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ORIGINAL ARTICLE

The Relationship Between Anaerobic Power and Arm Volume and Service Shot Speed in Volleyball Players

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ABSTRACT

Aim: The aim of this study is to examine the relationship between upper extremity anaerobic power and arm volume with the correct service shooting rate of athletes interested in volleyball. A total of 13 male athletes playing elite level volleyball participated in the study.

Method: Arm volumes were measured while the athlete was standing and legs were shoulder width apart. The distance between the acromion bone and the olecranon bone was measured with ± 1 mm accuracy at 10% intervals. Forearm volumes were measured while the athlete was standing and legs were shoulder-width apart. The distance between the olecranon bone and the ulnar styloid bone was measured with ± 1 mm accuracy at 10% intervals. To determine their anaerobic performance, Wingate anaerobic power and capacity test (AP) was performed on a pan arm ergometer, which was connected to a computer modified for this arm and operated with compatible software. The service speed (SS) of the athletes was used in Pocket Radar. Data evaluation was carried out using a statistical program in computer environment. "Shapiro-Wilk Test" was used for normal distribution of data. In statistical analysis, minimum and maximum values, arithmetic mean, standard deviation values were calculated. "Pearson" correlation analysis was used for the normally distributed data in the relationship of arm volume (AV) with anaerobic power. The data were evaluated according to the "0.05" significance level.

Results: When the findings are examined, the AP and SS values of the athletes (r =, 843 **; p <, 001), RightAV values with SS (r = .857 **; p <, 000), LeftAV and SS values (r = .924 **; p <, 000) and significant relationship was found between Total AV and SS values (r =, 894 **; p <, 000).

Conclusions: As a result, the findings of our study showed that men who do elite volleyball sports both have high upper extremity anaerobic power characteristics and have a high percentage of muscles around the arm, and play a decisive role in the correct service shooting speed.

Keywords: Volleyball, Power, Volume, Service

INTRODUCTION

With the advancement of sports, technology and science, it continues to develop rapidly day by day. Physical and physiological evaluations applied to achieve the targeted success play an important role in the success to be achieved [28]. Sporty performance; It can be described as the sum of efforts made for success during the performance of an athletic task that needs to be done. In a sense, the performance should be seen and evaluated in a relatively short time during the competition or the match and as a whole with the factors affecting the result [5].

Today, talented athletes are needed to compete on international platforms in sports and to take our place in this field in the world. The training of these athletes requires a systematic and coordinated work suitable for sports [9]. In sports branches, technique is considered to be very important. Briefly technical; It means performing the basic movements of the branch in the most economical way suitable for the purpose [22]. For this reason, it is stated that the shooting technique of the athletes should be evaluated and it is necessary to make sure that the shooting is made with the correct technique [14].

Anaerobic capacity can be defined as the work created by skeletal muscles using anaerobic energy transfer systems during maximal or supramaximal exercise [3]. Anaerobic power is defined as the ability to work without oxygen when sufficient oxygen does not enter the organism but the organism can continue to work during exercise [18]. Anaerobic power is one of the two components of anaerobic performance. Power is known as the maximum amount of power obtained per unit time in explosive charges. For ATP regeneration in severe loads, anaerobic power is based on the ATP-PC system [6]. Power is an important element, especially in sports that require speed and explosion. In the weightlifting branch, maximum weights are used, but at the same time, maximum acceleration and speed are equivalent to force. The force used to throw the handball ball must be less, but the movement speed must be very high. In this case, force is not as important as speed. However, it should not be forgotten that the increase in the force increases the speed. Most movements are formed by a combination of at least two motor characteristics. Strength and speed, namely quick force (power), are important in dunking movement in volleyball and in jumping and throwing branches in athletics [21]. Some studies emphasize that anaerobic power and maximal strength studies increase strength in athletes even in pre-test data [2]. In addition, muscle fiber length, muscle cross-sectional area, muscle mass, arm-leg volume, arm-leg mass are the characteristics that play a decisive role in sports performance. In many studies conducted with athletes, it was determined that the strength performance of the athletes increased as the arm-leg volume, muscle mass and muscle cross section area increased [24].

The concept of speed is defined as the ratio between distance and time. In sports science, speed can be defined as moving the body or a part of it over a certain distance as soon as possible [4]. It does not show that it is impossible to overcome too much resistance at high speeds in the force velocity relationship. The stronger the muscle, the more maximum isometric contraction can occur, ie if the resistance is increased before the muscle stretches, the maximum amount of force can be released. However, no matter how high the maximum isometric contraction, the general shape of the force velocity gradient does not change. The force-velocity relationship does not show that movement from another direction at low speed and with little resistance is impossible. Most of the movements in daily life require slow and controllable movements at the submaximal [21].

This work; It aims to reveal the relationship between upper extremity anaerobic power and arm volume in elite volleyball players and the accurate service rate.

MATERIALS AND METHODS

Participants: In this study, 13 elite men (mean age 21.33 ± 2.60 years, average height 182.25 ± 5.81 cm, average body weight 78.16 ± 9.00 kg, mean body mass index 23.56 ± 2 , 63, sports age average 9.50 ± 3.60 years) volleyball players participated voluntarily. Athletes do not have any health problems. Height and body weight of the athletes participating in the test were taken before the test started. Accurate service firing rates were measured after 24 hours. Before participating in the study, the athletes were informed about the content of the study and the volunteer consent form was filled out. The athletes had a light, standard breakfast on the morning of the measurement. They were ready at 10.00 in the morning in the performance lab. The height and body weight measurements of the athletes were measured with a 0.01 m stadiometer (Seca, Germany). Measurements were made in anatomical stance, with the heels of the feet united, holding the breath, and the head in the frontal plane, after the head was positioned to touch the vertex point. We applied the principles outlined in the Declaration of Helsinki.

Measurements of Height: It was measured on the bare foot by using a SECA (Germany) brand size scale with a sensitivity of 0.1 m.

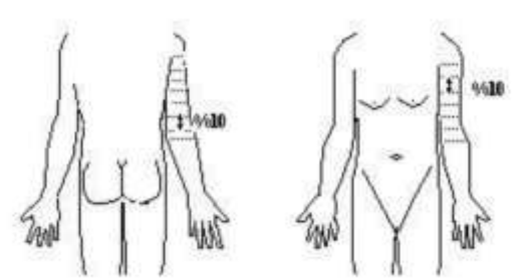
Measurements of Weight: It was taken by weighing on the bare foot via SECA (Germany) electronic scale, which has a sensitivity of 0.5 kg, only with shorts and a T-shirt on athletes.

Body Mass Index: Body mass index was calculated with the body weight / height^2 of the athletes [19].

Anaerobic Power and Capacity Measurement Tool: Wingate anaerobic power and capacity testing was performed on a pan arm ergometer (Monark 891 E, Sweeden) connected to a computer modified for this test arm and powered by compatible software.

Wingate Anaerobic Test Measurement Procedur: For the Wingate test, a Monark 894E model (made in Sweden) arm ergometer with a pan, connected to a modified computer and working with compatible software was used. Height adjustments were made for each athlete before the tests. The load to be applied as external resistance on the arm ergometer during the test for each athlete, 1 kg was put on the pans as standard. A 5-minute warm-up protocol was applied to the athletes with 20% of the test loads calculated on the arm ergometer, at a pedal speed of 60-70 rpm, consisting of two or three sprints of 4-8 seconds. Passive rest was given for 3–5 minutes after warming up. The athletes were required to reach the highest pedal speed in the shortest possible time without resistance. When he was sure that the maximum speed was reached (after about 3–4 seconds), a 1 kg load, which was previously added to all athletes as a standard, was left and then the test was started. The athletes pedaled at the highest speed for 30 seconds against this resistance and the athletes were verbally encouraged during the test.

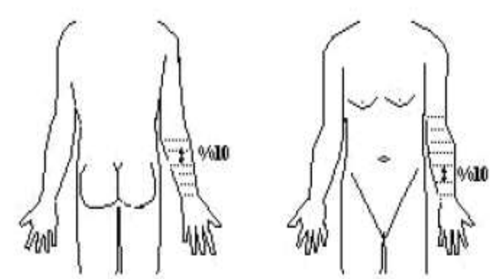
Determination of Arm Volume (Arm Volume): The distance between the acromion bone and the olecranon bone was measured with an accuracy of ± 1 mm with 10% intervals with the athlete standing and legs open at shoulder width.



Circumference measurements at 10% intervals to determine upper arm volüme

Calculating Arm Volume: After measuring the distance between the forearm volume acromion bone and olecranon bone at 10% intervals, the Frustum sign model method [27], first the volumes of the pieces taken at 10% intervals were calculated, then the volumes of all parts between the acromion bone and the olecranon bone were summed and the total volume of the forearm was calculated.

Forearm Volume: The distance between the olecranon bone and the ulnar styloid bone was measured with an accuracy of ± 1 mm at 10% intervals with the athlete standing and legs open at shoulder width.



Environmental measurements at 10% intervals to determine forearm volüme

Calculating Forearm Volume: Forearm volume, after measuring the distance between the olecranon bone and the ulnar styloid at 10% intervals, the Frustum sign model method [27], the volumes of the pieces taken at 10% intervals will be calculated first, then the volumes of all the pieces between the olecranon bone and the ulnar styloid will be summed and the total volume of the lower arm is calculated.

Volleyball Service Speed Measurement: The measurement was taken at the volleyball court in Süleyman Demirel University indoor sports hall. In terms of the efficiency of the study, the athletes were asked not to do an intense and intense training 24 hours before the measurements. The athletes strenched for 10 minutes after 12 rounds of straight running around the volleyball court. Later, they continued to warm up in rally form with a mutual (according to FIVB standards, the ball that all athletes can play with and a volleyball with a circumference of 65-67 cm, weight of 260-280 grams and an internal pressure of 0.300-0.325 kg / cm2). Then, after 5 minutes of rest, the measurement was started. The athletes were asked to throw the type of service they wanted in the service zone from the left corner to the reserved (1,6,5) places on the opposite court, in a planted and accurate manner. Although there are 2 rights for each region, the best service speed has been recorded. Pocket Radar (Speed Meter) was used to measure service speed.

Statistical Analysis: Data evaluation was carried out using a statistical program in computer environment. "Shapiro-Wilk Test" was used for normal distribution of data. In statistical analysis, minimum and maximum values, arithmetic mean, standard deviation values were calculated. "Pearson" correlation analysis was used for the normally distributed data in the relationship of arm volume (AV) with anaerobic power (AP). The data were evaluated according to the "0.05" significance level.

RESULTS

Table 1. Physical Properties of Athletes

	N	Minimum	Maximum	Mean	SD
Age (years)	12	18,00	27,00	21,33	2,60
Height (cm)		170,00	194,00	182,25	5,81
Body Weight (kg)		67,00	92,00	78,16	9,00
BMI (weight/height^2)		20,37	28,09	23,56	2,63
Sports age (years)		4,00	15,00	9,50	3,60

According to Table 1, the average age of the athletes is 21.33 ± 2.60 years, their average height is 182.25 ± 5.81 cm, their body weight is 78.16 ± 9.00 kg, their average body mass index is 23.56 ± 2, 63, the average age of sports was calculated as 9.50 ± 3.60 years.

Table 2. Descriptive Statistics

	N	Mean	SD
AP (Watt)	12	752,5000	81,37
Right AV (lt)		4,1847	,64
Left AV (lt)		3,9523	,69
Total AV (lt)		7,9683	1,58
SS (km/speed)		62,1667	4,28

Table 3. The Relationship between Athletes' Anaerobic Power and Arm Volume with Service Speed

		Right AV (lt)	Left AV (lt)	Total AV (lt)	SS (km/speed)	AP (Watt)
AP (Watt)	r	,874**	,934**	,833**	,843**	1
	p	,000	,000	,001	,001	
Right AV (lt)	r	1	,922**	,889**	,857**	,874**
	p		,000	,000	,000	,000
Left AV (lt)	r	,922**	1	,947**	,924**	,934**
	p	,000		,000	,000	,000
Total AV (lt)	r	,889**	,947**	1	,894**	,833**
	p	,000	,000		,000	,001
SS (km/speed)	r	,857**	,924**	,894**	1	,843**
	p	,000	,000	,000		,001

**p<0.01

According to Table 3, the AP and SS values of the athletes (r =, 843 **; p <, 001), Right AV and SS values (r =, 857 **; p <, 000), Left AV and SS values (r =. A positive significant relationship was found between Total AV and SS values (r =, 894 **; p <, 000).

DISCUSSION

In the study, it was aimed to examine the relationship between upper extremity anaerobic power and arm volume and the correct service shooting rate of elite volleyball men. The average age of the athletes participating in the study is 21.33 ± 2.60 years, their average height is 182.25 ± 5.81 cm, their body weight is 78.16 ± 9.00 kg, their average body mass index is 23.56 ± 2.63, sports Their average age was calculated as 9.50 ± 3.60 years.

In our study, a positive significant relationship was found between the AP and SS values (r =, 843 **; p <, 001) of the athletes.

In the volleyball branch, where upper extremity strength is also of great importance, when we look at the literature, there is no study about anaerobic power and service speed values that we have done, although many features have been examined. Therefore, when the branches where the upper extremity anaerobic power characteristics are examined, Wozniak et al. (2004) found the average anaerobic power as 516 W after the arm wingate strength test performed by giving 55 g / kg load in their study on 10 wrestlers in the Polish national wrestling team. In another study, after arm wingate test performed by giving 50 g / kg weight per body kilogram to 18 elite wrestlers, the average power level was 522.6 W, the average anaerobic power was 403 in the same test performed by giving 50 g / kg per body weight to 19 amateur wrestlers, They found it to be 2 W (Martinez-Abellan et al 2010). In the same study, the average anaerobic power was found to be 849.37 W by giving a load of 80 g / kg after the arm wingate anaerobic power test performed to 8 rowers at the elite level where the upper extremities are used extensively, and the average anaerobic power of 16 non-elite club rowers after the same test was given 80 g / kg. They calculated their power as 610.18 W (Koutedakis et al 1986). When the studies of Martinez et al. (2010) were examined on 18 national wrestlers, the arm wingate anaerobic power test, which was performed by giving a weight of 50 g / kg per body kg, was found to be 780.9 W, the test performed by giving the same load to 19 non-national wrestlers in the same study. The peak power levels of the result were reported as 433.2 W. In the handball branch in which the upper extremities are used extensively, 21 handball players were given 60 g / kg weight per kg of arm, and the peak power level after arm wingate anaerobic power was reported to be 655 W, and the peak power levels of sedentary individuals were reported as 571 W in the same study (Kounalakis et al 2008). When the previous studies are examined, it shows that those who train regularly at the elite level have higher upper extremity anaerobic power than those who do sports at the sedentary or amateur level. Based on this information, it can be interpreted that the anaerobic power of elite volleyball players may be higher and their accurate service firing rate may be due to upper extremity strength characteristics.

In our study, the volleyball players' Right AV and SS values (r =, 857 **; p <, 000), Left AV and SS values (r =, 924 **; p <, 000) and Total AV and SS values (r =, 894 * *; p <, 000), a significant positive correlation was found between. When the literature is examined, there is no study examining the relationship between arm volume and service speed in volleyball players. High upper extremity arm muscle volume, large muscle cross-sectional area, excess lean tissues, high percentage of muscle, high ratio of muscle mass and muscle fibers in the arm area (biceps, triceps) suggest that the service speed will affect the service speed positively. As in our study, these comments can be made as the reason for the emergence of a positive relationship between arm volume and service speed.

CONCLUSION

As a result, the findings of our study showed that men who do elite volleyball sports both have high upper extremity anaerobic power characteristics and have a high percentage of muscles around the arm, and play a decisive role in the correct service shooting speed.

Conflict of interests: The author declares that there is no conflict of interest.

REFERENCES

1. Adams GM. Exercise Physiology Laboratory Manual. New York. McGraw Hill Company, 2002.
2. Alp, M. (2020). The Effects of Plyometric Trainings on Agility Performances in Male Basketball Players. International Journal of Applied Exercise Physiology, 9(3), 154-161. DOI: 10.26655
3. Baydemir, B. (2020). Performance and Measurement Methods in Swimming Sport, Scientific Perspective on Swimming Sport (pp.91-102). Turkey: Academician publishing house.
4. Baydemir, B., & Yurdakul, H. Ö. Components of Speed, Quickness and Agility Performances in Amateur Footballers. Mediterranean Journal of Sport Sciences, 2020 3(1), 63-71. Doi: 10.38021
5. Bayraktar, B., & Kurtoğlu, M. (2004). Performance and performance enhancement methods in sports. Doping and performance enhancement methods in football, Istanbul, 269-296.
6. Bencke J, Damsgaard R, Saekmose A, Jorgenson P, Jorgenson K, Klauen K, 2002. Anaerobic Power and Muscle Strength Characteristics of 11 Years Old Elite and Non-Elite Boys and Girls From Gymnastics, Team Handball, Tennis and Swimming, Scandinavian Journal of Medicine and Science in Sports, 12: 171-178. Doi: 10.1034
7. Beyaz M. Isokinetic Torque Values and Evaluation of Anaerobic Power by Wingate Test İstanbul. Istanbul University Faculty of Medicine Sports Physiology Research and Application Center. Specialization Thesis in Medicine 1997
8. Calbet JAL, De Paz JA, Garatachea N, De Vaca SC, Chavarren J. Anaerobic Energy Provision Does Not Limit Wingate Exercise Performance in Endurance-Trained Cyclists. Journal of Applied Physiology. 2003;94: 668-676. Doi: 10.1152
9. Demiral Ş, Erdemir İ, Kızılyaprak H. Talent Selection in Female Judo Players. 9th International Sports Sciences Congress, Muğla, 2006.
10. Hirunrat S, Ingkatecha O. Kinematics And Kinetics of Jumping Serve In Youth National Andnational Thai Female Volleyball Players of Thailand. International Journal of Sport and Exercise Science 2015; 1:13-16.
11. Inbar O, Bar-Or O. Anaerobic characteristics in male children and adolescents. Medicine and Science in Sport Exercise. 1986;18(3):264-269. Doi: 10.1249
12. Ingulf J, Burgers S. Effects of Training on the Anaerobic Capacity, Norway. Department of Physiology, National Institute of Occupational Health. 1990.
13. Kocaman, G., Atay, E., Alp, M., & Suna, G. (2018). Evaluation of Sports Injuries Areas and Types in Archers. Journal of Sports Medicine, 53(1), 001-008. Doi: 10.5152
14. Kosar, S. N., & Ready, T. (1994). Reliability of Wingate Anaerobic Strength Test. Journal of Sport Sciences, 7(4), 21-30.
15. Kounalakis SN, Bayios LA, Koskolou MD, Geladas ND. Anaerobic capacity of the upper arms in top-level team handball players. İnternational Journal of Sports. Doi: 10.1123
16. Kouredakis Y, Sharp NC. A modified wingate test for measuring anaerobic work of the upper body in junior rowers. . British Journal of Sports Medicine. 1986;20:153-156. Doi: 10.1136
17. Kruger K, Pilat C, Ueckert K, French T, Mooren FC, 2014. Physical Performance Profile of Handball Players is Related to Playing Position and Playing Class. Journal of Strength and Conditioning Research. (28). 117-125. Doi: 10.1519
18. Kumartaşlı, M., Suna, G., Çalışkan, İ. V., Işıldak, K., & Demir, M. (2011). Comparison of anthropometric characteristics of tennis and football players. Selcuk University Journal of Physical Education and Sports Science, 13(3), 372-377.
19. Martinez-Abellan A, Garcia-Pallares J, Lopez-Gullon JM, Otegui XM, Banos VM, Martiez-Moreno A. Factores anaerobicos predictores delexito en lucha olimpica. Cuadernos de Psicologia del Deporte. 2010;10:17-23.
20. Muratlı S, Kalyoncu O, Şahin G, 2011. Training and Competition. 3rd Edition, Kalyoncu Publishing, Istanbul.
21. N.Gündüz et al., "Performance and Tests in Handball," Journal of Dynamic Sports Sciences, vol.1, pp.13-20, 2002.
22. Özkan A, Arıburun B, Kin-İşler A. (2005). Investigation of some physical and somatotype characteristics of American football players in Ankara. Gazi Journal of Physical Education and Sports Sciences; 2: 35–42.
23. Özkan A, Kayıhan G, Kaya S, Öz Ü. The role of morphological variables in determining the strength and flexibility of physical education students dealing with different sports branches. Int J Sci Cult Sport. 2014;5:453-459.
24. Riner WF, McCarthy ML, DeCillis LV, Ward DS. Anaerobic Performance in Young Males and Females. Pediatric Exercise Sciences, Naspem Abstracts. 1999;11:79-88. Doi: 10.1123
25. Saavedra C, Lagasse P, Bouchard C, Simoneau J. Maximal Anaerobic Performance of The Knee Extensor Muscles During Growth. Medicineand Science in Sport and Exercise. 1991;23 (9): 1083-1089.
26. Sukul, D.K.,Den Hoed, K.S.,Johannes, E.J. ve Van Dolder, R., Benda, E. (1993). Direct and indirect methods for the quantification of leg volume: comparison between water displacement volumetry, disk model method and the frustum sign model method, using the correlation coefficient and the limits of agreement, Journal of Biomedical England., 15, 477-480. Doi: 10.1016
27. Suna G., Beyleroğlu M. (2020). The Effect of Endurance Training on Macro Elements in Cyclists. LAP Lampert Academic Publishing. ISBN: 978-620-2-52999-0.
28. Turkish Volleyball Federation. 2009-2012 Official International Game Rules, http://www.voleybol.-org.tr;10.12.2012.