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Araştırma Makalesi

FARKLI SOMATOTİP YAPILARDAKİ SPORCULARIN RELATİF KOL KUVVETLERİNİN KARŞILAŞTIRILMASI

COMPARISON OF RELATIVE ARM STRENGTH OF ATHLETES WITH DIFFERENT SOMATOTYPE STRUCTURES

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Farklı Somatotip Yapılardaki Sporcuların Relatif Kol Kuvvetlerinin Karşılaştırılması

ÖZ

Bu çalışmanın amacı, farklı somatotip yapılardaki sporcuların relatif kol kuvvetlerinin karşılaştırılmasıdır. Araştırmanın örneklemi gönüllü katılım esasına göre çalışmaya katılmayı kabul eden (Tesadüfi örnekleme yöntemi) dengeli endomorf (55 kişi) yaş ortalamaları 21,73±1,69 yıl, dengeli mezomorf (60 kişi) 21,27±3,48 yıl ve dengeli ektomorf (55 kişi) 19,22±1,75 yıl olan toplam 170 erkek öğrenciden oluşmaktadır. Sporculardan alınan verilerin istatistiksel analizleri SPSS 29.0 paket programında yapılmıştır. Tanımlayıcı istatistikler için frekans ve tanımlayıcı analizler, karşılaştırma analizleri için Kruskal Wallis-H Testi yapıldı. Sonuç olarak, farklı somatotip yapılardaki sporcuların relatif kol kuvvetlerinin karşılaştırılmasının yapıldığı bu çalışmamızda en iyi relatif kol kuvveti değerleri sırasıyla; dengeli mezomorfi, dengeli ektomorfi ve dengeli endomorfi olarak tespit edilmiştir. Branşlara özgü vücut yapısı dikkate alındığında dengeli mezomorfi komponentine sahip olan sporcuların fiziksel ve fizyolojik kapasite ve performans düzeylerinin ektomorfi ve endomorfiye göre daha yüksek olmuş olması kuvvet antrenmanları ile artan kas kütlesi (hipertrofi) ve buna bağlı olarak artan kuvvet değerinin (salt kuvvet) sporcunun gerçek kuvvet değeri olmadığı ve sporcunun gerçek kuvvet artışını belirlemenin en sağlıklı yolunun relatif ölçümler olmasından dolayı relatif kol kuvveti yönteminin kullanılmasının özellikle kavrama kuvvetinin önemli olduğu bireysel, takım, bedensel engelli sporcuların bireysel olarak ve izlenmesi ve değerlendirilmesinde, gelişim çağındaki çocukların üst kol, alt kol ve el uzunluğunun artması ile beraber kol kuvvetinin gelişimlerinin doğru bir şekilde değerlendirilmesinde oldukça faydalı olacağı düşünülmektedir.

Anahtar Kelimeler: Somatotip, kuvvet, relatif kol kuvveti, performans

Comparison of Relative Arm Strength of Athletes with Different Somatotype Structures

ABSTRACT

The aim of this study was to compare the relative arm strength of athletes with different somatotype structures. The sample of the study consisted of 170 male students with balanced endomorphy (55 people) with an average age of 21,73±1,69 years, balanced mesomorphy (60 people) with an average age of 21,27±3,48 years and balanced ectomorphy (55 people) with an average age of 19,22±1,75 years. Statistical analysis of the data obtained from the athletes was performed in SPSS 29.0 package program. Frequency and descriptive analyses were used for descriptive statistics and Kruskal Wallis-H Test was used for comparison analyses. In conclusion, the best relative arm strength values were determined as balanced mesomorphy, balanced ectomorphy and balanced endomorphy, respectively, in this study in which the relative arm strength of athletes with different somatotype structures were compared. Considering the branch-specific body structure, the physical and physiological capacity and performance levels of the athletes with balanced mesomorphy component were higher than ectomorphy and endomorphy, which means that the muscle mass (hypertrophy) increased by strength training and accordingly increased strength value (pure strength) is not the actual strength value of the athlete, and since the healthiest way to determine the actual strength increase of the athlete is relative measurements, the use of relative arm strength method is especially important for grip strength, It is thought that the team will be very useful in the monitoring and evaluation of physically disabled athletes individually and in the correct evaluation of the development of arm strength with the increase in upper arm, lower arm and hand length of children in the developmental age.

Keywords: Somatotype, strength, relative arm strength, performance

INTRODUCTION

In determining the sportive performance of an athlete, morphological characteristics as well as motoric characteristics should be taken into consideration. If the physiological structure of the athlete does not meet the characteristics required by the sport, it is not possible to exhibit the desired performance. For this reason, it is thought that in order to have a good success in the sport branch, it is necessary to have a body type suitable for the sport branch[1,2]. Somatotype is used to describe the body structure of a person[3]. Somatotype is the presentation of the bodily shapes that people show[4]. Somatotype is a grading and classification system based on three components of the general body form. There are three basic types of somatotype: endomorph, mesomorph and ectomorph. Endomorphic individuals are generally rounder and shorter, mesomorphic individuals are muscular and athletic, and ectomorphic individuals are tall and thin[5-8]. Somatotype characteristics are important determinants of an athlete's physical movement ability[6]. Therefore, physical performance and somatotype characteristics are considered as important components of sportive performance[9]. The physical characteristics of an athlete are directly related to their body composition, which directly affects their performance[3]. Therefore, evaluating an athlete's body composition is an important step to determine potential strengths and weaknesses[2,10]. Physical structure, which is one of the important indicators for an athlete to perform optimally in his/her sport, contributes positively to the athlete's performance by combining with other performance elements such as strength, power, flexibility, speed, endurance and quickness[11]. Among these characteristics, strength is of particular importance[12,13]. In all sports disciplines, strength is used to improve the performance of athletes due to its direct and indirect effect on performance[14-16]. The concept of strength is defined as the ability of a muscle or muscle group to resist, contract, withstand or move against a resistance[17,18]. Muscular endurance along with strength is necessary for athletes to demonstrate their maximum performance throughout the season[19]. The aim of this study was to compare the relative arm strength of athletes with different somatotypes.

MATERIALS AND METHODS

Participants

The population of the study consisted of 500 male student athletes studying at Kırşehir Ahi Evran University Faculty of Sport Sciences and the sample consisted of 170 male student athletes who accepted to participate in the study on the basis of voluntary participation (Random sampling method). For this research, the necessary permissions were obtained from the Dean's Office of Kırşehir Ahi Evran University, Faculty of Sports Sciences (Number: E-51788177-000-00000604776 Date: 23.01.20244) and Kırşehir Ahi Evran University, Faculty of Medicine, Clinical Research Ethics Committee, decision number 2024-04/12 and dated 06.02.2024.

In this study, two measurements were taken by the researchers.

- Determination of relative arm strength
- Determination of somatotype structure

Determination of Relative Arm Force

- In determining the relative arm strength, firstly, upper arm mass, lower arm mass and hand mass were calculated separately and total arm mass was determined. Secondly, hand claw strength was measured.
- Relative arm strength method was determined by dividing the hand claw strength by the total arm mass (in kg)[18].

Calculation of Arm Mass

- Upper arm length (length between Acromiale-Radiale)
- Upper arm width (where Acromiale-Radiale gives the widest circumference measurement)
- Lower arm width (where it gives the widest circumference measurement between Radiale and Stylion)
- Wrist circumference
- Wrist width
- Measurements were made as described by the Hanavan model method (Formula 1, Formula 2 Formula 3)[20-22].

Upper Arm Mass Calculation

Upper arm length (length between Acromiale and Radiale) and upper arm width (where it gives the widest circumference measurement between Acromiale and Radiale) were calculated according to the Hanavan model method (Formula 1).

Total Upper Arm Mass =
0.007*Body Weight+0.092*Upper Arm Circumference+0.050*Upper Arm Length - 3.101
(Formula 1)

Lower Arm Mass Calculation

Lower arm width (where it gives the widest circumference measurement between Radiale and Stylion) was calculated according to the Hanavan model method (Formula 2).

Lower Arm Mass =
0.081*Body Weight+0.052*Lower Arm Circumference- 1.65
(Formula 2)

Hand Mass Calculation

The circumference of the wrist and the width of the wrist circumference were calculated according to the Hanavan model method (Formula 3).

Total Hand Mass =
0.038*Wrist Circumference + 0.080*Wrist Width - 0.660
(Formula 3)

Determination of Hand Grip Strength

Hand grip strength was measured with a Jamar hand dynamometer, which is the gold standard and recommended by the American Association of Hand Therapists (AETD)[23]. Hand grip strength was measured in the standard position recommended by the AETD; sitting position, shoulder in adduction and neutral rotation, elbow in 90º flexion, forearm in midrotation and supported, wrist in neutral[24].

Calculation of Relative Arm Force

Relative Arm Force = Hand Claw Force (kg) / Arm Mass (kg)[18].

Somatotype Calculation

The somatotype values of the athletes were determined by Heath Carter somatotype method. According to this method, somatotype values were determined by using body weight, height, biceps and calf circumference in flexion, humerus and femur diameter measurements and triceps, subscapula, suprailiac and calf skinfold thickness. SOMATOTÜRK Calculation Program was used to calculate somatotypes[8].

Data Collection Tools

- Skinfold thickness was measured with a skinfold (Holtain).
- Humerus and femur bicondyles, upper arm length and foot length were measured with a small lafayette anthropometer.
- The length of the upper arm and foot length were measured with a small lafayette anthropometer[8].
- The widest circumference of the upper arm, lower arm, thigh and calf and ankle circumference were measured with lafayette gulick tape measure[25].
- Leg press strength was measured with Cool line (CL-120 Leg Press Machine).
- Hand claw strength, In order to determine the hand claw strength of the candidates participating in the study, a calibrated JAMAR brand "Model J00105, USA" hydraulic hand dynamometer, which can measure in pounds and kg, has a measurement range of 200 pounds, 90 kg and can be adjusted in 5 different positions for people with different hand sizes, was used[26-28].

Statistical Analysis

The data in the study were analyzed with SPSS 29.0 package program. The normality test of the scale variables was examined. Since the number of participants in the study was 170 (n≥30), Kolmogorov-Smirnov was checked[29,30] and nonparametric analyses were applied since the variables were $p<0.05$. Frequence and Descriptive analyses were performed for descriptive statistics (Table 1) and Kruskal Wallis-H Test for comparison analyses (Table 2).

RESULTS

Table 1. Descriptive Statistics of Athletes with Different Somatotype Structures

	x±sd	x±sd	x±sd
	Balanced Endomorphy (n=55)	Balanced Mesomorphy (n=60)	Balanced Ectomorphy (n=55)
	x±sd	x±sd	x±sd
Age (years)	21,73±1,69	21,27±3,48	19,22±1,75
Weight (kg)	65,62±3,29	72,12±11,39	62,60±4,77
Height (cm)	168,60±2,65	173,98±7,40	177,05±5,63
Total Arm Mass (kg)	16,26±0,47	16,43±0,74	16,53±0,59
Hand Claw Strength (kg)	40,91±4,30	63,60±9,36	54,36±2,93
Relative Arm Force (kg)	2,52±0,30	3,88±0,59	3,29±0,21
Endomorphy	4,26±0,26	2,47±0,58	1,76±0,38
Mesomorphy	2,38±0,55	5,35±1,41	1,67±0,62
Ectomorphy	2,31±0,39	2,14±0,85	4,09±0,84

When the descriptive statistics of the athletes with different somatotype structures who participated in this study were examined (Table 1); age 21,73±1,69 years, weight 65,62±3,29 (kg), height 168,60±2,65 (cm), total arm mass 16,26±0,47 (kg), hand grip strength 40,91±4,30 (kg) and relative arm strength 2,52±0,30 (kg) were determined in athletes (n=55) with balanced endomorphy component (4,26-2,38- 2,31). Age 21,27±3,48 years, weight 72,12±11,39 (kg), height 173,98±7,40 (cm), total arm mass 16,43±0,74 (kg), hand grip strength 63,60±9,36 (kg) and relative arm strength 3,88±0,59 (kg) were determined in athletes (n=60) with balanced mesomorphy component (2,47-5,35-2,14). Age 19,22±1,75 years, weight 62,60±4,77 (kg), height

177,05±5,63 (cm), total arm mass 16,53±0,59 (kg), hand grip strength 54,36±2,93 (kg) and relative arm strength 3,29±0,21 (kg) were determined in athletes (n=55) with balanced ectomorphy component (1,76-1,67-4,09).

Table 2. Comparison of Total Arm Mass, Hand Claw Strength and Relative Arm Strength Variables of Athletes with Different Somatotype Structures

	Somatotype Structure	N	Mean Rank	X^2	p
Total Arm Mass (kg)	Balanced Endomorphy[ab]	55	72,00	8,271	,016*
	Balanced Mesomorphy[bc]	60	85,51		
	Balanced Ectomorphy[c]	55	98,99		
Hand Claw Strength (kg)	Balanced Endomorphy[a]	55	33,17	113,587	,000***
	Balanced Mesomorphy[b]	60	130,83		
	Balanced Ectomorphy[c]	55	88,38		
Relative Arm Force (kg)	Balanced Endomorphy[a]	55	33,76	108,425	,000***
	Balanced Mesomorphy[b]	60	129,18		
	Balanced Ectomorphy[c]	55	89,58		

*p<0.05 ***p<0.001 Balanced Endomorphism=a Balanced Mesomorphism=b Balanced Ectomorphism=c
No difference between groups with the same letter in the same column
There is a difference between groups with different letters in the same column

When the comparison of total arm mass, hand claw strength and relative arm strength variables of athletes with different somatotype structures participating in this study (Table 2) was examined; when the total arm mass of athletes with different somatotypes was analyzed, there was a significance between balanced endomorphy and balanced ectomorphy (,016* p<,05), but there was no significance between the other components. When the hand claw strength of athletes with different somatotype structures were examined, significance was found between balanced endomorphy and balanced ectomorphy (,000*** p<,001), between balanced endomorphy and balanced mesomorphy (,000*** p<,001) and between balanced mesomorphy and balanced ectomorphy (,000*** p<,001). When the relative arm strength of athletes with different somatotypes was analyzed, there was significance between balanced endomorphy and balanced ectomorphy (,000*** p<,001), between balanced endomorphy and balanced mesomorphy (,000*** p<,001) and between balanced mesomorphy and balanced ectomorphy (,000*** p<,001).

DISCUSSION

Since the relative arm strength methodwas recently introduced, no somatotype study on relative arm strength was found in the literature. Therefore, in this study, it was aimed to examine the relative arm strength of athletes with different somatotype structures[18]. Somatotype components, which are one of the factors affecting performance, affect the physical and physiological capacities[31,32]. It is not possible to reach the desired performance level unless the characteristics of the physical structure are suitable for the sport[33]. Physical structure is only one of the indicators of an athlete's ability to perform at a high level and it positively affects the athlete's performance by combining with other performance indicators such as strength, power, flexibility, acceleration, speed, endurance and quickness[34]. In individual and team sports, the strength parameter directly and indirectly affects performance. Therefore, hand grip strength is used as a measurement criterion of athlete training[35]. This high information content determines the widespread prevalence of this criterion in studies on sports and physical education[36-38]. When the literature was examined in terms of somatotype characteristics, the hand grip strength of endo-mesomorph Turkish National Team (2.97-4.56-1.59) and Kazakh National Team (3.59-4.30-2.98) young wrestlers was found to be 50.8±7.9 and 50.2±7.3 kg, respectively[34]. In a study, a very high positive correlation was found between relative strength and relative arm mass in both individual athletes (r:,957) and team athletes (r:,945). According to the relative arm strength method, it was determined that the strength value of team athletes (6.12±.78 kg) was higher than that of individual athletes (5.95±0.85 kg)[39]. The prerequisite for reaching a maximal speed is adequate fitness and strength. These two characteristics positively affect acceleration. Relative strength is a determinant of success, especially in sports requiring large acceleration to body weight[40].

In a study on the effects of body composition and somatotypes on acceleration speed in male athletes, the best acceleration test values of athletes with balanced mesomorphy, balanced ectomorphy and balanced endomorphy components (5 m, 10 m, 15 m) were ranked as balanced mesomorphy, balanced ectomorphy and balanced endomorphy[41]. In this study, which is thought to be caused by physical characteristics and different sports branches, the order of 5 m test values was as follows: mesomorphy 1.07±0.14 sec., ectomorphy 1.19±0.10 sec. and endomorphy 1.27±0.11 sec., and the order of 10 m test values was as follows: mesomorphy 1.86±0.18 sec., ectomorphy 1.97±0.12 sec. and endomorphy 2.13±0.16 sec. and 15 m test values; mesomorphy 2.34±0.29 sec., ectomorphy 2.67±0.15 sec. and endomorphy 2.95±0.25 sec.[42]. In another similar study, the 10 m test time of 36 soccer players with ecto-mesomorph somatotype values (2.30-3.73-3.08) was 1.70±0.1 sec. [43]. The 0-10m values of 100m running distances in international competitions in different years were determined as follows; Ben Johnson (1988) 1.83 sec. Carl Lewis (1988) 1.89 sec Maurice Greene (1999) 1.86 sec Maurice Greene (2001) 1.83 sec Tim Montgomery (2002) 1.89 sec Asafa Powell (2005) 1.89 sec Usain Bolt (2008) 1.85 sec and Usain Bolt (2009) 1.89 sec. It was determined that these athletes ran 0-10 m in 1.83-1.89 sec., 10-20 m in 0.99-1.07 sec., 20-90 m in 0.81-0.86 sec. and 90-100 m in 0.85-0.90 sec. [41]. The fact that the best acceleration values belong to the athletes in the mesomorphy component leads to the conclusion that their relative arm strength is higher than the other components.

As a result, the best relative arm strength values were determined as balanced mesomorphy, balanced ectomorphy and balanced endomorphy, respectively, in this study in which the relative arm strength of athletes with different somatotype structures were compared. In other words, it was determined that the relative arm strength of the athletes with balanced mesomorphy component was higher than the athletes with balanced ectomorphy and balanced endomorphy components. Considering the branch-specific body structure, the physical and physiological capacity and performance levels of the athletes with balanced mesomorphy component were higher than those with balanced ectomorphy and endomorphy, which means that the increased muscle mass (hypertrophy) and accordingly increased strength value (pure strength) with strength training is not the actual strength value of the athlete, and since the healthiest way to determine the actual strength increase of the athlete is relative measurements, the use of the relative arm strength method, especially grip strength, is important individual, It is thought that the team will be very useful in the monitoring and evaluation of physically disabled athletes individually and in the correct evaluation of the development of arm strength with the increase in upper arm, lower arm and hand length of children in the developmental age.

REFERENCES

1. Wilber RL., Pitsiladis YP. (2012). Kenyan and Ethiopian distance runners: what makes them so good? International journal of Sports Physiology and Performance. 7(2), 92-102.
2. Massidda M, Toselli S., Brasili P., M Calo C. (2013). Somatotype of elite Italian gymnasts. Collegium Antropologicum. 37(3), 853-857.
3. Marangoz İ. (2019). Fiziksel performansın ölçümünde sık kullanılan bazı testler ve hesaplama programları. Gazi Kitabevi, Ankara.
4. Carter H. (2002). The Heath-Carter anthropometric somatotype-instruction manual. Department of Exercise and Nutritional Sciences San Diego State University.
5. Carter BH. (1990). Somatotyping: development and applications: Cambridge University Press.
6. Ryan Stewart H., Faulkner J., Jobson S. (2018). The influence of somatotype on anaerobic performance. PloS one. 13(5), e0197761.
7. Silventoinen K., Maia J., Jelenkovic A., Pereira S., Gouveia É., Antunes A., Thomis M., Lefevre J., Kaprio J., Freitas D. (2021). Genetics of somatotype and physical fitness in children and adolescents. American Journal of Human Biology. 33(3), e23470.
8. Marangoz İ. (2023). Somatotype and somatoturk calculation programme. Gazi Bookstore, Ankara.
9. Chaabene H., Negra Y., Bouguezzi R., Capranica L., Franchini E., Prieske O., Hbacha H., Granacher U. (2018). Tests for the assessment of sport-specific performance in Olympic combat sports: A systematic review with practical recommendations. Frontiers in Physiology. 9, 386.
10. Top E., Çelenk Ç., Marangoz İ., Aktug ZB., Yılmaz T., Akıl M. (2018). The effect of somatotype characteristics of athletes on the balance performance. Journal of Education and Learning. 7(5), 174-80.
11. Barlow MJ., Findlay M., Gresty K., Cooke C. (2014). Anthropometric variables and their relationship to performance and ability in male surfers. European Journal of Sport Science. 14(sup1), 171-177.
12. Sevim Y., Önder O., Gökdemir K. (1996). Effects of circuit training related to explosive strength on some conditional characteristics of male students aged 18-19 years. Gazi Journal of Physical Education and Sport Sciences. 1(3), 18-24.
13. Muratlı S., Kalyoncu O., Sahin G. (2007).Training and competition. Ladin Printing, Antalya.
14. Aydos L., Pepe H., Karakuş H. (2004). The Research of relative force evaluations in some team and individual sports. Gazi University Kırşehir Faculty of Education. 5(2), 305-315.
15. Hekim M., Hekim H. (2015). Overview to Strength development and strength trainings in children. The Journal of Current Pediatrics. 13(2), 110-115.
16. Günay M., Şıktar E. (2017). Training science, Gazi Bookstore. Ankara.
17. Özdemir S. (2009). The effects of complex training program on explosive power, strength, sprint and agility development between 14-16 aged young footballers. Doctoral dissertation, Master Thesis. Marmara University, Health Sciences Institute. Istanbul.
18. Marangoz İ. (2022) Determination of relative arm strength. Turkish Journal of Health and Sport. 3(2), 30-34.

19. Demirel T., Taşkıran MY.(2020). Modifiye 5x5 madcow programının kas hipertrofisi ve gücü üzerine etkileri. Journal of Health and Sport Sciences. 3(3), 77-82.
20. Hanavan EP .(1964). A mathematical model of the human body: Aerospace medical research laboratories, aerospace medical division, aerospace medical division, Air Force Systems Command.
21. Miller DI., Morrison WE. (1975). Prediction of segmental parameters using the Hanavan human body model. Medicine and Science in Sports. 7(3), 207-212.
22. Norton KI. (2018). Standards for anthropometry assessment. Kinanthropometry and Exercise Physiology. 4, 68-137.
23. Narin S., Demirbüken İ., Özyürek S., Eraslan U. (2009). Relationship of the grip and pinch strength of the dominant hand with anthropometric measurements of forearm. Journal of Dokuz Eylul University Faculty of Medicine. 23(2), 81-85.
24. Keçelioğlu Ş., Akçay B. (2019). Multi-directional approach to evaluation of hand-wrist in athletic performance: Review. Izmir Democracy University Health Sciences Journal. 2(2),118-134.
25. Marangoz İ. (2022). Sporda kinantropometri. Gazi Kitabevi, Ankara.
26. Mathiowetz V. (2002).Comparison of rolyan and jamar dynamometers for measuring grip strength. Occupational Therapy International. 9(3), 201-209.
27. Lafayette. (2004). JAMAR Hydrolic hand dynamomete. Jamar Hydrolic Hand Dynamometer User Instructions Model J00105 USA.
28. Massy Westropp NM., Gill TK., Taylor AW., Bohannon RW., Hill CL. (2011). Hand grip strength: age and gender stratified normative data in a population-based study. BMC Research Notes. 4(1), 1-5.
29. Alpar R. (2020). Uygulamalı çok değişkenli istatistiksel yöntemler. Detay Yayıncılık, Ankara.
30. Cevahir E. (2020). SPSS ile nicel veri analizi rehberi. Kibele Yayınları.
31. Dopsaj M., Marković M., Kasum G., Jovanović S., Koropanovski N., Vuković M., Mudric M. (2017). Discrimination of different body structure indexes of elite athletes in combat sports measured by multi frequency bioimpedance method. International Journal of Morphology. 35(1),199-207.
32. Özkan F., Ünver F., Baltacı G. (2005). Somatotypes of American football players. Gazi Journal of Physical Education and Sports Sciences. 10(1), 35-44.
33. Açıkada C., Ergen E. (1990). Bilim ve spor. Büro-Tek Ofset Matbaacılık, Ankara.
34. Taş M., Özkan A., Uzun A., Koç H., Akyüz M., Kıyıcı F. (2008). Comparison of some physical fitness and somatotype characteristics of young wrestlers in national teams of two different countries. Selçuk University Journal of Physical Education and Sports Science.10(3), 1-9.
35. Podrihalo OO., Podrigalo LV., Bezkorovainyi DO., Halashko OI., Nikulin IN., Kadutskaya LA., Jagiello M. (2020). The analysis of handgrip strength and somatotype features in arm wrestling athletes with different skill levels. Physical Education of Students. 24(2), 120-126.
36. Fewell LK., Nickols R., Tierney AS., Levinson CA. (2018). Strength and power improvements in athlete and non-athletes during intensive eating disorder treatment. Journal of Clinical Sport Psychology.12(4), 562-577.
37. Szabolcs Z., Kormendi J., Ihász F., Koteles F., Szemerszky R. (2018). Physiological characteristics of aikido practitioners and aikido workouts. Archives of Budo.14, 259-266.
38. Oliveira A., Monteiro A., Jacome C., Afreixo V., Marques A. (2017). Effects of group sports on health-related physical fitness of overweight youth: A systematic

review and meta-analysis. Scandinavian Journal of Medicine & Science in Sports. 27(6), 604-611.

39. Marangoz İ., Genç V., Yağız K. (2022). The relationship between arm mass and arm relative strength of individual and team athletes using the upper extremity more actively. Journal of Physical Education and Sports Sciences. 16(2), 117-127.
40. Murphy AJ., Lockie RG., Coutts AJ. (2003). Kinematic determinants of early acceleration in field sport athletes. Journal of Sports Science & Medicine. 2(4), 144-150.
41. Marangoz İ. (2016). The effects of body composition and somatotypes on acceleration speed in male athletes. Erciyes University, Graduate School of Health Sciences , Department of Physical Education and Sports, PhD Thesis. Kayseri.
42. Marangoz İ., Polat Y. (2019). The effects of body composition and somatotypes on accelaration speed in male athletes. The Journal of Academic Social Science. 54(54), 345-360.
43. Köklü Y., Özkan A., Alemdaroğlu U., Ersöz G. (2009). Genç futbolcuların bazı fiziksel uygunluk ve somatotip özelliklerinin oynadıkları mevkilere göre karşılaştırılması. Spormetre Beden Eğitimi ve Spor Bilimleri Dergisi. 7(2), 61-68.