olarak; Serbest stil güreşçilerin yağ yüzdesi (15.8±3.3%) Grekoromen güreşçilerden daha fazlaydı (%9.1±2.3) ($p<0.05$). Grekoromen güreşçilerin somatotipleri dengeli mezomorf, serbest stil güreşçilerin ise endomorfik-mezomorf bulundu. Serbest stil güreşçilerin özellikle eklem genişlikleri ve yağ yüzdesinin Grekoromen!lerden

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daha yüksek olduğu görüldü. Bu farklılığın Grekoromen güreşçilerin antrenman programında ağır izometrik egzersizler kullanılırken, serbest stil güreşçilerde daha aktif ve izotonik tipte antrenman programı yaptırılması ile ilişkili olabileceği düşünülmektedir.

Anahtar Kelimeler: Güreşçi, Antropometrik ölçümler, Somatotip, Serbest stil, Grekoromen Stil

INTRODUCTION

Wrestling is widely recognized as the oldest competitive sport in the world. Male's wrestling discipline at the modern Olympics is divided into two categories: Freestyle and Greco-Roman. Greco-Roman wrestlers must not use the legs to trip or lift an opponent, or attack an opponent's legs, while in Freestyle competition, wrestlers can use their legs and may hold opponents above or below the waist (1). Also wrestling is a high-intensity sport which requires strength and power of both the upper and lower body as well as relying heavily on isometric force for the various wrestling techniques (1-4).

Anthropometric values give an insight into the adequacy of athletes for the sports they play. In their study, Hosh et al. compared body compositions, anthropometric and somatotype characteristics of swimmers and runners, and suggested changes occurring in different sports disciplines (5, 6). In recent years, anthropometric qualifications turned out to be a quite important issue among wrestlers. Sady et al. compared body compositions, extremity lengths, skinfold values, width and girth measurements of young wrestlers and sedentary youth, and established that wrestlers have lower fat thickness and girth measurements (7). Steering the athletes towards sports according to their anthropometric qualifications and a proper training program are considered to help raise more successful athletes. Data about this issue were revealed by anthropometric measurement studies in different sports (8-10). Norton et al. showed that, as far as wrestling is concerned, a short-limbed physique is generally considered to best suit the biomechanical characteristics of the sport, thus favoring the selection of athletes with a limited vertical skeletal development (11).

Correct evaluation of the performances of elite wrestlers is only possible with defining their anthropometric qualifications. Determining the style and weight competitions that wrestlers will compete and especially correct guidance during talent selections gain significance in line with the results of anthropometric measurements (12).

While, in literature, studies on anthropometric measurements of wrestlers exist (8, 13) studies that compare the anthropometric characteristics of Freestyle and Greco-Roman wrestling were not found. This was also the case in the literature in Turkey (14, 15). Differences in training programs of Greco-Roman and Freestyle wrestlers are believed to cause changes in anthropometric characteristics. However, determining anthropometric values is considered to help in getting an insight into the style in which the wrestlers would succeed. The objective of this study is to determine if there are any differences between Freestyle and Greco-Roman wrestlers' anthropometric qualifications in Turkish young national team.

METHODS

This study included eighty-one volunteered male Turkish National wrestlers (Greco-Roman style, n=46; Freestyle, n=35). Age of the wrestler ranged between 17 and 20 years and their body mass index (BMI) were 21-36 kg/m^2 (Greco-Roman style mean age: 18±1.1 years, BMI: 26±3.68 kg/m^2; Freestyle mean age: 18±0.8 years, BMI: 26.27±4.48 kg/m^2). Exclusion criteria were as follows: a) less than 3 years of experience in wrestling, b) history of musculoskeletal injury in the last 6 months, c) history of any systemic diseases. Physical characteristics of the each group of wrestlers are shown in Table 1. Each participant and their parents were familiarized with the experimental procedure, and all provided informed consent to participate in the study. All procedures were in accordance with the current revision of the Helsinki Declaration.

Table 1. Physical characteristics of the wrestlers.

	Greco-Roman (n=46)		**Free Style (n=35)**			
	X	SD	X	SD	p	t
Weight (kg)	76.83	15.89	78.89	19.78	>0.05	-0.522
Height (cm)	171.18	6.81	172.17	8.28	>0.05	-0.591
BMI (kg/m^2)	26.00	3.68	26.27	4.48	>0.05	-0.294
Fat Mass (kg)	7.27	3.52	11.69	4.39	<0.001	-4.670
Lean Body Mass (kg)	69.56	12.62	60.24	9.69	<0.001	3.254

BMI: Body Mass Index

X: Mean

SD: Standard Deviation

Wrestlers divided into two groups based on their style: Greco-Roman and Freestyle. All volunteered Turkish junior national wrestlers team participants were included in this study.

The same physiotherapist made all anthropometric measurement with the participants in a resting state according to established procedures (16-17).

Standing height was recorded by an anthropometer (Holtain Anthropometer, London, United Kingdom, Ranges:50-570mm). Weight was measured using a calibrated electronic scale, and body mass index was calculated as weight/$height^2$, where weight was expressed in kilograms and height in meters. Furthermore, proportion between height and body length was measured.

Knee and elbow diameter were measured by caliper (Holtain Bicondylar Caliper, London, United Kingdom). Knee diameter was measured between medial and lateral condyles, elbow diameter was measured between medial and lateral epicondyles. Calf and biceps circumferences measurements were conducted by tape measurement.

Subcutaneous fat thickness (SFT) was assessed on triceps, subscapularis, supraspinale and calf by skinfold (Holtain Skinfold Caliper, London, United Kingdom) on non-dominant side (16). Percent adiposity was calculated with Sloan-Weir formula (18). Percent adiposity was measured with following formula;

Percent adiposity=1.1043-(0.0133xthigh)-(0.00131xsubscapularis).

Somatotype of all wrestlers was determined by using Heath-Carter anthropometric method (19). Height, weight, ST of triceps, subscapular, suprailiac, thigh and calf, bi-epicondylar diameter of knee and elbow, and flexed biceps and calf circumference of the wrestlers were used for calculation.

Statistical Analysis

IBM SPSS Statistics 22 program was used in statistical analysis. In order to show the difference in anthropometric measurements between the groups by 5% Type I error and 80% power, approximately 34 individuals need to be included in each group. Data were expressed as mean and standard deviations. Data were normally distributed. Differences between groups were tested using Independent Student's t-test. The level of significant was set at 0.05 for all analysis.

RESULTS

There were no statistical differences in age between Greco-Roman and Freestyle wrestlers (Greco-Roman: 18±1.1 years, Freestyle: 18±0.8 years) ($p>0.05$). Statistical differences were not found between the groups in terms of total years spent in the discipline

by the wrestlers (Greco-Roman: 7.64±2.21 years, Freestyle: 7.33±2.06 years) ($p>0.05$). There were no significant differences on weight, height and BMI between groups ($p<0.05$). However freestyle wrestlers had greater fat mass than Greco-Roman ($p<0.001$). Physical characteristics of the wrestlers are shown in Table 1. There were no differences in calf and biceps circumference between two groups ($p>0.05$) (Table 2). Also knee and elbow diameters of the Freestyle wrestlers were greater compared to Greco-Roman style wrestlers ($p<0.05$) (Table 2). ST was greater in Freestyle wrestlers than Greco-Roman in all sides ($p<0.05$) (Table 3). Percent adiposity in Freestyle wrestlers (15.8±3.3%) was greater than Greco-Roman wrestlers (9.1±2.3%) ($p<0.05$) (Table 3). The rate between height and umbilicus height was found as 1.688±0.04 in Greco-Roman wrestlers while it was established in Freestyle wrestlers as 1.692±0.029. No differences were found between the groups ($p>0.05$).

Table 2. Diameter and circumferential results of the wrestlers.

	Greco-Roman (n=46)		**Free Style (n=35)**			
	X	SD	X	SD	p	t
Knee diameter (cm)	9.50	0.74	10.27	1.10	0.00	-3.745
Elbow diameter (cm)	6.97	0.50	9.50	0.89	0.00	-16.254
Calf circumferential (cm)	36.92	3.55	37.33	4.38	>0.05	-0.475
Biceps circumferential (cm)	32.55	3.36	31.56	3.99	>0.05	1.215

X: Mean

SD: Standard Deviation

Table 3. Skinfold measurements of the wrestlers

	Greco-Roman (n=46)		**Free Style (n=35)**			
	X	SD	X	SD	p	t
Triceps (mm)	6.28	1.52	16.49	5.51	0.00	-12.016
Subscapularis (mm)	10.86	2.60	18.15	6.11	0.00	-7.278
Supraspinale (mm)	5.25	1.20	13.47	6.30	0.00	-8.664
Calf (mm)	7.77	2.31	15.58	3.50	0.00	-11.389
Percent of the body fat (%)	9.06	2.35	15.81	3.31	0.00	-10.076

X: Mean

SD: Standard Deviation

Although endomorphic and mesomorphic values of the Freestyle wrestlers were more dominant than Greco-Roman ($p<0.05$), no significant differences were established in ectomorphy values between the two groups ($p>0.05$) (Table 4). Somatotypes of the Greco-Roman wrestlers were found as balanced mesomorphy, however, it was endo-mesomorphy for Freestyle wrestler.

Table 4. Somatotype of the wrestlers

	Greco-Roman (n=46)		**Free Style (n=35)**			
	X	SD	X	SD	p	t
Endomorphic values	2.17	0.48	4.22	0.92	0.00	-12.425
Mesomorphic values	5.58	1.29	6.92	1.22	0.00	-4.297
Ectomorphic values	1.31	0.95	1.71	1.01	>0.05	-1.666

X: Mean

SD: Standard Deviation

DISCUSSION

This study suggests that Freestyle wrestlers have more body fat than Greco-Roman wrestlers. While Greco-Roman wrestlers are balanced mesomorph, Freestyle wrestlers are in endomorphic-mesomorph somatotype.

Body type and features are parameters that affect performance. Anthropometric qualifications of athletes show differences based on their discipline.

Wrestlers in general tend to have relatively short legs and long upper bodies, especially Greco-Roman wrestlers (11). This arrangement is advantageous for competitive performance, as the lower centre of gravity aids the athlete in maintaining balance in contact sports and having short legs is convenient in the execution of abrupt changes of direction (8). Studies report that proportion between height and body length in wrestlers is important and athletes who have longer body are more successful in this discipline. However, no publications related to proportional differences between Greco-Roman and Freestyle wrestlers are currently present. It may be observed in our study that while it is 1.688±0.044 in Greco-Roman wrestlers, it is 1.692±0.029 in Freestyle wrestlers, and there is no difference between them. It is considered that even though they compete in different branches, since the sport itself is basically the same, a change is not present in this rate. The proportion between height and body length in wrestlers is close to 1.618, which is considered to be the golden ratio (20), however, it's not possible to say it is exactly the golden ratio. In his study, Zaccagni has reported that Freestyle Italian wrestlers are taller and heavier than Greco-Roman wrestlers (8). However; in our study, any differences in length and body weight between two groups were not established. A classification according to weights is not present in our study. However, the fact that no differences were found in body weights shows that the groups are homogeneous and body weight is not effective on the differences that were found. In addition, while no differences were established in body weight and BMI between the groups, it was found that measurements of under skin fat thickness of fat mass, lean body mass, triceps, subscapular, supraspinal area and calf and percentage of the body fat were much higher in Freestyle wrestlers than Greco-Romans. Percent of the body fat of the Greco-Roman wrestlers was between 5% and 15% while the said percentage of Freestylers was between 10% and 24%. Among Italian wrestlers, Greco-roman wrestlers have fatter bodies (8). American Dietetic Association and Dietitians of Canada reported that the range of percent body fat values for

male wrestlers was between 6% and 15% (21). Horswill states that ‘‘in the well-trained state, wrestlers appear to be 3 to 13% fat, which is exceptionally lean compared with non-athletes and most other athletes’’ (22). Akyuz et al. reported the body fat rate of Turkish wrestlers as 9.8% (14). Body fat rate of the Greco-Roman wrestlers in this study was established as 9%. Our results were similar to the study by Akyuz et al. (14). In addition, this study observed that the percent body fat of Greco-Roman wrestlers was in the range of these values and the percentage was higher in Freestyle wrestlers. Our study is believed to differ from that of Manore et al. since they generally evaluated the percent body fat of the wrestlers and did not discriminate according to styles (23). Obtaining optimal body composition is one of the major concerns of wrestlers, and percent body fat is considered to be especially important by athletes and coaches.

In addition, wrestling is a high-intensity sports which requires strength and power of both the upper and lower body as well as relying heavily isometric wrestling techniques in Greco-Roman style. That there are no major physiological differences between wrestlers of both Freestyle and Greco-Roman styles was demonstrated (22-24). However, Demirkan et al. showed that Greco-Roman wrestler had higher level of anaerobic power and capacity in the upper extremity than Freestyle wrestlers (25). Contrary to heavy isometric exercise training program of Greco-Roman wrestlers, a more active and isotonic type of training program is adopted by Freestyle wrestlers. Studies regarding the effect of isometric and isotonic training program on percentage of fat were not found in the literature. It is believed that the difference in percentage of fat may be related to difference in training programs. In addition, anthropometric differences between Greco-Roman and Freestyle wrestlers could be related to training program differences.

In Italian Freestyle discipline, wrestlers had on average a larger arm girth and thinner triceps SFT compared to Greco-Roman wrestlers (8). In Turkish wrestlers, differences in calf

and biceps circumferential measurements were not found between Greco-Roman and Freestyle wrestlers and triceps SFT was found as lower in Greco-Romans.

Another finding of this study was that the knee and elbow diameter of the Freestyle wrestlers were greater than Greco-Roman style wrestlers. In Greco-Roman style, wrestlers use only their arms and upper bodies. In Freestyle, wrestlers also use their legs and may hold opponents above or below the waist (1). In their study, Aydos et al. reported correlations between leg strength and knee and calf diameters, and between grip strength and elbow and upper arm circumference (15). An explanation to this would be that the knee diameter is greater in Freestyle compared to Greco-Roman wrestlers, however, we expected that the elbow diameter to be higher in Greco-Roman than Freestyle, this was not the case.

Somatotype is significant in determining the tendency of the athlete to the sport. It is a combination of many factors such as the power, strength and body composition of the athlete. Body shape plays an important role in the self-selection of individuals for competitive sports. Bloomfield et al. proposed that endomorphy and mesomorphy increase and ectomorphy decreases in the higher weight classes in wrestling and the lighter wrestlers tend to be balanced mesomorphs and the heavier ones endomesomorphs (26). Carter, in a study of Olympic athletes, reported a mean somatotype of 2.5– 6.5–1.5, but they range from 1.5–5.5–2.5 in the under 60-kg class to 4.0–7.5–1.0 in the heavy weight class (19). In their study, Akyuz et al. found somatotype of Turkish wrestlers as 2.9-4.5-1.5 (14). While, in our study, somatotypes of Greco-Roman wrestlers were 2.2-5.5-1.3, it was found as 4.2-6.9-1.7 in Freestyle wrestlers. We believe that such a difference observed in Turkish wrestlers was due to Akyüz et al. not taking into consideration the styles of wrestlers (14). However, Cicioglu et al. reported in their study that somatotype values could differ depending on seasonal changes (27). This difference between our study and the study by Akyüz et al. may be correlated with seasonal changes (14). In our study, endomorphic and mesomorphic values of the Freestyle

wrestlers were more dominant than Greco-Roman. When taken into consideration that weight distribution of Freestyle and Greco-Roman wrestlers are homogeneous, it is thought that differences in somatotype may be related to training programs. Somatotypes of the Greco-Roman wrestlers were found as balanced mesomorphy but it was endomorphic-mesomorph for Freestyle wrestlers. In both groups, strength features become prominent, Freestyle wrestlers having fatter bodies cause appearance of endomorphic features.

Our study compared the anthropometric characteristics of Greco-Roman and Freestyle wrestlers, and the differences that were found were considered as being related to training programs. However, any comparison of the training programs of athletes was not possible. We believe that a comparison of training programs in future studies may shed more light on such differences.

CONCLUSION

Freestyle wrestlers had greater joint diameter and percent adiposity than Greco-Roman wrestlers. Differences in anthropometric features between Greco-Roman and Freestyle wrestlers are conspicuous. Especially, it might be related that fattier bodies of Freestyle wrestlers and differences in game rules cause some modifications in training programs, and this results in changes in the anthropometric features of the athlete.

REFERENCES

1. McGuigan MR, Winchester JB, Erickson T. The importance of isometric maximum strength in college wrestlers. J Sports Sci Med 2006;5(CSSI):108-13.
2. Callan SD, Brunner DM, Devolve KL, Mulligan SE, Hesson J, Wilber RL, et al. Physiological profiles of elite Freestyle wrestlers. J Strength Cond Res 2000;14(2):162-9.

3. Kraemer WJ, Fry AC, Rubin MR, Triplett-McBride T, Gordon SE, Koziris LP, et al. Pysiological and performance responses to tournament wrestling. Med Sci Sports Exerc 2001;33(8):1367-78.
4. Utter A, Stone M, O'Bryant H, Summinski R, Ward B. Sport-seasonal changes in body composition, strength, and power of college wrestlers. J Strength Cond Res 1998;12(4):266-71.
5. Housh TJ, Thorland WG, Johnson GO, Tharp GD. Body build and composition variables as discriminators of sports participation of elite adolescent male athletes. J Sports Med Phys Fitness 1984;24(3):169–74.
6. Housh TJ, Thorland WG, Johnson GO, Tharp GD, Cisar CJ. Anthropometric and body build variables as discriminators of event participation in elite adolescent male track and field athletes. J Sport Sci 1984;2(1):3–11.
7. Sady SP, Thomson WH, Savage M, Petratis M. The body composition and physical dimensions of 9 to 12-year-old experienced wrestlers. Med Sci Sports Exerc 1982;14(3):244–8.
8. Zaccagni L. Anthropometric characteristics and body composition of Italian national wrestlers. Eur J Sport Sci 2012;12(2):145-51.
9. Aouadi R, Jlid MC, Khalifa R, Hermassi S, Chelly MS, Van Den Tillaar R, et al. Association of anthropometric qualities with vertical jump performance in elite male volleyball players. J Sports Med Phys Fitness 2012;52(1):11-7.
10. Molik B, Morqulec-Adamowicz N, Kosmol A, Yilaa AB, Filipkowska A, Lewandıwski M, et al. Game performance in ice sledge hockey: an exploratory examination into type of disability and anthropometric parameters. Clin J Sport Med 2012;22(1):65-9.

11. Norton K, Olds T, Olive S, Craig N. Anthropometry and sports performance. In K. Norton, & T. Olds, editor, Anthropometrica, Sydney, University of New South Wales Press. 2004; p 287-364.
12. Cvetkovic C, Maric J, Marelic N. Technical efficiency of wrestlers in relation to some anthropometric and motor variables. Kinesiology 2005;37(1):74-83.
13. Camic CL, Housh TJ, Mielke M, Hendrix CR, Zuniga JM, Johnson GO, et al. Age-related patterns of anthropometric characteristics in young wrestlers. Med Sci Sports Exerc 2009;41(5):1014-9.
14. Akyüz M, Koç H, Uzun A, Özkan A, Taş M. An examination of some physical fitness and somatotype characteristics of young wrestlers in Turkish National Team. Atabesd 2010; 12(1):41-7.
15. Aydos L, Taş M, Akyüz M, Uzun A. Investigation of the relationship between strength and some anthropometric parameters in young elite wrestlers. Atabesd 2009;11(4):1-10.
16. Lohman TG. Skinfolds and body density and their relation to body fatness: A review. Human Biology 1981;53(2):181-225.
17. Lohman TG, Roche AF, Martorell R. Anthropometric standardization reference manual. Champaign, IL: Human Kinetics. 1988.
18. Sloan AW, Weir JB. Nomograms for prediction of body density and total body fat from skinfold measurements. J Appl Physiol 1970;28(2):221-2.
19. Carter J. Physical structure of Olympic athletes. Med Sport Sci 1984;18(1):56–63.
20. Livio M. The Golden Rtaio: The story of phi, The world's most astonishing number. New York: Broadway Books.

21. American College of Sports Medicine, American Dietetic Association, Dietitians of Canada. Joint position statement: nutrition and athletic performance. Med Sci Sports Exerc 2000;32(12): 2130-45.
22. Horswill CA. Applied physiology of amateur wrestling. Sports Med 1992;14(2):114-43.
23. Manore MM, Barr SI, Butterfield GE. Position of dietitians of Canada, the American Dietetic Association, and the American College of Sports Medicine: Nutrition and athletic performance. J Am Diet Assoc 2000;100(12):1543–56.
24. Mirzaei B, Curby DG, Rahmani-Nia F, Moghadasi M. Physiological profile of elite Iranian junior Freestyle wrestlers. J Strength Cond Res 2009;23(8):2339-2344.
25. Demirkan E, Kutlu M, Koz M, Özal M, Favre M. Physical fitness differences between freestyle and Greco-Roman junior wrestlers. J Hum Kinet 2014;41:245-251.
26. Bloomfield JA, Timothy R, Elliott BC. Applied anatomy and biomechanics in sport. Oxford, Melbourne: Blackwell Scientific Publications 1994; 93–102.
27. Cicioğlu I, Kürkçü R, Eroğlu H. Seasonal changes on some anthropometrical characteristics of wrestlers aged 15-17 years. Atabesd 2007;4:1-8.