Mehmet Akif Ziyagil*
Mehmet Türkmen**

MULTIPLE SPRINTS PERFORMANCE AND FATIGUE LEVEL BETWEEN TURKISH NATIONAL MALE SENIOR FREE AND GRECO-ROMAN STYLES' WRESTLERS

PRIMERJAVA USPEŠNOSTI IN RAVNI UTRUJENOSTI PRI PONAVLJAJOČIH SE ŠPRINTIH TURŠKIH REPREZENTANČNIH ROKOBORCEV V PROSTEM IN GRŠKO-RIMSKEM SLOGU

ABSTRACT

Multiple sprints test (MST) is a useful tool for testing directly the efficiency of phosphagen system and indirectly the efficiency of MaxVO2 enhancing capacity to recover between sprints. The aim of this study is to compare the physical characteristics and multiple sprints performance and sprints induced fatigue level between male Turkish National Free Sytle Wrestlers (FSW) and Greco-Roman Styles Wrestlers (GSW).

The data were collected from 25 FSW and 21 GSW at male senior level. Speed and reduction in speed level were tested by MST. A t-test was used for comparing two-groups. Also, correlations coefficients were calculated among variables.

The results of this study showed that GSW were more explosive during the first 10 m part, while FSW were faster at the second 10 m part of each 20 meters sprint. No significant difference was observed between the two styles in the mean 20 m sprinting speed during MST. Sprints variables showed negative correlation with physical characteristics in two styles but level of wrestlers was only correlated with first 10 m sprint speed in GSW. The ability to resist anaerobic fatigue in GSW was higher than FSW during repeated sprints. In conclusion, the intensity, the number of intervals and duration of explosive exercises should be based on the scores of GSW and FSW depending on the demand of wrestling in MST.

Key words: Wrestling, multiple sprints, fatigue.

Mersin University, School of Physical Education and Sports, Mersin University, Mersin, Turkey

Mus Alparslan University, School of Physical Education and Sports, Mus, Turkey

Corresponding Author:
Mehmet Akif Ziyagil,
School of Physical Education and Sports,
Department of Physical Education and Sports,
Mersin University, 33343 Çiftlikköy,
Yenişehir/Mersin, Turkey or
e-mail: mziyagil@gmail.com

IZVLEČEK

Test ponavljajočih se šprintov (MST) je uporabno orodje za neposredno testiranje učinkovitosti anaerobnega alaktatnega sistema in posredno sposobnosti izboljšanja $MaxVo_2$ za okrevanje med sprinti. Namen te raziskave je primerjati telesne značilnosti ter uspešnost in raven utrujenosti pri ponavljajočih se šprintih med turškimi reprezentančnimi rokoborci prostega sloga (FSW) in grško-rimskega sloga (GSW).

Podatke smo zbrali pri 25 rokoborcih FSW in 21 rokoborcih GSW iz moških članskih ekip. Hitrost in zmanjšanje hitrosti smo testirali z MST. Obe skupini smo primerjali s t-testom. Izračunali smo tudi korelacijske koeficiente med spremenljivkami.

Rezultati raziskave so pokazali, da so bili GSW bolj eksplozivni v prvem 10-metrskem delu, FSW pa so bili hitrejši v drugem 10-metrskem delu šprinta na 20 m. Med obema slogoma rokoborbe niso bile opažene značilne razlike pri srednji hitrosti šprinta na 20 m pri MST. Spremenljivke šprinta so pokazale negativno korelacijo s telesnimi značilnostmi pri obeh slogih, vendar pa je raven rokoborcev korelirala samo s hitrostjo GSW pri prvih 10 m šprinta. Sposobnost obvladovanja anaerobne utrujenosti pri ponavljajočih se šprintih je bila pri GSW večja kot pri FSW. Kot zaključek, intenzivnost, število intervalov in trajanje eksplozivnih vaj bi morali temeljiti na rezultatih GSW in FSW glede na zahtevnost rokoborbe pri MST.

Ključne besede: rokoborba, ponavljajoči se šprinti, utrujenost

Correspondence:
Mehmet Akif Ziyagil,
School of Physical Education and Sports,
Department of Physical Education and Sports,
Mersin University, 33343 Çiftlikköy,
Yenişehir/Mersin, Turkey or
e-mail: mziyagil@gmail.com

This study was presented in the 2th International Olympic and Traditional Wrestling Congress, held in September, p.24, 14-15, 2012, Kahramanmaraş in Turkey.

INTRODUCTION

Success in wrestling depends on technical, tactical, psychological and biomotor factors. Wrestling is an intermittent sport and it is characterized by a short duration, and high intensity bursts of activity, especially in repeated explosive movements with continuous energy flow in a biological system (Brooks et al., 2000).

It requires significant anaerobic fitness, and operates within a moderate-level of aerobic system (Bompa & Carrera, 2005). In wrestling, 90% of the energy comes from phosphagen (ATP-PC) and glycolysis (lactic acid system) while the aerobic system contributes 10% of the energy production systems. Improving the anaerobic system is the most important part of wrestling training workouts due to the contributions of the phosphagen and lactic acid systems to generate energy (Kell, 1997; Watts, 1996).

The increasing importance of aerobic metabolism should be known while the lactic acid system is fully blocked during the repeated sprints. In this case, repeated sprint training actually improves aerobic metabolism by stimulating recovery while the coach tends to develop anaerobic metabolism and lactic acid production (Plowman & Smith, 2014). Many researchers have reported that repeated sprinting ability is consistently associated with aerobic power (Laursen et al. 2005; Farzad, 2011). Kaynak et al. (2017) indicated that the integrating of a repeated sprint training program can improve both the aerobic capacity and anaerobic performance of college volleyball players after 6-week sprint interval training program.repeated sprint training can be an effective training strategy for inducing aerobic and anaerobic adaptations.In other side, Farzad et al. (2011) also examining the effects of 4 weeks of sprint-interval training (SIT) program, on selected aerobic and anaerobic performance of Iranian wrestlers, found that the addition of an SIT program with short recovery can improve both aerobic and anaerobic performances in trained wrestlers during the preseason phase. Clearly, sprint interval training has a potential to enhance rapid improvement in performance capacity and skeletal muscle energy metabolism (Farzad et al. 2011; Laursen et al. 2005). Aerobic fitness is a prerequisite for the maintenance of sprinting speed during intermittent maximal efforts (Tomlin & Wenger, 2001). Durandt et al. (2006) stated that 5 meters repeated sprint test is not only a physical fitness feature, but also it is as a result of combined interactions of many fitness components including body mass, strength and aerobic capacity. While both alactic and lactic acid systems use carbohydrates as fuel, aerobic system uses low-intensity fat and high-intensity carbohydrates in moderate periods as fuel. The primary aim of body conditioning for wrestling is to delay the onset of fatigue by increasing the tolerance of lactic acid build-up which increases the production of ATP and creatine phosphate. This also improves both the efficiency of oxygen use, and the recovery between intense bursts of activity (Bompa & Carrera, 2005). Creatin phosphate stores may decrease by 50-70% within the first 5-30 seconds, and may be exhausted to a great extent as the result of high-intensity loads. After exercise, the duration of regeneration is 3-5 minutes for ATP and 8 minutes for creatine phosphate. After exercise, most of the phosphagens are regenerated by aerobic mechanisms. In order to improve the phosphagen system, it is necessary to exercise 90 or 100% for 5-10 seconds and to rest for a period of 12 or 20 fold of loading period. Also, to improve the lactic acid system, loadings by 75 – 90% for 15-30 seconds must be accompanied by a resting period of 3 or 5 fold of the exercising period (Baechle & Earle, 2000; Brooks et al, 2000).

The wrestlers should have repeated high speed movement ability for maintaining their quickness and movement speed at the highest level during the contest (Farzad et al. 2011). However, it is

impossible to connect the performance in MST directly to wrestling performance. This measures the wrestlers' anaerobic energy systems and anaerobic fatigue and indirectly determines the recovery or the efficiency of aerobic power between intense bursts of activity.

There is a limited knowledge about multiple sprints performance of Turkish free and Greco-Roman styles' wrestlers. In this study, the term of sprint describes a maximal exercise lasting 10 seconds or less. An understanding of multiple maximal efforts of wrestlers could assist in diagnosing the deficiencies related to training efficency including a reversible, exercise-induced reduction in maximal power output or fatigue during running exercise and recovery level between sprints.

In our study, 10 repetitions (20 m x 10 repetitons) MST used measures the efficiency of the phosphagen system in free and Greco-Roman styles wrestling, where there are intermittent maximal loads, and also anaerobic fatigue induced as the result of these loads.Thus, this study aims to compare multiple sprint performance and fatigue levels between Turkish national senior male free and Greco-Roman style wrestlers.

MATERIAL AND METHOD

The data for this study were collected from a total of 46 wrestlers as 25 national FSW and 21 national GRW participated in the national training camp for the world championship competitions. Most of them were world class athletes. All the participants were asked not to participate in training a day before MST. They also went through a medical examination before the study. The body height of the subjects was measured by a metal scale with 0.1 cm sensitivity, while the body weight measurement was taken by a digital weight with 0.1 kg sensitivity. Average values of FSW; 22,92±3,08 years for age, 174,04±9,19 cm for body height, 81,24±20,69 kg for body weight and 26,48±4,63 for BMI, respectively. Average values for GSW; 22,67±2,58 years for age, 168,71±8,58 cm for body height, 75,90±20,72 kg for body weight and 26, 37±5,26 for BMI, respectively.

For wrestlers, MST was modified from the sprint test of Bangsbo (1994). After 10 repetitions of 20 m multiple sprint, speed and decrement in the speed level of the subjects were tested by a New Test Photocell system on a grass floor with a sensitivity of 0.01 second. Start and finish points were determined by 2 photocells at one meter height from the ground. After a standardized 20-min warm-up period including low-intensity running, several short acceleration sprints, and balistic stretching exercises, the subjects ran 20 m repeatedly for 10 times at maximum speed. The participants took off with the order of "ready and go" in every 20 seconds with one of their feet being on the start line. They returned to the start point by walking and started other speed running when 20 seconds was over.

All speed tests less than sixty meters measure positive acceleration ability of the athletes (Ward-Smith, 2001). However, the results of this study were calculated as m/sec by dividing the average speed running distance into running time. In terms of average speed, it is known that the athletes reach the constant speed between 55 – 60 meters after the start line (Ward-Smith, 2001). Fatigue level was computed by extracting the average of the last two sprints from the average value of the first two sprints. The difference between the two values was accepted as the sprint induced fatigue level. Sprint results were presented as a mean first 10 m part of 20 m sprint (first 10 m), second 10 m part of 20 m sprint (second 10 m). The mean value of 10 sprints was compared by

t-test analyzes between FSW and GSW and correlation coefficients among variables in Turkish National Male Senior Free and Greco-Roman Wrestlers were also presented.

A t-test was used for comparing two-groups. Also, correlations coefficients were calculated among variables.

RESULTS

Table 1 shows comparisons of physical characteristics between Turkish male senior free and Greco-Roman male wrestlers. Comparisons of mean sprint speed of Turkish male senior free and Greco-Roman male wrestlers in the first 10 m part of 20 m, second 10 m part of 20 m and whole 20 m were presented in Table 2 while Table 3 demonstrates comparisons of the sprint speed

Table 1. Comparisons of Physical Characteristics betweenTurkish Male Senior Free and Greco-Roman. Wrestlers.

Variables	Styles	N	Mean	SS	Min.	Max.	Diff	% Diff	t-	Sig
Age (years)	**Free**	25	22,92	3,08	18,00	30,00				
	Greco- Roman	21	22,67	2,58	18,00	27,00	0,25	1,09	,299	,766
	Total	46	22,80	2,83	18,00	30,00				
Body Height (cm)	**Free**	25	174,04	9,19	157,00	190,00				
	Greco- Roman	21	168,71	8,58	155,00	188,00	5,33	3,06	2,017	.050*
	Total	46	171,61	9,22	155,00	190,00				
Body Weight (kg)	**Free**	25	81,24	20,69	56,00	130,00				
	Greco- Roman	21	75,90	20,72	58,00	137,00	5,34	6,57	,870	.389
	Total	46	78,80	20,65	56,00	137,00				
Body Mass Index (BMI)	**Free**	25	26,48	4,63	18,08	37,65				
	Greco- Roman	21	26,37	5,26	20,55	42,52	0,11	0,42	,075	,941
	Total	46	26,43	4,87	18,08	42,52				

*P<.05, **P<.01

Table 2. Comparisons of Mean Sprint Speed between Turkish Male Senior Free and Greco-Roman Male Wrestlers.

Variables	Styles	N	Mean	SS	Min.	Max.	Diff	% Diff	t-	Sig
First 10 m part of 20 m sprint (m/sn)	**Free**	25	5,10	0,27	4,67	5,56				
	Greco- Roman	21	5,33	0,25	4,57	5,71	-0,23	-4,51	-3,005	**,004****
	Total	46	5,21	0,28	4,57	5,71				
Second 10 m part of 20 m sprint (m/sn)	**Free**	25	7,56	0,40	6,54	8,20				
	Greco- Roman	21	7,18	0,43	6,45	7,87	0,38	5,03	3,093	**,003****
	Total	46	7,39	0,45	6,45	8,20				
20 m Sprint (m/sn)	**Free**	25	6,09	0,25	5,62	6,60				
	Greco- Roman	21	6,12	0,29	5,35	6,58	-0,03	-0,49	-,383	,703
	Total	46	6,10	0,27	5,35	6,60				

*P<.05, **P<.01

Table 3. Comparisons of Fatigue Levels between first two sprints and last two sprints speed differences in Turkish National Male Senior Free and Greco-Roman Wrestlers.

Variables	Styles	N	Mean difference	SS	Min.	Max.	Diff	% Diff	t-	Sig
First 10 m part of 20 m sprint (m/sn)	**Free**	25	0,18	0,25	-,30	,95	-0,23	-4,51	-3,005	**,004****
	Greco- Roman	21	0,25	0,19	-,40	,49				
	Total	46	0,21	0,23	-,40	,95				
Second 10 m part of 20 m sprint (m/sn)	**Free**	25	0,57	0,34	-,81	1,27	0,38	5,03	3,093	**,003****
	Greco- Roman	21	0,55	0,34	-,20	1,67				
	Total	46	0,56	0,34	-,81	1,67				
20 m Sprint (m/sn)	**Free**	25	0,31	0,22	-,29	,78	-0,03	-0,49	-,383	,703
	Greco- Roman	21	0,36	0,18	-,07	,84				
	Total	46	0,33	0,21	-,29	,84				

*P<.05, **P<.01

Table 4. Correlation coefficients among variables in Turkish National Male Senior Free and Greco-Roman Wrestlers.

	FREE STYLE			GRECO-ROMAN STYLE		
	Firs 10 m of 20 m Sprint	**Second 10 m of 20 m Sprint**	**20 m Sprint**	**Firs 10 m of 20 m Sprint**	**Second of 20 m Sprint**	**20 m Sprint**
Firs 10m of 20 m Sprint	1	**,608****	**,920****	1	**,684****	**,923****
Second 0f 20 m Sprint	**,608****	1	**,870****	**,684****	1	**,912****
20 m Sprint	**,920****	**,870****	1	**,923****	**,912****	1
Age	**-,133***	**-,164****	**-,163****	-,108	-,034	-,078
Body Height	-,023	-,071	-,052	**-,158***	-,098	**-,140***
Body Weight	-,084	**-,230****	**-,167****	**-,355****	**-,304****	**-,359****
Level of wrestlers	,075	-,041	,026	**-,140***	,013	-,069
Order of Sprints	**-,215****	**-,442****	**-,349****	**-,307****	**-,445****	**-,405****

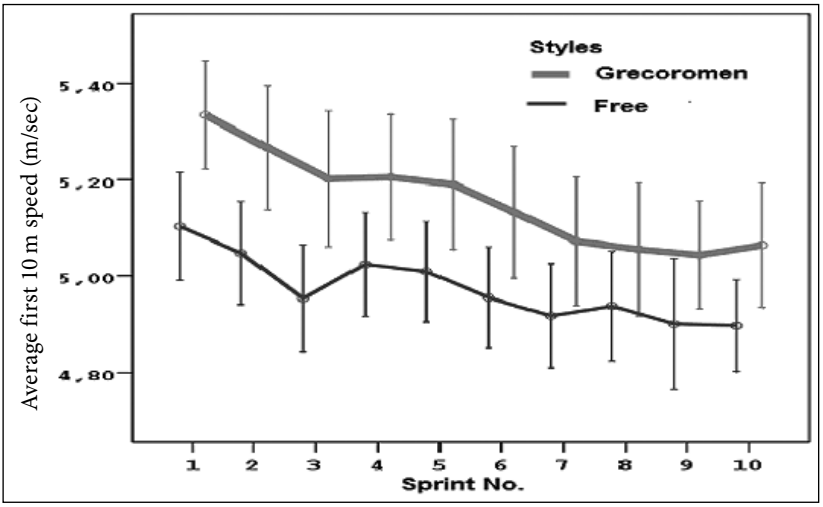
*Significant correlation at .05 level,
**Significant correlation at .01 level.

fatigue levels between first two sprints and last two sprints speed differences in Turkish national male senior free and Greco-Roman wrestlers for the first 10m part, second 10m part and entire 20 m. Pearson correlation coefficients were presented in Table 4, respectively.Comparisons of mean sprint speed of the first 10 m part and second 10 m part of 20 m sprint and 20 m between Turkish Male Senior Free and Greco-Roman Male Wrestlers in MST were displayed in Figures 1, 2 and 3, respectively.

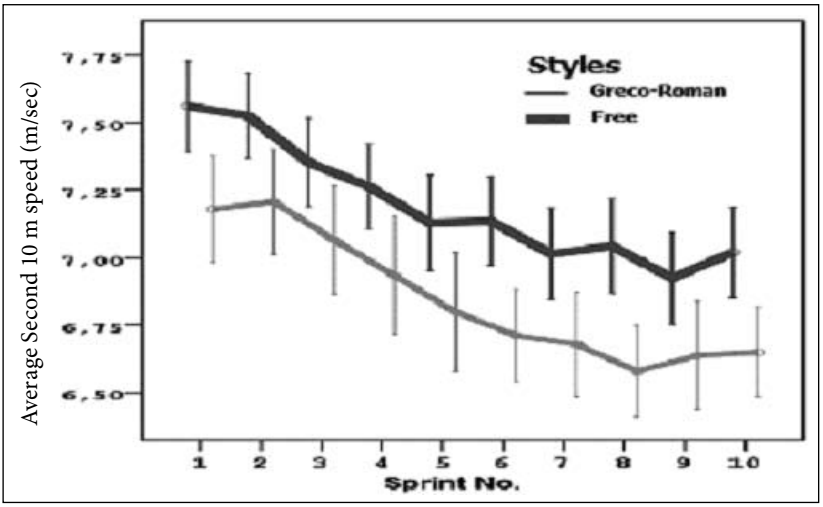
DISCUSSION

Although there were no significant differences between FSW and GSW with respect to average age, body weight and body mass index, yet FSW were taller, at a statistically significant level, than GSW. Conversely, López-Gullón et al. (2011) reported that there was no difference in any

Graph 1. Comparisons of Mean Sprint Speed in the First 10m of 20 m betweenTurkish Male Senior Free and Greco-Roman Male Wrestlers in Multiple Sprints test.

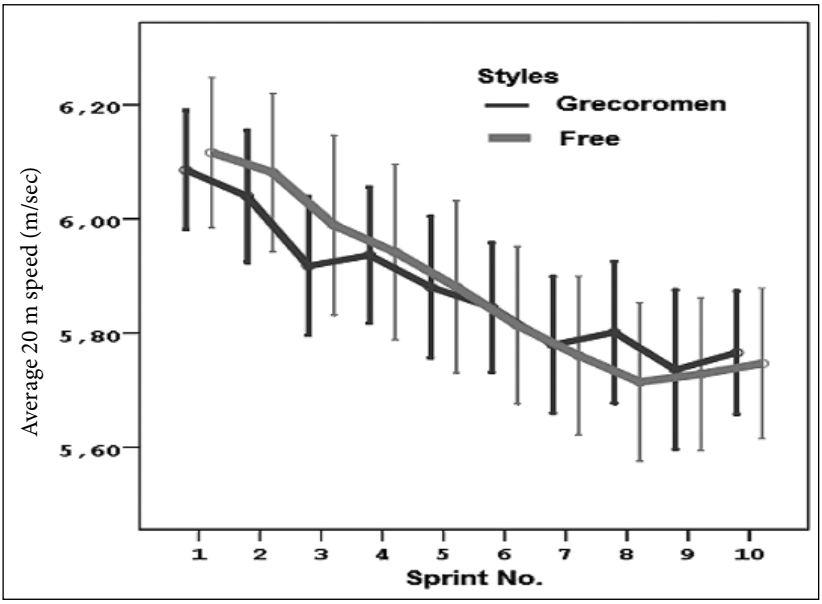


Graph 2. Comparisons of Mean Sprint Speed in the Second 10m of 20 m betweenTurkish Male Senior Free and Greco-Roman Male Wrestlers in Multiple Sprints Test.



anthropometrical, physical characteristics between Freestyle and Greco-Roman elite wrestlers in any weight class because of the current official rule differences between both wrestling styles. This result is in consistent with the average body height of our study.The results of this study showed that average speed changed at a statistically significant level between FSW and GSW, regardless of wrestling weight classes, in first 10m part and second 10m part and entire 20m with the increasing number of sprints. These results were supported by Bishop's explanation (2012). He stated that maximum or near maximum contractions caused a reversible decline in muscles' force production and fatigue mechanisms might be differentiated depending on types of contractions in the nature of the task-dependent. In addition Ziyagil et al., (1989) concluded that physical and speed characteristics were differentiated depending on wrestlers' success level.

Graph 3. Comparisons of Mean Sprint Speed of 20 m betweenTurkish Male Senior Free and Greco-Roman Male Wrestlers in Multiple Sprints Test.



They showed that wrestlers who were first in their weight classes were leaner, more mesomorphic, stronger, and had wider chest, long arm, short legs, and more developed strength and speed than wrestlers who came second at a national junior championship in Turkey.

In the first 10 m part, FSW, with an average value of 4.97 m/sec, have significantly lower speed value than the GSW team's average value of 5.16 m/sec. For the second 10m part of 20 meters, FSW, with an average value of 7.19 m/sec, have higher average sprint speed than GSW's mean of 6.87 m/sec. In 20 meters sprint, FSW and GSW had nearly same average values of 5.88 and 5.89 m/sec respectively. GSW were faster in the first 10 m part of 20 meters while FSW were faster in the second 10 m part of 20 m. MST differences between the two styles may be partly explained by the major difference that only the upper body attacks in Greco-Roman can be used, making offensive and defensive techniques in standing position. Whereas freestyle allows wrestlers to use both upper and lower body efforts during attacks, with locking hands in the top position. Apparently, more muscle mass is recruited at the beginning of each attack in top position during Greco-Roman wrestling. Also smaller body height of GSW may have positive effect on acceleration during first 10 meters sprint. Maćkała, Fostiak, and Kowalski (2015) showed strong relationships between anthropometric characteristics including body height, leg length, the stride number and stride length and kinematics of 10 m, 30 m acceleration in competitive sprinters.

During the first 10 meters of 20 m sprints, GSW had a higher sprint speed than FSW in the average values of first two and last two sprints. The amount of speed decrement in GSW was higher than FSW. During the second 10 m part of 20 m sprints, FSW had a higher sprint speed than GSW in the average values of first two and that of the last two sprints. The amount of speed decrement as a fatique criteria in GSW was little higher than that of FSW. During 20m sprints, GSW had a higher sprint speed than FSW in the average values of the first two sprints while FSW had a little higher sprint speed than GSW in the average values of the last two sprints during

20 m sprints. But the difference was insignificant. The 20 m average sprint value of GSW was nearly similar to that of the FSW. The decrement in sprinting speed as a fatigue indicator was observed with increasing numbers of sprints in the wrestlers of two styles. Horswill et al. (1992) reported that there was no significant difference related to the lower and upper limb mean and peak power attained during a 30 s Wingate test between FSW and GSW. López-Gullón et al. (2011) also confirmed similar findings suggesting that there was no significant difference in the crank-arm Wingate test. This holds in absolute or in normalized fat free mass values between FSW and GSW in the light, middle and heavy weight classes.

Despite the fatigue level during MST changed meaningfully depending on sprinting distance, it does not change between two styles. High percentage explosiveness was accompanied with another high percentage fatigue level. The VO_{2max} of highly trained wrestlers were similar to those of athletes from other short duration events or even just the physically active population (Horswill, 1992). Glaister et al. (2006) suggested that aerobic capacity was affected positively in improving resistance ability against the fatigue sustained during multiple sprinting efforts. Similarly, McLester et al. (2008) examined the effect of being aerobically trained on anaerobic performance. They indicated that VO_2 peak is associated with repeated anaerobic performance, possibly due to greater capacity to recover between bouts. In other words, multiple sprint tests need the combination of characteristics of maximum speed and endurance.

Cvetković et al. (2005) investigated the relations between the technical efficiency, some anthropometric and motor characteristics in 16-20 year old male wrestlers preparing for the world youth championship. They reported that technical efficiency of young top-level wrestlers in hip headlock throw, take-down and throw can be partly predicted by a 20-meter run from the standing start. Also, Nastenko and Stašenko (1966) emphasized the importance of the motor reaction speed in the 20-meter run regardless of weight category for top level wrestlers (Nastenko & Stašenko, 1966). Multiple speed performance may be a means of estimation about whether fatigue conditions affect technical efficiency during the later stages of wrestling competitions. In short, efficient and faster application of techniques is significantly important (Cvetković et al, 2005). Multiple speed performance may be a means of estimation about whether fatigue conditions affect technical efficiency during the later stages of wrestling competitions. Mirzaei et al. (2009) reported the average speed valueus of Iranian young national free style wrestlers (mean age19.8 ± 0.9 years) was 7.89 m/sec (5.07 sec) on 40 meters sprint. Mirzaei at al. (2011) also reported that the average running speed in the 40 meters sprint was 8 m/sec for the world champion four times in Greco-Roman style of 55 kg. In both studies, running distance is longer such that average values are higher than the mean values of this study and cannot be compared with the results of our study. Demirkan et al. (2012) found that training experience, leg average power (W), average arm power (W/kg), back strength and agility level were statistically differentiated between the selected and unselected wrestlers in Turkish national junior wrestling team. They concluded that training experience, anaerobic performance, strength and agility were key factors in wrestling success (Demirkan et al. 2012). On the contrary, López-Gullón et al. **(2011)** investigated the validation of the crank-arm Wingate test in order to assess the anaerobic metabolism contribution during an official wrestling match. The 30 s crank-arm Wingate test may not adequately simulate the metabolism involved during an official wrestling match, but it may still be a reasonable indicator of wrestling performance. Also, Farzad et al. (2011) examined the effects of a 4 week sprint-interval training (SIT) program, on selected aerobic, anaerobic, hormonal and hematological parameters in addition to the traditional Iranian wrestling training

in the preseason phase. They indicated that the addition of an SIT program with short recovery can improve both aerobic and anaerobic performances in trained wrestlers during the preseason phase. The hormonal changes seen suggest training-induced anabolic adaptations.

In FSW sprints variables showed significant negative correlations with age, body weight and order of sprints (number of sprints). On the other hand, sprint variables showed significant negative correlation with body height and weight, level of wrestlers (national or rezerv team member) and order of sprints in GSW (Table 4).

This study can present basic knowledge about energy production systems of the wrestlers in competitions and can lead trainers to determine exercise and competition strategies about whether the wrestlers are individually ready concerning aerobic and anaerobic performance or not. Generally, rapid acceleration as a unique energetic demand is a more important character for GSW than FSW due to speed difference in first 10 m sprint. Sprint interval exercise can be accepted as a method of improving aerobic and anaerobic power. In our study, multiple sprint performance differentiated between two wrestling styles for 10 meters but not for 20 meters repeated sprints.

CONCLUSION

Consequently, it is necessary to execute explosive technics and maximal efforts interspersed short active or passive resting periods in 2 periods of 3 minute bouts against opponent resistance for succesful wrestling performance. The ability of high speed movement at first and quickness during the match are key factors in GRW than FSW performance in an intermittent sense. Using periodically repeated or multiple sprint tests will be a useful tool during the preparation of effective exercise programmes for improving fatigue tolerance and increasing fatigue threshold together with special energy production for both of GRW and FSW energy demands.

REFERENCES

Baechle, T.R., and R.W., Earle. (2000). Essentials of Strength Training and Conditioning. Champaign, IL: Human Kinetics,

Bishop, D.J. (2012). Proceedings of the Australian Physiological Society Symposium: Fatigue mechanisms limiting exercise performance fatigue during intermittent-sprint exercise. Clinical and Experimental Pharmacology and Physiology 39: 836–841.

Brooks, G.A., Fahey, T.D., White, T.P., and Baldwin, K.M. (2000). Exercise Physiology: Human Bioenergetics and its Applications. Mountain View, CA:Mayfield Publishers.

Bompa, T.O., Carrera, M. (2005) Periodization Training for Sports: Science-Based Strength and Conditioning Plans for 17 Sports, Human Kinetics, 141.

Cvetković, Č., Marić, J., Marelić, N. (2005).Technical efficiency of wrestlers in relation to some anthropometric and motor variables. Kinesiology 371:74-83.

Demirkan, E., Ünver, R., Kutlu, M., & Koz, M. (2012). The comparison of physical and physiological characteristics of junior elite wrestlers. Journal of Physical Education & Sports Science . Aug, Vol. 6 Issue 2, p138-144. 7p. 3.

Durandt, J., Tee, J.C., Prim, S.K., and Lambert, M.I. (2006). Physical Fitness Components Associated With Performance in a Multiple-Sprint Test, International J of Sports Physiology and Performance, 1:150-160.

Farzad, B., Gharakhanlou, R., Agha-Alinejad, H., Curby, D.G., Bayati, M., Bahraminejad, M., & Mäestu, J. (2011) Physiological and performance changes from The addition of a sprint interval program to wrestling training. J Strength Cond Res 25: 2392-9.

Glaister, M., Stone, M.H., Stewart, et al. (2006). Aerobic and anaerobic correlates of multiple sprint cycling performance. Journal of Strength and Conditioning Research, 20: 792-798.

Horswill, C.A., Miller J.E., Scott J.R. et al. (1992). Anaerobic and aerobic power in arms and legs of elite senior wrestlers. Int J Sports Med,13: 558–61.

Horswill, C.A. (1992). Applied physiology of amateur wrestling. Sports Med 14: 114–43.

Kaynak, K., Eryılmaz, S.K., Aydoğan, S. & Mihailov, D. (2017) The effects of 20-m repeated sprint training on aerobic capacity in college volleyball playersBiomedical Human Kinetics, 9, 43–50.

Kell, R. (1997). The use of interval training to condition for wrestling. Strength and Conditioning 19: 62-64.

Laursen, P.B., Shing, C.M., Peake, J.M., Coombes, J.S., and Jenkins, D.G. (2005). Influence of high-intensity interval training on adaptations in welltrained cyclists. J Strength Cond Res 19: 527–533.

López-Gullón, J.M., Muriel, X., Torres-Bonete, M.D. et al. (2011). Physical fitness differences between Freestyle and Greco-Roman elite wrestlers Archives of Budo/Science of Martial Arts, 7: 217-225.

Maćkała, K.Fostiak, M. & Kowalski (2015) Selected Determinants of Acceleration in the 100m Sprint. Journal of Human Kinetics volume 45/2015, 135-148 DOI: 10.1515/hukin-2015-0014.

McLester, J.R., Green, J.M., Wickwire, P.J. and Crews, T.R. (2008). "Relationship of VO_2 peak, body fat percentage, and power output measured during repeated bouts of a wingate protocol, International J of Exercise Science 1:(2), 1-12.

Mirzaei, B., Curby, D., Rahmani-Nia, F., and Moghadasi, M. (2009). Physiological profile of elite Iranian junior freestyle wrestlers. J Strength Cond Res. 23: 2339-2344.

Mirzaei, B., Curby, D.G., Barbas, I., and Lotfi, N. (2011). Anthropometric and physical fitness traits of four-time World Greco-Roman wrestling champion in relation to national norms: a case study. J of Human Sport & Exercise 6: 406-413.

Nastenko, V.T., Stašenko, P.A. (1996). Ob osobennostjah fizičeskoj podgotovlennosti borcev. [On characteristics of physical condition of wrestlers.] Teorija i praktika fyzičeskoj kuljtury 6,

Plowman, S.A. & Smith, D.L.,. (2014) Exercise physiology for health, fitness, and performance Lippincott Williams & Wilkins (4th ed.), pp, 69-71.

Tomlin, D., & Wenger, H.A. (2001). The relationship between aerobic fitness and recovery from high intensity intermittent exercise. Sports Med 31: 1–11.

Ward-Smith, A. J. (2001) Energy conversion strategies during 100 m sprinting. Journal of Sports Sciences, 19, 701-710.

Watts, J.H. (1996). Sport-specific conditioning for anaerobic athletes. Strength and Conditioning, 18:33-35,

Ziyagil, M.A., Zorba, E., Eliöz, M. (1989). Anthropometric and functional characteristics of junior wrestlers. Hacettepe Journal of Sport Sciences, 5:1, 37-45.