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COMPARISON OF AEROBIC AND ANAEROBIC PERFORMANCES OF WELL TRAINED WRESTLERS ACCORDING TO WEIGHTS

PRIMERJAVA AEROBNE IN ANAEROBNE ZMOGLJIVOSTI ROKOBORCEV GLEDE NA TEŽO

ABSTRACT

The aim of this study is to examine the aerobic and anaerobic performances of well trained wrestlers according to their weights. 19 young female wrestlers (age: 18.84 ± .83 years; height: 165.84 ± 4.58 cm; weight: 62.78 ± 8.81 kg; body mass index (BMI): 22.80 ± 2.94 kg/m2) voluntarily participated in this study. Body weight, height, BMI, sprint, agility, jump, flexibility and 20 m shuttle run tests of the wrestlers were measured. The data obtained were recorded according to the weights of the athletes. One Factor Analysis of Variance and Kruskal Wallis H test were used to analyze the data. Tukey's multiple comparison test was conducted to find the difference between the groups. As a result of the study, a statistically significant difference was determined in terms of height, weight and BMI values of the wrestlers according to their weights ($p<0.05$). Significant differences were found between light and heavy weight groups in view of speed, agility, jumping, flexibility and shuttle running test performances ($p<0.05$). A statistically significant difference was found between the middle and heavyweight groups in speed and agility tests ($p<0.05$). This research shows that, the performance output of the athlete decreases as their weight increases.

Keywords: wrestling, weight, aerobic performance, anaerobic performance, flexibility

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IZVLEČEK

Namen študije je preučiti aerobno in anaerobno zmogljivosti dobro usposobljenih rokoborcev glede na njihovo težo. V tej študiji je prostovoljno sodelovalo 19 mladih rokobork (starost: 18,84 ± 0,83 let; višina: 165,84 ± 4,58 cm; teža: 62,78 ± 8,81 kg; indeks telesne mase (ITM): 22,80 ± 2,94 kg/m2). Izmerili smo telesno težo, višino, ITM, sprint, agilnost, skok, prilagodljivost in 20-m stopnjevalni tek. Za analizo podatkov smo uporabili enofaktorsko analizo variance in Kruskal Wallis H test. Za ugotavljanje razlik med skupinam smo uporabili Tukeyev test. Ugotvili smo značilne razlike glede na višino, težo in ITM borcev glede na njihovo težo ($p <0,05$). Ugotovljene so bile pomembne razlike med lahkimi in težkimi skupinami glede na hitrost, okretnost, skakanje, prilagodljivost in preizkušanje tekaških žogic ($p <0,05$). Med preskusi hitrosti in agilnosti je bila ugotovljena statistično pomembna razlika med srednjimi in težkimi skupinami ($p <0,05$). Ugotavljamo, da se uspešnost športnika zmanjšuje, ko se njegova teža povečuje.

Ključne besede: rokoborba, teža, aerobna zmogljivost, anaerobna zmogljivost, prilagodljivost

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INTRODUCTION

Wrestling is an important part of the ancient Olympic Games and still one of the most popular events of the modern Olympic Games (García-Pallarés et al., 2011). Wrestling is a sports discipline that places great demands on athletes in terms of physical preparation, with a total match duration of 6 minutes (2 halves with 2 x 3 minutes) (Sterkowicz-Przybycień et al., 2011; Ari, 2021). There are two styles in wrestling for men in the Olympics (Demirkan et al., 2014). Greco-Roman is a classic style that allows only upper body movements. In freestyle wrestling, both lower and upper body wrestling are allowed (Lopez-Gullon et al., 2011). Wrestling sport for women is only performed in freestyle. United World Wrestling has determined different weight categories for Greco-Roman and freestyle wrestling since 2018. Moreover, they decided the competitions to be carried out with 10 weight categories in Continent and World Championships and with 6 weight categories in Olympic Games. These decisions have increased the competition for winning a medal in wrestling in Olympic Games. Women's wrestling is held with different weight categories subject to freestyle wrestling competition rules (Nadirova et al., 2020).

In the game of wrestling, several specific features including maximum strength, aerobic endurance, and anaerobic abilities are required to achieve success (Kara et al., 2021; Zi-Hong et al., 2013). For this reason, players must have high physiological characteristics in performances special to wrestling such as aerobic-anaerobic performance, speed, flexibility and strength of upper-lower extremities (Mirzaei et al., 2009) in order to achieve the desired result in wrestling competitions (Baić et al., 2006; Ziyagil & Turkmen, 2017). While the anaerobic system provides short and rapid bursts of maximum power during the match, the aerobic system contributes to the wrestler's ability to maintain effort throughout the match (Demirkan et al., 2015). In many studies, the importance and necessity of motoric features such as power, speed, and flexibility have been stated in the superiority of wrestlers over the opponent (Arakawa et al., 2020).

Physical fitness is one of the main factors required for the success of the athletes. A high level of certain elements of physical fitness, such as cardiovascular endurance, muscular strength and endurance, flexibility and speed, are essential for success in many different sports. Determination of physiological characteristics in each branch is an effective factor in specifying the performance of athletes (Revan et al., 2018). In the studies conducted in weight sports such as weightlifting, judo, taekwondo and boxing, it is seen that athletes in different weight

categories have different body structures (Turnagöl & Demirel, 1992; Balcı & Akkuş, 2003; Revan et al., 2018; Noh et al., 2014). Therefore, it is important to carry out studies on body structure and performance in weight sports by taking weight categories into consideration (Revan et al., 2018). It is based on a weight class system aiming to balance physical characteristics among wrestlers and thereby increase the percentage of performance based on technical skills (García-Pallarés et al., 2011). Physical images (height, body mass) are also taken into account while determining the weight categories of the wrestlers (Acar & Özer, 2018).

Although many studies have been conducted on elite male wrestlers, there seems to be a limited number of studies examining elite female wrestlers representing their countries and competing in international arenas (Nadirova et al., 2020). It is assumed that the motoric characteristics of the wrestlers may differ according to their weight categories. Therefore, in this study, it was aimed to determine and compare the aerobic and anaerobic performances of well trained wrestlers according to weights.

METHODS

Participants

Nineteen female wrestlers between the ages of 18 and 20 in the Turkish junior women's national team participated in this study. The players have not been involved in any training or competition during the study. According to the inclusion criteria of the study, wrestlers must not have musculoskeletal injuries at least 6 months before the study and the athletes must have active participation in trainings between 4 and 6 days a week. Principles of Helsinki Declaration have been followed in the study. All players participated voluntarily and signed the written informed consent form prior to the test.

Data collection tools

Anthropometric Measurements: Height (cm) and body weight (kg) of each participant were measured. Electronic height/weight measuring machine (TEM EKO) was used for height and body weight measurement. The players were bare feet and wore shorts and T-shirts during measurement (Bayrakdar et al., 2019; Erbas & Aydos, 2019).

10 m sprint: Athletes were positioned 0.5 m from the starting point and started the tests when they felt ready. Time was recorded using the Microgate Witty photocell device. The timer was

automatically activated as the subjects passed through the first gate and their time was recorded at 10 m after they passed the finish gate (Gorostiaga et al., 2004).

Agility T Test: The four cones are located 9.14 m from the starting cone, a T shape is formed with one cone and additional 2 cones placed 4.57 m on either side of the second cone. All times were recorded using the Microgate Witty photocell device (Semenick et al., 1990).

Sit and reach test: A standard sit and reach box was placed on the floor. A centimeter scale was placed on the top surface of the box. The athletes were seated on the ground with legs fully extended and placed the soles of their feet flat towards the end of the flex board. Participants stretched the measuring scale as far forward as possible with their arms, palms facing down, without bending their knees and they waited for 3 seconds where their fingers reached the farthest point (López-Miñarro & Rodríguez-García, 2010; Cakir et al., 2016).

Countermovement jump (CMJ): Participants were positioned within a specified area. A camera was placed right across the area to see the participant and the participant was asked to make an active jump, hands free. Jump was considered invalid when the knees were bent; the legs flexed at the hip, and were landed on or out of the marked field lines. The athletes made 3 jumps after sufficient rest and the best jump was recorded. The images were then transferred to the computer environment via SD card. The flight time of the participants was calculated using the Kinovea 0.8.15 program by looking at the transferred images. The jump heights of the participants whose flight times were determined were calculated by the formula (Markovic et al., 2004).

$$h = t_f^2 \cdot g^{-1} \cdot 8^{-1} \text{ (m)}$$

h = height g = 9.81 $m \cdot s^{-2}$ *t* = flight time

Shuttle Run Test: Lines were drawn with the help of adhesive tape at the start and finish points of the track, which has a distance of 20 m. Lines were drawn 2m in front of the start and finish lines in order to understand whether the athletes are 2mahead of the start and finish lines at each signal sound. The test started at the speed of 8 km/hour and increased 0,5 km/hour at every 1 minute. The participants were informed about the test in advance and each step was explained in detail on the track on foot so that they could understand the test. Each 20 m (1 signal) that the athletes run was recorded as 1 shuttle, the participants who could not reach the 2m line before the signal sound were considered as faulty and the test was ended after having 3 faults in a row (Leger & Lambert, 1982).

Statistical analysis

Statistical analyzes were made using SPSS 18.0 version software. Whether the data obtained from the variables of all wrestlers are appropriate for normal distribution was analyzed using the Skewness-Kurtosis normality test. The data were grouped according to the weights (Lightweight: 50 kg, 53 kg, 55 kg; Middleweight: 57 kg, 59 kg, 62 kg, 65 kg; Heavyweight: 68 kg, 72 kg, 76 kg). The data showing normal distribution were tested by Single Factor Variance Analysis. In case of a difference, Tukey's multiple comparison test was conducted to determine which group caused the difference. Kruskal Wallis H test was used for data not showing normal distribution. Effect sizes (Cohen's d) were calculated for the significance of the comparisons. Thresholds for effect size statistics are as follows: <0.20 = trivial, 0.20-0.59 small, 0.6-1.19 = moderate, 1.2-1.99= large, ≥ 2.0 very large (Hopkins et al., 2009). Statistical significance level was accepted as $p<0.05$.

RESULTS

The averages of age, height, weight and BMI characteristics, standard deviation, minimum, maximum and Anova values of the athletes participating in the study are given in Table 1. In the comparison of the wrestlers according to their weights, there was a statistically significant difference in height, weight and BMI values ($p<0.05$), while no statistically significant difference was found in age values ($p>0.05$), (Table 1).

Table 1. Anova test results in terms of physical characteristics variable of the wrestlers.

Variables	Weight	Mean	SS	Min.	Max.	F
Age (year)	Light	18.50	.83	18.00	20.00	1.765
	Middle	18.71	.95	18.00	20.00	
	Heavy	19.33	.51	19.00	20.00	
Height (cm)	Light	162.16	3.31	157.00	166.00	3.652*
	Middle	167.42	2.57	163.00	171.00	
	Heavy	167.66	5.75	159.00	173.00	
Weight (kg)	Light	53.48	3.53	49.20	58.50	45.879*
	Middle	61.75	3.14	57.60	65.50	
	Heavy	73.30	4.13	67.80	77.40	
BMI (kg/m^2)	Light	20.32	.98	18.98	21.49	18.519*
	Middle	22.04	1.27	20.65	24.65	
	Heavy	26.16	2.53	22.92	30.62	

*p<0.05

The averages of speed, agility, flexibility and shuttle running performances, standard deviation and Anova values of wrestlers according to their weights are given in Table 2. In the comparison

of the wrestlers according to their weights, a statistically significant difference was found in the values of speed, agility, flexibility and aerobic performances ($p<0.05$). A statistically significant difference was found between the light and heavyweight and middle and heavyweight groups in the tests of speed ($p=.009$; $p=.009$) and agility ($p=.030$; $p=.010$) ($p<0.05$). A significant difference was found between the light and heavy weight groups in flexibility ($p=.011$) and shuttle running ($p=.024$) values ($p<0.05$).

Table 2. Anova test results in terms of speed, agility, flexibility and aerobic performance variable of the wrestlers.

Variables	Weight	N	Mean	SS	F	p	Anova	η2
Speed (10 m)	Light	6	2.01	.10	6.746	.008*	L-H*	1.78
	Middle	7	2.04	.05			M-H*	2.02
	Heavy	6	2.16	.06				
Agility T test	Light	6	10.73	.88	7.757	.004*	L-H*	1.79
	Middle	7	10.81	.61			M-H*	1.97
	Heavy	6	12.31	.87				
Flexibility	Light	6	45.00	3.74	5.875	.012*	L-H*	2.36
	Middle	7	39.57	5.15				
	Heavy	6	40.47	2.96				
VO_2 max	Light	6	42.09	3.07	4.385	.030*	L-H*	1.74
	Middle	7	38.93	3.38				
	Heavy	6	36.51	3.33				

*p<0.05 Light (L), Middle (M), Heavy (H)

In Table 3, a significant difference was found in the comparison of the jump performance of the wrestlers according to their weights ($\chi2=6.886$, $p<0.05$). According to these findings, it was found that there was a statistically significant difference between the jumping performances of light and heavyweight wrestlers ($p=.026$).

Table 3. Kruskal Wallis test results in terms of jumping performance variable of the wrestlers.

Variables	Weight	N	Mean Rank	Sd	χ2	p	U-Test	η2
Jumping	Light	6	14.08	2	6.886	.026*	L-H*	1.56
	Middle	7	9.86					
	Heavy	6	6.08					

*p<0.05 Light (L), Middle (M), Heavy (H)

DISCUSSION

Although physical fitness is important for sportive performance, these characteristics of athletes vary according to the requirements of the branch (Nadirova et al., 2020). One of the difficulties

encountered is the understanding of these physical and physiological requirements by the trainers (Mirzaei et al., 2009). In this respect, it is important to compare the physical performance parameters of female wrestlers according to their weight categories and to understand whether there is a difference between the performance outputs according to the weight categories in order to determine the physical and physiological requirements. In the current literature, there are limited studies examining the performance parameters of female wrestlers according to weights (Pallarés et al., 2012; Podlivaev, 2015).

Body size is stated to affect performance especially in wrestling (Zaccagni, 2012). Accordingly, when anthropometric characteristics of the athletes participated in the study has been examined in view of weights, while their height has been found to be similar in middle and heavy weight, it has been determined that it is significantly different from the lightweight. Body weights (BW) and BMI increase as the weight increases (respectively: BW: 53.48, 61.75, 73.30; BMI: 20.32, 22.04, 26.16). In such a way that it supports the findings of this study, Revan et al. (2018) stated in their study conducted on somatotypes of male and female athletes according to the weight groups that somatotype characteristics of the athletes increased as the weight of female athletes increased. Basar et al. (2014) in their study with male wrestlers stated that as the weight increased, BMI values increased in both styles (Greco-Roman style: 22.6, 24.5, 29.9, freestyle: 21.9, 26.0, 31.3). Demirkan et al. (2015) stated in their study conducted on elite male Turkish wrestlers according to the weight groups that height values of heavyweight athletes are significantly different from middleweight. The fact that there is no increase in height with weight gain can be stated as the reason for the difference according to weight groups.

A good anaerobic characteristic along with maximum power is important in wrestling and aerobic endurance forms the basis of anaerobic endurance. Zi-Hong et al. (2013) stated in a study examining the aerobic endurance characteristics of elite Chinese female wrestlers according to the weight groups that the weight group of 72 kg showed different $VO_{2\ max}$ results than the 48 kg, 55 kg and 63 kg weight groups (48kg: 52.43±1.83 ml.kg.min^{-1}, 55kg: 51.28±.1.82 ml.kg.min^{-1}, 63kg: 50.20±2.31 ml.kg.min^{-1}, 72kg: 46.48±4.17 ml.kg.min^{-1}). Demirkan et al. (2015) reported in a study in which elite and amateur Turkish male wrestlers were compared that the $VO_{2\ max}$ values of the elite athletes were lower than the middleweight and similar to the light weight (Elite wrestlers: LW: 51.1±5.3 ml.kg.min^{-1}, MW: 57.6±2.0 ml.kg.min^{-1}, HW: 52.7±5.9l ml.kg.min^{-1}), and that the $VO_{2\ max}$ values of amateur athletes were lower than the other two weight groups (Amateur wrestlers: LW: 49.5±5.1 ml.kg.min^{-1}, MW: 50.4±5.4 ml.kg.min^{-1}, HW: 46.7±5.2 ml.kg.min^{-1}). In the results of these study findings, a

significant difference was found in the $VO_{2\ max}$ characteristics of light and heavyweight athletes, similar to the literature (LW: 42.09±3.07 ml.kg.dk-1, MW: 38.93±3.38 ml.kg.dk-1, HW: 36.51±3.33 ml.kg.dk-1). However, it has been thought that the lower values compared to the literature may be due to the fact that the selected athlete group is relatively young wrestlers or the test type chosen. Chaabene et al. (2017) stated that a wide range of values were reported in the literature regarding $VO_{2\ max}$ characteristics in wrestling athletes and it may be due to the fact that the measurements were carried out with ergometers such as field, area, treadmill, bicycle, etc. These opinions also explain the results of our study. However, in addition to this, it is seen that relative $VO_{2\ max}$ decreases as the weight increases when evaluated together with the data in the literature. In this direction, as the weight increases, diversifying the endurance exercises and increasing the duration, volume and intensity of the training can increase the performance.

In wrestling, explosiveness is important for sudden explosive movements and the responses to the opponent's attacks. In the literature, CMJ and standing long jump (SLJ) tests are generally used to measure this feature (Chaabene et al., 2017). There is information in the literature that jumping performance increases as the experience level of the athletes increases (Chaabene et al., 2017). The study conducted by Pallarés et al. (2012), one of the limited studies on female wrestlers, evaluated the jump heights of elite and amateur female athletes competing in low and medium weight categories. They stated that elite athletes performed better than amateur athletes in terms of middleweight category (Elite Middleweight: 26.5±2.4 cm, Amateur Middleweight: 24.0±2.7 cm). In addition, they found that the CMJ jump performance of elite middleweight athletes was significantly different from that of elite low-weight athletes (Elite low-weight: 23.0±2.1 cm, elite middleweight: 26.5±2.4 cm). Ergun et al. (2021) reported in their study examining the effect of short-term lack of training with 20 elite female wrestlers that their pre-training jump performance is 40.12±2.79 cm. In another study, Haugen et al. (2020) who compared the CMJ jump heights of Norwegian national team athletes competing in various sports branches reported that the performance value of Norwegian female wrestlers is 28.8±4.9 cm. In this study, the jump height of all participants was determined as 50.63±3.86 cm (LW: 53.5±2.94 cm, MW: 50.85±1.46 cm, HW: 47.5±4.54 cm). Since there are limited studies in the literature comparing the jumping performances of female wrestlers according to the weight groups, it is difficult to discuss the high results of this study.

Pallarés et al. (2012) reported sprint performance values of elite middleweight (EMW) and elite low weight (ELW) – amateur middleweight (AMW) and amateur low weight (ALW) female athletes, respectively: ELW: 2.05±0.05 sec, ALW: 2.08±0.10 sec, EMW: 2.01±0.04 sec, AMW:

2.06±0.05 sec. In their analysis, they reported that there was no statistically significant difference according to weight and skill level. In this study, it was determined as LW: 2.01±0.10 sec, MW: 2.04±0.05 sec, HW: 2.16±0.06 sec and that the heavyweight athletes were statistically significantly slower than the lightweight athletes in terms of the sprint performance of female wrestlers. In another study, Nadirova et al. (2020) stated in their study on Kyrgyz wrestlers that the 10 m sprint performances of young and adult (military school student – cadet) female wrestlers were 2.27±0.26 and 3.11±0.57 seconds, respectively. However, Pallarés et al. (2012) included the low-weight group in the range of 49-58 kg, and the middle-weight group in the range of 58-67 kg. In our study, the data were grouped according to weights (Light: 50 kg, 53 kg, 55 kg; Medium: 57 kg, 59 kg, 62 kg, 65 kg; Heavy: 68 kg, 72 kg, 76 kg). On the other hand Nadirova et al. (2020) carried out an evaluation in the adult youth category. For this reason, it makes it difficult to evaluate due to the differences between the weights in the literature. It is reported that there are different results in the literature in terms of agility and flexibility performance outcomes. While Demirkan et al. (2015) stated that there was a difference in the agility performance of young wrestlers at different levels; they did not report a difference in the flexibility performance. Moroever, Demirkan et al. (2012) reported that there is a statistically significant difference in favor of the players selected for the national team in terms of the agility performances of the wrestlers selected and not selected for the national team. In this study, it was determined that there was a statistically significant difference in agility performances among the weight categories. Mirzaei et al. (2009) reported that there was no statistically significant difference in the flexibility performances of athletes in different weight categories (mean: 38.2±3.98 cm). Better performance values were obtained in the flexibility results obtained in this study considering other studies in the literature. It is thought that this is due to the characteristics of the selected participant group.

Before reaching the final results, considering the universe of the athletes, the analysis of the athletes participating in this study for a certain age group and the evaluation of the athletes only with female wrestlers were determined as a limitation of the research.

CONCLUSION

As a result of the study, it was determined that the participants showed different findings in terms of 10 m sprint, agility, jumping, flexibility and endurance according to the weight groups. It has been found out that as the weight increases, the performance outputs decrease. The increase in body mass is thought to be effective in these results. Therefore, it will be important

for the trainers to adjust the training content according to the weight groups for maximum performance output.

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Conflicts of Interest

The author declares no conflict of interest.

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