INTERNATIONAL SCIENTIFIC
AND PROFESSIONAL CONFERENCE
ON WRESTLING

# "Applicable Research in Wrestling"

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David Curby
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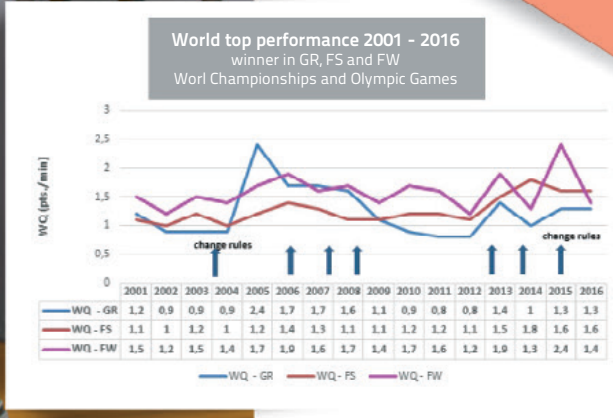


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INTERNATIONAL SCIENTIFIC AND PROFESSIONAL CONFERENCE ON WRESTLING

# "Applicable Research in Wrestling"

Novi Sad, Serbia, 5th-7th May, 2017

## PROCEEDINGS BOOK

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# FOREWORD

**Dear wrestling friends and colleagues,**

Welcome to the International Scientific and Professional Conference on Wrestling, which will hopefully become a traditional place for scholars and practitioners involved in wrestling to meet and exchange information. Our Conference forum is located at the Faculty of Sport and Physical Education, University of Novi Sad, Serbia, which is only a 150-meter-walk from the location of the Sports Hall "Spens" where the European Wrestling Championship for seniors is held from the 2nd to 7th May, 2017.

Organization of the Conference was a cooperative enterprise of two partner university institutions – Faculty of Kinesiology, Zagreb, Croatia, and Faculty of Sport and Physical Education, Novi Sad, Serbia, which are linked by a long-term agreement signed years ago.

I would like to express the organizer's gratitude to diligent people who unselfishly contributed their time and effort to the Conference organization. Special recognition goes to Mr. Nenad Lalović, the President of the United World Wrestling (UWW), who eagerly accepted the Conference under his patronage, and to Mr. Dualet Turlkhanov, the President of the UWW Scientific Commission, who willingly entrusted the Organizers with the inclusion of some official business of the Scientific Commission in the conference agenda. Our gratitude also goes to Prof. Dr. Włodzimierz Starosta who prompted his respected International Association of Sport Kinetics (IASK) to accept the Conference under the patronage and, especially, for his personal devotion to raise quality of the Proceedings book to a higher level. And last but not least, our appreciation goes to the International Network of Wrestling Researchers (INWR) and its President Dr. David Curby who also accepted the Conference under the patronage and promoted it from the very beginning among the Network members by calling and encouraging them to take part in it.

As announced, the main aim of the Conference is to provide the latest scientific and professional insights into recent research findings and practical experiences that have an applicative value in wrestling. Also, our goal is to further improve and expand the communication network of researchers interested in wrestling and practitioners, thus enabling them to share ideas in a much easier way as well as to distribute the most up-to-date knowledge of training practices. That link between science and practice provides a platform for discussion about scientific and professional solutions for wrestling-relevant issues. From the discussion we expect new ideas for further improvement of wrestling science and practice in general.
This Conference, like previous ones, is a good example of how to bridge a gap between science and practice – more than 100 researchers, authors of the scientific and professional contributions to this Proceedings book, are active in wrestling practice as

selectors or coaches to the national teams, or coaches to wrestling clubs, then scholars who teach wrestling-related subjects at universities, leaders of wrestling personnel training, members of executive professional and scientific boards with their national federations. Thesis that sports science is isolated from sports practice has been refuted by our example as well as by quite a number of coaches who announced their participation in Conference work parallel to their participation in the European Championship. Such a practice is already a tradition of many European and world sports federations (e.g. judo).

Conclusions that will be drawn from the Conference work, discussion panels and meeting of the Scientific Commission of UWW should facilitate planning and programming of the UWW Scientific Commission's agendas for the four years. Personally, I am of opinion that the Conference participants and the UWW Scientific Commission members should deal with the following wrestling-relevant issues:

1. How to create even better, closer connected and wider network of scientists involved in research on wrestling and how to overcome communication difficulties emerging from globally wide publishing of works on different languages and scripts (e.g. Cyrillic and Latin)?

2. How to connect research even closer with wrestling practice?

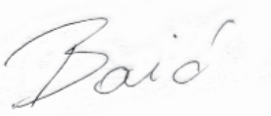
3. What can we, scholars, do to direct our knowledge and energy towards the areas critical for national wrestling federations and to those topics globally requested by UWW?

We already have some means at our hand to solve these problems – it is the Conference itself, Proceedings book with the collection of works on wrestling, publication in the International Journal of Wrestling Science, and International Network of Wrestling Researchers. It is upon us to exploit them as much as possible. Conferences like ours should be a complementary part of continental and world wrestling championship (once a year) and they should involve, apart from UWW, world academic and scientific associations. Furthermore, involvement of other UWW official commissions apart from the Scientific Commission, like Athletes, Coaches, Development, and Medical one, would be of great importance for further advances of wrestling and science of wrestling. Joint conferences, discussion panels and meetings between different UWW commissions can become a part of the official calendar of Events of the United World Wrestling.

Perhaps we can join our efforts to see what can be done to reduce injury risks or withdrawal of the young from wrestling. The United World Wrestling and its Scientific Commission can moderate these future endeavours. Not only that wrestling would benefit from it; it would be beneficial for scientists as well, for their recognition in the worlds of both science and practice.

We sincerely apologise for any lapse or fault in the Conference organization – we tried to do our best. However, do not hesitate to indicate our mistakes because we wish to be better next time in conformity with athletes' raison d'être.

On behalf of the Organizing Committee,



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# Table of contents:


**INVITED LECTURES: FULL PAPERS AND ABSTRACTS** 12

**Technical-tactical combat behavior in the wrestling finals of the 2016 Olympic Games Rio in comparison to the 2012 OG London**
Harold Tünnemann 13

**Does ambient temperaure affect on exercise-induced fatigue and sustainability of repetitions in cadet wrestlers?**
Bahman Mirzaei, Navid Lotfi, Lotfali Bolboli 23

**Considerations in the Establishment of Weight Classes for Wrestling**
David G. Curby 31

**Effects of dehydration performance for cut weight in combat sports**
José María López Gullón, Alberto Martínez Abellán, José de Calasanz Rabadán Iniesta, Cristina Casals 47

**3D DUTH wrestling dummy and training**
Ioannis Barbas, Erasmia Giannakou, Nikolaos Aggeloussis, Vasilios Gourgoulis 52

**Optimal age to begin with Greco-Roman wrestling and reach peak performance – trends in cases of world-class medal winners of various weight groups**
Hrvoje Karninčić, Mario Baić, Dražen Šprem 56

**Structure, conditions and development of 'opponent's feeling" in opinion of high advanced wrestlers and athletes of selected combat sports**
Włodzimierz Starosta 63

**Determination of foot posture distortions in wrestlers**
Mahmut Açak, Celal Taşkıran, Mehmet Fatih Korkmaz, Erkan Demirkan 81

**Mitochondrial dynamic during the exercise: bioenergetic, morphometry, damage and aging**
Jesús Francisco Rodríguez Huertas, Cristina Casals Vázquez and Patrik Drid 83

**Sudden heart arrest at wrestling – whose responsibility is it?**
Tibor Barna & Szabolcs Molnár 84

**FULL PAPERS** 85

**Accelerometric analysis of head impacts in amateur wrestling: An exploratory analysis**
Mark Hecimovich, Doug King, Troy Garrett 86

**The University of Mary Wrestling Anaerobic Performance Test (UMWAPT) – A Wrestling Specific New Protocol**
Brendan Eichmann, Jason Kobes, Chris Sherve, Adam Aho, Moran Saghiv 91

**Methodological development of a wrestling shuttle test on the mat**
Kazunori Iwai, Ray Takahashi, Kenichi Yumoto, Koichi Nakazato 100

**Physical and anthropometric profile of international-level Japanese male freestyle wrestlers**
Daichi Yamashita, Hiroshi Arakawa, Takahiro Wada, Kenichi Yumoto, Kotaro Fujiyama, Tomoyuki Nagami, Seshito Shimizu **106**

**Basic and specific fitness tests for freestyle wrestlers realized in the Republic of Macedonia: A review of research**
Strasho Gligorov & Viktor Bogdanov **112**

**The impact of emotions on visual-movement performance and effectiveness of competitive activity of elite wrestlers**
Georgiy Korobeynikov, Lesia Korobeinikova, Sergey Latishev, Vladimir Shackih **123**

**Somatotypes and anthropometric profile of elite Serbian Greco-Roman wrestlers**
Cristina Casals, José María López-Gullón, Tatjana Trivic, and Patrik Drid **128**

**Current control of physchophysiological state of elite wrestlers during training process**
Georgiy Korobeynikov, Lesia Korobeinikova, Sergey Latishev, Vladimir Shackih, Victoria Mischenko **133**

**Creatine kinase activity effects on coordination and physical ability tests in elite classical style wrestlers**
Wlodzimierz Starosta, Elzbieta Hübner-Wozniak, Piotr Zurek **141**

**Physical condition profile of Serbian Greco-Roman style wrestlers**
Valdemar Štajer, Tatjana Trivić, Roberto Roklicer, Dejan Madić, Sergej Ostojić, Patrik Drid **146**

**Proposal for a new regulation of unofficial weight categories in the age group of schoolboys**
Kristijan Slačanac, Mario Baić, Nikola Starčević **153**

**Characterization of specific effort in female wrestlers: lactacidemia, FC, VFC and rate of perceived effort (BORG).**
P.R. Pintos-Figueroa, E. Carballeira-Fernández, X. Dopico-Calvo, I. Castro-Seoane, N. Castro-Seoane, E. Iglesias-Soler **159**

**Psychological factors and their relation with performance in women's Olympic wrestling**
Athanasios Gkrekidis, Ioannis Barbas **163**

**'Official' or 'Unofficial' were the European championships in Greco-Roman wrestling in the beginning of the 20th century**
Sylvia Bakalova **167**

**12th World Universities Wrestling Championship Greco-Roman style - Competition technical analysis**
Aydogan Soygüden, Osman İmamoğlu **172**

**Comparison of female wrestler and female judokas' weight loss situations**
Osman İmamoğlu, Aydoğan Soygüden, Mehmet Türkmen **181**

**Developing coordination abilities of wrestlers by means of three kinds of body submerging**
Włodzimierz Starosta, Genadij Markiewicz, Piotr Zurek 188

**Criteria of selection of candidates for wrestling**
Włodzimierz Starosta, Andrzej Głaz 194

**Wrestling as a timeless and complete educational system of physical education**
Christos Kollias, Kassis Vassileios, Anagnostou Alexandros, Soufleris Evaggelos 200

**Level of kinaesthetic differentiation of movement amplitude in Polish national team wrestlers at various training stages**
Włodzimierz Starosta, Danuta Fostiak, Piotr Żurek 208

**Differences between weight groups of schoolboy Greco-Roman wrestlers in their fitness abilities**
Ivica Biletić, Mario Baić, Nikola Starčević, Izet Rađo, Amel Mekić 214

**Thermal responses in Greco-Roman wrestlers during training sessions**
Roberto Roklicer, Sandra Vujkov, Valdemar Stajer, Marko Stojanović, Patrik Drid 221

**Comparison of freestyle wrestlers' competitive activity at the European competitions in 2013, 2014 and 2015**
Milan Marković, Goran Kasum, Milivoj Dopsaj 226

**ABSTRACTS** 239

**Investigating the effectiveness of the partial and traditional (total) assay in teaching/learning complex technical ordinary activities in children wrestling**
Papadakis Ktistakis Ioannis, Kollias Christos, Athina-Evgenia Antonopoulou, Baggeli Eugenia 240

**Model features of sensorimotor reactions and specific perception in wrestling** 241
Yuriy Tropin, Vladimir Shatskikh

**Applying model of individual zone of optimal functioning in Serbian wrestling national team** 242
Dragana Zanini, Patrik Drid

**The investigation of loneliness levels of wrestlers in athletes' education centers** 243
Yasin Altin, Mücahit Çiğdem, Taha Akgül, İsrafil Deniz, Rahmi Yildiz

**The tradition of master-apprentice in Turkish wrestling: instance of hikmet kesen (master) - recep kara (apprentice)** 244
Ahmet Şahin, Mehmet Gül, Ahmet Gülhan

**Creation of wrestling competition analysis form according to the latest competition rules** 245
Ozkan Isik, H. Ibrahim Cicioglu, Mehmet Gul, C. Berkan Alpay

**The investigation of aptitude test of wrestlers in Turkey** 246
Ömer Kaynar, Mehmet Türkmen, Mehmet Gül

**Comparison of skin infections of wrestlers in different climatic regions of Turkey**
Ömer Kaynar, Bora Özkan, Mehmet Türkmen, Mikail Yilmaz **247**

**Differences in performed actions of winners and defeated female cadet wrestlers in a standing position**
Husnija Kajmovic, Izet Rađo, Adis Kapur, Amel Mekić, Safet Kapo **248**

**An ancient sports institution of Turks: The example of Ottoman wrestling tekkes**
Mehmet Türkmen, Mehmet Gül, Bilal Demirhan **249**

**The place of wrestling and wrestlers in the Ottoman state tradition**
Mehmet Türkmen, Mehmet Gül, Mücahit Fişne **250**

**Effect of a two-week beta-alanine supplementation on plasma carnosine and lactic acid in trained-wrestlers**
Amir Rashidlamir, Reza Bagheri, Mohsen Akbari **251**

**The development and initial validation of the Russian version of mental toughness questionnaire**
Alyona Grushko, Vladimir Kasatkin **252**

**Strength and training profiles of top Greco-Roman wrestlers in Finland**
Tomi Vanttinen **253**

# **INVITED LECTURES:**
# FULL PAPERS AND ABSTRACTS

# Technical-tactical combat behavior in the wrestling finals of the 2016 Olympic Games Rio in comparison to the 2012 OG London

**Harold Tünnemann**

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**ABSTRACT**
PURPOSE: Due to television broadcasts the world takes a picture of the attractiveness not only of our sport, but also of all Olympic sports. Therefore it is interesting to analyze the combat behavior and the technical structure of the finalist in all three styles. METHODS: Dartfish video analysis. RESULTS: The analysis of the finals of all three wrestling styles shows – with some differences – a tendency towards defense strategies, an application of low-risk techniques with low attractiveness and low technical versatility. The champions are starting the first effective attack normally about 3 minutes after the beginning of a bout. Only two main techniques predominate in Greco-Roman wrestling and female wrestling. CONCLUSIONS: This is a challenge for coaches in the current technical training and, in addition, for the long-term technical and tactical training concepts to develop more attractive techniques.

**Key words:** Greco-Roman style, free style, women's wrestling

## Introduction

The extremely fair and enthusiastic audience in the Carioca Arena 2 and numerous always polite and enthusiastic volunteers made the RIO Games to Games of hope and glory. With fans young and old, the games went to a fantastic festival of sport. The International Wrestling Association (UWW) decided some serious changes during the Olympic Cycle 2012-2016 with positive effects and revaluation of Wrestling in the Olympic family.
Technical-tactical analysis is important in wrestling (López-González & Miarka, 2013) as in other sports. They are often carried out on large and important competitions (Tünnemann, 2011a, 2011b, 2013a, 2016). Technical-tactical analysis is especially important in moment of rule changes (Tünnemann, 2013b). Changes of rules influence technical trends (Middleton, Creavalle, & Cipriano, 2013), fitness trends (Tropin, 2013), they even can affect the health status of a wrestler (Davis et al., 2002; Tarnopolsky et al., 1996).
Among them: Changes of the scoring system; Changes in the ratings of technical-tactical actions; Changes of the overall presentation of the competition; Changes of the multi-media presentation. Always interesting is the development of the world top performance in all three styles (Figure 1). In order to determine the technical and tactical performance, one can draw the technical points per combat minute (WQ). At the same time, the influence of rule changes on technical-tactical performance can be assessed.
In Greco-Roman wrestling, the increase in 2005 was marked by significant rule changes. The following problems of the loss of attractiveness up to the Olympic Games 2012 are also clear; In Freestyle Wrestling Men the quality increase in 2013 is remarkable after the

rules changes; In Freestyle Women Wrestling with 1.4 points per minute the value is going down almost to the level of the Olympic Games 2012 in London. This is the level before the rule changes 2013 and a loss of 1 point per minute in comparison to the World Championships 2015 in Las Vegas. In addition, it should be noted that the technical assessments have been significantly increased in connection with the rule changes made during the Olympic cycle 2012-2016.

## Results and discusion

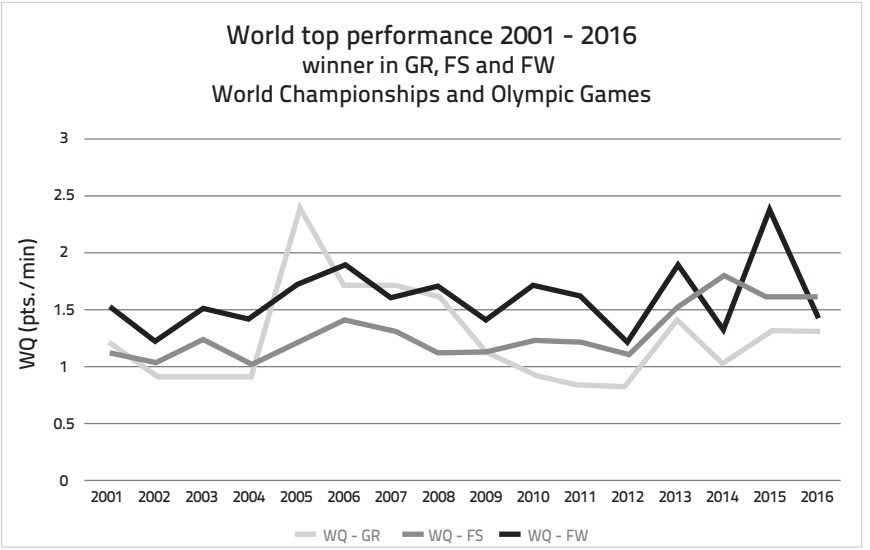


Figure 1. Development of the three Wrestling disciplines since 2001

If we assume that - due to television broadcasts - the world takes a picture of the attractiveness of our sport, get the finals also at the center of our analysis. Especially for coaches are opponent-related analyzes of the bouts and other technical and tactical details of particular importance to change their training and competition concepts more strongly on attractive technical-tactical actions. This applies both to the long-term technical-tactical performance as well as to the current technical-tactical training. Therefore, we analyzed the combat behavior of the champions and the technical-tactical attractiveness of the final bouts in more details.

Greco- Roman Wrestling-Relation standing and parterre wrestling
This relationship has always been in the past of great interest. Even with the current rule discussions this aspect plays an important role. 82% of the technical points are coming out of the ordered parterre situation and 18% of standing position (Figure 2). Compared to the World Championships 2015 in Las Vegas, the further increase in the parterre wrestling compared to the standing wrestling is clear.

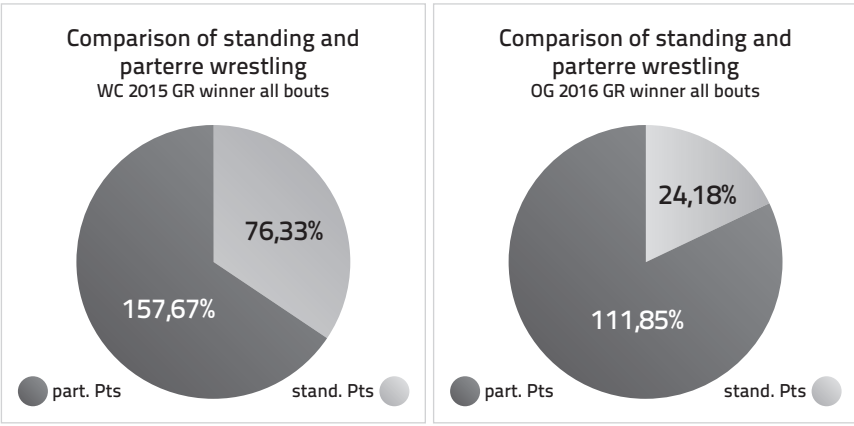


Figure 2. Comparison of standing and parterre wrestling Olympic Games 2016 and World Championships 2015

Moment of the first realized technical point

To find out the general strategy of activity we analyzed all bouts of the champions. It is obvious that the Greco-Roman wrestlers are concentrating during the first two minutes on a 'warning behavior" respectively using at first the 'Out" techniques (Figure 3).

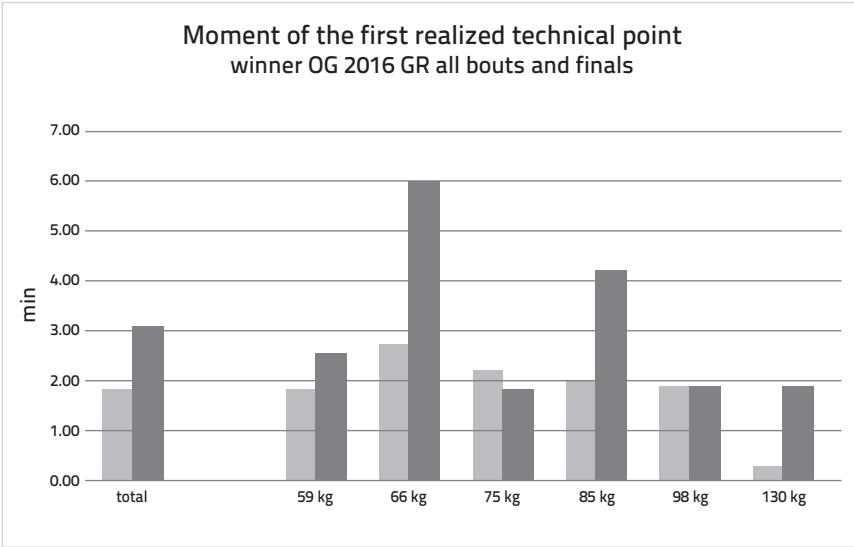


Figure 3. Moment of the first realized technical point winner all bouts and finals 1/2

The average value is about 2 minutes if we are looking at all bouts of the winners. The wrestlers want to impress the referees to send the opponents into the parterre position. Even more defensive are the final bouts for the first place. On average, the first technical point takes place after approx. 3 minutes (the high value of Stefanek results from the fact that he could not win a technical point in the final match).

'Caution Strategy"

The 'Caution Strategy" leads us to the question what about the relation between caution points and technical points. Therefore, we analyzed the relation between realized caution points, points after ordered parterre situation and 'normal technical" points. We analyzed all finals 1/2 because they are the advertisement for our sport (Figure 4).

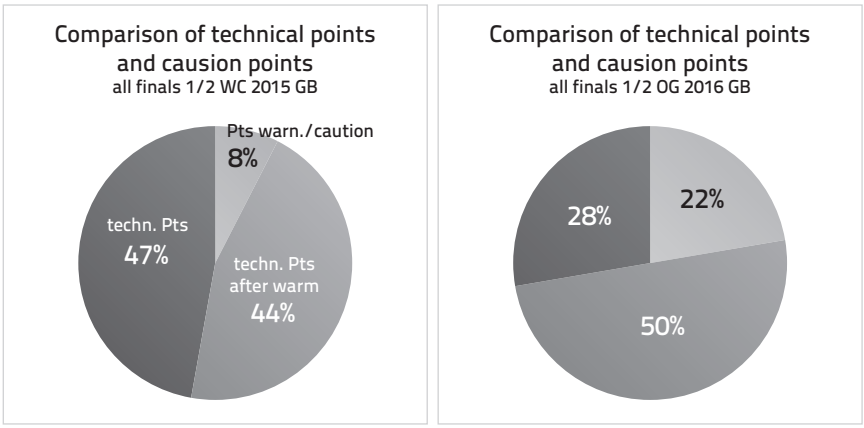


Figure 4. Relation between realized technical and caution points (gold medals finals) in comparison OG Rio and WC 2015

If we take a look at the "big" finals (1/2) the importance of the points of the ordered parterre position is increased versus 2015. 50 % of the technical points are coming from ordered parterre position (2015: 45%), 22% are caution points (2015: 8%) and 28% are "normal" technical points (2015: 47%). The degrease of technical points and the upgrade of the technical points after ordered parterre position during the Olympic Games in Rio is a clear proof of the tendency of passive wrestling in Rio. Not to speak of the destructive prevention of technical-tactical actions by permanent head-banging and finger-grabbing.

Technical structure
In general, there is a different development of the technical structure during the Olympic Cycle 2012 (old rules) and 2016 (new rules) see Figure 5.

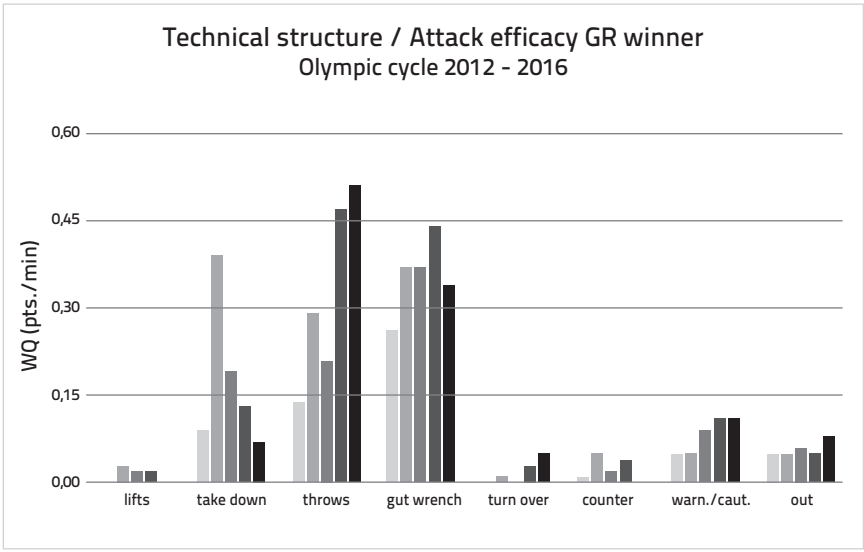


Figure 5. Development of the technical structure during the Olympic Cycle 2012 - 2016

In general gut wrench, throws (mainly from parterre situation) and take downs with a distance had been the dominating techniques. When looking at the last two years, the prominence of the throws and the gut wrench becomes clear.
Especially in Rio the technical – tactical variety was very poor (Figure 6). We have had throws - predominantly from ordered parterre situation - and gut wrench and nothing more.

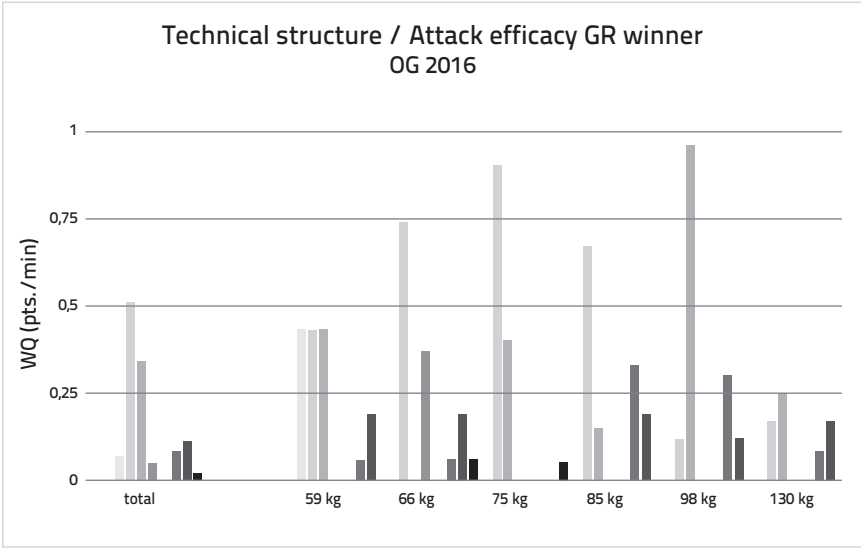


Figure 6. Technical structure of the Olympic champions 2016

The significant increase of throws and gut wrench as dominant techniques in 2015 and 2016 requiring a deeper analysis.

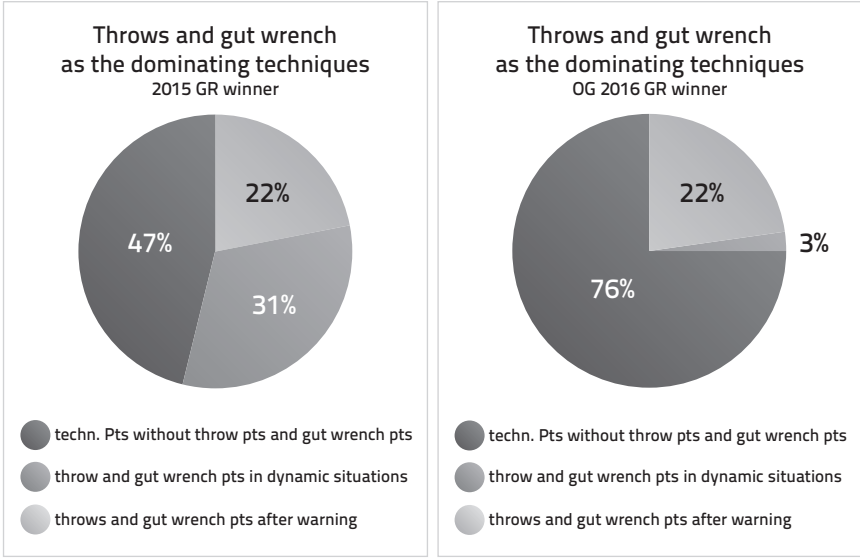


Figure 7. Throws and gut wrench as the dominating techniques

In Rio (Figure 7) 79% of the technical-tactical actions are throws and gut wrench, 78% in Las Vegas. The most throws and gut wrench actions are coming after warnings that means from parterre position (76%). In Las Vegas the value was 47% (an increase of 31%)! Only 3% of the technical points are coming from dynamic situations. In Las Vegas the value was 31% (a decrease of 28%). When looking at the last two years, the prominence of the throws and the gut wrench will become clear. During the Olympic Games the main strategy was organizing or waiting for ordering parterre situation. And together with the fact that only 21% of the techniques are not throws and gut wrench seems to be a problem of the technical – tactical versatility.

Freestyle - women

As in the Greco-Roman wrestling and Freestyle wrestling men the Freestyle women wrestlers are also starting their final bouts with a "security strategy" (Figure 8).

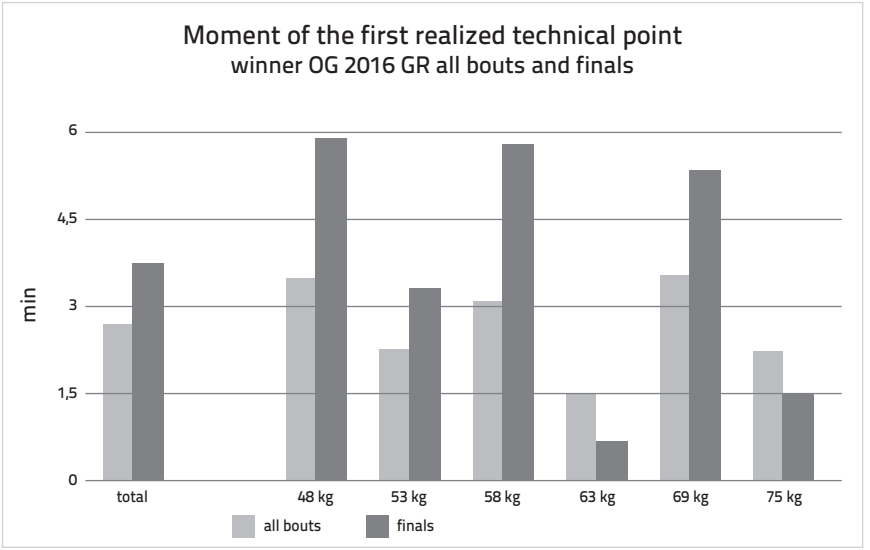


Figure 8. Moment of the first realized technical point FW

In the final bouts for gold medal, this tendency of the relatively late first point realization is clear (average after 3.75 minutes). This is especially true for Eri Tosaka (JPN, 48kg), Sara Dosho (JPN, 69kg) and Kaori Icho (JPN, 58kg). They realized their first technical point in the grand final during the last minute of the bout, but after the realization of an activity point. This seemed to be a typical "Japanese strategy" in RIO, and it bears witness to the tremendous physical, psychological and technical-tactical strength of the Japanese women. This is underpinned by the fact that both Eri Tosaka and Kaori Icho made their victory points in the final 10 seconds of the bout, after they had been in the back after points.

Technical structure
As with the freestyle wrestling men, the women's wrestling bouts are dominated by leg attacks (Figure 9).

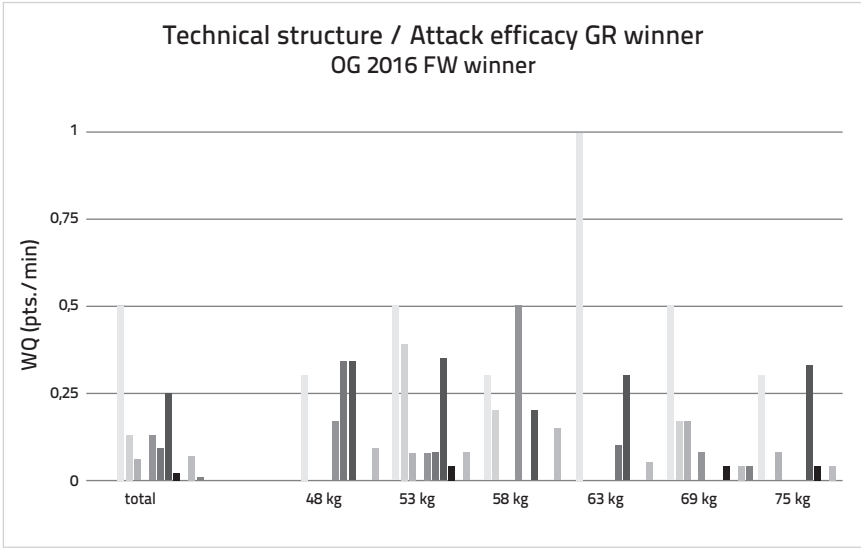


Figure 9. Technical structure of the winner FW

It is interesting but understandable, the high value of the counter-attacks. The technical and tactical versatility is reflected in the further application of take downs, turn overs and ankle lace. There are clear differences in the technical profile of the individual Olympic champions.

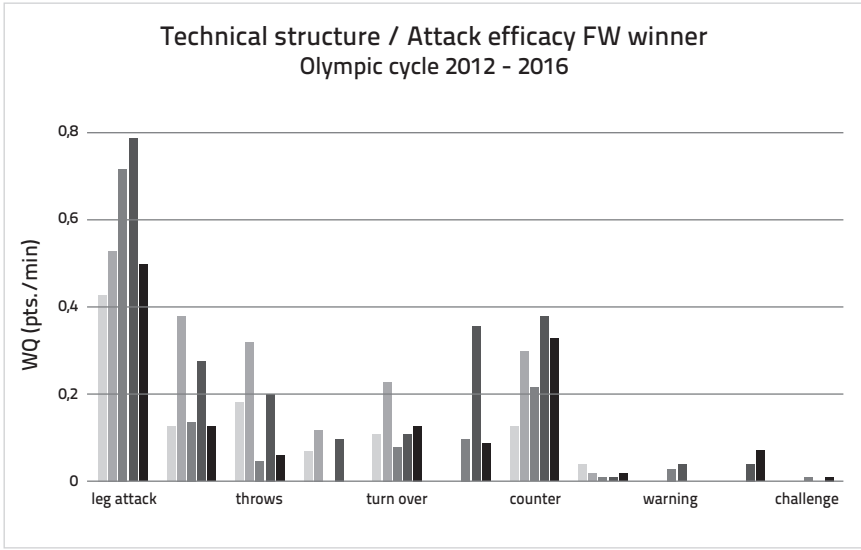


Figure 10. Technical structure during the Olympic Cycle 2012-2016

In addition to the already mentioned dominance of the leg attacks, the decline of take down, throws, turn over, ankle lace and 'out"- techniques are noticed when looking at the Olympic cycle (Figure 10). Gut wrench have completely disappeared and Warning and Challenge points were meaningless. The decline of throws since the rule changes should find special attention with the coaches.

Freestyle Wrestling Men - Moment of the first realized technical point
As in the Greco-Roman wrestling, the Freestyle wrestlers are also starting their final bouts with a "security strategy" (Figure 11). In the final bouts for gold medal, this tendency of the relatively late first point realization is clear (average after 2.6 minutes). This is especially true for Akguel (TUR, 125kg), Yazdani (IRI, 74kg) and Khinchegashvili (GEO, 57kg).

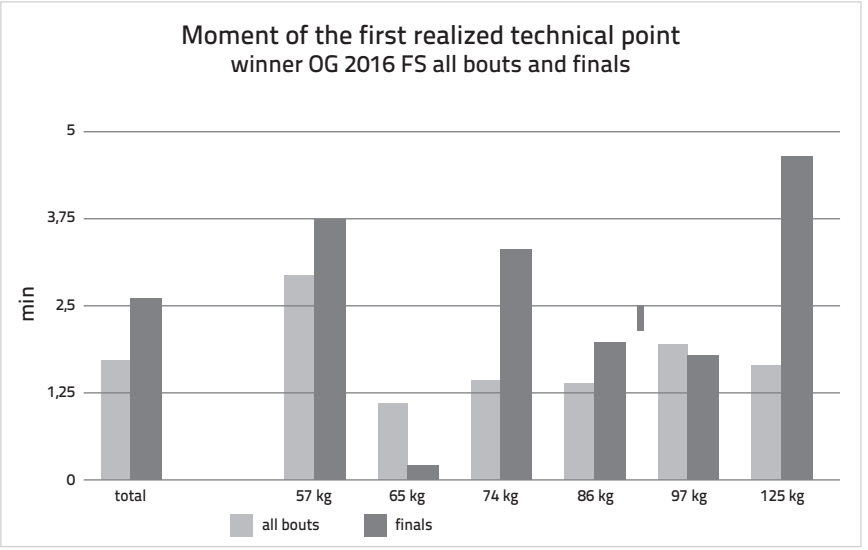


Figure 11. Realization of the first technical point during the final bouts

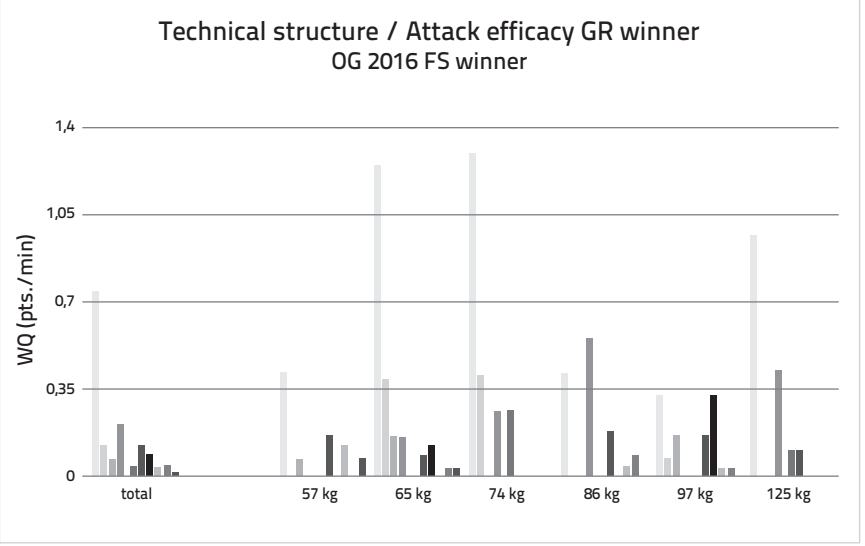


Figure 12. Technical structure of the Olympic Champions 2016

We see in RIO in general leg attacks as the dominating techniques followed with gut wrench, counter, take down and "out" (Figure 12). Especially the leg attacks are very popular because after rule changes you can get for one attack 4 points. Of course even under the Olympic champions there are individual differences within the technique profile. So Sadulaev (RUS, 86kg), Akguel (TUR, 125kg) are very strong with the gut wrench while Khinchegashvili (GEO, 57kg) does not prefer this technique. Snyder (USA, 97kg) is the specialist for "Push out" techniques and Yazdani (IRI, 74kg) is versatile besides leg attacks with ankle lace and take downs.

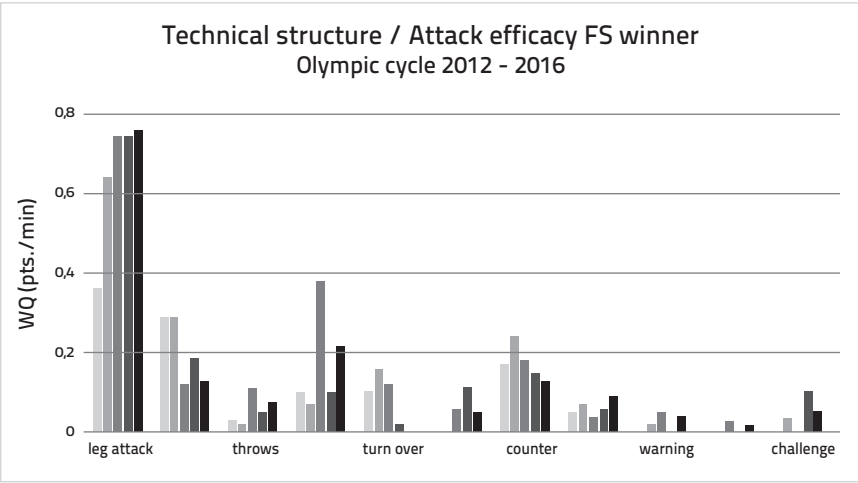


Figure 13. Comparison of the technical structure during the Olympic cycle 2012 and 2016

With a look at the technical structure within the Olympic cycle 2012 - 2016, it becomes clear that leg attacks are the dominant techniques with a rule-driven increase since 2013 (Figure 13). Take downs, gut wrench and counter also belonged with different peaks in the different years to the most important techniques. Overall, there is a high technical-tactical versatility in the cycle 2012 - 2016.

**Conclusion**

Due to television broadcasts the world takes a picture of the attractiveness not only of our sport, but also of all Olympic sports. For this reason the degree of difficulty of the elements in gymnastics - and thus the attractiveness - is increased during the finals. The analysis of the finals of all three Wrestling styles shows – with some differences – a tendency towards defense strategies, an Application of low-risk techniques with low attractiveness and low technical versatility. This is a challenge for the coaches in the current technical training and, in addition, for the long-term technical and tactical training concepts.

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# Does ambient temperature affect on exercise-induced fatigue and sustainability of repetitions in cadet wrestlers?

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**ABSTRACT**
PURPOSE: The purpose of the present study was to investigate the effect of ambient temperature on exercise-induced fatigue and sustainability of repetitions in cadet wrestlers. METHODS: 21 cadet wrestlers (age: 15.04±0.8 years, weight: 59.20±12.67 kg, height: 163.47±7.39 cm, body fat: 10.03±3.39%) participated as subjects in this study. Based on body composition and anthropometric profiles, subjects were divided into three similar groups. After providing the desired temperature (30, 18 and 10 °C), subjects were asked to complete a Wrestling Technique Based Circuit Training protocol. Fatigue level was measured by Likert scale (5-point scale) before, immediately and 30 minutes after exercise and the ability of sustainability of repetitions was measured by counting number of implemented techniques. Independent Samples t-test, ANOVA repeated measures, one-way ANOVA and Bonferroni post-hoc tests were used to analyze the results at a significance level of $p< 0.05$.RESULTS: The results showed that the levels of fatigue increased significantly after exercise in all groups and it was observed significant difference between high-temperature (HT) and low-temperature (LT) groups with normal-temperature (NT) group. In addition, the ability to sustainability of repetitions decreased significantly in all groups in second-round and this reduction was higher in HT and LT groups compared to NT group. Also, significant differences were observed between HT- NT groups and LT - NT groups. However, after 30-minutes of active rest despite the decrease in fatigue levels, significant difference was observed between the levels of pre- exercise and after 30-minute recovery time in all groups. CONCLUSION: The results showed that heat stress can aggravate exercise-induced fatigue in cadet wrestlers. Thus, it is suggested that special attention should be paid to ambient temperature of competition and training gyms of this age group.

**Key words:** fatigue, anaerobic exercise, temperature, environment, cadet

## Introduction

Exercise scientists describe fatigue during sport competition as an exercise-induced impairment of performance. Sport performance depends on the ability of an athlete to produce and then sustain high levels of physical, technical, decision-making and psychological skills throughout competition. Deterioration of any of these skills could appear as a symptom of fatigue (16). Fatigue is combination of progressive process that drops performance during intense or long time physical activity. Several mechanisms have been proposed that cause or

contribute to peripheral fatigue. These factors include metabolic factors (ATP, Pi, PCr and lactate) (1), reducing the availability of glucose (15), ionic factors (K+, Na+, Ca2+ and CL-) (7), acidosis (6), hypoxia (13), reactive oxygen species or structural damage (1).
There are several investigations dealing with the effects of environmental conditions on physical and physiological functions of athletes and non-athletes. Lloyd et al (2015) studied the interactive effect of cooling and hypoxia on forearm fatigue development (17). They concluded that when compared to exercise in thermoneutral normoxic conditions, both cold and hypoxia significantly reduce MVC force output. This effect appears to be of mechanical origin, not a failure in muscle fiber recruitment per se. Additionally, the reduction in force is greater when the stressors are combined, showing an additive effect. Brazaitis and Skurvydas (2010) studied the hypothesis that heat acclimation (HA) does not reduce the impact of hyperthermia on central fatigue (5). They concluded that passively induced HA for 2 weeks improved the physiological symptoms, but did not change central or peripheral fatigue during exercise in hyperthermia. Nybo and Nielsen (2001) tested the hypothesis that perceived exertion during prolonged exercise in hot environments is associated with changes in cerebral electrical activity rather than changes in the electromyogram (EMG) of the exercising muscles (21). They reported that alterations in cerebral activity may be associated with the hyperthermia-induced development of fatigue during prolonged exercise in hot environments. Tatterson et al (2000) examined the effect of heat stress on physiological responses and exercise performance in elite road cyclists (25). The results showed that heat stress is associated with a reduced power output during self-paced exercise in highly trained men.

Despite the identification of factors affecting the physical fitness, there are other factors such as temperature, humidity and altitude of the competition environment that may affect the sports performance and even determine victory or defeat. Weather conditions, including temperature, altitude, humidity, etc. are always considered as factors affecting different body organs. Environmental factors can have short-term or long-term effects on the health and performance (29). Among these factors, the temperature as a very important environmental factor has been of interest to researchers, physicians and coaches.

Various studies have investigated the responses of adolescents and adults to exercise and heat. It was reported that children and adolescents as compared with adults produce more metabolic heat relative to body mass (18). Also, children and adolescents have higher sweating threshold (12) and lower sweating capacity than adults (18). So, they would be at a greater risk of overheating than adults during physical activity in the hot environments (19). In addition, there is little information on the effects of physical activity and acute intensive anaerobic exercise in wrestling, especially in cadet wrestlers and based on our knowledge there is no study that investigated the interactive effects of exercise and ambient temperature on fatigue in cadet wrestlers. Therefore, the purpose of the present study was to investigate of the effect of ambient temperature on exercise-induced fatigue and sustainability of repetitions in cadet wrestlers.

## Methods

### Subjects

21 cadet wrestlers were recruited from the Kurdistan province wrestling clubs and served as subjects in this study. They all had at least 3 years training experience and were representative from top wrestlers of Kurdistan province competing in Iran national competitions. Subject characteristics (mean ± SE) were as follows: age: 15.04±0.8 years, height: 163.47±7.39 cm, weight: 59.20±12.67 kg and body fat: 10.03±3.39%.

Subjects were divided into three equal groups based upon the individual characteristics: high temperature (30°c), normal temperature (18°c) (24) and low temperature groups (10°c) (20). Also, the relative humidity was 50% in all above-mentioned conditions (20).
The following inclusion criteria were used in this study: lack of physical injuries, flu and other infections disease, not using dietary supplements and anti-inflammatory drugs in the last six month (2). Furthermore, all subjects complete health evaluation including cardiovascular system and liver functions by a specialist physician. The subjects were asked to avoid from vigorous exercise for a week and food consumption contains caffeine, alcohol and antioxidants 24 hours before the test.

**Research design**
In the first session, individual features of subjects such as weight, height and body fat percentage were measured between 8:30 AM to 10:00 AM and subjects were familiarized with the study. Furthermore, since the subjects were under the age of 18 years, before participating, subjects' parents were informed of the potential risks and gave their written informed consent to participate their children in this study. In the second session, environmental conditions were created, and the subjects were asked to attend the wrestling club from 8:00 AM to 10:00 AM. Then, the subjects rested at intended temperature for 20 - 30 minutes. After warming-up exercises (including running and stretching exercises) for 10 minutes, the subjects were asked to complete training program. Blood sampling was repeated immediately and 30 minutes after exercise. As according to the United World Wrestling (UWW) it should be at least 30 minutes rest time between two wrestling matches, so to simulate match time the third sampling was done before the second match (after 30 minutes). In order to simulate the real match condition, the subjects were asked to do optional active rest. At this time, they drank 3ml of room-temperature mineral water per kilogram of their body weight in fourth steps (to eliminate the cooling effect at high temperature) (30).

**Training protocol**
Protocol of wrestling techniques based on the circuit exercise (WTBCE) designed by Rashid-Lamir et al (2013) was used to simulate real wrestling match pressure (8 stations with 5m distances between them) (23). After commend go, subjects performed techniques quickly at each station and went to the next one with maximum effort for 2 minutes (Wrestling match time in cadet wrestling in each round). Then, the subjects rested for 30 seconds (rest time between first and second round of wrestling match) and this repeated for 2 minutes.

Body weight was measured to the nearest 0.1 kg using a Seca scale and height recorded to the nearest 0.5 cm with a Seca height gauge, Germany. The body fat percentage was measured by subcutaneous fat thickness method and Slater equation (1988) rewritten by Lehman (1992) (28). Non-contact digital thermometer (NC 100 Microlife, Switzerland) with an accuracy of ±0.1 was used for measuring of mineral water temperature provided for subjects. Digital thermometer (HTC-1, China) was used to measuring temperature and humidity of testing room. Three thermometers were placed in 3 locations around the chamber to precisely control the temperature (20). Fatigue level was measured by Likert scale (5-point scale) before, immediately and 30 minutes after the exercise (3) and the ability of sustainability of repetitions was measured by counting number of the implemented techniques.

**Statistical method**
General characteristics of the subjects were presented as means and standard deviations. Paired sample t-test was performed to compare sustainability of repetitions differences between two times in each group. In addition, one-way analysis of variance with Bonferroni post-hoc test was used to show differences between groups. Also, analysis of variance with

repeated measures used to show differences between times. For all results, $p < 0.05$ was considered significant. Analyses were conducted using IBM SPSS version 23.0 for Windows.

**Results**

Individual information including age, weight, height and body fat percentage are presented in table1.

Table 1. Individual information of subject

| Groups | N | Age (years) | Weight (kg) | Height (cm) | Body fat (%) |
|---|---|---|---|---|---|
| **High temp** | **7** | 15.00±1.00 | 55.02±8.35 | 161.14±7.92 | 10.75±2.84 |
| **Normal temp** | **7** | 15.14±0.99 | 54.78±13.96 | 160.28±6.15 | 9.14±3.56 |
| **Low temp** | **7** | 15.00±0.81 | 63.37±13.54 | 169.00±5.25 | 10.21±4.02 |

The values of the fatigue levels and body temperature in the three groups are presented in Table 2. Analysis of variance with repeated measures in each group showed that the levels of fatigue after exercise were significantly increased in all groups. In addition, fatigue levels decreased significantly after 30-minutes recovery. In addition, significant difference was observed between the fatigue after 30 minutes and before the exercise.

Table 2. The values of the fatigue level and body temperature in three groups: high, normal and low temperature

| Variables | Groups | Pre-exercise | Post-exercise | Recovery |
|---|---|---|---|---|
| **Fatigue** | High | 00.00 | 8.28±0.75 * | 2.85±0.69 *** |
| | Normal | 00.00 | 6.00±1.00 | 2.14±0.69 *** |
| | Low | 00.00 | 7.85±0.69 ** | 2.42±0.97 *** |
| **Body temperature** | High | 37.01±0.15 | 37.95±0.17 | 37.47±0.21 |
| | Normal | 36.81±0.30 | 37.22±0.14 | 37.14±0.21 |
| | Low | 36.5±0.41 | 37.11±0.24 | 37.04±0.34 |

* Significant difference between high-normal groups
** Significant difference between low-normal groups
*** Significant difference between pre-exercise and recovery

Paired t-test results showed that the activity has a significant effect on the sustainability of repetitions (Table 3). In addition, the results of Bonferroni post-hoc test showed significantly differences between high-normal and low-normal groups in sustainability of repetitions.

Table 3. The number of repetitions at different temperatures and paired t-test results

| | Time 1 | Time 2 | Difference | df | t | sig |
|---|---|---|---|---|---|---|
| **High** | 27.42±1.39 | 18.57±0.78 * | 8.85±1.06 *** | 6 | 21.92 | P <0.01 |
| **Normal** | 28.00±2.51 | 22.57±1.81 | 5.42±0.97 *** | 6 | 14.71 | P <0.01 |
| **Low** | 25.42±0.97 | 17.85±1.46 ** | 7.57±1.51 *** | 6 | 13.25 | P <0.01 |

* Significant difference between high-normal groups
** Significant difference between low-normal groups
*** Significant difference between time 1 and time 2

**Discussion**

The results showed that the level of fatigue increased significantly in all groups after the exercise protocol. In addition, there were significant differences between high temperature and low temperature groups comparing normal temperature groups. Also, increased levels of fatigue were higher in high temperature and low temperature groups compared to normal temperature. In addition, the numbers of implemented techniques by subjects (sustainability of repetitions) in three groups were significantly lower in the second time (time 2) and this reduction in high temperature and low temperature groups were greater compared to normal temperature group. Also, significant differences were observed between high temperature-normal temperature groups and low temperature-normal temperature groups.

Our results about fatigue are consistent with Zhao et al (2013) that reported higher levels of fatigue in high temperature environment (32). Fatigue caused by the anaerobic activities affected by many factors including the accumulation of ammonia, increased body temperature, accumulation of Pi in sarcoplasm (decrease in contractile force due to inhibition of cross-bridge binding), accumulation of ions (mg2+) in sarcoplasm, inhibiting the release of Ca2+ due to mg2+ accumulation, glycogen depletion of body (especially within several matches in a wrestling tournament), reducing the action potentials conduction velocity along the sarcolemma resulting from biochemical changes caused by muscle fibers activity and increase the flow of potassium ions (K+) from muscle fibers. In addition, anaerobic glycolysis results in increased production of lactate and hydrogen ions (H+) and a significant decrease in intracellular and extracellular pH. Accumulation of metabolites ADP, Pi and H+ are increased specially in strength and power activities and can have direct effects on the efficiency of cross-bridge bindings (11).

Many studies have shown that lactate levels and pH changes associated with it can be one of the factors responsible for fatigue and impaired muscle function (26, 27). It is reported that cellular acidosis is an important factor in muscle fatigue and even a slight reduction in the muscle pH interfere with the cross-bridge bindings and ATPase activity due to competitive connection and declining enzymatic functions (14). In addition, the decrease in intracellular pH can cause oxidative enzymes dysfunction and have a negative effect on the ryanodine receptor function (4). Due to the severity of wrestling activity and high levels of lactate produced during these activities (3) a part of decrement in performance during the second time can be related to this issue.

One reason for the significant increase in the level of fatigue in hot environments can be related with motor unit recruitment and the effect of temperature on it. It is believed that fast-twitch motor units are recruited during exercise in the heat faster than natural environment. Decreased blood flow to active muscles in a hot environment cause inadequate oxygen delivery to active muscles and faster activation of fast-twitch motor units (31). Given

the lower level of endurance of fast-twitch muscle fibers, increased levels of fatigue in high temperature group due to more recruitment of these fibers is justified.

There are many factors affecting decrement of physical performance during exercise in a cold environment. In cold environments there are slower hydrolysis of ATP (10), slower release and consumption of Ca+2 from sarcoplasmic reticulum and reduce the sensitivity of Ca+2 of actomyosin (8). These factors may cause disruption in the attachment/detachment of cross-bridges and reduce the force of the each cross-bridge (22).

Oksa (2002) showed that antagonist muscle activity increased significantly during eccentric phase of contraction and at the same time agonist muscles activity decrease with exposure to a cold environment. These factors increased levels of co-activation of agonist and antagonist muscles and is one of the reasons for the decline in physical function (22). In addition to decreased physical function, has been shown that cooling the body has a profound effect on the functional properties of skeletal muscle (9). It is well established that reduction of tension at the beginning muscle contraction is associated with body temperature. In addition, the speed of muscle contraction muscle decreases with decreasing muscle temperature (9). Hence, performance decline and increasing levels of fatigue in low temperature group compared to normal temperature groups can be justified.

Performance decline with increasing fatigue during a wrestling match in a tournament occurs simultaneously and in parallel (3). The results of recovery in line with the Barbas et al. (2011) showed that 30-minute resting between the two wrestling matches is not enough to eliminate fatigue signs (3). Hence, it seems that more time is needed to achieve maximum performance and should be had special attention to different methods of recovery and relaxation after a wrestling match.

**Conclusion**

In conclusion, results of our study showed that physical activity simulated to wrestling in high and low ambient temperatures can increase level of fatigue comparing normal temperature. In addition, the results showed that 30-minute resting period between two matches in a tournament is not enough for the full recovery of cadet wrestlers and special attention should be paid to ambient temperature of competition and training gyms of this age group.

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# Considerations in the Establishment of Weight Classes for Wrestling

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**ABSTRACT**
The decision by the international governing body for wrestling, United World Wrestling (UWW) to reorganize its weight classes, along with an increase to 10 classes for competition in non-Olympic years, provides the sport with a wonderful opportunity to create an approach that is rational, based on scientific knowledge and creates more opportunities for participation. We now have a blank slate, and while no set of weight classes can be perfect, one should be able to explain the basis for its formulation. This paper will review the history of weight classes in the sport, and attempt to put forth a rationale means for the establishment of a weight class model in the future, and also to provide an example of such a process.

**Key words:** competition, population data, combat sports, weight, size

**Background**
Weight classes are used in several Olympic sports. These include the combat sports of wrestling, boxing, judo, taekwondo, and also weight lifting. They are ostensibly used to provide for fair competition, fair opportunity for athletes of various sizes to become champions, and provide safety for the participants. Table 1 lists these sports and the weight classes currently used in competition. One can see that the range of classes for men extends from 49 kg to unlimited, and women from 46 to unlimited. Wrestling is the only sport in this group that has set a limit on the highest weight (first done in 1985). There are also differences in the classes used between sports world championships and the Olympic Games.

Boxing, weightlifting and wrestling have been long-standing sports in the Olympic program, and over the years, expanded their weight classes. At their peaks boxing had 12 classes, weightlifting and wrestling had 10. Both judo and taekwondo are relative newcomers, judo joined the Olympic program in 1964 and taekwondo in 2000.

Table 2. shows the evolution of weight classes used in wrestling since the first modern Olympics. In those Games held in Athens in 1896, there was only a single class, without limits. The number of classes grew incrementally, reaching a high of 10 classes in 1969. Wrestling is the only sport that imposes a limit on the highest weight class. It was first imposed in 1985 with a limit of 130 kg. It was further reduced to 120 kg in 2002. The number of classes remained at 10 until 1997.

Inclusion of women in all of these sports in the Olympics began late in the 20th century, with judo in 1992, taekwondo and weightlifting in 2000, wrestling in 2004, and boxing in 2012. During this same time period the International Olympic Committee was working to control the size of the Games. In wrestling, this was approached in two ways. A quota was first put in place for the 2008 Olympic Games that set limits on the number of competitors. The process

was conducted through a qualification system whereby athletes qualified a weight class for their country through designated competitions. Additionally, in 1997, the number of weight classes in men's wrestling styles were reduced from 10 to 8, and was further reduced to 7 classes in 2002.

Table 1. Olympic Sports Utilizing Weight Classes

| Sport | Men | | | | | | | | | | # Classes | Women | | | | | | | | | | # Classes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Boxing** | 49 | 52 | 56 | 60 | 64 | 69 | 75 | 81 | 91 | +91 | 10 | 48 | 51 | 54 | 57 | 60 | 64 | 69 | 75 | 81 | +81 | 10 |
| Olympic Games | 49 | 52 | 56 | 60 | 64 | 69 | 75 | 81 | 91 | +91 | 10 | Only 3 Classes in Olympics: 48-51, 57-60, 69-75 | | | | | | | | | | 3 |
| **Judo** | 60 | 66 | 73 | 81 | 90 | 100 | +100 | | | | 7 | 48 | 52 | 57 | 63 | 70 | 78 | +78 | | | | 7 |
| **Taekwondo** | 54 | 58 | 63 | 68 | 74 | 80 | 87 | +87 | | | 8 | 46 | 49 | 53 | 57 | 62 | 67 | 73 | +73 | | | 8 |
| Olympic Games | 58 | 68 | 80 | +80 | | | | | | | 4 | 49 | 47 | 67 | +67 | | | | | | | 4 |
| **Weightlifting** | 56 | 62 | 69 | 77 | 85 | 94 | 105 | +105 | | | 8 | 48 | 53 | 58 | 63 | 69 | 75 | 90 | +90 | | | 8 |
| **Wrestling** | | | | | | | | | | | | | | | | | | | | | | |
| Freestyle | 57 | 61 | 65 | 70 | 74 | 86 | 97 | 125 | | | 8 | 48 | 53 | 55 | 58 | 60 | 63 | 69 | 75 | | | 8 |
| Olympic Games | 57 | 65 | 74 | 86 | 97 | 125 | | | | | 6 | 48 | 53 | 58 | 63 | 69 | 75 | | | | | 6 |
| Greco-Roman | 59 | 66 | 71 | 75 | 80 | 85 | 98 | 130 | | | 8 | | | | | | | | | | | |
| Olympic Games | 59 | 66 | 75 | 85 | 98 | 130 | | | | | 6 | | | | | | | | | | | |

Table 2. Evolution of Men's and Women's Weight Classes Used in Olympics and World Championships (from UWW Database: https://unitedworldwrestling.org/DataBase)

| **Men** | | | |
|---|---|---|---|
| Year | Event | # Classes | Classes |
| 1896 | Olympic Games | 1 | |
| 1904 | World Championships | 2 | 75, +75 |
| 1905 | World Championships | 3 | 68, 80, +80 |
| 1908 | World Championships | 2 | 75, +75 |
| 1908 | Olympic Games | 4 | 66.6, 73, 93, +93 |
| 1909 | World Championships | 2 | 75, +75 |
| 1910 | World Championships | 4 | 60, 70, 85, +85 |
| 1911 | World Championships | 5 | 60, 67, 73, 83, +83 |
| 1913 | World Championships | 4 | 68, 75, 82.5, +82.5 |
| 1920 | World Championships | 5 | 60, 67, 75, 82.5, +82.5 |
| 1921 | World Championships | 6 | 58, 62, 68, 75, 82.5, +82.5 |
| 1950 | World Championships | 8 | 52, 57, 62, 67, 73, 79, 87, +87 |
| 1962 | World Championships | 8 | 52, 57, 63, 70, 78, 87, 97, +97 |
| 1969 | World Championships | 10 | 48, 52, 57, 62, 68, 74, 82, 90, 100, +100 |
| 1985 | World Championships | 10 | 48, 52, 57, 62, 68, 74, 82, 90, 100, 130 |
| 1997 | World Championships | 8 | 54, 58, 63, 69, 76, 85, 97, 130 |
| 2002 | World Championships | 7 | 55, 60, 66, 74, 85, 96, 120 |
| 2015 | World Championships | 8 | 57, 61, 65, 70, 74, 86, 97, 125 |
| 2016 | Olympic Games | 6 Greco-Roman | 59, 66, 75, 85, 98, 130 |
| | | 6 Freestyle | 57, 65, 74, 86, 97, 125 |
| **Women** | | | |
| 1987 | 1st World Championship | 9 | 44, 47, 50, 53, 57, 61, 65, 70, 75 |
| 1997 | World Championships | 6 | 46, 51, 56, 62, 68, 75 |
| 2002 | World Championships | 7 | 48, 51, 55, 59, 63, 67, 72 |
| 2004 | 1st Olympic Games | 4 | 48, 55, 63, 72 |
| 2014 | World Championships | 8 | 48, 53, 55, 58, 60, 63, 69, 75 |
| 2016 | Olympic Games | 6 | 48, 53, 58, 63, 69, 75 |

The efforts to control the size of the Olympic Games has extended to eliminate entire sports from its program. Wrestling faced this challenge in 2013. As part of its effort to retain Olympic status, the International Federation of Associated Wrestling Styles (FILA) made a recommendation to the IOC that the number of women's weight classes be increased, and on August 9, 2013 the IOC Executive Board acted on this request and added two weight classes to the women's Olympic program, and announced that women's freestyle would include six weight classes in the 2016 Olympics. In order to achieve this, the men's disciplines of freestyle and Greco-Roman would be reduced by one weight class, from seven to six each. This action reflects the high value that the International Olympic Committee places on gender equity within its sports on the Olympic program.

The reduction in the number of weight classes has been met with concern within the wrestling community and has focused attention on the rationale behind the changes, and ultimately in this paper, the identification of a scientific rationale for the establishment of a weight class system.

The use of weight classes is based on an assumption that differences in body weight can create an unfair advantage for the larger wrestler, and therefore the establishment of weight classes is a rationale solution to this inequity created by differences in size. When looking at the history of hand to hand sports, in ancient times, they ignored the advantage that larger and stronger men most often possessed (Sayenga, 1995). Sayenga links what he views as an excessive number of weight classes with the duration of bouts. In ancient times, there were no time limits. Time limits were established in order to accommodate the increased number of matches. This mandated a need for an arbitrary judging system to select a winner. This has taken the decision away from the athletes themselves, not to mention reducing the importance of endurance. The records of wrestling in England throughout the 19th century show that two classes were generally used, a lightweight and heavyweight.

In order to address the problem from a scientific standpoint, it seems that the establishment of weight classes for world class competition for mature men and women requires two sets of information. (1) Use population distributions to ensure fairness of access; and 2) Determine a means of scaling the effects of differences in body weight to equilibrate these effects in a competitive situation to achieve safety and performance equity. This second approach is not easily defined. Additionally, these two approaches can be contradictory.

Use of Population Distributions to Identify the Possible Wrestling Athletes

Population statistics from the United States were used in this analysis (NHANES III 1994 Survey). There are limitations posed by such data, 1) How representative is it of the athletic population? and 2) How generalizable is it to the entire world of wrestling? Data listing the distribution of body mass (weight) for the age range of the competitors was studied. The range of data selected was for the span of 20-29 years of age and is listed in Table 3.

Table 3. Weight (kg) at each centile for U.S. men and women aged 20-29 years

| Centile | Men | Women | Centile | Men | Women | Centile | Men | Women |
|---|---|---|---|---|---|---|---|---|
| 1 | 52.95 | 42.40 | 34 | 69.95 | 56.30 | 67 | 82.05 | 66.45 |
| 2 | 54.95 | 44.05 | 35 | 70.25 | 56.45 | 68 | 82.35 | 67.23 |
| 3 | 55.95 | 45.00 | 36 | 70.50 | 56.65 | 69 | 82.80 | 67.70 |
| 4 | 57.20 | 45.95 | 37 | 71.10 | 57.05 | 70 | 83.05 | 68.05 |
| 5 | 57.70 | 46.65 | 38 | 71.45 | 57.30 | 71 | 83.80 | 68.45 |
| 6 | 58.50 | 47.25 | 39 | 71.81 | 57.55 | 72 | 84.05 | 69.25 |
| 7 | 59.40 | 47.80 | 40 | 72.15 | 57.65 | 73 | 84.35 | 69.65 |
| 8 | 59.90 | 48.10 | 41 | 72.40 | 57.85 | 74 | 84.90 | 70.70 |
| 9 | 60.35 | 48.55 | 42 | 72.65 | 57.90 | 75 | 85.60 | 71.55 |
| 10 | 60.95 | 49.10 | 43 | 73.20 | 58.35 | 76 | 86.30 | 72.30 |
| 11 | 61.80 | 49.55 | 44 | 73.60 | 58.60 | 77 | 86.70 | 72.90 |
| 12 | 62.00 | 49.75 | 45 | 73.90 | 58.85 | 78 | 87.45 | 73.65 |
| 13 | 62.40 | 49.80 | 46 | 74.15 | 59.15 | 79 | 88.35 | 74.60 |
| 14 | 62.75 | 50.45 | 47 | 74.25 | 59.45 | 80 | 89.60 | 75.20 |
| 15 | 63.10 | 50.55 | 48 | 74.65 | 59.75 | 81 | 90.25 | 75.95 |
| 16 | 63.85 | 50.80 | 49 | 74.85 | 59.85 | 82 | 90.75 | 76.50 |
| 17 | 64.15 | 51.20 | 50 | 75.35 | 60.50 | 83 | 91.90 | 77.75 |
| 18 | 64.70 | 51.55 | 51 | 75.70 | 60.80 | 84 | 92.50 | 78.50 |
| 19 | 65.00 | 52.10 | 52 | 76.15 | 61.10 | 85 | 93.65 | 79.85 |
| 20 | 65.50 | 52.35 | 53 | 76.60 | 61.65 | 86 | 94.45 | 80.45 |
| 21 | 65.70 | 52.45 | 54 | 76.95 | 62.00 | 87 | 95.45 | 81.05 |
| 22 | 66.05 | 52.75 | 55 | 77.25 | 62.65 | 88 | 96.60 | 82.90 |
| 23 | 66.40 | 53.20 | 56 | 77.60 | 63.05 | 89 | 98.05 | 84.35 |
| 24 | 66.80 | 53.40 | 57 | 77.90 | 63.30 | 90 | 99.40 | 86.60 |
| 25 | 67.10 | 53.60 | 58 | 78.05 | 63.55 | 91 | 101.10 | 88.65 |
| 26 | 67.50 | 53.90 | 59 | 78.45 | 63.80 | 92 | 102.85 | 90.65 |
| 27 | 67.75 | 54.30 | 60 | 79.05 | 64.15 | 93 | 104.70 | 91.80 |
| 28 | 67.90 | 54.75 | 61 | 79.60 | 64.55 | 94 | 105.95 | 94.55 |
| 29 | 68.10 | 55.05 | 62 | 80.00 | 64.95 | 95 | 107.70 | 99.05 |
| 30 | 68.55 | 55.25 | 63 | 80.35 | 65.10 | 96 | 112.40 | 100.15 |
| 31 | 69.10 | 55.50 | 64 | 80.75 | 65.45 | 97 | 115.50 | 102.05 |
| 32 | 69.30 | 55.75 | 65 | 81.05 | 65.90 | 98 | 123.00 | 105.05 |
| 33 | 69.70 | 56.15 | 66 | 81.30 | 66.25 | 99 | 130.45 | 114.65 |

Another use of these data is to create a model based on an equal distribution of the population within the weight class system. This approach would be an attempt to address the issue of fairness. If one were to create a fair system, a first approach could be to divide the population into the number of classes deemed necessary. For this hypothetical model, ten weight classes were developed. The procedure was to divide the distribution into eight classes (each class containing approximately 12% of the distribution) and also add a class at each tail of the distribution. The results of this approach are shown in tables 4 and 5.

Table 4. Population Equity Model for 10 Weight Classes

| Percentile | Men | Women |
|---|---|---|
| 2 | 55 | 44 |
| 12 | 62 | 50 |
| 24 | 67 | 53.5 |
| 36 | 70.5 | 56.5 |
| 48 | 74.5 | 60 |
| 60 | 79 | 64 |
| 72 | 84 | 69 |
| 84 | 92.5 | 78.5 |
| 96 | 112 | 100 |
| 98 | 123 | 105 |

Table 5. Population Equity Model for 6 Weight Classes

| Percentile | Men | Women |
|---|---|---|
| 16.5 | 64 | 51 |
| 17-33 | 70 | 56 |
| 34-49 | 75 | 60 |
| 50-66 | 81 | 66 |
| 67-83 | 92 | 78 |
| 84-99 | 130 | 115 |

How well the current world championship weight classes used by UWW address the potential population pools are shown in figs. 1 and 2. One can see that the potential number of athletes is much higher in the middle weights. The men's 86 kg class has the highest potential with 30% of the population. One could use this in support for more weight classes in this region to make the access to success more equitable.

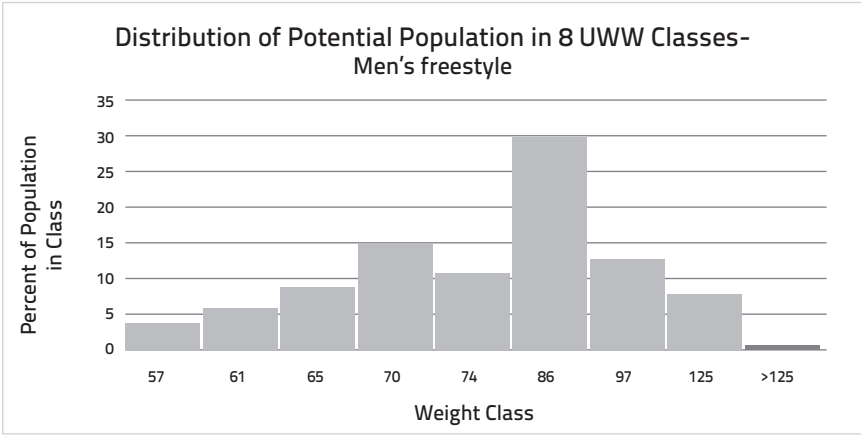


Figure 1. Distribution of Potential Population in UWW Weight Classes-Men's Freestyle

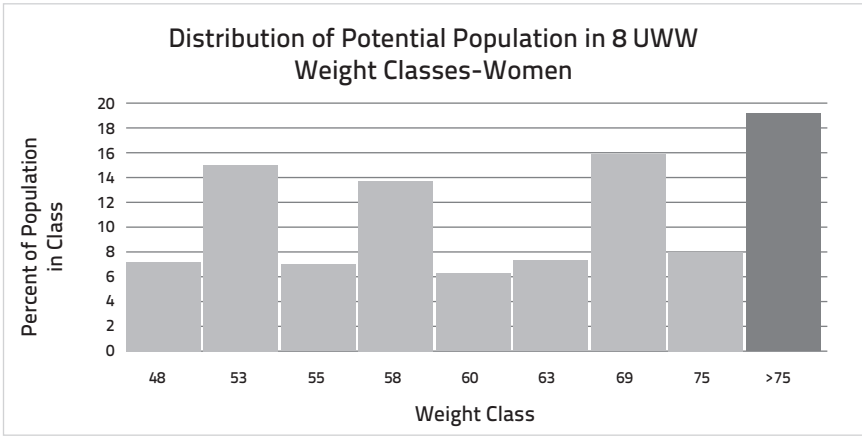


Figure 2. Distribution of Potential Population in UWW Weight Classes-Women

There is a better dispersion of the potential population for women's wrestling. It is interesting to note that the largest proportion of women in this population fall outside of the competitive limits of 72 kg.

Discussion needs to be focused on the question of whether the population data is truly representative of the pool of potential athletes. If the people above 72 kg are not likely to be athletes, it would not be appropriate to add an additional weight class.

## Formulation of weight class recommendations

*Step 1-Establish the Range for Lowest and Highest Weight Classes*

**Lowest Weight Class for Men**

Prior to the contraction of weight classes, as well as the Olympic quota and qualification per weight class, the weight classes at the extremes, while having fewer entrants, were still represented with a seemingly sufficient number of competitors (see Table 6). These competitors have distinguished themselves in the annals of wrestling lore-Issaev (Bul), Javadi (IRI), Dimitriev and Kornilaev (URS), Kim (PRK) and Berceanu (ROM) all at 48 kg. It is worth noting that the highest points per match in the 1995 WC were from the 48 kg weight class. There is a

world-wide secular trend towards larger people. However, many athletes may be lost to the sport of wrestling because of the elimination of the 48 kg weight class and this is an area that deserves additional research.

Further study should include population data from other countries. While there is only 2.1% of this population in the lowest weight class, one must remember that this is U.S. data. Other data sets need to be investigated. It is likely that some countries have body mass distributions that have smaller people. Population data from Asian countries of such as Japan seem to indicate a smaller population. For instance, athletes from the Peoples Republic of Korea won the FS 48 kg weight class in the 1986 and 1987 World Championships, and also the 1992 and 1996 Olympic Games.
Recommendation: 54 kg

Lowest Weight Class for Women
While the history for women is not as long, the original weight class in 1987 used 44 kg.

**Recommendation: 45 kg**

**Highest Weight Classes**

**Men**
Beginning with the 1985 world championships, FILA instituted a maximum weight of 130 kg (286 lbs.) for the highest weight class. It is not clear how the limit was established by FILA, although a doctor on the FILA Medical Committee stated that it was due to the disparate sizes seen when the huge Chris Taylor wrestled for the US in the 1972 Olympic Games at a weight of 196 kg (Nickhah, personal communication, 2003).

A similar limitation was made for U S collegiate wrestlers in 1986, when the NCAA established the 275 lb. class (123.8 kg). Health and safety of the participants was cited by the NCAA Committee on Competitive Safeguards and Medical Aspects of Sports in the development of this rule change. This entailed concern for the potential mis-matches in size, as well as the personal health risks present in an athlete is in the 150-200 kg range. In regard to the former, there was no data cited that documents excessive weight difference causing injuries in the heavyweight class. The concern for the health of the athlete outside of competition centered around the following: 1) encourage the athletes who were obese to move towards a lower, and healthier weight and lifestyle; 2) discourage the practice of artificially inflating the athletes size by way of tremendous caloric intake; and 3) discourage the use of ergogenic aids, such as anabolic steroids, in their quest to become larger. There is no data that has tracked the success of the rule change in achieving the goal in 1. While there are some athletes who have lost weight to wrestle in this class, many of these huge athletes probably just quit the sport.

Possible negative effects of this weight class restriction include, 1) a reduced pool of potential athletes, and 2) going against the trend one sees in many sport of larger athletes. One can look at the National Football League in the USA and see that 140kg linemen are the norm. While some of these men are obese, because of sophisticated weight training programs, one can see many who possess minimal fat, along with great speed and quickness. A review of the weights of world and Olympic champions is shown in table 6.

The heavyweight limit theoretically perhaps 1% of the population. Other data sets need to be investigated.

Table 6. Heavyweight Champions - Sizes in World and Olympic Championships

| Year | Greco-Roman | Weight | Height | Freestyle | Weight | Height |
|---|---|---|---|---|---|---|
| 1896 | Karl Schumann (GER) | 71 | 175 | | | |
| 1904 | Rudolf Arnold (AUT) | | | Bernhoff Hansen (USA) | | |
| 1905 | Soeren Marinus Jensen (DEN) | | | | | |
| 1907 | Hans Heinrich Egeberg (DEN) | | | | | |
| 1908 | Hans Heinrich Egeberg (DEN) | | | George Cornelius O'Kelly (USA) | 100 | |
| 1909 | Anton Schmidt (AUT) | | | | | |
| 1910 | Gustav Sperling (GER) | | | | | |
| 1911 | Yrjoe Erik Mikael Saarela (FIN) | 91 | 182 | | | |
| 1912 | Yrjoe Erik Mikael Saarola (FIN) | 91 | 182 | | | |
| 1913 | Anders Ahlgren (SWE) | 82.5 kg 1912 | 191 | | | |
| 1920 | Heinrich Bock (GER) WC | | | Robert Roth (SUI) | | |
| 1920 | Adolf Valentin Lindfors (FIN) OG | 95.5 | 176.5 | | | |
| 1921 | Johan Salila (FIN) | 100 | 176 | | | |
| 1922 | Ernst Nilsson (SWE) | 82.5 kg 1913 | 189 | | | |
| 1924 | Henri Deglane (FRA) OC | 100 | | Harry Dwight Steel (USA) | | |
| 1928 | Rudolf Svensson, (SWE) | 87 kg in 1928 | 191 | Johan Cornelius Richthoff (SWE) | | 194 |
| 1932 | Carl Oscar Westergren, (SWE) | 75 kg in 1922 | 178 | | | |
| 1936 | Kristjan Palusalu (EST) | 110 | 185 | Kristjan Palusalu (EST) | 110 | 185 |
| 1948 | Ahmet Mersinli Kirecci (TUR) | 79 kg in 1936 | | Gyula Bobis (HUN) | 130 | 189 |
| 1950 | Bertil Antonsson (SWE) | 93 | 188 | | | |
| 1951 | | | | Bertil Antonsson (SWE) | 93 | 188 |
| 1952 | Johannes Kotkas (URS) | 110 | 185 | Arsen Mekokishvili (URS) | 120 | 186 |
| 1953 | Bertil Antonsson (SWE) | 93 | 188 | | | |
| 1955 | Alexander Masur (URS) | 119 | 183 | Arsen Mekokishvili (URS) | 120 | 186 |
| 1956 | Anatoli Parfjonow (URS) | 110 | 190 | Hamit Kaplan (TUR) | 115 | 188 |
| 1957 | | | | Hamit Kaplan (TUR) | 115 | 188 |
| 1958 | Ivan Bogdan (URS) | 114 | 186 | Ljutvi Dshilber Akhmedev (BUL) | 115 | 180 |
| 1960 | Ivan Bogdan (URS) | 114 | 186 | Wilfried Dietrich (GER) | 122 | 189 |
| 1961 | Ivan Bogdan (URS) | 114 | 186 | Wilfried Dietrich (GER) | 122 | 189 |
| 1962 | Ivan Bogdan (URS) | 114 | 186 | Alexander Ivanizki (URS) | 106.5 | 190 |
| 1963 | Anatoli Roschtshin (RUS) | 125 | 191 | Alexander Ivanizki (URS) | 106.5 | 190 |
| 1964 | Istvan Kozma (HUN) | 135.5 | 202 | Alexander Ivanizki (URS) | 106.5 | 190 |
| 1965 | Nikolai Schmakow (URS) | 120 | 197 | Alexander Ivanizki (URS) | 106.5 | 190 |
| 1966 | Istvan Kozma (HUN) | 135.5 | 202 | Alexander Ivanizki (URS) | 106.5 | 190 |
| 1967 | Istvan Kozma (HUN) | 135.5 | 202 | Alexander Medved (URS) | 120 | 190 |
| 1968 | Istvan Kozma (HUN) | 135.5 | 202 | Alexander Medved (URS) | 120 | 190 |
| 1969 | Anatoli Roschtshin (RUS) | 125 | 191 | Alexander Medved (URS) | 120 | 190 |
| 1970 | Anatoli Roschtshin (RUS) | 125 | 191 | Alexander Medved (URS) | 120 | 190 |
| 1971 | Alexander Tomov (BUL) | 126 | 192 | Alexander Medved (URS) | 120 | 190 |
| 1972 | Anatoli Roschtshin (RUS) | 125 | 202 | Alexander Medved (URS) | 120 | 190 |
| 1973 | Alexander Tomov (BUL) | 126 | 192 | Soslan Andiev (URS) | 116 | 198 |

| Year | Greco-Roman | Weight | Height | Freestyle | Weight | Height |
|---|---|---|---|---|---|---|
| 1974 | Alexander Tomov (BUL) | 126 | 192 | Ladislau Simon (TUR) | 114 | 183 |
| 1975 | Alexander Tomov (BUL) | 126 | 192 | Soslan Andiev (URS) | 116 | 198 |
| 1976 | Alexander Koltschinski (URS) | 119 | 193 | Soslan Andiev (URS) | 116 | 198 |
| 1977 | Nikola Dinev (BUL) | 130 | 184 | Soslan Andiev (URS) | 116 | 198 |
| 1978 | Alexander Koltschinski | 119 | 193 | Soslan Andiev (URS) | 116 | 198 |
| 1979 | Alexander Tomov (BUL) | 126 | 192 | Salman Khasimikov (URS) | 118 | 180 |
| 1980 | Alexander Koltschinski | 119 | 193 | Soslan Andiev (URS) | 116 | 198 |
| 1981 | Refik Memisevic (YUG) | 112 | 188 | Salman Khasimikov (URS) | 118 | 180 |
| 1982 | Nikola Dinev (BUL) | 130 | 184 | Salman Khasimikov (URS) | 118 | 180 |
| 1983 | Jewgeni Artjuchin (RUS) | 108 | 189 | Salman Khasimikov (URS) | 118 | 180 |
| 1984 | Jeff Blatnick (USA) | 110 | 189 | Bruce Baumgartner (USA) | 126 | 185 |
| 1985 | Igor Rostorotzki (RUS) | 128 | 195 | David Gobedischvili (RUS) | 110 | 200 |
| 1986 | Tomas Johansson (SWE) | 132 | 193 | Bruce Baumgartner (USA) | 126 | 185 |
| 1987 | Igor Rostorotzki (RUS) | 128 | 195 | Aslan Chadarzev (URS) | 110 | 183 |
| 1988 | Alexander Karelin (RUS) | 128 | 191 | David Gobedischvili (RUS) | 110 | 200 |
| 1989 | Alexander Karelin (RUS) | 128 | 191 | Ali-Reza Soleimani (IRI) | 121.5 | 190 |
| 1990 | Alexander Karelin (RUS) | 128 | 191 | David Gobedischvili (RUS) | 110 | 200 |
| 1991 | Alexander Karelin (RUS) | 128 | 191 | Andreas Schroeder (GER) | 105 | 192 |
| 1992 | Alexander Karelin (RUS) | 128 | 191 | Bruce Baumgartner (USA) | 126 | 185 |
| 1993 | Alexander Karelin (RUS) | 128 | 191 | Bruce Baumgartner (USA) | 126 | 185 |
| 1994 | Alexander Karelin (RUS) | 128 | 191 | Mahmut Demir (TUR) | 120 | 184 |
| 1995 | Alexander Karelin (RUS) | 128 | 191 | Bruce Baumgartner (USA) | 126 | 185 |
| 1996 | Alexander Karelin (RUS) | 128 | 191 | Mahmut Demir (TUR) | 120 | 184 |
| 1997 | Alexander Karelin (RUS) | 128 | 191 | Zekeriya Gueclue (TUR) | 125 | 180 |
| 1998 | Alexander Karelin (RUS) | 128 | 191 | Alexis Rodriguez-Valera CUB) | 124 | 188 |
| 1999 | Alexander Karelin (RUS) | 128 | 191 | Stephen Neal (USA) | 120 | 196 |
| 2000 | Rulon Gardner (USA) | 125 | 191 | David Musulbes (RUS) | 113 | 186 |
| 2001 | Rulon Gardner (USA) | 125 | 191 | David Musulbes (RUS) | 113 | 186 |
| 2002 | Dremiel Byers (USA) | 130 | 188 | David Musulbes (RUS) | 113 | 186 |
| 2003 | Khassan Baroev (RUS) | 120 | 188 | Artur Taimazov (UZB) | 110 | 190 |
| 2004 | Khassan Baroev (RUS) | 120 | 188 | Artur Taimazov (UZB) | 110 | 190 |
| 2005 | Mijain Lopez(CUB) | 130 | 196 | Aydin Polatci (TUR) | 120 | 185 |
| 2006 | Khassan Baroev (RUS) | 120 | 188 | Artur Taimazov (UZB) | 110 | 190 |
| 2007 | Mijain Lopez(CUB) | 130 | 196 | Bilyal Makhov (RUS) | 120 | 196 |
| 2008 | Mijain Lopez(CUB) | 130 | 196 | Artur Taimazov (UZB) | 110 | 190 |
| 2009 | Mijain Lopez(CUB) | 130 | 196 | Bilyal Makhov (RUS) | 120 | 196 |
| 2010 | Mijain Lopez(CUB) | 130 | 196 | Bilyal Makhov (RUS) | 120 | 196 |
| 2011 | Riza Kayaalp (TUR) | 130 | 183 | Aleksei Shemarov (BLR) | 115 | 188 |
| 2012 | Mijain Lopez(CUB) | 130 | 196 | Artur Taimazov (UZB) | 110 | 190 |
| 2013 | Heiki Nabi (EST) | 115 | 194 | Khadshimourad Gatsalov (RUS) | 120 | 178 |
| 2014 | Mijain Lopez(CUB) | 130 | 196 | Taha Akguel (TUR) | 118 | 192 |
| 2015 | Riza Kayaalp (TUR) | 130 | 183 | Taha Akguel (TUR) | 118 | 192 |
| 2016 | Mijain Lopez(CUB) | 130 | 196 | Taha Akguel (TUR) | 118 | 192 |

Other athletes of interest include: Adam Sandurski (PL) who weighed 135 kg and was 214 cm tall. Between 1977 and 1986, he earned 2 silvers and a bronze in the freestyle World Championships, and a bronze in the 1980 Olympics (he did make the 130 kg limit in 1985, placing 4th in the WC); and Chris Taylor (USA) who weighed a huge 196 kg. Taylor won a bronze medal in the 1972 Olympic FS competition.

Mass in open-ended sports (or highest weight classes) provides advantages, especially if the additional mass is fat-free mass. Khosla (1964) cites the 1964 Olympic champions of the Greco-roman, freestyle, and weightlifting in the highest weight division. All champions weighed more than the mean weight of all competitors.

While only one champion from the list exceeded 130 kg, GR Champion, Istvan Kozma (HUN) was 135.5 kg and 202 cm. The average and median values are listed in Table 7.

Table 7. Mean Weight and Height of Olympic and World Champions in Highest Class

| **Greco-Roman** | **Weight** | **Height** |
|---|---|---|
| **mean** | 120.8 | 190.3 |
| **median** | 126 | 191 |
| **Freestyle** | | |
| **mean** | 116.1 | 189.2 |
| **median** | 118 | 190 |

Some of these heavyweight champions wrestled at a lower weight class earlier in their careers. Several of the wrestlers from the early 20th century, for whom their competition weight is missing, wrestled and won championships at the last weight for which there was a limit. For instance, Anders Algren (SWE) and Ernst Nilsson (SWE) both wrestled at the 82.5 kg limit class; Rudolf Svensson, (SWE) wrestled at 87 kg in 1928; Carl Oscar Westergren, (SWE) wrestled at 75 kg in 1922; and Ahmet Mersinli Kirecci (TUR) wrestled at 79 kg in 1936. Alexander Medved won several world championships at the 97 kg weight class before moving up to the unlimited category.

Outside of Olympic competition, there are some notable heavyweight competitors from professional wrestling from the late nineteenth, and early 20th centuries. Prior to 1896 revival of the Olympic Games, professional wrestling was well established. The early Olympic Games did not always have the best heavyweights represented. Because the professionals won prize money, de Coubertin cast them in a negative light. This, along with disagreements on the rules between French Rules and those used in Great Britain and the US, resulted in the world's best wrestlers ignoring the Athens Games. Schumann of Germany won the wrestling competition and was actually a gymnast.

**Recommendation: 130 kg**

**Women's Maximum**

Data has been shown that indicates a need for a higher ceiling or cap to the highest weight class for women. Discussion needs to be focused on the question of whether the population

data is truly representative of the pool of potential athletes. If the people above 75 kg are not likely to be athletes, it would not be appropriate to increase the weight class.

If one examines female athletes in a variety of sports, it is apparent that the range of weights of some outstanding female athletes extends beyond the 75 kg limit. Here are some examples from recent Games:

> **London:** Football-Abby Wambach of the USA 81kg; Rowing-Heather Stanning of UK, 75kg; Swimming- Allison Schmitt of the USA, 75 kg; Tennis-Venus Williams 74 kg and Volleyball-Fabiana Claudino of Brazil, 73 kg.
>
> **Rio:** Mélina Robert-Michon of France, Silver medal in Discus; Sandra Perković of Croatia-Discus-2x Gold then Bronze in Rio 85 kg; Javelin- Barbora Špotáková of the Czech Republic, 80 kg; Émilie Andéol of France was +78 Judo Gold in Rio-85 kg; Anita Włodarczyk, Poland, Hammer Throw Gold-100kg; Valerie Adams, NZ Shot Put Gold-120 kg.
>
> (https://en.wikipedia.org/wiki/Summer_Olympic_Games)

In the USA and Canada collegiate women's wrestling nationals they have weight classes higher than FILA's 72kg limit. Professor Bruno Hartmann, a long-time coach of women, recommended the raising of the women's limit, citing drastic weight loss in order to be able to participate by some women (Hartmann, personal communication, 2017).

**Recommendation: 80 kg**

**Performance equity model**

**Use of Performance Factors: At what point does a difference in weight make a difference in the competitive outcome?**

If one looks at the span from one weight class to the next, it can be expressed in absolute terms (kg), or as a percentage of the preceding weight class. The absolute difference between classes continually increases as one moves from lower to higher weight classes.

What is the role of mass in wrestling? The muscle tissue in the fat-free mass is the source for the generation of force and power to execute holds and overcome the forces and mass of the opponent. What percentage difference creates a competitive advantage? In competitions decided by the narrowest of margins, small differences in strength, power, inertia, and leverage could make difference in the outcome

One focus of attention can be on the relationship between strength and body mass. Studies have shown that the increase in strength as the subject increases in mass is not linear. An increase in size does not allow for the proportional increase in force generation. This suggests that one could employ an approach to the normalization of strength in relation to size. Jaric (2003) in his review of the role of body size in the relation between muscle strength and movement performance, distinguishes between various types of strength and testing modalities, and lists the resulting allometric scaling equations. However, taking the simplest case of strength (S) measured by a dynamometer, the normalized strength ($S^n$) in relation to body mass (m) is:

$$Sn = S/m^{2/3}$$

A simple examination of the world record clean and jerk in Olympic weightlifting (fig. 3) shows a curvilinear relationship, with the strongest athletes, "pound for pound" at the lowest classes. Some of this relationship may be explained by the fact that in weightlifting as well as wrestling one sees progressively higher percentages of body fat as the classes increase in size. Both of these observations can be used in an argument for larger spans between the upper weight classes.

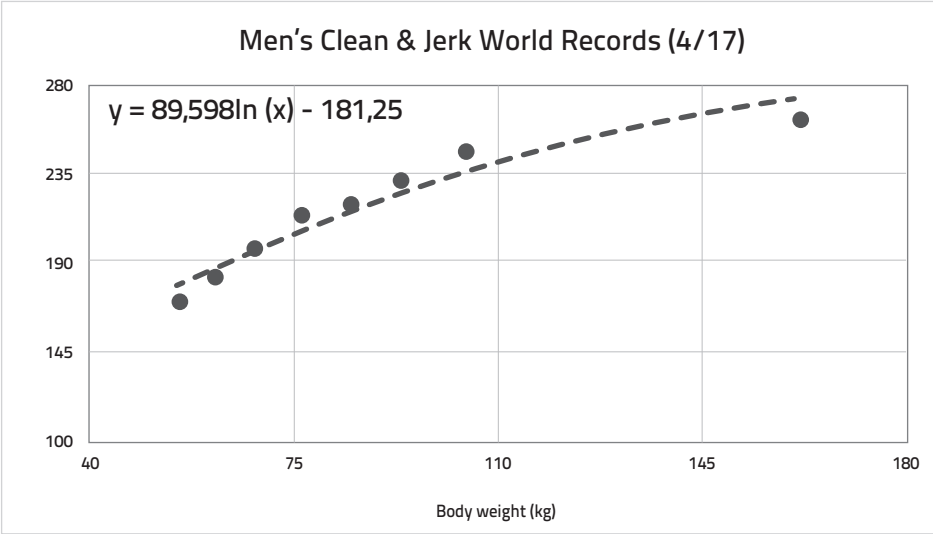


Figure 3 The Relationship Between Size and Strength in Weightlifting World Records (Clean and Jerk) http://www.iwf.net/results/world-records/

**Creating a Performance Potential Equity Model**

**Anthropometry and Weight Loss:** The general anthropometric characteristics of wrestlers show a high level of mesomorphy. Studies of studies of elite wrestlers have shown the following somatotypes: 2.4 – 6.7 – 1.5 (Carter et al); Cuban freestyle wrestlers 1.8-6.8-1.4, Greco-roman wrestlers 2.0-6.5-1.5 (Betancourt-Leon et al); and greco-roman competitors from the European Championships 2.7 – 6.2 – 1.7 (Charzewski et al). The brachial index (length of the forearm relative to the upper arm as a %) is low for wrestlers and weightlifters where strength and stability is important. A low brachial index provides the biomechanical advantage of short force arms. Most wrestlers seek to compete in a weight class where their strength (power) to size ratio is maximized. Studies on wrestlers yield low body fat values. In his summary of the characteristics of elite wrestlers, Horswill reports a range of 7.6 – 9.8% body fat. This minimization of body fat-high fits the description of Norton and Olds, as most weight category sports, as one where the competitors use "size optimization." This classification system of sports is based on the size qualities of the athletes the sport attracts. Additionally, wrestlers will intentionally lose weight to compete at a lower weight class using short-term weight loss methods that can prove to be injurious to health. The American College of Sports Medicine (ACSM), in their position statement on weight loss in wrestlers recommended adding additional weight classes, particularly in the lower and middle classes to reduce the need to use artificial or dangerous means to reach a competitive weight.

The placement of classes must also consider the health impact of wrestlers attempting to move to a lower weight class. Poleva (2008) identified rational boundaries of reduction of body weight - the maximum limits in reduction of body weight, which do not reduce the physical strength of the athlete. This research regarding the advantage gained through weight

reduction had a limit of about 9% reduction of body weight. This research supports the notion that an equal difference in percentage of body weight can be the most equitable and fairest choice in the establishment of weight classes (Lopez-Gonzalez, 2017). Poleva defined the boundaries of a rational reduction of body weight - a maximum reduction limits which does not reduce the physical strength athlete. In the weight category up to 42 kg, this figure it amounted to 7.6% of body weight; 50 kg- 9.5%; 56 kg - 9.3%; 62 kg - 10.2%; 69 kg -10.5%; 77 kg-10.3%; 85 kg - 10.3%; 94 kg -10.1%; and 105 kg -9.4%.

We set out to create sets of weight classes which are based on application of scientific knowledge and equity to wrestlers of all sizes. Thus, our guiding principles for the development of a new weight class structure were:

> It must be based on fact and not tradition. To simply line up and adjust classes which have been used before and examine by an "eyeball" or "feel" approach, is not acceptable. The weight classes must have an equitable impact on athletes along the entire span of classes. Therefore, the distance between classes cannot be a constant, absolute value, but must be based the relative value that accounts for the percentage of the body weight that the span of weight between classes yields. Simply stated, a five kg span between classes has a greater effect on a 55 kg wrestler, compared to a 90 kg wrestler.
>
> The initial decisions to be made must concern the range. This means the establishment of minimum and maximum classes that provide access to wrestling that is as inclusive as possible to the sizes of the entire human population.
>
> While population equity is important, performance equity, had to take precedence.
>
> The 10-class structure must be developed to appropriately accommodate the move to 6 weight classes for Olympic years. This necessitated that the 6-weight class structure be established first.

For the range, we recommend the 130 kg limit that was first used in 1997, and is presently the limit used in Greco-Roman wrestling. For the women, we favor an increase from the present 75 kg to 80 kg. The evidence for this that prominent coaches have spoken out that the current limit was too low and caused some drastic weight reduction. Further evidence is provided by the many larger women who are extremely successful athletes in other sports, and are in excess of 75 kg.

We then produced a model with relative equity of span between classes. This was done first for 6 weight classes, using relatively equal weight reduction percentages to the next lowest class. This model was then adjusted by applying the information from the strength performance model to the higher weight classes, whereby the larger weight classes tolerate greater differences in weight. Finally, the additional 4 weight classes were added in an attempt to reflect the limits of weight reduction observed by the Poleva research. Table 8 contains the recommendations for weight classes for men and women, with Olympic classes shaded.

Table 8. Recommended Weight Classes for Men and Women

| Men's 10 Weight Classes (kg) | % of Body Weight Reduction to Next Lower Class | Body Weight Reduction to Next Class (kg) |
|---|---|---|
| 54 | | |
| 58 | 7 | 4 |
| 66 | 9 | 6 |
| 70 | 6 | 4 |
| 75 | 7 | 5 |
| 80 | 6 | 5 |
| 85 | 6 | 5 |
| 92 | 8 | 7 |
| 100 | 8 | 8 |
| 130 | 23 | 30 |
| Olympic Weights Only | | |
| 58 | | |
| 66 | 12 | 8 |
| 75 | 11 | 9 |
| 85 | 12 | 10 |
| 100 | 15 | 15 |
| 130 | 23 | 30 |
| Women's 10 Weight Classes (kg) | % of Body Weight Reduction to Next Lower Class | Body Weight Reduction to Next Class (kg) |
| 45 | | |
| 48 | 6 | 3 |
| 53 | 9 | 5 |
| 55 | 4 | 2 |
| 58 | 5 | 3 |
| 60 | 3 | 2 |
| 63 | 5 | 3 |
| 69 | 9 | 6 |
| 73 | 5 | 4 |
| 80 | 9 | 7 |
| Olympic Weights Only | | |
| 48 | | |
| 53 | 9 | 5 |
| 58 | 9 | 5 |
| 63 | 8 | 5 |
| 69 | 9 | 6 |
| 80 | 14 | 11 |

**Considerations:**

1) Use all available information
2) Serve the greatest number of athletes
3) Be sensitive to the extremes of our athlete population
4) Be sensitive to population differences around the world
5) Maintain the maximum limits
6) Valid needs and solutions were often in opposition, but decisions must be made.

For instance, in this paper, the position was taken to assure inclusion of a lower weight class for men (54 kg). Support could also be given to adding an additional class somewhere between 70-85 kg.

**Limitations**

1) We do not currently possess anthropometric data for all of the world's population. Additionally, where this data exists, it does not necessarily describe the population of interest, - the potential athletic population. We must infer from expert opinion (coaches and trainers).
2) We are bound to create a maximum of 6 classes for Olympic competition.

**Future Work:**

1) Identify and use additional population studies from other continents, particularly Asia.
2) Do these population distributions reflect the true pool of potential athletes for wrestling?
3) The performance factor used in this paper only dealt with strength as a function of mass. Is this the best allometric scaling equation for wrestlers? For women? Are there other parameters that would be more useful, such as power?
4) There needs to be a discussion among experts, convened for the purpose of establishing a methodology for the "meshing" the population-based model and the performance-based models.

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# Effects of dehydration performance for cut weight in combat sports

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**ABSTRACT**
PURPOSE: In this review we discuss: I) the physiological and neuromuscular effects described in the literature for different degrees of body mass loss before the official weigh, II) the recovery or "rebound effect" that occurs between the official weigh and the competition beginning, III) the validity of non-invasive markers to estimate hydration status that coaches may use in monitoring the athlete's weight loss. METHODS: Comparison of various studies in which the hydration status and weight loss of combat sports athletes are analyzed. RESULTS: "Weight loss effects" Dehydration can produce many negative physiological effects that have an obvious repercussion on sport performance, however, it is important the diet applied after weighing up to competition so as not to have a performance loss. "Rebound effect". There are few studies analyzing what occurs in the athletes after the official weighing and the beginning of the competition, it is interesting to know that it occurs in 6 - 18 hours until the beginning of the competition, affecting the athletes' concentration and decision making. "Hydration Indicators". The best method in the majority of investigations is the osmolality in plasma (POSM) or urine (UOSM); although other methods have been reviewed as more economical, such as specific gravity of the urine, urine color, bioelectric impedance, and perception of thirst, being these simpler methods to know the state of hydration. CONCLUSIONS: It is necessary to elaborate a method that allows to know the weight loss habits of the athletes; thus, it could impact on their health and sport performance allowing an optimal recovery for the competition after the weighting. Future investigations are needed to know the rapid weight loss habits and consequences, the level of performance after weighing, and the psychological effects due to the weight loss habits of the athletes.

**Key words:** hydration, elite athletes, weight cycling, weight rebound, wrestling

In this review we analyzed the international literature that has studied the effects of combat sport athletes on physical performance during the pre-competition weight loss period, as well as the limited scientific information available to date on the rapid recovery of energy substrates, rehydration and physical performance recovery which occurs during the hours that separate the official weighing and the beginning of the tournament. This study will also analyze the validity of various techniques commonly used to know the hydration status of these athletes, as well as the available tools to know the habits and strategies of weight loss and its subsequent recovery in combat sports.

The international federations of these Olympic sports (judo, taekwondo, wrestling, and boxing) establish a body weight assessment few hours before the start of the competition, which can vary between 6 and 18 hours depending on the sport. These regulatory characteristics make athletes try to maximize muscle mass levels, minimize fat mass and induce severe

dehydration to minimize their total body mass during the set-up or tuning phases for the competitions (García-Pallarés, de la Cruz, Torres-Bonete, Muriel & Díaz, 2011).

These weight loss methodologies used by combat sports specialists prior to competitions are considered in the scientific and informative literature as "aggressive" and detrimental to health. This approach to competition is internationally known as "Cutting weight", and is practiced in all Olympic combat sports that are governed by weight categories.

The rapid weight loss methods most used by combat sports competitors are the reduction of energy intake, carbohydrates, fats, and fluid intake, and the increase of physical exercise, dehydration, use of saunas and plastic suits, etc.

**Effects of weight loss**

The rapid weight losses carried out by combat sports in the precompetitive productive phases and the different adverse effects on performance that have been examined by the researchers in the international literature. The majority of authors focused on and analyzed the effects they produced during these phases of body mass loss on the performance of various manifestations of strength (isometric, isokinetic and isoinertial), muscular endurance, muscle power, anaerobic capacity and the VO2max.

Most research describes the negative effects of rapid body weight losses, but also some characteristics of athletic performance that are not affected and may even improve. Periard, Tamman and Thompson (2012) in a very specific study, where they isolated the dehydration using the electrical stimulation, concluded that the production of the force remains the same, regardless of the state of hydration.

Kraemer et al. (2001), in a study that evaluated the neuromuscular, physiological and performance changes during the period between the official weighing and the beginning of the competition, were able to highlight the great capacity of the body of these competitors to "rebound" decreases in neuromuscular performance and anaerobic metabolism that occur during the weight loss phase. In this period of time (6-18 hours), athletes significantly increase their performance, being this change that they recover a good part of the state of form that before beginning the period of lowering of body mass. (Table 1).

Table 1: Studies on the effects of weight loss (dehydration) performance

| Publication | Sample | Loss of body mass (%) | Time loss body mass | Methods used in weight loss | Results |
|---|---|---|---|---|---|
| **Tuttle, 1943** | 6 University wrestlers | 4.5% | S/I | S/I | ▪ Isometric force with no significant differences<br>▪ Reaction time without significant differences |
| **Saltin, 1964** | 10 Athletes | 1.6% y 4.7% | S/I | S/I | ▪ Maximum isometric force without significant differences |
| **Bock et al., 1967** | 10 University wrestlers | 0.4% y 3.8% | S/I | S/I | ▪ VO2 peak without significant differences |
| **Greeleaf et al., 1967** | 12 women | 3.3% | S/I | Aerobic exercise | ▪ Maximum isometric force without significant changes |
| **Singer & Weiss, 1968** | 10 wrestlers | 7.1% | S/I | S/I | ▪ Isometric force without significant changes |
| **Bosco et al., 1974** | 21 Athletes | 5.7% | S/I | Water restriction | ▪ Maximum isometric force (-10.4%)<br>▪ Muscle resistance (-9%) |
| **Kelly et al., 1978** | 4 University wrestlers | 3.0% | S/I | S/I | ▪ VO2 peak without significant differences |
| **Torranin et al., 1979** | 20 Athletes | 4.0% | S/I | Sauna | ▪ Muscle resistance (-31% depletion time) |
| **Jacobs, 1980** | 11 wrestlers | 2.0% y 5.0% | S/I | S/I | ▪ Lower train force without significant differences |

| Table 1: Studies on the effects of weight loss (dehydration) performance | | | | | |
|---|---|---|---|---|---|
| Publication | Sample | Loss of body mass (%) | Time loss body mass | Methods used in weight loss | Results |
| **Bijlani & Sharma, 1980** | 14 Athletes | 3.0% | S/I | Sauna | ▪ Muscle resistance (-31.8%)<br>▪ Maximum isometric force without significant differences |
| **Houston et al., 1981** | 4 wrestlers | 8.0% | S/I | S/I | ▪ VO2 peak without significant differences<br>▪ Anaerobic capacity without significant differences<br>▪ Isometric force decreases (no data) |
| **Wilderman & Hagan 1982** | 1 wrestler | 8.0% | S/I | Diet<br>Aerobic exercise<br>Specific Exercise | ▪ Maximum maintained aerobic power<br>▪ Maintained muscular strength |
| **Serfass et al., 1984** | 11 wrestlers | 5.0% | S/I | S/I | ▪ Isometric force with no significant differences<br>▪ Strength isometric resistance without significan differences |
| **Caldwell et al., 1984** | 62 Athletes | 4.1% y 1.2% | S/I | Sauna<br>Diuretics<br>Aerobic exercise | ▪ VO2 peak without significant differences<br>▪ Load VO2 work without significant differences |
| **Vitasalo et al., 1987** | 14 Volleyball players | 3.4%, 5.8% y 3.8% | S/I | Sauna<br>Diet and diuretics<br>Diuretics | ▪ Maximum isometric force (-7.8%) (sauna)<br>▪ Force production rate (-16.1%) (sauna) |
| **Caterisano et al., 1988** | 6 athletes short distance<br>5 athletes background and half background<br>6 sedentary | 3.0% | S/I | S/I | ▪ Lower muscle strength (-19.5% anaerobic, -19.3% sedentary) |
| **Horswill et al., 1990** | 12 wrestlers | 6.2% | 4 days | i) Low diet; ii) high in carbohydrates | ▪ Anaerobic capacity of arms without significant differences |
| **Wester et al., 1990** | 7 University wrestlers | 4.9% | 36 hours | Plastic sweater | ▪ Anaerobic power (-21.5%)<br>▪ Anaerobic capacity (-9.7%)<br>▪ Speed and peak lactate threshold without significant differences<br>▪ VO2 peak (-6.7%)<br>▪ Aerobic capacity (-12.4%) |
| **McMurray et al., 1991** | 12 wrestlers | 3.2% | 7 days | i) Normal diet; ii) High carbohydrate diet | ▪ Total anaerobic power (-7%) normal diet<br>▪ Average anaerobic power (-6%) normal diet |
| **Greiwe et al., 1998** | 7 men | 3.8±0.4% | S/I | Sauna | ▪ Plasma volume (-7.5 ± 4.6%, 60 min / 5.7 ± 4.4.120 min)<br>▪ Isometric strength knee extension and elbow flexion without significant changes<br>▪ Muscle strength knee extension and elbow flexion without significant changes |
| **Montain et al., 1998** | 5 men and 5 women | 4.0% | S/I | Aerobic exercise in hot environment (40 ° C, 20% relative humidity) | ▪ Muscle resistance (-15%)<br>▪ Muscle strength without significant differences |
| **Choma et al., 1998** | 14 University wrestlers | 5% | S/I | S/I | ▪ Negative moods.<br>▪ Glucose 13.7 mg· dl-1 lower.<br>▪ Hypoglycemia (+ 37%).<br>▪ Plasma volume (-11%). |
| **Smith 2000** | 7 Amateur boxers | 3.8% | S/I | Plastic Suit<br>25 min pedaling at 60W per day | ▪ Plasma volume without significant differences<br>▪ Specific boxing performance without significant differences |
| **Schoffstall et al., 2001** | 10 Athletes of combat sports | 1.7% | S/I | Sauna (2 hours) | ▪ Maximum force (1RM Press bench) (-5.6%) |

| Table 1: Studies on the effects of weight loss (dehydration) performance | | | | | |
|---|---|---|---|---|---|
| Publication | Sample | Loss of body mass (%) | Time loss body mass | Methods used in weight loss | Results |
| **Bigard et al., 2001** | 11 men | 2.95% | S/I | Sauna | ▪ Muscle resistance at 25% (-23%)<br>▪ Muscle resistance at 70% (-13%)<br>▪ Maximum isometric force without significant differences |
| **Gutiérrez et al., 2003** | 6 men and 6 women | 1.8% men 1.4% women | S/I | Sauna | ▪ Manual dynamometer without significant differences<br>▪ Vertical jump power without significant differences |
| **Umeda et al., 2004** | 22 athletes of judo | 5.5±2.8% y 1.3±1.0% | 4 days | Plastic Suit Sauna | ▪ Maximum anaerobic power (-4.9%) |
| **Judelson et al., 2007** | 7 Athletes | 2.4±0.4% y 4.8±0.4% | S/I | Aerobic exercise in chamber (36-37 ° C, 40-50% relative humidity) | ▪ Vertical jump without significant differences<br>▪ Peak power of the lower train without significan differences<br>▪ Peak strength of the lower train without significant differences<br>▪ Lower tensile strength (-series 2 and 3; -series 2 and 5) |
| **Artioli et al, 2010c** | 7 athletes of judo | 4.8±1.1% | 5 days | Common methods (S/I) | ▪ Specific performance without significant differences<br>▪ Wingate upper body without significant differences<br>▪ Glucose and lactate without significant differences |
| **Kraft et al, 2010** | 10 men | 3.0% | S/I | Sauna. Restriction of liquids | ▪ Muscle resistance (-15%) |

*S/I: Without information*

## Methods for detecting hydration status

*Specific gravity of urine*

This technique studies the density (ratio of mass to volume) of a urine sample compared to water density. Any liquid that is denser than water has a specific gravity greater than 1,000 u. Urine samples from healthy adults are in the range of 1.013 to 1.029. Subjects during dehydration have a USG that exceeds 1.030, being in the opposite case of hyper-hydration with values between 1,001 and 1,012 (Amstrong, Maresh, Castellani, Bergeron, Kenefick, LaGasse and Riebe, 1994, Amstrong, Soto, Hacker, Casa, Kavouras and Maresh, 1998). To carry out this process, only a hand held refractometer is needed, where a few drops of urine are placed.

*Bioelectric impedance*

This technique collects the electric current that flows through the human body, through the hands and feet. These measurements use this property to provide estimates of body composition as well as body water.

*Color of urine*

This technique would be one of the easiest to carry out, since anyone with a minimum of experience could determine, by looking at the color of the urine, how much a subject needs to be rehydrated. This scale would be comprised of eight color levels ranging from pale yellow to green brown (Amstrong et al., 1994; Amstrong et al., 1998).

*Perception of thirst*

This protocol is usually used in the practice of combat sports as a last resort when other instruments or technical knowledge are not available. The perception of thirst can be monitored to predispose the threshold of dehydration. Thirst is measured with a rating scale ranging from 0 (no thirsty at all) to 10 (very, very thirsty) developed by Riebe et al. (1997).

*Weight loss questionnaires*

Different authors have designed questionnaires to record the habits and methods that combat athletes perform to manage their weight during the Weight Cutting phases (Steen & Brownell, 1990; Oppliger, Landry, Foster and Lambrecht, 1993; Kiningham and Gorenflo, 2001, Artioli et al., 2010b). However, none of these instruments allows the study of the protocols and strategies that these athletes perform in order to recover in the time that separates the official weigh-in and the beginning of the tournament. Also, it is noteworthy that these questionnaires ask athletes at any time of the season about their usual practices in the Weight Cutting phases, so none of these instruments is designed to be administered in the specific context of a competition.

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# 3D DUTH wrestling dummy and training

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**ABSTRACT**
The purpose of the training partner 3D DUTH wrestling dummy is to allow wrestling athletes to train at full speed and full contact, to improve their technique along with their specific wrestling power and speed. Using this dummy many head snapping technical holds and head snap set-ups, used to attack the legs, can be perfected without the risk of injury. At the same time significant data of technical applications are recorded in a database and compared with a previous training session in order to improve the configuration of the training program. The 3D DUTH wrestling dummy is made of durable and flexible materials and has Wi-Fi and Bluetooth connectivity, a point-of-view camera, auditory stimulus, 6 visual stimuli sensors, 11 pressure sensors and 4 accelerometers which can wirelessly send data to a computer. With the measurement of the kinematic parameters and the help of an analysis system, the motion curves (graphs) that describe the motion of the individual parts of the body and especially the legs can be derived during the whole training session, using the 3D DUTH wrestling dummy, the athlete's most valuable partner.

**Key words:** training, wrestling, equipment

**Introduction**
Wrestling requires a great number of physical (strength, speed, balance, flexibility, and stamina) and mental abilities. Moreover, the wrestler needs to master specific wrestling skills (technique) and to continuously alter his tactics and adapt his strategy during the game. These skills are improved with practice, preferably against live interactive partners, which in some cases may induce an injury. So the use of sophisticated equipment that can mimic an active partner without any risk for injury is highly desired.
A wrestling dummy is an anthropomorphic doll that bodies forth the wrestling partner during the training procedure. In our days, a variety of grappling dummies is used by wrestling coaches in order to practice snap downs, duckunders, armdrags etc. They are very popular because they give the opportunity to the athletes to practice on their own, without the attendance of an actual partner.

Their two major categories of wrestling dummies a) throwing dummies (not attached anywhere, free to grab and drop), and b) wall dummies (mounted in the wall, provide resistance in their leg, arm and neck joints). Both dummy types are used for different training purposes but none of them provide the coach with useful information about the quality of the technique execution.

Main objective of the 3D DUTH wrestling dummy project was the development an anthropomorphic dummy that would be successfully used a) to collect experimental data during the execution of wrestling grasping techniques, b) to help coaches evaluate wrestler's technique and performance during training.

**Design selected**

The design chosen for 3D DUTH wrestling dummy takes inspiration from the wall dummies. The height of the dummy is 1,75m so it can easily be used by short or tall athletes. The wrestling mannequin simulates the human body and is consisted of 12 joints located in upper (shoulder, elbow and wrist) and lower extremities (hip, knee and ankle). Shoulder, elbow, hip and knee joints are spring-loading to provide resistance. The referral joints allow movements of the body parts in sagittal (flexion/extension) and frontal plane (adduction/abduction). Each joint is pre-flexed in order the dummy's standing position to mimic the basic square stance of the wrestling opponent.

Spine is represented by a big compression spring that gives torso the freedom to move three-dimensional and returns to the neutral position after the force application. Between neck and head there is no joint. Both body parts are stacked together and no movement among them is allowed.

**Material**

Twelve iron pipes were used to represent all the body parts (feet -2, shanks-2, tights-2, pelvis-1, shoulders-1, arm-2 and forearm-2). All metal pipes were covered with polyester casts, filled with polyurethane, in order to mimic the volume and the anatomy of each human part. The cast is wrapped with sponge; neoprene and leatherette finish that whole the appearance of the dummy (Figure 1).

Figure 1

Each joint is mounted with one torsion spring and two extension springs, on the right and left side of the joint (Figure 2). Totally, eight torsion springs were mounted on the metal joints (shoulder-2, elbow-2, hip-2 and knee-2), a) to provide resistance in flexion/extension (torsion spring) and abduction/adduction movement (extension spring) and b) to bring body parts back to neutral position.

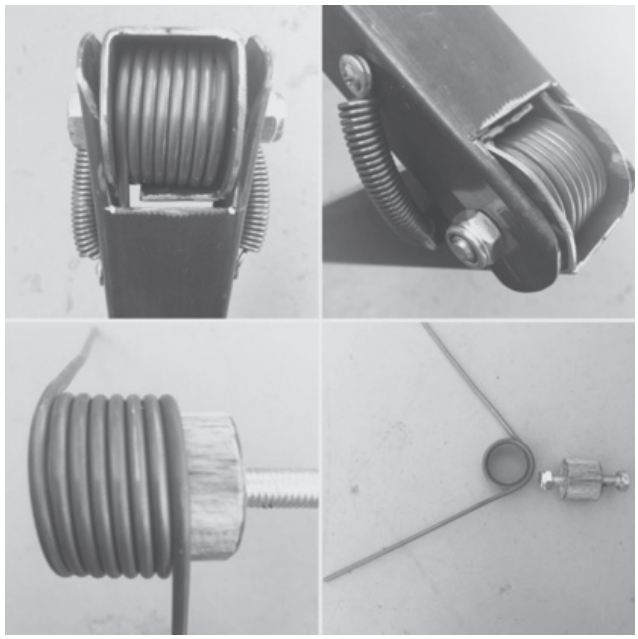

Figure 2

Instrumentation

Acceleration values of the upper and lower extremities can be measured by 4 triaxial accelerometers placed at the arms and legs of the dummy. The pressure that the wrestlers produce during the grasping techniques is calculated by 11 piezo electric sensors located at the arms (forearms and arms), the legs (shank) the torso and the head of the dummy (Figure 3).

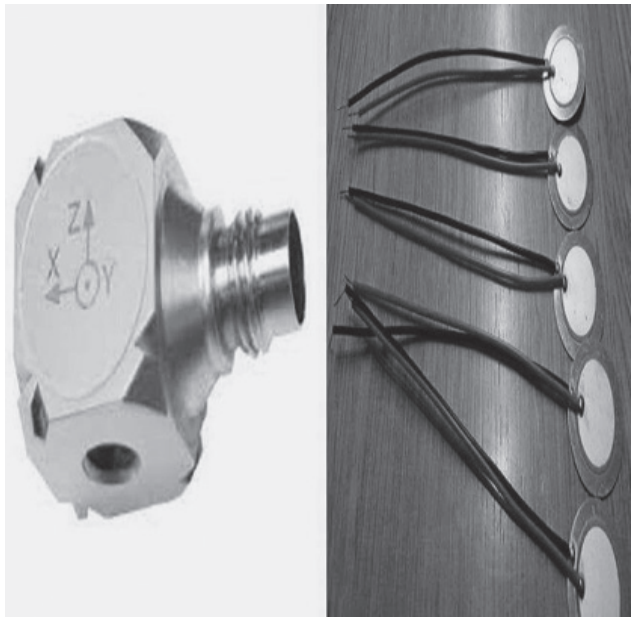


Figure 3

All acceleration and pressure signals can be collected wirelessly in a preferably by the coach device (computer, tablet, cellphone) that support's Wi-Fi and Bluetooth technology. Except of real time data the coach will have the chance to evaluate the execution technique of their athlete with the use of a point-of-view camera that is placed on the head of the wrestling dummy. In addition, their 6 visual stimuli sensors, with led lights, positioned on the forearms, the torso and the tights of the dummy, over the neoprene cover to be visible by the wrestler.

**Training and research applications**

3D DUTH wrestling dummy aims to change coaches' perspectives about the use of a wrestling dummy during training. Until now wrestling dummies were used only for practicing grasping techniques but no kind of feedback was available about the quality of technique execution during training procedure, except of the coach's eye. Thus, valuable information's about the way that the athlete approaches the dummy, the force that he applied and the speed of the movement could not be assessed. 3D DUTH wrestling dummy offers to the coaches a complete training tool that combines technique evaluation and speed-agility training possibilities. Data retrieved from the dummy are very useful in training design and evaluation. Acceleration and pressure values are actually indices of the force applied by the wrestles on the dummy. Use of visual or audio stimuli provides information about the speed of the wrestler during the grappling technique and his reaction time after the stimuli. The combination of the above information helps coaches to discern their athletes lack in technique or physical abilities and to adapt their training program accordingly. In addition, data retrieved from the 3D DUTH wrestling dummy can be combined with parameters captured by a 3 dimensional analysis system, such us motion curves (graphs) that describe the motion of the individual parts of the body, in order to assess a complete biomechanics lab analysis.

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# Optimal age to begin with Greco-Roman wrestling and reach peak performance – trends in cases of world-class medal winners of various weight groups

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**ABSTRACT**
INTRODUCTION: When to start doing Greco-Roman wrestling? How many years of experience are needed to accomplish world-class standard and achievements? At which age do wrestlers nowadays win their world championship or Olympic medals? What age-related trends can be observed in wrestlers of different weight groups? This study explored all these questions. PURPOSE: The aim of the research was to determine differences between weight groups in age-related parameters (beginning age, wrestling experience, and peak performance age) of world-class top-level wrestlers and to analyse the revealed trends. METHODS: The sample of entities (N=299) comprised wrestlers who won their first World Championship or Olympic Games' medals in the period 2002-2015. The sample of variables consisted of three age-related parameters: Beginning, Experience and Peak. The variables were processed by descriptive statistics. The differences between weight groups were analysed using the Kruskal-Wallis test and trends were added to graphical representation to perform analysis across years. RESULTS: Olympic Games or world championship (OG/WCh) medal winners started their wrestling training at the age of 10.51±2.98 years. They had been training for 15.09±4.28 years before they won their first medal at the age of 25.55±3.10 years. The middleweight wrestlers started to train wrestling significantly earlier ($p<0.01$), than their lightweight counterparts and most heavyweight counterparts and thay acquired more wrestling experience before the first OG/WCh medal winning. CONCLUSIONS: The wrestling beginning age demonstrated a decreasing trend across the years of the observed period, so caution is advisable as regards early specialization. A rising trend in training experience is a consequence of a declining trend in wrestling beginning age. Analysis across weight groups indicated, although not pronouncedly, that lightweight- and heavyweight-group wrestlers may begin to train at later age and accomplish outstanding achievements with less experience. This study provides a precise set of information to wrestling coaches on when to include their trainees in wrestling, for how long one needs to wrestle before winning the first medal and at which age we can expect a wrestler to win his/her first major competition (WCh or Olympic) medal in accordance with the respective weight groups.

**Key words:** Wrestling World Championships, Olympic Games, Greco-Roman style, weight categories, adult wrestlers, experience, achievements

## Introduction

Age-related parameters, like the appropriate age (span) to start with wrestling training, wrestling experience (required for certain sport achievements), sports career peak age, and

career cessation age are very important for wrestlers and, especially, coaches for optimal design of one's sports career from its beginning to the end of competition. This issue has already been addressed by Mirzaei et al. (2013) on seven most successful world countries, by Baić, Karninčić, and Šprem (2014), with the sample of European medal winners, and by Šprem (2013), with the sample of European and world medal winners. Previous literature recommended that specialized wrestling training should begin at the age span of 11-13 years (Bompa, 1999), or at 13 years of age (Petrov, 1977). The study by Baić and colleagues reported that the European medal winners started with wrestling at the age of 10.27±2.79 years (Baić, et al., 2014). Consequently, we can feasibly suggest that 10 years of age is an appropriate age to start with wrestling training. However, world population, hence world wrestling population as well, living in various geographical areas, is not uniform with regard to phenotypic and genotypic characteristics (King, Stansfield, & Mulligan, 2006). So, would we find these various genotypic and phenotypic characteristics reflected in the age-related parameters, or would they appear to be the same worldwide? Furthermore, years and years of training experience is needed for any noteworthy achievement in most sports branches, wrestling alike (Pallares, Lopez-Gullon, Torres-Bonete, & Izquierdo, 2012). To win a European-level medal, wrestlers had to have 14.61±4.02 years of training experience (Baić, et al., 2014). Yet, competition at the world championships and/or Olympic Games is even more intense, so a question arises: is experience of 14.61 years enough to win an OG/WCh medal or do wrestlers must train for a longer period? According to some researchers, there is an age difference between elite-level wrestlers and their less successful counterparts – the former are older (Lopez-Gullon, et al., 2011). Nonetheless, medal winners' age appear to decrease. Curby (2004) reported that Olympic winners were 27.15 years old on average, whereas Baić and colleagues (2014) published that the European medal winners were on average 24.86±3.29 years old with the note that the trend in medal winning age decreased. The mentioned findings are in line with the theory saying that the best, peak wrestling performance is achieved at the age span of 24-27 years (Bompa, 1999). Interestingly enough, all the analysed age-related parameters manifested a decreasing trend in the sample of European wrestlers – children start doing wrestling ever earlier; ever less experience (in years) is needed before a noteworthy medal winning, and, consequently, medal winning wrestlers are ever younger. Earlier biological maturation (Lingor & Olson, 2010), advances in sports training methodology, and ever expanding selection of legal (sometimes even illegal) supplementary substances are among relevant causes of such trends. Regardless of causes, coaches must know the trends and take them into account in order to be able to harmonize sports training programmes with biological maturation and to set reasonable, attainable goals for their wrestlers. Analysis across weight classes at the European level (Baić, et al., 2014) demonstrated that it was feasible to start wrestling later and had less years of experience before a medal winning at the extremes of weight spectrum (the lightest and heaviest weight categories), probably due to less intense rivalry in these weight classes. Competition at the world championships and Olympic Games in all weight categories is even more intense, so we were curious if there were any differences in age-related parameters at the global level. The aim of the research was to establish differences between weight groups in age-related parameters (beginning age, wrestling experience, and peak performance age) of top-level world-class wrestlers and to analyse the revealed trends.

**Methods**

The sample of entities was comprised of a group of 229 Greco-Roman wrestlers who won their first Olympic Games or world championship (OG/WCh) medal in the period 2002-2015. The entire sample was divided into three subsamples/groups: Lightweight (n=84; weight classes: 55 kg, 60 kg, 66 kg, and a new class, 59k g), Middleweight (n=93; weight classes: 71 kg, 75 kg, 80 kg), and Heavyweight (n=53; weight classes: 85 kg, 96 kg, 130 kg).

The sample of variables consisted of three age-related variables: age at which medal winners started doing wrestling (Beginning), years of training experience before the first OG/WCh

medal winning (Experience), and age at which wrestlers won their first OG/WCh medal (Peak). All variables are expressed in the number of years. The data were retrieved from the wrestlers' publicly available charts, published at the United World Wrestling (UWW) site.
The data were processed by the statistical package Statistica 12 (Statsoft, USA). Descriptive statistics were computed (arithmetic means and standard deviations). Kolmogorov-Smirnov test was used to explore data goodness of fit (distribution normality). To establish possible differences between the three weight groups Kruskal-Wallis test was used and trends were added for the analysis across the observed years. The level of significance was set at $p<0.05$.

**Results**

(Table 1.) Descriptive statistics (arithmetic means and standard deviations) and goodness of fit (Kolmogorov-Smirnov test) for the variables of weight groups together and, separately, of each of the three specific weight groups

| | All groups | Lightweight | | Middleweight | | Heavyweight | |
|---|---|---|---|---|---|---|---|
| | N=229 | n=84 | | n=93 | | n=53 | |
| | Mean±SD | Mean±SD | K-S | Mean±SD | K-S | Mean±SD | K-S |
| Beginning | 10.51±2.98 | 10.92±2.80 | p<0.10 | 10.02±2.88 | p<0.20 | 10.73±3.34 | p<0.20 |
| Experience | 15.09 ± 4.28 | 15.06±4.20 | p<0.10 | 15.86±4.20 | p<0.01 | 15.35±4.73 | p<0.20 |
| Peak | 25.55 ± 3.10 | 24.99±3.04 | p<0.05 | 24.99±3.04 | p<0.20 | 25.94±3.16 | p<0.20 |

Apparently (Table 1.), two variables (Lightweight/Peak; Middleweight/Experience) deviated significantly from the normal distribution, therefore further data processing was completed using non-parametric statistical methods.

(Table 2.) Differences (Kruskal-Wallis test) between the three wrestling weight groups in the age-related variables: Beginning, Experience and Peak

| | Begininng | | Experience | | Peak | |
|---|---|---|---|---|---|---|
| | Middle | Heavy | Middle | Heavy | Middle | Heavy |
| Light | p=0.06 | p=1.00 | p=0.01 | p=0.45 | p=0.17 | p=0.23 |
| Middle | | p=0.40 | | p=0.98 | | p=1.00 |
| Kruskal-Wallis | H=5.87 p=0.05 | | H=8.01 p=0.02 | | H=4.70 p=0.09 | |

*Note. Light – Lightweight; Middle – Middleweight; Heavy – Heavyweight*

It is obvious from Table 2 that there was a statistically significant difference ($p<0.01$) between the lightweight and middleweight groups of wrestlers in their years of wrestling experience, whereas the difference in the beginning age was on the border of significance ($p=0.06$).

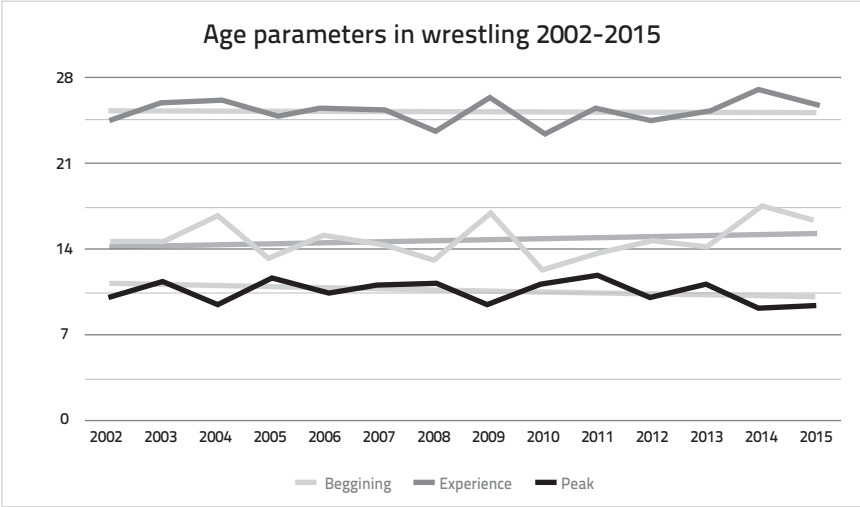


Figure 1. Trends of age-related parameters for the period of 2002-2015 - world-class Greco-Roman wrestling medal winners.

The line of beginning age (Figure 1.) of world-class wrestlers is slightly declined, whereas the line of experience needed for OG/WCh medal winning is slightly inclined. Peak performance line demonstrates constant trend throughout the analysed 14 years.

**Discussion**

Within the analysed period, prospective OG/WCh medal winners started to train wrestling at 10.51±2.98 years of age. The finding is in line with the findings regarding the European level and manifests the same decreasing trend. Children's inclusion in organized sport has been shifted tremendously nowadays, almost to the early childhood (to 3-5 years of age), but not because of earlier biological maturation; the shift has commercial and performance conditioned roots. A sport branch lagging behind in talent identification and selection will lose quality novices to other sports disciplines. It is possible to lower the beginning age in wrestling, but it would enormously increase the risks of early specialization, probably leading to serious health issues and/or early drop-out from sport (McKay, Broderick, & Steinbeck, 2016). The contemporary development of sport forces an early start of systematic training. This is connected in general to the intensive exploitation of the child's organism, which causes injuries, overload degenerative changes, deterioration or even loss of health. Some countries take part in this "race" but the fact is it is against Children's Rights Convention of the UN (Klodecka-Rozalska, 1991). The analysis of the age at which martial arts were taken up by about 20000 champions (master class) of that discipline (Tumanjan, 1984) demonstrated that competitors who started training late, achieved almost the highest class. For example, a considerable majority of free style and classical wrestlers started practicing the discipline after they were 13 years old. This observation may confirm that it is not advisable to start early the training process in wrestling. Wrestlers of lighter weight group started their training later (almost significant, p=0.06); the same trend also exists at the European level (Baić et al., 2014). Middleweight-group wrestlers' inclusion in the sport-specific organized training was the earliest, so we can say that a somewhat less intense rivalry is obvious at the ends of weight spectrum, a phenomenon apparent at the European level and global level alike, although the global-level differences were not statistically significant. In research conducted by Mirzaei et al. (2013) Iranian medal winner begin with wrestling much later (12.25±2.19 yrs) and von their medals much earlier, after only 6.97±3.06 years of practise. The possible reason for that is great tradition and popularity of wrestling in Iran, there are a lot of quality sparring partners, good treining metodology and wrestlers van and wrestlers can collect experience faster. The variable wrestling experience manifested an increasing trend at the OG/WCh level. Such a

trend is probably due to the decreasing trend in beginning age, whereas the medal-winning age has been constant throughout the years. Experience is a multi-layer category and may imply training experience and/or combat experience. Due to the increased number of competitions in recent wrestling calendars and the practice of specific international sports preparation, which gathers quite a number of high quality sparring partners (Hodges, 1995), athletes rapidly acquire combat experience; on the other hand, training experience has been accelerated by the application of better training methodology and advances in sports pharmacology (de Andrade Kratz, et al., 2016; Manjarrez-Montes de Oca, et al., 2013), although within the limits of biological development laws. When experience is analysed from the aspect of weight group, then the longest experience of the middleweigh group becomes obvious, yet the statistical significance was obtained only between the lightweight and middleweight group. The average age at which wrestlers win OG/WCh medals is 25.55±3.10 years. According to Bompa (1999), wrestlers are at the peak of their performance, accomplishing their highest sport achievements, at the age of 24-27 years, whereas Curby (2004) says it is the age of 27 years. The obtained trend line has been anchored at the age of 25.5 years throughout the investigated period (14 years), which is in concordance with the findings regarding the Iranian Olympic medal winners' age of 24.9 years (Golbar, Gharakhanlou, Barmaki, Khazani, & Khorshidi-Hosseini, 2015). A slight decrease of this parameter is a feasible assumption. If the wrestlers' improvement can be attributed to biological acceleration and sports training advances, than it is an acceptable trend; however, if the improvement has been induced by a phenomenon known in kinesiology as "burnout", caused by a premature specialization (Brenner, 2016; Feeley, Agel, & LaPrade, 2016) and inappropriately early onset of wrestling training, then it warrants serious future research. Yet, the heavyweight group wrestlers were slightly older at the moment of OG/WCh medal winning, although the difference was not significant. The similar, yet statistically significant, difference was observed in the European medal winners (Baić, et al., 2014), so it can be concluded that "heavier" wrestlers should be "more mature". Age parameters are under influence of numerous factors and average span of time needed to achieve a champion's rank (level) should be treated in a flexible way that is, it should be defined within the limits involving most of the cases (Puni, Starosta, 1979; Starosta, 1982; Starosta, Handelsman, 1990).

**Conclusion**

Beginning age manifests a modest decreasing trend, whereas wrestling experience has a modest growing trend. These two phenomena are correlated: wrestlers have more experience because they commence to train earlier. The trend of OG/WCh medal winning age is consistently at 25 years. Wrestlers of the lighter weight groups started their training somewhat later than their heavier counterparts and had less years of experience. Heavier wrestlers were older when winning their first OG/WCh medal. This study offers a precise set of information to wrestling coaches on when to include their trainees in wrestling, for how long one needs to wrestle before winning the first medal and at which age we can expect a wrestler to win his/her first major competition (WCh or Olympic) medal in accordance with the respective weight group.

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# Structure, conditions and development of "opponent's feeling" in opinion of high advanced wrestlers and athletes of selected combat sports

*"..muscle feeling is a sum of sensations accompanying very body movement, and every change un their position in respect to one another"*
*[Sietschenov, 1952]*

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**ABSTRACT**
The level of coordination abilities is of crucial importance in combat sports and martial arts. Its particular and very specific manifestation is the "opponent's feeling" which exerts a considerable impact on the effectiveness of the fight. Despite the considerable importance of the "opponent's feeling" this problem has been treated very marginally so far . The proof of the fact is the lack of very little number of publications [2, 19] and attempts to define the notion, to describe its structure and conditions of development. PURPOSE: of the work was: 1. Define the term of "opponent's feeling" in combat sports and martial arts competitors. 2. Specify components (structure) of "opponent's feeling". 3. Define the conditions of high level of "opponent's feeling". 4. Attempt to establish the conditions affecting the "opponent's feeling" and methods of its development. 5. Look for reserves as far as the development of movement coordination, and focus particularly on its complex manifestation such as "opponent's feeling", "mat feeling" etc. MATERIAL and METHOD. Studies were conducted on 154 advanced athletes: wrestlers in classical style (n =50) and female and male wrestlers in free style (n=11+59=70), 20 kyokushinkai karatekas and 14 wrestling coaches. A particularly high level of advancement was recorded for wrestlers, who included former Olympic champions and medal winning athletes of the highest rank. Responses to 12 of them were then processed. The age of studied individuals was within 18-40 years, and the training period was 5-25 years. A questionnaire prepared by W. Starosta and containing 21 questions dealing with "opponent's feeling" was research method. The questions concerned the "opponent's feeling" among representatives of selected of combat sports and martial arts. CONCLUSIONS: 1. A complex manifestation of a high level of coordination abilities such as "opponent's feeling" or "mat feeling" depend on a number of conditions: level of sport advancement, training experience, length of training period, part of training session, temperature of the surrounding, level of emotions etc. 2. The majority of the questioned observed in the themselves a higher level of "opponent's feeling" during the start training period, rather than during preparatory period. 3. According to the surveyed (45%), the highest level of the "opponent's feeling"

occurred in the main/ core part of the training session, and the lowest in its further part (31%). 4. The symptoms of the high level of "opponent's feeling" include: The correct predicting of the opponent's intentions; Proper psychic attitude; The certainty of the fight; The improper of "opponent's feeling" is the lack of these symptoms.

**Key words:** coordination abilities, "opponent's feeling", training period, structure of "opponent's feeling", conditions of this feeling, advanced competitors.

**Introduction**

In combat sports a high level of movement abilities is a requisite for achieving a significant result. In the event of an equal level of physical abilities and technical and tactic preparation, coordination abilities become of crucial importance. The application of appropriate proportions in the development of physical and coordination abilities allows achieving a champion level of technique. Combat sports belong to sport disciplines that are of complex coordination, as they necessitate manifestation of accurate and quick movements in changing conditions (Figure1).


III - Spartial, time and strenght precision of movement performed in minimum time units under changing conditions.
II - Spartial, time and strenght precision of movement performed in minimum time units (under almost standard conditions).
I - Spartial, time and strenght precision of movement performed iaccording to pattern.

Figure 1. Suggested classification of selected sport disciplines according to their degree of complexity of movement coordination level [Starosta, 2004]

This means that they should be classified to the third, highest level of movement coordination. They occupy leading positions in the hierarchy of sport disciplines taken into account at this level, along with sport games. They demand from the athletes high level of almost all coordination abilities. Their higher level is advantageous when mastering the technique at a champion level. One of particularly significant elements is specific kinaesthetic impressions called: "opponent feeling", "mat feeling", "tatami feeling", "distance feeling" etc. Those sensations form an individualised synthesis of all types of preparation of an athlete (Figure 2).

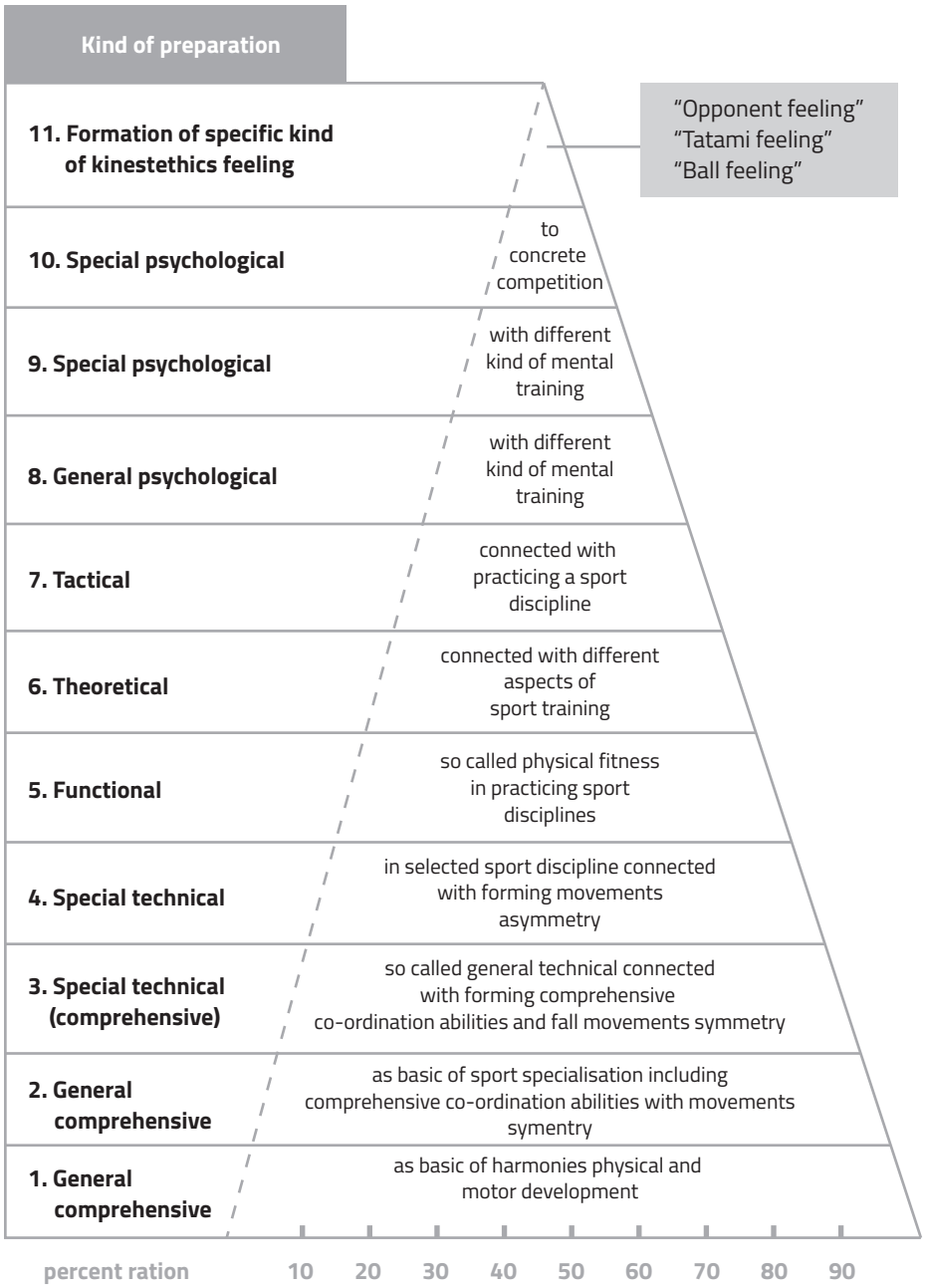


Figure 2. Formation of specific kinaesthetic sensations (feeling) by athletes in comprehensive preparation during long-term training [Starosta, 2001]

The concept of "ball feeling" or "water feeling" have been present in theory for quite some time [6, 8-10, 18-19, 24] and also in sport practice. Representatives of psychology have dedicated to them most attention [5, 7, 14-15]. A lot of attention was furthermore dedicated to "ball feeling". For example, for T. T. Dżamgarov and A.C. Puni [5] "ball feeling" "...is a multiform complex regulator of motor activity and a manifestation of sensory culture". A comprehensive definition was proposed by G. M. Gagajewa, who defined "ball feeling" as: "Ability of accurate regulation of movements and muscle effort based on observations in relation to specified activities and evaluation of distance between players, the ball and the goal" [7, 23]. "Ball feeling", "opponent feeling" and its other specific types concern especially important elements of technique, and their high level is an indispensable component of sport championship. Hence, determination of the content of those notions, their structure and conditions is of considerable theoretical importance, and even of a bigger practical one. It would help activating reserves which up to now have not been sufficiently used, and would also modify the presently functioning system of training in sport games and in combat sports. Despite the fact that the notion of "ball feeling" and its importance has been emphasised by many sport theoreticians, research related to this issue has continued to a limited extent in football, which was commenced by G. Gagajewa [7] several years ago [23, 3]. They were expanded by "ball feeling" in basketball [12, 18] and in table tennis [21-22]. Despite the fact that the exceptional importance of "ball feeling" for effectiveness of the game has never been questioned, hitherto studies have not taken up this issue too frequently [7, 18-20].

The situation was much less advantageous for the notion of "opponent feeling", which up to now has not been used much, and which differs practically in each type of combat sports. It occupies a special position owing to its range and multiaspect character of manifestation. It was not long ago that the content of this notion and its associated conditions were taken up, probably for the very first time [2, 19]. A survey performed using a questionnaire with 21 questions was based on material that comprised 56 athletes from the national teams of 5 Arab countries practising taekwondo. It was found that the majority of tested subjects (64%) experienced a higher level of "opponent feeling" in the competition period, and the lowest one in the preparatory period (31%). In the opinion of the majority of surveyed persons (45%) the highest level of this feeling occurred in the basic part of the training, and its lowest level in the initial (33%) or final part (18%). Symptoms of high level of "opponent feeling" comprised: correct "perceiving" of intentions of the opponent (35%), appropriate mental attitude (29%), self-assertiveness during the fight (21%), appropriate body position (6%), quick reaction to a movement made by the opponent (4%). Almost a half of surveyed athletes (47%) have noticed a relation that occurs between "opponent feeling" and the level of movement coordination. The high level of this is affected to a large extent (57%) by the acquired training level, as well as by the quality of performed training (17%).

Results of those tests outlined a problem that appears in taekwondo for 56 high class athletes of five Arab countries. It was impossible to say whether research conducted on representatives training other combat sports and on a more numerous group would allow achieving similar results. Hence, the aim of this study was the: 1. Attempt to formulate a definition for the content of the notion "opponent feeling". 2. Seeking of elements of the structure of this notion. 3. Determination of the level of "opponent feeling" depending on the length of the training period. 4. Attempt to determine associations between "opponent feeling" and the sport result. 5. Seeking of dependencies between "opponent feeling" and the dominant body side. 6. Endeavour at determining associations between "opponent feeling" and external conditions. 7. Determination of conditions that affect the high or low level of "opponent feeling" and methods of its shaping. 8. Determination of interdependencies between "opponent feeling" and the level of movement coordination.

**Material and Methods**

Studies were conducted on 154 advanced athletes: wrestlers in classical style (n =50) and female and male wrestlers in free style (n=11+59=70), 20 kyokushinkai karatekas and 14 wrestling coaches [1, 4, 11, 13]. A particularly high level of advancement was recorded for

wrestlers, who included former Olympic champions (A. Wroński, R. Wolny, W. Zawadzki) and medal winning athletes of the highest rank (among others J. Fafiński, J. Tracz, P. Stępień). A considerable majority of surveyed athletes belonged to a group of leading Polish athletes and had a long training experience. On all the subjects a survey was conducted using an identical questionnaire, which comprised two parts. The first one of them included information concerning personal data, training period, age, advancement in sport, achievements and self-evaluation of lateral differentiation of the upper and lower extremities. The second one comprised 21 questions connected with the notion of "opponent feeling", its structure and determining conditions. Responses to 12 of them were then processed. The age of studied individuals was within 18-40 years, and the training period was 5-25 years. Hence, those were athletes with long sport training experience.

**Results**

***1. The notion of "opponent feeling" and its understanding by the surveyed athletes***

The vast majority of advanced wrestlers in both styles (65%) understood this notion in the following way: "ability of anticipating, feeling movements of the opponent and immediate response to them". Their individual opinions related to "opponent feeling" differed: "ability of performing a counteraction with the entire body to the opponent's action"; "ability of making use of the opponent's force to one's advantage"; "ability of the body to anticipate intentions of the opponent, as well as their full control"; "experiencing each factor applied on us by the opponent"; "ability of quick recognition and reaction to stimuli applied by the opponent". In a similar way it was possible to define the feeling based on opinions expressed by karate athletes: "ability of anticipating the behaviour of the opponent during a fight". However, in individual statements they provided a different definition: "feeling each factor that the opponent uses on us"; "feeling of distance and the ability of anticipating movements of the opponent"; "ability of foreseeing movements of the opponent allowing preparation for defence and counterattack".

In addition efforts were made to define interpersonal conditions for shaping the "opponent feeling". Athletes of various combat sports have listed similar components: congenital predispositions, high level of movement coordination, "feeling of the muscles", high level of technical training, mental resilience, ability of tensing and relaxing muscles, reaction time, ability of foreseeing the opponent's movements, general frame of mind, intellectual fitness, experience.

***2. Manifestation of the "opponent feeling"***

A synthetic formulation of opinions expressed by female and male wrestlers showed that this feeling was manifested in: quick response, controlling progress of the fight, appropriate muscle tension, anticipating intentions of the opponent, selection of the best moments for attack, quick and accurate assessment of developments on the mat, suitable position during the fight. Also of interest were opinions of some wrestlers with respect to manifestation of this feeling: "I manage to perform all the planned technical elements"; "readiness of response to actions of the opponent at an appropriate time, including also dominating over the opponent"; "muscle tension"; "the athlete is able to feel the opponent anticipates his actions, does not let the opponent take him by surprise or avoids a part of a fight which seems to him to be dangerous. He is able to foretell attacks in the so-called second and third intention".

Statements made by karatekas were generally the same. Also of interest was a statement of one of them that this feeling is manifested by: "appropriate fight control (during the fight I must feel well and be relaxed)". The original wording was maintained for statements of the athletes, even though at times it was similar to slang used in the athlete milieu, as some of them pertinent expressed the essence of the discussed notion. Responses granted to the first two questions form constituents, out of which it may be possible to formulate a more comprehensive and a more correct definition of the notion of "opponent feeling".

***3. Symptoms of high and low level of "opponent feeling"***

An analysis of symptoms of both levels of synthetic approach to this feeling in wrestlers (table 1) and karatekas has indicated a considerable convergence of their statements. A certain differentiation was observed in opinions of particular athletes. Below are some selected statements of wrestlers: "a symptom of low level of this feeling is the insufficient anticipation of actions of the opponent"; "a high level of this feeling is associated with quicker response and vigour , and the lower level – heaviness, lack of fight concept, insufficient endurance"; "high level of the "feeling of the opponent" is manifested by correct response and control of actions of the opponent, and the low one with stress, continuous muscle tension and belated reaction"; "direct contact with the largest possible surface of the opponent's body allows good feeling, the smaller this surface, the inferior is this feeling"; "at a high level of this feeling I can sense in the hands changes in muscle tension of the opponent and I know exactly when he is going to attack, and when he is only feigning an attack, and I can also tell when he is relaxed. Then I am not overly tired in simple actions. At a low level of this feeling I must continuously be fully alert and careful, and I am unable to foresee the consequent action of my opponent, and if I get the feeling that he is weaker, I lose the fight."

Table1. Symptoms high and low level of „opponent feeling" in opinion advanced wrestlers of free and Greek-roman style and karatekas (n=156) [Starosta, 2006]

| No | Symphtoms of high level | No | Symphtoms of low level |
|---|---|---|---|
| **1** | Quick reaction to the opponent's movement | **1** | Delayed reaction to the opponent's movement |
| **2** | Correct feelings towards the opponent's (i.e. distinguishing simulated from real attack) | **2** | Lack of abilities to forsee the intentions of the opponent |
| **3** | Adequate preparation for competitions | **3** | Inadequate preparation for competitions |
| **4** | Proper position of body during various movements of the fight | **4** | Improper position of body during various moments of the fight |
| **5** | Proper physical attitude (toward the realization of the tactical program) | **5** | Improper physical attitude (towards the lost fight) or it's lack |
| **6** | Contact the large surface of the opponent's body | **6** | Contact with small surface of the opponent's body |
| **7** | Ability to relax muscles at various moments of the fight | **7** | Constant tension of the muscles during the fight |
| **8** | Confidence in applying technical and tactical elements | **8** | Uncertainty as far as own actions |
| **9** | Lack of injuries and fear of them | **9** | Fear of the recurrence of the injury or of the suffering another one |
| **10** | Control actions executed by the opponent | **10** | Inability to adjust the way of fight or imposing one's own style fighting |
| **11** | Skillfull use of the opponent's strenght | **11** | Low level or lack as far as the use of the opponent's strenght |
| **12** | Ability to anticipate the opponent's movements | **12** | Delayed reaction towards the opponent's movements i.e. inability to foresee |

Karatekas, have to a large extent, repeated symptoms stated by the wrestlers. Among individual opinions worthy of attention were: "symptoms of high level of this feeling are observable when I am generally well prepared and when I am fully in form"; "at a high level of this feeling self-assertiveness appears"; "at a low level of this feeling I become unable to adapt to the fight of the opponent"; "low level of this feeling is manifested in erroneous responses to attack and in the lack of feeling of the distance involved".

***4. Factors affecting high or low level of the "opponent feeling"***

Wrestlers in both styles specified 15 factors and ordered them hierarchically according to percentage values (table 2). They agreed with respect to the first three of them: congenital predispositions, level of training and movement abilities. Divergence of opinions took place with respect to technical preparation, which was placed by classical style wrestlers on the fourth position, and free style on 5th- 6th, including professional training experience. For the latter ones the fourth position was taken by the level of movement coordination, which was not specified by classical style wrestlers (it may not be ruled out that they have ascribed it to the level of movement abilities?). Karatekas took 12 such factors into account, a part of which did not come up for wrestlers: level of involvement in the fight, atmospheric conditions, health state, frame of mind. Medal winners of Olympic games have provided an interesting formulation of factors that affect the high level "opponent feeling": high disposition, general physical, speed and endurance preparation, as well as freshness of the athlete" (R.W.); "first of all the attitude of the athlete, his involvement in training and general feeling during the fight" (J.T.); general feeling, temperature, acquired training level" (P.S.).

Table 2. Factors influencing high and low level of "opponent feeling" in the opinion of advanced wrestlers of free and Greek-Roman style (n = 43) [Starosta, 2006]

| No | Factor | Classical style | Free style |
|---|---|---|---|
| 1 | Inborn predispositions | 43.8 | 40.7 |
| 2 | Degree of training | 37.5 | 40.7 |
| 3 | Level of movement abilities | 25.0 | 25.9 |
| 4 | Level of technical preparations | 25.0 | 14.8 |
| 5 | Number of executed fights | 18.8 | 3.7 |
| 6 | Psychological features | 18.8 | 7.4 |
| 7 | External (outside) practice | 6.3 | 3.7 |
| 8 | Training period | 12.5 | 7.4 |
| 9 | Level of sport advancement | 12.5 | - |
| 10 | Competitor (sport) practice | - | 14.8 |
| 11 | Adequate concentration of attention | - | 11.1 |
| 12 | High speed of executed movements | - | 7.4 |
| 13 | Recognition of the opponent | - | 3.7 |
| 14 | Kind and quality of training | - | 3.7 |
| 15 | Level of movement coordination | - | 18.5 |

***5. Level of the "opponent feeling" in various training periods***

The highest level of this feeling in the major part of free style wrestlers (88.9%), of the classical style (93.7%) and karatekas (95%) was observed in the competition period (Figure 3). In a very small group of surveyed subjects it took place in the preparatory period (5 to 11.1%). The appearance of the highest level of this feeling already in the preparatory period may be the proof of: application of adequate training loads for the given individual, appropriate proportions occurring between exercises that shape fitness and coordination abilities, high level of sensory sensitiveness of the athletes, as well as insufficiently correct self-evaluation. A considerable divergence of opinions concerned the lowest level of this feeling. In the majority of surveyed classical style (50%) and free style (59.2 to 100%) wrestlers and karatekas (10%) it was observed in the preparatory period, and in part of wrestlers (22.2 to 70%) and karatekas (90%) in the transitory period. In the light of modern training theory, it appeared to be difficult to explain the occurrence of the lowest level of "opponent feeling" in the transitory period, i.e. when the training content was supposed to have been focused on shaping various coordination abilities and kinaesthetic impressions.

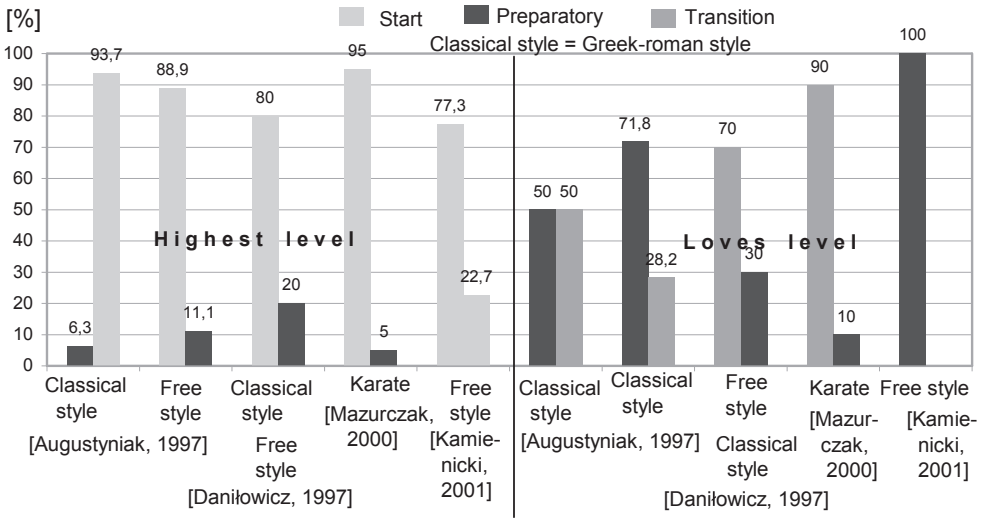


Figure 3. Level of "opponent feeling" in different periods of training in the opinion of advanced wrestlers and karate competitors (n = 156) [Starosta, 2006]

***6. "Opponent feeling" in various parts of the training unit***

In the vast majority of free style (62,5%) and classical style (92,5%) wrestlers, as well as karatekas (65%), the highest level of "opponent feeling" appeared in the upper part of the training unit (Figure 4). The occurrence of such a level in a numerous group of athletes (classical style wrestlers – 7.5%, and free style wrestlers– 25%, karatekas – 35%) already in the initial part was surprising. Perhaps they belonged to sensory individuals, for whom a high level of kinaesthetic sensations appears after a short warm up. It was unexpected that the lowest level of this feeling appeared for wrestlers of classical style (6%), free style (11%) and karatekas (70%) already in the initial part of their training unit. This may indicate an exceedingly intensive warm up or insufficient restitution of forces after the preceding training. In the considerable majority of wrestlers of the classical style (87.5%) and free style (85%) the lowest level of the feeling was found in the final part of the training unit. Results achieved by karatekas clearly diverged from that trend, as only 30% of them have observed such a level of this feeling in the final part of the training.

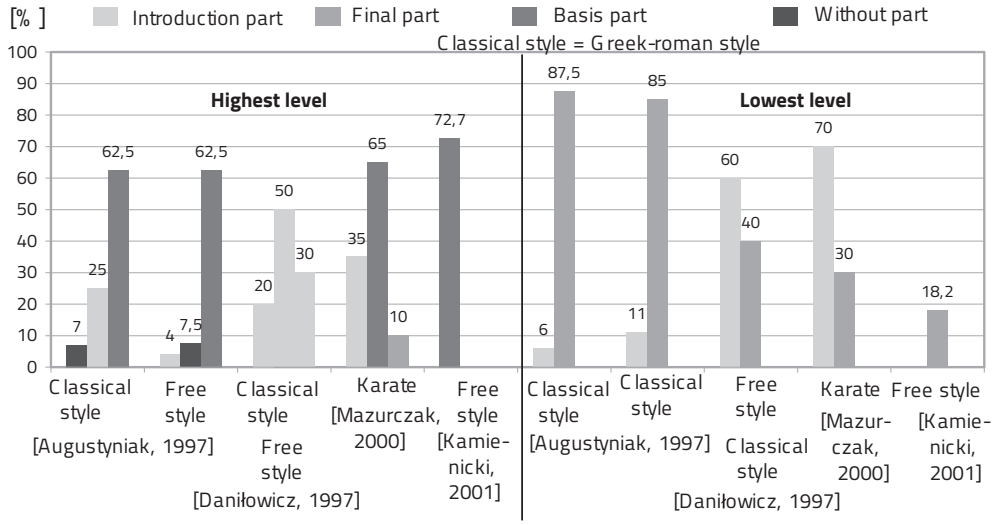


Figure 4. Level of "opponent feeling" in different parts of the training session in the opinion of advanced wrestlers and karate competitors (n = 156) [Starosta, 2006]

***7. "Opponent feeling" and the achieved sport result***

A considerable majority of wrestlers in both styles and karatekas (90-100%) have noticed the relation taking place between the level of that feeling and the achieved sport result. For few wrestlers (10%) such a relation did not exist. Here are some selected opinions expressed by wrestlers: "This relation is manifested in the effectiveness of executed technical and tactical actions aimed at obtaining a score or technical advantage"; "High level of this feeling allows saving strength, endure the fight with regard to physical condition, and allows having some moments of rest during the fight. Following an unconscious tensioning of muscles in the arm, placing of the legs, and a "feeling" of the opponent in the hands enables quicker response", "if we do not "feel the opponent", and if the opponent feels us we are not likely to win the fight. In such a situation the opponent would be quicker or counter our holds. The athlete with no "opponent feeling" would never be able to achieve a significant sport result"; "when I have a good feeling of the opponent I am able to make use of his mistakes, which allows me to win the fight with him". Some karatekas have drawn our attention to slightly different aspects: "when we feel the opponent we can avoid dangerous situations and gain advantage, and in addition appropriately distribute strength during the entire fight"; "the higher is the level of "opponent feeling", the better is the style of conducted fights, and exhaustion of the organism is reduced and the number of injuries decreased". These opinions show that the level of this feeling is a determining condition for achieving a good result in a fight.

***8. "Opponent feeling" and lateral differentiation of the lower extremities***

In combat sports an important role is played by the lower extremities. Their importance grows particularly in free style wrestling and in karate. In karate actions with the use of legs get the highest scores. Speed of leg movement combined with the strength of the "blow" predetermines the result of the fight. Studies have shown a significantly higher level of kinaesthetic feelings of the lower extremities than of the upper ones [16]. Long lasting sport training lowers the sensitiveness threshold, i.e. raises the level of space, time related and strength related differentiation of executed movements. The high level of technical championship requires an almost identical share of both extremities in the fight. A considerable majority of statements of the surveyed wrestlers of the classical style (87.5%), free style (81.5%) and karatekas (60%) indicates the domination of the right extremity. In a very small number of wrestlers a much better level of feeling concerned the left leg (6.3% in the classical style and 7.4% in the free style).

In karatekas this was observed in almost 40% of surveyed individuals. Very few wrestlers have indicated a uniform level of feeling of both the extremities (6.3% in the classical style and 11.1% free style). Also quite interesting were opinions expressed regarding causes of lateral differentiation between the extremities. Here are some selected opinions concerning the wrestlers: "I am a right handed athlete, and I tend to perform the majority of holds with the right arm and the right leg"; "because I use the right leg more frequently during training". Karatekas have provided a different justification: "the right leg has a stronger blow, and is much more accurate"; "in karate a fighting stance is preferred, in which the left leg is in front and is characterised by a higher level of feeling, speed, but it is slightly weaker". Formation of a functional differentiation of the extremities, including also the dominating leg, results from its more frequent use during training, which in due course becomes a permanent habit. Possibilities of improving the "opponent feeling" though symmetrical performance of technical elements was noticed by few persons – mainly wrestlers (6.3 to 11.1%).

***9. "Opponent feeling" and the level of movement coordination***

Such a dependence was acknowledged by a vast majority of the surveyed wrestlers (96.3 to 100%) and a half of the karatekas. Such a relation was not observed by a numerous group of karatekas (50%). A vast majority of both styles of wrestlers (96.3% to 100%) and karatekas (95%) came to the conclusion that a high level of movement coordination is favourable to shaping of the "opponent feeling" as a component of the technical champion level. Medal winners in Olympic games have expressed quite interesting opinions with respect to such a relation: "coordination affects significantly the level of the 'feeling of the opponent'" (A.W.); "motor coordination and this feeling go well together. Movements become easier to learn and to train" (R.W.); "a fitter athlete has a better movement coordination and consequently his 'opponent feeling' is higher" (W.Z.); "the fitness and movement coordination allow easier learning of the wrestling technique, and consequently helps improve the feeling" (P.S.).

Materials collected through the questionnaire supplement results of a survey performed on 24 wrestlers which concerned the influence of a particular coordination ability on the course and result of a fight during contests. The questionnaire included 8 abilities, and the surveyed individuals were to define the impact of particular abilities on the result of the fight in percentage (fig. 5). In this hierarchy the leading places were occupied by the following abilities: manifestation of quick response (22%), maintaining balance (18%), adaptation (combining) (15%), space and time related orientation (12%) and movement differentiation (11%). Such an approximate hierarchy may become the subject of discussion.

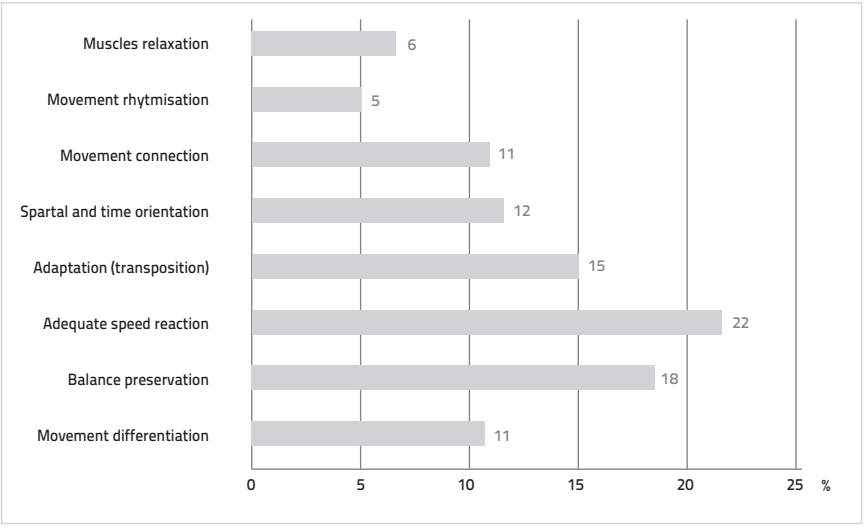


Figure 5. Hierarchy of movement coordination abilities influencing the process and the result of fighting in the opinion of advanced wrestlers (n = 24) [Starosta, Augustyniak, 2006]

***10. "Opponent feeling" and external conditions***

The impact of those conditions on changes with respect to feeling was observed by the majority of wrestlers (62 to 67%) and a half of the karatekas. Low ambient temperature lowers the quality of the applied technique, and an optimum one may be advantageous to the appearance of a higher level of "opponent feeling" and a better technique. Here are some selected opinions of wrestlers: "the excessively high or low temperature affects adversely the psychical and movement system, while lighting has a smaller impact on the 'opponent feeling', while the type and quality of surfacing affect significantly its level"; "a high ambient temperature and the consequent sweating of the opponent during a fight hinder the ability of anticipating potential actions"; "during a fight on a smooth and resilient mat in a warm and well lit facility the level of the „opponent feeling" tends to increase. It is also manifested in quicker response". As many as 33 to 38% of the wrestlers and 50% of karatekas were of the opinion that external conditions do not affect significantly the effectiveness of the fights. Here are some opinions expressed by wrestlers to justify this standpoint: "on each surface and in all conditions, when an athlete has the 'feeling' it would be likely to be the same"; "for me personally those conditions are of no importance at all; if I am well prepared then the feeling is also at a suitable level".

***11. "Opponent feeling" and emotions***

Responses to the question concerning the impact of emotions were varied. Many athletes perceived the adverse impact of emotions on the level of the "opponent feeling" (37.5% of classical style wrestlers, 44.4% of free style wrestlers, 40% karatekas). This was further confirmed by statements of some of the wrestlers: "the higher the emotions, the lower is the ability of assessing the situation and the effectiveness of performed actions,"; "under stress the level of the "opponent feeling" is reduced". Less numerous subjects were of the opinion that emotions affect them in a stimulating way (12.5% of classical style wrestlers, 14.8% of free style wrestlers). As many as 60% karatekas confirmed the beneficial impact of emotions on the level of "opponent feeling". This is supplemented by their selected opinions: "the high level of emotions during a fight may release an increasing level of the 'feeling of the opponent'"; "in a good and experienced athlete the 'opponent feeling' affected by emotions becomes better. It is then assumed that such an athlete has achieved a champion level".

Medal winners in Olympic games have pointed out to different aspects of the impact of emotions on the level of this feeling: "the more tense is an athlete, mentally blocked, the lower is the feeling" (R.W.); "the 'opponent feeling' is reduced because of a lost fight, irritation, unjust verdict of the referee" (W.Z.); "when I am influenced by emotions during a fight, I tend to be less concentrated, and then this feeling tends to become reduced" (J.T.); "if an athlete is not thinking about the fight, and becomes tense, the feeling is decreased" (P.S.); "this is related to the psyche of each athlete. If he is to fight with a practically stronger opponent, his feeling is most probably also going to decrease (theoretically)" (J.F.).

***12. Methods of developing the "opponent feeling"***

The vast majority of studied individuals (80% of karatekas, 93% of wrestlers) stated that only contact with an opponent allows shaping this type of feeling, i.e. in natural conditions, which probably means during competitions. It seems that a fight directed at winning does not offer advantageous conditions for focusing on sensations that shape the "opponent feeling". Perhaps the surveyed athletes meant improvement of this feeling once it had been developed during training fights. Few of them were convinced that it would be better formed in the process of the improvement of the technique (20% of karatekas) or during training meetings with a partner, especially during the so-called technical training, i.e. one focused specifically on improving the technique in particular exercises. Few subjects admitted the possibility of developing this feeling through imaginative training, or the possibility of genetic conditions of this feeling and the inability of its development (4.7%). Here are some selected opinions: "The 'opponent feeling' may only be shaped through free style fights, in which the executed technical elements are not directed by anyone"; "fighting with various opponents, of various

somatic build types, training level, and abilities". Quite interesting were statements of medal winners in Olympic games: "during training in task related fights (A.W.); "during control fights" (R.W.); "through training and watching fights on the video" (W.Z.); "during a fight with a lighter partner, who has a bigger speed and is flexible" (P.S.).

***13. Use of the "opponent feeling" in different variations of sport/fight tactics***

Based on the result of a survey conducted on 62 people, including 28 wrestlers of classic style, 10 of free style, 11 women wrestlers and 14 coaches, an attempt was made to determine the magnitude (%) of the use of the "opponent feeling" in 4 different variations of tactics (Fig.6). The highest magnitude in the attack occurred in the classical style wrestlers (35%). Significantly lower were observed in free-style wrestlers (25%) and coaches (26%). In defense, the highest magnitude of the „opponent feeling" were characterized by the opinions of coaches (31%) and women wrestlers (28%). The highest values related to free style wrestlers in the counterattack (32%) and coaches (27%). In the counterattack, these values were similar in the four groups surveyed, but the highest values were characteristic of the coaches (29%). These rather mosaic results obtained from different groups of examined subjects, illustrate the importance of the "opponent feeling" in the different variations of fight tactics. This differentiation was not large, which seems to indicate the importance of feeling in all forms of tactics regardless of sports specialization, and sex. Special attention should be paid to the views expressed in percentage by quite a large group of people.

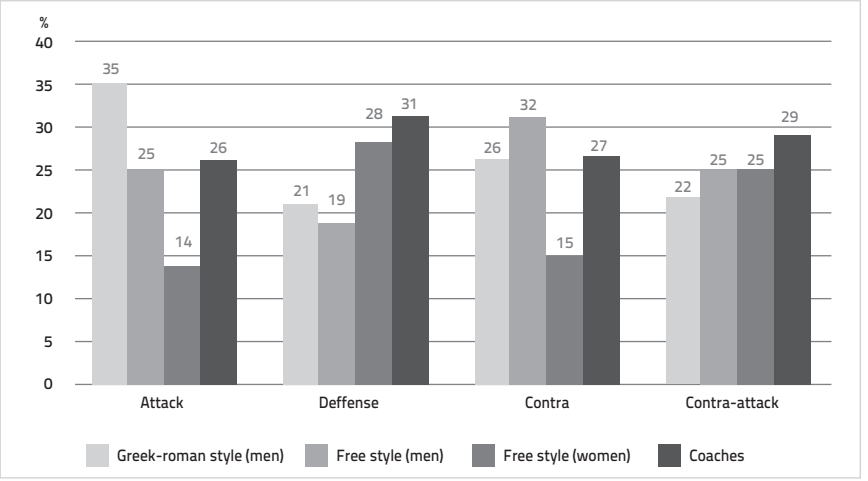


Figure 6. Utilization of "opponent feeling" in different forms of tactic during fighting in the opinion of women wrestlers, wrestlers of Greek-roman style and their trainers (n =63) [Starosta, Daniłowicz, 2006].

***14. Effect of different types of sport preparation on fight results***

In the next part of the additional survey an attempt to determine, in a precise way (%), the magnitude of the impact of different types of preparation on the final outcome of the fight in wrestling (Fig.7). The study involved 63 people, i.e. the classical style wrestlers and the free style wrestlers, women wrestlers and coaches. Among the types of preparations the following were included: muscle strength, the "opponent feeling", technique, movement coordination and more. Classical style wrestlers ranked the power (28%) first; the next was technique (24%) and the "opponent feeling" (21%). In the opinion of the men free-style wrestlers, this hierarchy was as follows: technique (22%), and the next two were equivalent: the „opponent feeling" and tactics (21%). Women wrestlers considered that the greatest impact on the final result of the fight was exerted by: technique (29%), tactics (26%) and the "opponent feeling" (23%). Quite similar hierarchy was identified by coaches: technique (26%),

tactics (22%), the "opponent feeling" (19%). In all groups, one of the highest places was given to the "opponent feeling", which significantly affected the final result of sportsmanship. Surprising is the quite distant, but similar position (fifth), given to movement coordination, within the range of 11-16%. This highest value was given by the coaches.

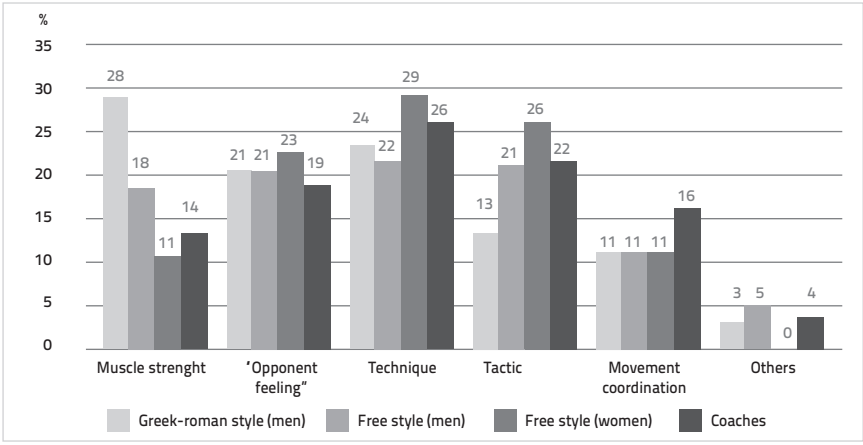


Figure 7. Influence of particular elements of athletes preparation on the results of the fighting in the opinion of women wrestlers, wrestlers of Greek-roman style and their coaches (n=63) [Starosta, Daniłowicz, 2006]

***15. Approximate structure of the "opponent feeling"***

Based on the results of own studies and of those of the co-authors, as well as of the coaches, an indicative structure of the „opponent feeling" in judo was set up [2]. It took into account only five out of 11 co-ordination abilities: kinesthetic differentiation of movements and their rhythmization, spatial indicative, reaction speed, balance maintenance (Fig.8). Despite considering only part of the coordination abilities, its structure included 28 components. Most of them were in the spatial orientation (n = 9) and kinesthetic differentiation of movements (n = 7). This structure was narrowed to judo, but many of its components also apply to other combat sports and martial arts. Nevertheless, this structure should be considered as indicative, since it does not take into account all coordination abilities, and it was developed based on the results of little research and on the experience of a relatively small group of people. But even in this initial form it may become the subject of a substantive discussion and of further research verifying the option presented. The more so that no other has been presented yet in the available and rich literature.

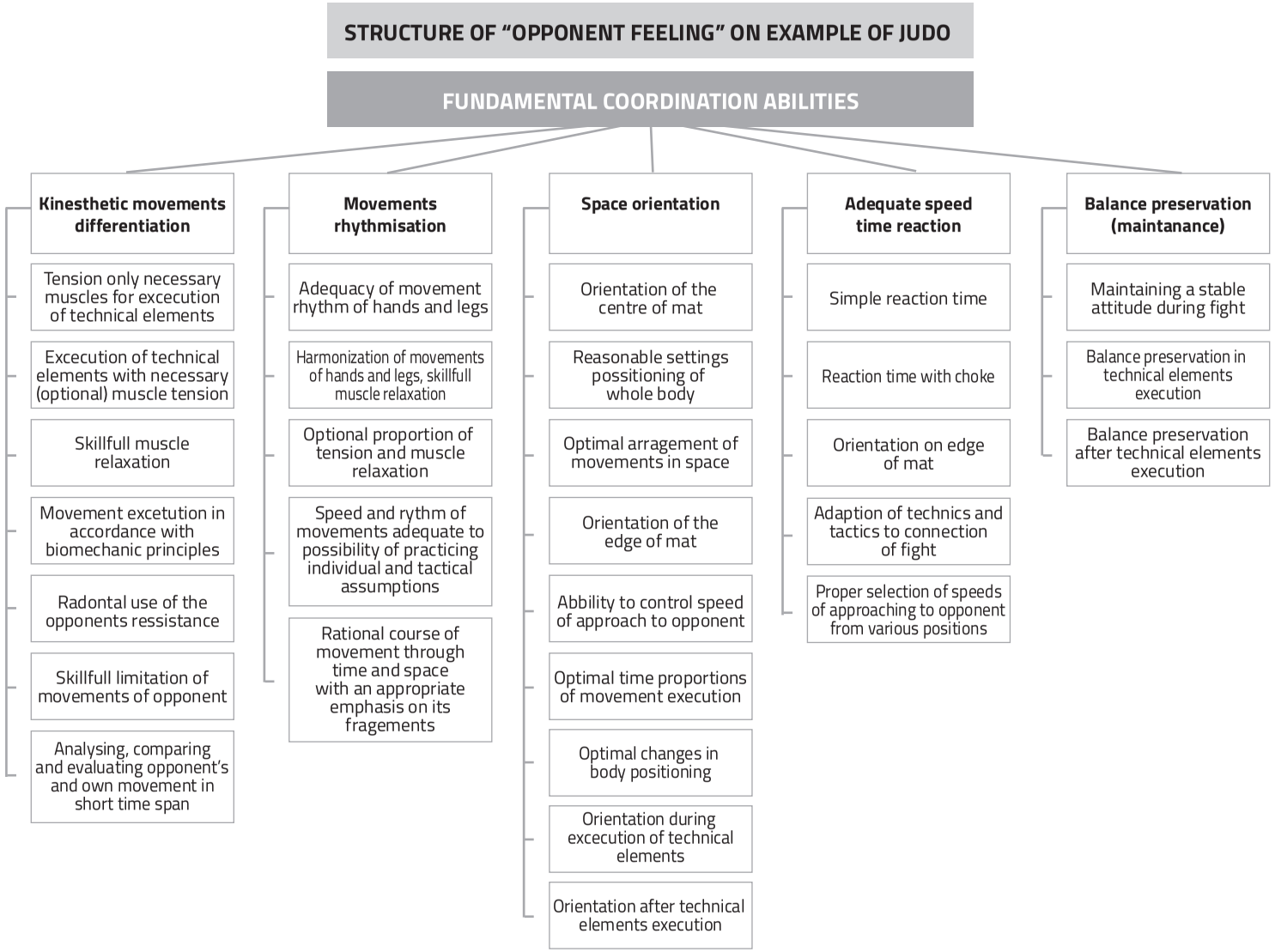


Figure 8. Structure of "opponent feeling" in judo [Blady, Starosta, 1998]

**Discussion**

The conducted surveys allowed the definition of the highest level of "opponent feeling" in the competition period, and the lowest one in the transitory or preparatory periods. Similar results were obtained in studies of taekwondo athletes [2] and of those practising sport games [18-19]. This trend conformed to assumptions of the sport training.

The extensive notion of the "opponent feeling" based on opinions expressed by the studied athletes was preliminarily defined, which may be of considerable importance for practice. A high level of this feeling allows the following: ability of foreseeing, "feeling" of the opponent's movements and immediate reacting to them, ability of performing counteractions with the entire body to an action of the opponent, ability of using the opponent's strength to one's advantage, ability of foretelling intentions of the opponent, as well as their full control, ability of quick recognition and reacting to stimuli of the opponent. Those elements determine the effectiveness of the applied technical and tactical solutions during the fight, i.e. winning [18]. An analysis of results in the discussed survey allowed the determination of a strong relation that takes places between "opponent feeling" and the achieved sport result (95 to 100%).

Symmetrisation of movements consists of compensating the fitness in both sides of the body. This requires that the athletes perform exercises with the less fit side of the body (the upper extremity or the lower extremity, or with a turn/rotation), which favours the development of movement coordination and indirectly the higher level a of the "opponent feeling" with the dominating side of the body [16-17, 19]. In the presented material the relation of right-legged wrestlers to left-legged ones was as 5 : 1 (free style) or 7 : 1 (classical style). Only in karatekas it was more advantageous, i.e. 3 : 2. Very few wrestlers pointed to an identical level of feeling in both extremities (6.3% in classical style and 11.1% free style). They constituted a group of wrestlers not only both-legged, but also bilateral – athletes who performed symmetrical exercises. They belong to dangerous opponents owing to the considerable diversity of applied technical options. The group of such versatile wrestlers included, among others, A. Supron, R. Świerad, P. Michalik – multiple medal winners of the most prestigious international competitions. The process of symmetrisation seems to be underestimated in the training of Polish athletes in some combat sports, despite the fact that for example in Japanese judokas it was and still remains obligatory. This discipline appeared in Poland in such a version, but as time passed it has been completely abandoned. Meanwhile some Polish judokas endeavoured to their technical abilities, which allowed them to have considerable successes in international contests, as for example J. Pawłowski (vice champion in Olympic Games in Seoul).

"Opponent feeling", its contents and structure were difficult, but all the same proved to be feasible for initial defining. This feeling acquires a particular significance in technical mastering at champion level. This fact was admitted by the majority of surveyed athletes. Similarly, as the relation that occurs between this feeling and external conditions. Optimum conditions are advantageous for the manifestation of a higher level of "opponent feeling" and of the technique. It also depends on the psychical state of the athlete. Excessive emotions may affect it in an adverse way, while optimum ones – in a stimulating way.

Presented results cover a fragment of the penetrated research field. Opinions expressed by the surveyed athletes were formulated in a synthetic way with respect to 12 issues. A lot of them have not been analysed here for lack of available space, even though they present a highly interesting material. Of exceptional value are statements of highly experienced athletes, particularly classical style wrestlers, many of whom belonged to the world elite.

**Conclusions**

1. A complex manifestation of a high level of coordination abilities such as "opponent's feeling" or "mat feeling" depend on a number of conditions: level of sport advancement, training experience, length of training period, part of training session, temperature of the surrounding, level of emotions etc. 2. The majority of the questioned observed in the themselves a higher level of "opponent's feeling" during the start training period, rather than during preparatory period. 3. According to the surveyed (45%), the highest level of the "opponent's feeling"

occurred in the main/ core part of the training session, and the lowest in its further part (31%). 4. The symptoms of the high level of "opponent's feeling" include: the correct predicting of the opponent's intentions, proper psychic attitude, the certainty of the fight, the improper of "opponent's feeling" is the lack of these symptoms. 5. The vast majority of advanced wrestlers of both styles (65%) understood the term "opponent feeling" as: "the ability to anticipate, to feel the movements of the opponent and to respond to them immediately." In the same way the feeling was defined based on the opinion of karate athletes: "the ability to predict the behavior of the opponent during a fight." 6. An attempt was made to determine the intra-individual factors shaping the "opponent feeling". Athletes of various martial arts listed similar components: innate predisposition, high level of movement coordination, "muscle feeling", and high level of technical training, mental resilience, and ability to tense and loosen muscles, quick reaction, ability to predict the opponent's movements, well- being, intellectual efficiency, experience. 7. In the opinion of a large group of wrestlers of both sexes the "opponent feeling" is manifested by: rapid reaction, control of the fighting, appropriate muscle tension, anticipation of the opponent's intentions, the choice of the best moment for the attack, fast and accurate assessment of events on the mat, appropriate position of the body during the fight. 8. The responses to the first two questions from the components, which enable the elaboration of a more correct definition of the "opponent feeling". 9. Symptoms of the low and high levels of the synthetic presentation of this feeling in wrestlers and karate athletes were aligned. Differentiation occurred in the opinions of individual wrestlers. The "opponent feeling" is manifested by an appropriate reaction and control of the opponent, and low stress, constant muscle tension and late reaction, direct contact with the greatest surface of the opponent's body creates a good feeling, the smaller the area, the worse is the feeling , with a high level of the feeling I sense in my hands the changes of muscle tension of my opponent, and I know when he will attack, I also know when my opponent just simulates an attack, and I also know when he is relaxed. Then I do not get overly tired in simple actions. At a low level of this feeling that I need to be one hundred percent alert and attentive, I cannot predict the opponent's next action, and with the impression that he is weaker, I lose the fight. 10. Wrestlers of both styles mentioned 15 factors influencing the high or low level of the "opponent feeling" setting them hierarchically basing on percentages. They were unanimous in the first three: hereditary predisposition, fitness level and movement skills. Karate athletes considered 12 of such factors, some of which have not occurred in wrestlers: the degree of involvement in the fight, weather conditions, health and well-being. 11. The highest level of this feeling in the vast majority of free-style wrestlers (88.9%), classical style (93.7%) and karate athletes (95%) appeared in the starting period. Only for a few respondents, it occurred during the preparatory period (5-20%). Significant dispersion of opinions related to the lowest level of the feeling. 12. In the vast majority of classical style wrestlers (62.5%) and free style wrestlers (92.5%) and also of karate athletes (65%), the highest level of the "opponent feeling" was present in the main part of a training unit. 13. The large majority of wrestlers of both styles and of karate athletes (95-100%) observed the link that exists between the level of the feeling and the sports result achieved. 14. The vast majority of classical wrestlers (87.5%), of free-style (81.5%) and of karate athletes (60%) indicated the domination of the right lower limb, i.e., a higher level of its feeling. 15. Relationship between the level of movement coordination and the "opponent feeling", was observed by the vast majority of wrestlers (96,3-100%) and by half of karate athletes. Such a relationship was not observed by a large group of karate athletes (50%). 16. Influence of external conditions on the changes in the feeling was observed by most of the wrestlers (67%). At the same time, a fairly large group of wrestlers (33%) and 50% of karate athletes thought that external conditions did not have a decisive impact on the effectiveness of the fight. 17. Answers to questions about the influence of emotions were mixed. A large number of participants expressed views on the negative effects of emotion on the level of the „opponent feeling" (37.5% of classical style wrestlers, 44.4% free-style wrestlers, karate athletes 40%). Some respondents thought that emotions affected them in a mobilizing way (12.5% of classical style wrestlers, 14.8% free-style wrestlers, karate athletes 60%). 18. The large majority of respondents stated that

only contact with the opponent allows the development of this feeling. Perhaps it related to the improvement of the feeling after shaping it during training fights. A few considered it a better way to develop it during the training with a partner, especially during the "technical training" . 19. Based on an additional questionnaire survey carried out on 63 wrestlers of both styles and sex, the magnitude of the use of the „opponent feeling" in various forms of tactics was defined. The highest values related to the offense and defense. These values varied in different groups of respondents. 20. An attempt to determine the hierarchy and the size of the impact of particular components of the preparation of a sports athlete on the sport result was made on a similar group of respondents (n = 63). In this hierarchy, a high place was given to the "opponent feeling" mentioned as the third by different groups of respondents. 21. Based on the results of own and of other authors' research, as well as on coaching experience, an indicative structure of the "opponent feeling" which takes into consideration the five coordination abilities, was set up. It covered 28 elements. It was narrowed to judo, but many of its components can also apply to other combat sports and martial arts.

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# Determination of foot posture distortions in wrestlers

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**ABSTRACT**
PURPOSE: The aim of this study is to determine the effects of wrestling shoes during practicing wrestling, wrestling mats and wrestling styles on foot posture deformation and form opinions about its causes. METHODS: A total of 158 athletes, which consist of 49 females and 109 males from 18 different countries who participated in the 12th World Universities Wrestling Championship, which was held in the City of Çorum, Turkey during October 25-30, 2016. 102 of these wrestlers are freestyle wrestlers while 56 of them are Greco-Roman wrestlers. Footprint parameters were used in order to determine and evaluate the general structure of the foot (Forriol and Pascual, 1990; Waldecker, 2004). The Staheli index (Staheli et al., 1987), which has a high validity rate, was used in the study. BMI was formulated using Anthropometric measurements by proportioning the body weight with height in meter squares (weight / height2, kg / m2). The analysis of the data was carried out in SPSS 17.00 package software. Comparison meaningfulness tests were conducted on the level of $\alpha$ = .05. In the analysis of whether the observed and expected frequencies had a meaningful difference and in the qualitatively expressed data analysis, the Chi-square test was adopted. RESULTS: It was concluded that wrestlers who are 19 years old or younger had a pes planus rate of 10.5%, for 20-23 years old, it was 15.7%, for 24-27 years old, it was 26.2% and for 28 years old and older, it was 28.6%. In the conducted Chi-square test statistical equation, it was observed that there was not a meaningful relationship between the ages of wrestlers and their pes planus states. Wrestlers who practiced wrestling for 5 years or less had a pes planus rate of 9.1%, for 6-10 years, it was 13.6% and for 11 years or more, it was 28.8%. In the conducted Chi-square test statistical equation, it was observed that there was a meaningful relationship between the years practicing sports of wrestlers and their pes planus states. In terms of gender variable, the rate of having pes planus for women was 8.4%, while males had a rate of 19.3%. In the conducted Chi-square test statistical equation, it was observed that there was no meaningful relationship between the genders of wrestlers and their pes planus states. In terms of wrestling style variable, the rate of having pes planus for freestyle wrestlers was 22.5%, while Greco-Roman wrestlers had a rate of 12.5%. In the conducted Chi-square test statistical equation, it was observed that there was a meaningful relationship between the wrestling styles of wrestlers and their pes planus rates. CONCLUSIONS:It was observed that there was a meaningful relationship between ages in the conducted percentage tests (with increased age, pes planus rates also increased) yet in the results of Chi-Square Test for One Sample (,064), it was concluded that there was no

meaningful relationship. In terms of years of practicing sports of wrestlers, in the examination of rates of pes planus, it was concluded that there was a meaningful relationship between years of practicing sports and the rate of pes planus. Years of practicing sports express the number of wrestling trainings and matches practiced. In other words, it expresses the fact that wrestlers wear the wrestling shoes for a long time and they exercise on the wrestling mat for a long time. This situation can be interpreted to be a cause of pes planus of wrestlers. No meaningful relationship was observed between the genders of wrestlers and their pes planus states. However, a meaningful relationship was observed between the wrestling styles of wrestlers and their pes planus states. Freestyle wrestlers lean forward and they try to disturb the balance of their opponents by moving forward, backward or to right or left, and they push and pull their opponents and their center of mass shifts during these movements. The sole of the foot extends the contact surface on the mat in order to maintain the balance or a plethora of surface of the foot contacts with the mat. This situation can be interpreted as the reason for freestyle wrestlers' higher rate of having pes planus. In addition, the fact that wrestling shoes cover the Achilles tendon, the extension of this tendon is obstructed. The Achilles tendon's obstruction of extension strengthens the opinion that freestyle wrestlers experience pes planus more.

**Key words:** Wrestling, Pes Planus, Posture Distortion

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# Mitochondrial dynamic during the exercise: bioenergetic, morphometry, damage and aging

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**ABSTRACT**
A negative aspect of sport practice, wrestling included, is the elevated production of superoxide radical as a consequence of the high oxygen consumption or by xanthine oxidase activity. According to the mitochondrial theory of aging, elite athletes will be more vulnerable because they are lifelong more exposes to deleterious effect of superoxide radical. Surprisingly, and against this theory, we have recently demonstrated in elite athletes, wrestlers included, a less lipid peroxidation at rest and after a submaximal exercise (Barranco-Ruiz Y et al, 2016, 2017). This phenomenon also occurs after training at moderate hypoxia (2320 meters over sea level) that generates less amount of oxidative stress markers with respect to the same intensity and volume training in normoxia environments (Casuso R et., 2017). This lesser lipid peroxidation cannot be solely justified in base to antioxidant defense mechanisms, enzymatic and nonenzymatic, because they do not change or decreases. In this presentation, we analyze the possible mechanisms involved and probably related to unknown mitochondrial adaptations. More concretely with the mitochondrial respiratory complexes that are known to undergo assemblies into supercomplexes (SCs) under physiological conditions. One of the functional roles of these entities is the limitation of reactive oxygen production through Complex I. In fact, we have verified in our laboratory that a cross-training program (HIT / HVI) induces the Complex I assembly into SCs together with a systemic reduction of lipid peroxidation. We also reported an inverse relationship between Complex I superassembly and mitochondrial lipid peroxidation. We conclude that Complex I assembly into SCs may be a potential mechanism underlying the antioxidant effects of exercise. In this presentation we also analyze the role of mitochondrial fusion-fission dynamics and the gene expression of the key proteins involved in this phenomenon, comparing rtPCR data and electronic microscopy images. This study could provide another point of view on aspects related to mitochondrial bioenergetics efficiency and movement economy.

**Key words:** oxidative stress, superoxide radical, mitochondrial respiratory complexes

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# Sudden heart arrest at wrestling - whose responsibility is it?

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**ABSTRACT**
PURPOSE: The sudden death of a young athlete, who seems to be healthy and has access to regular medical care, is a shocking event. Cardiac arrest is the leading cause of death in young athletes, but the incidence of it is unclear. Perhaps 1 in every 50,000 sudden cardiac deaths a year occurs in young athletes. These cases are highly publicized and make us think over certain things, and of course it stirs up public opinion. In this lecture we examine how this unexpected fatal heart attack can be avoided, prevented, and what athletes, coaches and trainers, and the family and sports doctors can do to this end. METHODS: When someone collapses and has no pulse and is not breathing, there is still a chance he can survive. The heart beats more rapidly, so it is not able to pump blood. This is the result of the chaotic activity of the electric network operated by the heart. It is called chamber fibrillation. This network has to be reconstructed to survive, with the help of another electronic shock (defibrillator). The sooner the reconstruction of the electronic shock happens, the higher the chance for survival. RESULTS: First of all the most important thing is to trust and to share information; among the coach, family and sport doctor. CONCLUSION: So, it is important that if someone is ill, even if they only have a cold, that they not expose their body to an intense physical load, and skip their training session.

**Key words:** wrestling, sudden death, family, doctor, coach

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# FULL PAPERS

# Accelerometric analysis of head impacts in amateur wrestling: An exploratory analysis

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**ABSTRACT**
PURPOSE: The aim of this exploratory study was to investigate the frequency, magnitude and distribution of head impacts greater than 10 g with the use of wireless head impact sensors over a single tournament in a small sample of adult collegiate wrestlers. METHODS: Three participants wore an impact-sensing skin patch on their mastoid process during each match. The patch contained a low-power, high-g triaxial accelerometer with 200 g maximum per axis and a triaxial angular rate gyroscope to capture linear and rotational time history accelerations of the heads center of gravity for all impacts that occurred during the matches. Head impact exposure including frequency, magnitude and location of impacts were quantified using previously established methods. Two measures of impact frequency were computed for each participant: impacts per match, the total and average number of impacts per match for all matches; participant group impacts, the total and average number of recorded head impacts for the three participants' groups for all matches. Head impacts were assessed for injury tolerance level for a concussion occurring using previously published injury tolerance levels for linear (>95 g) and rotational acceleration (>5,500 rad/s2). Head impacts were assessed for impact severity using previously published levels for linear acceleration (mild <66 g, moderate 66-106 g, severe >106 g) and rotational acceleration (mild <4,600 rad/s2, moderate 4,600-7,900 rad/s2, severe >7,900 rad/s2). RESULTS: Participants averaged 41 ± 4 impacts with a resultant median peak linear and rotation acceleration of 15 g and 1,880 rad/s2 resulting in a median HITSP and the RWECP of 15 and 0.0004, respectively. The location of impacts varied considerably with more head impacts to the front of the head than the back and top. CONCLUSIONS: Due to the exploratory nature of this study, small sample size and the absence of a diagnosed concussion, the results are to be viewed with caution, as it is unclear of the generalizability of the data. Results indicate lower levels in all measurements compared to football and rugby. Interestingly the back of the head recorded higher median peak linear accelerations then the side that may be the result of takedown maneuvers. This may have also contributed to the higher median RWECP of the top right side of the head than of the front right side. The key to this study was obtaining and thus gaining initial measurements on the frequency, magnitude, distribution and risk weighted exposure of head impacts in collegiate wrestling in order to assist in the identification of at-risk wrestlers and better inform medical personnel of the need to evaluate an athlete for concussion.

## Introduction

This exploratory study investigated the frequency, magnitude and distribution of head impacts greater than 10 g (g-force) with the use of wireless head impact sensors over a single tournament in a small sample of adult collegiate wrestlers.

**Methods**
A prospective observational cohort study was conducted on three Division I collegiate NCAA male wrestlers (mean±SD age, height and body mass of 21±2 yr., 173.5±12.5 cm and 73±19 kg) over three matches during a 2015 tournament contest. Consent was obtained from the participants prior to enrolment in the study. The researchers' University Institutional Review Board approved all procedures in the study (16-0089).

Study participants wore the XPatch impact-sensing skin patch (X2Biosystems Ltd, Seattle, Washington. United States of America; www.x2biosystems.com) on the skin covering their mastoid process (right side) during each match. Following the tournament, the XPatch were removed from the wrestlers and downloaded to the Injury Management Software (IMS) (X2Biosystems). The biomechanical measures of head impact severity consisted of impact duration (ms), linear (g), and rotational head acceleration (rad/s2). Two measures of impact frequency were computed: impacts per match, the total and average number of impacts per match for all matches; participant group impacts, the total and average number of recorded head impacts for the three participants group for all matches.

Head impacts were assessed for injury tolerance level for a concussion occurring for linear (>95 g) and rotational acceleration (>5,500 rad/s2). Head impacts were assessed for impact severity for linear acceleration (mild <66 g, moderate 66-106 g, severe >106 g) and rotational acceleration (mild <4,600 rad/s2, moderate 4,600-7,900 rad/s2, severe >7,900 rad/s2).

Two additional risk equations were included to identify participants of risk of a concussion. The Head Impact Telemetry Severity profile (HITSP) (Greenwald et al., 2008) is weighted composite score including linear and rotational accelerations, impact duration, as well as impact location. The Risk Weighted Exposure Combined Probability (RWECP) (Urban et al., 2013) which combines the resultant linear and rotational accelerations to elucidate individual participant exposure to head impacts. As a value of 63 is a 75% indicator for a concussive injury (Broglio et al., 2011; Greenwald et al., 2008) the HITSP values were evaluated by limits of less than 25% risk (<21), 25% to 75% risk (21-63) and >75% risk (>63). The RWECP values were evaluated by the same values of 25% risk (<0.2500) 25% to 75% risk (0.2500-0.7500) and >75% risk (>0.7500).

Impact locations were analyzed by front, back, side and top impacts using a Friedman repeated measures ANOVA on ranks. A one sample chi-square ($\chi 2$) test was to determine whether the observed head impact frequency was significantly different to the expected head impact frequency. The HITSP and RWECP were analyzed using a Friedman repeated measures ANOVA on ranks. Post hoc analysis with Wilcoxon signed-rank tests was conducted with a Bonferroni correction applied. A one sample chi-squared ($\chi 2$) test and risk ratio (RR) with 95% confidence intervals (CI) were used to determine whether the observed impact frequency was significantly different from the expected impact frequency.

**Results**
Over the duration of the tournament, three individual matches were completed with a total of 122 impacts recorded resulting in an average of 41 ± 4 impacts per-participant to the head over. The linear accelerations recorded ranged from 10.0 to 45.8 g. This data was right skewed with a median (IQR) value of 14.5g [12.2g to 20.1g] and 95th percentile value of 34.6g. The rotational accelerations recorded ranged from 333.3 rad/s2 to 9,037.0 rad/s2. This data was right skewed with a median (IQR) value of 1,880.2 rad/s2 [1,200.8 rad/s2 to 2,757.6 rad/s2] and 95th percentile value of 5,066.5 rad/s2. The HITSP recorded varied from 6.3 to 81.3 and had a median [IQR] value of 14.5 [11.0 to 22.0] and a 95th percentile of 52.7 (see Table 1). The RWECP recorded varied from 0.0001 to 0.3124 and had a median [IQR] value of 0.0004 [0.0002 to 0.0010] and a 95th percentile value of 0.2625. There were no observable differences identified over the tournament for the resultant linear ($\chi 2(2)=0.38$; $p=0.8276$), and rotational ($\chi 2(2)=0.38$; $p=0.8276$) accelerations, HITSP ($\chi 2(2)=0.84$; $p=0.6585$) and RWECP ($\chi 2(2)=1.06$; $p=5892$) of all the participants.

There were more head impacts to the front of the head (n=51) than the back ($\chi2=14.6$; $p<0.0001$) and top ($\chi2=24.1$; $p<0.0001$) of the head. There were observable differences identified that back of the head recorded higher median peak linear accelerations then the side (18.9 g vs. 13.7 g) of the head ($\chi2(1)=6.37$; $p=0.0116$) and on post hoc analysis ($z=-2.70$; $p=0.0070$). There were observable differences identified that the right side of the top of the head recorded higher median peak rotational accelerations than the right side of the side (2,072.8 rad/s2 vs. 1,529.1 rad/s2) of the head ($\chi2(1)=4.50$; $p=0.0339$) and on post-hoc analysis ($z=-2.38$; $p=0.0173$). As a result the top right side of the head recorded a higher median RWECP (0.0004 vs. 0.0002) than the front right side of the head ($\chi2(1)=6.0$; $p=0.0143$) and on post-hoc analysis ($z=-2.21$; $p=0.0273$).

There were 4 (3.3%) of impacts to the head recorded above the rotational (>5,500 rad/s2) tolerance threshold with a median peak resultant rotational acceleration of 7,039.9 [6,205.6-8,931.3] rads/s2. As a result there were 4 (3.3%) of impacts to the head above the HITSP severe (>63) threshold with a mean score of 78.0 [73.2-81.1]. The majority (99.2%) of impacts to the head had a median RWECP value (0.0003 [0.0002-0.0010]) in the mild category.

| Participant | Total impacts n= | Impact duration (ms) Mean ± SD | PLA (g) Mean ± SD | PLA (g) Meadian [IQR] | PLA (g) 95 % | PRA (rad/s²) Mean ± SD | PRA (rad/s²) Meadian [IQR] | PRA (rad/s²) 95 % | RWE$_{CP}$ Mean ± SD | RWE$_{CP}$ Meadian [IQR] | RWE$_{CP}$ 95 % | RWE$_{CP}$ Mean ± SD | RWE$_{CP}$ Meadian [IQR] | RWE$_{CP}$ Mean ± SD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 37 | 5.7 ±5.4 | 16.7 ±7.8 | 14.3 [11.6 to 19.5] | 36.8 | 2,082.3 ±1,331.5 | 1,792.7 [1,012.1 to 2,802.9] | 5,188.1 | 20.0 ±15.2 | 15.2 [11.2 to 21.2] | 57.2 | 0.0016 ±0.0039 | 0.0003 [0.0002 to 0.0010] | 0.0012 |
| 2 | 40 | 7.5 ±5.8 | 18.9 ±8.2 | 16.2 [12.6 to 22.5] | 36 | 2,463.3 ±1,724.0 | 1,959.2 [1,302.7 to 3,036.4] | 7,495.9 | 20.0 ±15.3 | 15.2 [10.6 to 20.7] | 66.3 | 0.0111 ±0.0511 | 0.0004 [0.0002 to 0.0011] | 0.0910 |
| 3 | 45 | 7.5 ±5.5 | 16.3 ±5.7 | 14.0 [12.1 to 19.5] | 29.2 | 2,161.8 ±1,290.9 | 1,861.3 [1,211.5 to 2,707.2] | 5,175.3 | 20.0 ±14.8 | 14.0 [10.8 to 24.1] | 59.3 | 0.0015 ±0.0043 | 0.0003 [0.0002 to 0.0010] | 0.0079 |
| Total | 122 | 7.0 ±5.6 | 17.3 ±7.2 | 14.5 [12.2 to 20.1] | 34.6 | 2,236.6 ±1,455.3 | 1,800.2 [1,200.8 to 2,757.6] | 5,066.5 | 20.0 ±15.1 | 14.5 [11.0 to 22.0] | 52.7 | 0.0047 ±0.0296 | 0.0004 [0.0002 to 0.0010] | 0.0085 |

*[IQR] = Interquartile (25th to 75th) percentile; 95% = 95th percentile; PLA (g) = peak linear acceleration in gravitational force (g); PRA (rad/s2) = peak rotational acceleration in radians/second2; HITSP = Head Impact Telemetry severity profile; RWECP = Risk Weighted Exposure Combined Probability;*

Table 1. Impacts to the head greater than 10 g for individual participants and for total impacts recorded in a amateur wrestling tournament. Data are presented as mean and standard deviation (±SD), median [interquartile range] and 95th percentile for individual participants and total impacts, impacts per player position group, impact duration (ms), resultant linear and rotational acceleration, head impact telemetry severity profile and risk weighted exposure combined probability.

**Discussion**

An average of 41 impacts per-wrestler to the head occurred over the duration of the tournament. Comparisons with other sports is difficult due to vast differences in the structure of competition and the frequency of collisions associated with a specific sport is a function of the opportunity for collision to occur within the context of the sport (Powell, 2001). The mean, median and 95th percentile value of the resultant linear (17g + 7g, and 34g) and rotational accelerations (2,236 + 1,455 rad/s2, 1,800 rad/s2 and 5066 rad/s2) were established. When compared with collegiate American football (Crisco, et al., 2011) the 95th percentile resultant linear (62g) acceleration, the resultant rotational (4,378 rad/s2) acceleration were higher than measured in the wrestlers. When compared with senior amateur rugby union (King, et al., 2015)

the mean resultant linear (22g) and rotational (3,903 rad/s2) accelerations were higher than those reported for the wrestlers. A possible reason for the lower linear and rotational accelerations may be due to the proximity, or closeness, of the participants.

The inclusion of a risk-weighted cumulative exposure (RWE) measure (Urban, et al., 2013) was incorporated. By adjusting the impacts' contribution to cumulative exposure according to its associated impact tolerance, the RWE for linear, rotational, and a combined (linear and rotational) probability measure can be established (Urban, et al., 2013). Only one other study (Urban, et al., 2013) has reported the RWECP and this was in High School-level American Football. Results from that show the median RWECP in High School-level American football players was 0.497 (Urban, et al., 2013) and this was higher than the current study (0.0003) recorded on wrestlers.

The location of impacts varied considerably with more head impacts to the front of the head than the back and top that may be due to the head-up, front-facing position of the wrestlers. However, the back of the head recorded higher median peak linear accelerations then the side which may be the result of takedown maneuvers. This may have also contributed to the higher median RWECP to the top right side of the head than front right side. Additionally, all the participants were right hand dominate and thus placing their head toward the right side of their opponent in a front aligned position therefore creating a dominate right-sided effect.
There are several limitations in this study. For example, the sample size is small and thus the results may not represent totals across a whole season and the participants were all in a similar weight class that cannot be transferrable to all wrestlers. Data collection occurred over a limited period and none of the participants sustained a concussion therefore no conclusions should be made on the significance of the impact levels.

**Conclusion**
The key to this study was obtaining and thus gaining initial measurements on the frequency, magnitude, distribution and risk weighted exposure of head impacts in collegiate wrestling in order to assist in the identification at-risk players which will better inform medical personnel of the need to evaluate a player for concussion.

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# The University of Mary Wrestling Anaerobic Performance Test (UMWAPT) – A Wrestling Specific New Protocol

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**ABSTRACT**
BACKGROUND: The UMWAPT protocol simulates the anaerobic requirements of a full wrestling match, providing a way to measure the wrestler's ability to complete an entire match against his most challenging opponent. PURPOSE: The purpose of the study was to compare and correlate the mechanical outcomes and fatigue index between the WAnT and the UMWAPT. METHODS: 15 wrestlers underwent both protocols in random order. Mechanical outputs (W), and fatigue index (%) were calculated and compared between the protocols and within the UMWAPT. RESULTS: Peak power correlations between protocols were weak to moderate, and weak to strong within the UMWAPT test. Mean power correlations between protocols were weak, and weak to strong within the UMWAPT test. Anaerobic capacity correlations between protocols were weak, and weak to strong within the UMWAPT test. Fatigue index correlations between protocols were weak, and weak to moderate within the UMWAPT test. Body weight relative peak power correlations between protocols were weak, and weak to very strong within the UMWAPT test. Body weight relative mean power correlations between protocols were weak, and weak to very strong within the UMWAPT test. All participants indicated the UMWAPT as a very accurate simulation of their most challenging wrestling match. CONCLUSIONS: The UMWAPT seems to be a very good protocol to simulate a wrestler's most challenging match. The UMWAPT allowed the wrestlers to utilize their own technique, leading to better mechanical outputs, thus, it seems that this study gives hope that a wrestling specific all out performance protocol such as the UMWAPT be utilized, rather than a non-specific protocol such as the WAnT.

**Key words:** Anaerobic performances, peak power, mean power, anaerobic capacity, fatigue index, BW relative mean power, Wingate Anaerobic Test, University of Mary Wrestling Anaerobic Performance Test.

**Introduction**
The sport of wrestling is very popular in the USA and has needs of its own. Physically, this sport is a combination of aerobic fitness, possible sub-maximal and perhaps maximal anaerobic power bouts, technique, and isometric work.
Often, field and lab tests are utilized to predict sub-maximal and maximal performance. Such protocols exist in regards to both aerobic and anaerobic capacities. [1,2] The Wingate Anaerobic Test (WAnT) is an all-out anaerobic performance exercise test, consistent of 30 seconds of maximal cycling on a cycle ergometer against 8% of the subject's body weight (kg), while fully seated on the cycle. In sport science, the WAnT is a widely-administered protocol which, despite its short duration, evokes substantial cardiac work by requiring peak power

outputs (Watts) up to 300% of maximal workload (Wmax) [3].
In wrestling, repetitive forceful muscle contractions are required during most of sport's maneuvers and the upper-body anaerobic power of an athlete is considered an important factor influencing competitive success. [1, 2]
Relatively few data exist regarding power and wrestling, the majority of which are from non-wrestling –specific performance protocols, and some relate more to martial arts rather than wrestling [4, 5, 6, 7].
The University of Mary Wrestling Anaerobic Performance Test mimics the structure of a full wrestling match while incorporating features and components of the WAnT. To the best of the researcher's knowledge, no wrestling specific performance protocol exists, that allows measuring a wrestler's true mechanical outputs while utilizing the most wrestling-like techniques.
The utilization of non-wrestling specific performance protocols may influence a coach's decision or interpretation of results, thus acting against the coach and athlete's best interest. The same can be said for any athlete in any sport [8,9].

Thus, it was the aim of this study to investigate the application of wrestling specific techniques while pushing a one-man football blocking sled, and its ability to allow the production of better, same or worse mechanical outcomes in comparison to the WAnT.

**Methods**
15 University of Mary male wrestlers, 20.07±1.75 years old, volunteered to participate in this study. The wrestlers were notified that the study was for one of the coaches' thesis and that by no way do they have to volunteer and that refusal to take part would not result in any consequences regarding their studies or wrestling team related issues. The wrestlers were given direct access to Dr. Saghiv in case they felt mistreated by the coaches if they have not volunteered. Subjects' Wingate Anaerobic Test mechanical results (peak power (Watts·5 seconds-$^{1}$), mean power (Watts· second-$^{1}$), body-weight relative power (Watts·30 seconds-$^{1}$· kg-$^{1}$), anaerobic capacity (Watts·30 seconds-$^{1}$) and fatigue index (%)) were compared and correlated to those of the UMWAPT (peak power (Watts·5 seconds-$^{1}$), mean power (Watts· second-$^{1}$), body-weight relative power (Watts·30 seconds-1·kg-1), anaerobic capacity (Watts· 30 seconds-$^{1}$) and fatigue index (%) of the first session of pushing the sled.). Each subject visited with the research team a total of three times. The first visit was dedicated to familiarization with the Monark cycle, WAnT protocol, the football sled, UMWAPT protocol and the lab. In addition, during the first visit to the lab, the subjects received a detailed explanation about the purpose of the study, its importance, design, benefits, risks and protocols.
All subjects signed an informed consent form. Those who agreed to participate in this study underwent risk stratification via health questionnaire (appendix A), according to the ACSM guidelines (ACSM's Health-Related Physical Fitness Assessment Manual 4th Edition, Page 21). Subjects found to be of low risk only were included in the study. Baseline resting measurements, including height (m), weight (kg), resting heart rate (bpm), and resting blood pressure (mmHg), were measured. The adjustment of the cycle seat height was also recorded. During the second visit to the lab, all subjects underwent either the WAnT or the UMWAPT protocol in random order.

For the Wingate Anaerobic Test the researchers ensured that the equipment was fully functional and safe and that the weight was calculated correctly for the subject (8% of body weight). The research team also ensured that an AED is present and working the whole duration of data collection. When the subject arrived, the researchers started out by confirming that nothing had changed with the subject's physical condition by measuring resting HR, and BP, and that the subject has complied with the instructions given prior to testing (see appendix B). The cycle's seat height was then set for the subject as recorded during the first visit.

The subject began by sitting on the cycle while the video camera was prepared to record the repetitions per minute (RPM) screen of the cycle. The subject then cycled with no resistance for 55 seconds at a warm-up pace and then cycled as fast as he could for 5 seconds. The subject repeated this warm up procedure two more times (a total of three times) as the warm-up before the actual test. Then, the subject sat on the cycle for two minutes, doing nothing at all. After two minutes, the subject pedaled into maximal cadence within three to five seconds. The weights were then released by an automatic mechanism (by means of pushing a button on the Monark 884E ergometer), which was a total of 8% (including the basket's weight) of the subject's body weight (kg), and the subject cycled as fast as he could with verbal encouragement from the research group for 30 seconds. During the test, the subject held to the handles of the cycle at all times and had full contact with the seat of the cycle. Video recording of the RPMs produced was obtained during this phase. The results in RPMs were noted by two different people to increase reliability. The subject then continued to cycle without resistance for a cool-down of two minutes. The subject then got off the cycle and stood beside the cycle with their hands on the cycle to become accustomed to not being on the cycle for three to five seconds. The subject then laid down on a plinth for 15 additional minutes to ensure that his hemodynamic responses return to normal, that he did not have any light headiness, nausea, a need to vomit or any other response to the test. When the subject's heart rate was lower than 100 beats per minute and blood pressure was within 5 mmHg of resting blood pressure, the subject was allowed to leave with the instructions to avoid driving immediately and to avoid exercise for the rest of the day. If the subject did not meet the criteria mentioned above, he stayed under the supervision of the research team until all criteria were met. Peak power, relative peak power, fatigue index, mean power and anaerobic capacity were calculated and explained to the subject immediately.

For the UMWAPT protocol, the researchers ensured that the equipment was fully functional and safe. The research team ensured that an AED was within 3 minutes reach and working during the duration of data collection. When the subject arrived, the researchers ensured that nothing had changed with the subject's physical condition. At this time, the football blocking sled (Gilman one man tackle-back) was loaded with weights to a total weight (sled's actual weight + added weights) equivalent to 2.5 times the subject's body weight. The sled's actual resistance was calculated by taking into consideration the coefficients of static friction and dynamic friction calculated at multiple loads for the surface. Subjects were to grasp the sled at the height of their own waist (a holding point believed to be the most representative of a wrestling match). To warm up, the subject was instructed to run in place for two minutes and 55 seconds. When the subject reaches that mark, they are to sprint in place for 5 seconds. After 5 seconds, they continue to jog in place for another two minutes and 55 seconds. There are three rounds of this warm up. Afterwards, the subject sat down and did nothing for a minute and 50 seconds. The subjects then stood up right near the sled, and took their "holding point" on the sled. In order to ensure that the test mimicked real wrestling movement as much as possible, each subject was allowed to use his own technique relevant to the position. Subjects pushed the football blocking sled as far as they could for 30 seconds. They pushed the sled across a Mondo indoor track surface which was not wet and had no debris on it. The surface was also examined to make sure that it has no holes or safety hazards and that the surface is relatively flat. Although the sled weighs 265 pounds (120.45kg) it did not oppose resistance equal to its full weight. The actual resistance the sled opposed was only about 45% of its total weight (119.25 pounds/54.2kg). Thus, weight was added to the sled to ensure that every participant was working against the same amount of resistance relative to their body weight. A measuring wheel was used to measure the total distance traveled (m), whereas the distance traveled every 5 seconds (m) was marked with a bean bag. The deviation from the main line and the distance traveled forward were measured separately in order to utilize the Pythagorean Theorem and calculate the actual distance traveled with the sled. These measurements allowed the researchers to create a graph of the distances traveled during the test and every 5 seconds of the test, as well as convert distance into the force produced

(Watts·5 seconds-1) while pushing the sled. Immediately after the subject finished the initial 30 second sled push, he drilled double legs with a teammate for two and a half minutes (150 seconds) at a live drill pace (roughly 20-25 double legs in total). Then the subject rested for 20 seconds before pushing the sled for the second time for 30 seconds as fast and far as possible. The subject then immediately engaged in drilling half nelsons with a pre-breakdown with a teammate for one and a half minutes (90 seconds) at a live drill pace (roughly 15-20 repetitions). The subject once more rested for 20 seconds and pushed the sled for the third time for 30 seconds as fast and far as possible. The subject then immediately engaged in drilling escapes with a teammate for one and a half minutes (90 seconds) at a live drill pace (roughly 20-25 repetitions). Immediately after resting for 20 seconds the subject pushed the sled for the fourth and last time, for the duration of 30 seconds as fast and far as possible. The subject then lay supine for 15 minutes. In case the subject's heart rate was lower than 100 beats per minute and blood pressure was within 5 millimeters of mercury of resting blood pressure the subject was allowed to leave with the instructions to avoid driving immediately and to avoid exercise for the rest of the day. If the subject did not meet the criteria mentioned above, he stayed under the supervision of the research team until all criteria are met. Peak power (Watts·5 seconds-1), mean power (Watts· second-1), body-weight relative power (Watts·30 seconds-1·kg-1), anaerobic capacity (Watts·30 seconds-1) and fatigue index (%) were calculated for every time the sled was pushed and explained to the subject immediately. The results of the WAnT were compared with the first session of the UMWAPT, and all sessions within the UMWAPT were compared to each other. Immediately after the UMWAPT, the wrestlers have been as to compare the UMWAPT with a wrestling match. Utilizing SPSS 23.0 for windows, correlation between the result of the WAnT and UMWAPT were calculated, as well as the correlation between the sessions of the UMWAPT itself. Results are presented as average ± SD where appropriate, and at a significance level of 5% ($p \leq 0.05$) or less. Feedback from the wrestlers is presented as qualitative information rather than quantitative information.

**Results**

All subjects completed the whole study including both protocols without difficulties or abnormal symptoms or reactions.

During the WAnT, the wrestlers worked against an average resistance of 6.43±1.15 Kg (8% of body weight), while during the UMWAPT, the wrestlers worked against an average resistance of 180.88±32.55 kg (225% of body weight).

Analyzing the data, the research team became aware of a pattern in regards to the mathematical relationship between the mechanical outputs during the WAnT and the UMWAPT. According to this pattern, the values of UMWAPT 1 were always higher than the value for the same variable during the WAnT, the values for UMWAPT 2, 3 were (for the most part) lower than the value for the WAnT, and UMWAPT 4 was (for the most part) higher than the values of UMWAPT 2, 3 for the same variable. Table 1 presents a comparison of values for the mechanical outputs during the WAnT and UMWAPT.

Table 1: The mechanical outputs and fatigue index (FI) during the WAnT and the UMWAPT (mean ± SD).

| Variable | WAnT | UMWAPT 1 | UMWAPT 2 | UMWAPT 3 | UMWAPT 4 |
|---|---|---|---|---|---|
| Peak power (Watts·5sec-1) | 959 ± 236 | 1511 ± 710 | 889 ± 171 | 893 ± 252 | 981 ± 256 |
| Mean power (Watts·sec-1) | 716 ± 194 | 903 ±222 | 628 ±165 | 627 ± 145 | 672 ± 158 |
| Anaerobic capacity (Watts·30sec-1) | 4301 ± 1169 | 5421 ± 1334 | 3770 ± 997 | 3765 ± 874 | 4033 ± 949 |
| Fatigue index (%) | 40.48 ±13.28 | 45.63 ± 19.58 | 39.7 ± 24.19 | 40.47 ± 17.34 | 39.65 ± 21.8 |
| BWRPP (Watts·kg·5sec-1) | 12.17 ± 1.39 | 19.57 ± 11.32 | 11.31 ± 2.63 | 11.41 ± 3.65 | 12.44 ± 3.5 |
| BWRMP (Watts·kg-1·sec-1) | 9.09 ± 1.03 | 11.53 ± 3.56 | 7.93 ± 2.06 | 8.73 ± 1.47 | 8.53 ± 2.13 |

*WAnT = Wingate Anaerobic Test; UMWAPT = University of Mary Wrestling Anaerobic performance Test; BWRPP = body weight relative peak power; BWRMP = body weight relative mean power; UMWAPT 1,2,3,4 = order of sled pushing sessions during the UMWAPT.*

Table 2. presents the levels of differences' significance (P value) between the mechanical outputs of the WAnT and the UMWAPT, and within the UMWAPT.

Table 2: Value of the differences' significance (P value) between the mechanical outputs of the WAnT and the UMWAPT, and within the UMWAPT.

| **Variable** | **UMWAPT 1** | **UMWAPT 2** | **UMWAPT 3** | **UMWAPT 4** |
|---|---|---|---|---|
| Peak power (Watts/5sec) | † | †,1 | †,1,2 | 1,2,3 |
| Mean power (Watts/sec) | † | †,1 | †,1 | †,1,2,3 |
| Anaerobic capacity (Watts/30sec) | † | †,1 | †,1 | †,1,2,3 |
| Fatigue index (%) | † | †,1 | †,1 | †,2 |
| BWRPP (Watts/kg/5sec) | † | †,1 | 1 | 1,2 |
| BWRMP (Watts/kg/sec) | † | †,1 | 1,2 | †,1 |

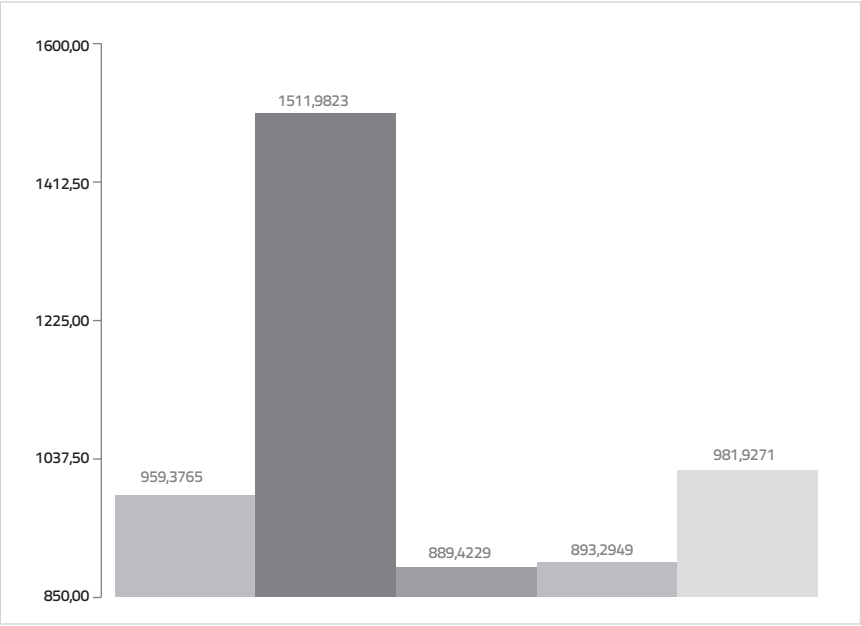
*WAnT = Wingate Anaerobic Test; UMWAPT = University of Mary Wrestling Anaerobic performance Test; BWRPP = body weight relative peak power; BWRMP = body weight relative mean power; UMWAPT 1,2,3,4 = order of sled pushing sessions during the UMWAPT; † = significant differences between the variable and the same variable during the WAnT; 1 = significant differences between the variable and the same variable for UMWAPT1; 2 = significant differences between the variable and the same variable for UMWAPT2; 3 = significant differences between the variable and the same variable for UMWAPT3; significant differences: p≤0.05.*

Table 3: The average mathematical ratio (% of the WAnT) between the UMWAPT mechanical outputs and those of the WAnT.

| Variable | UMWAPT 1 | UMWAPT 2 | UMWAPT 3 | UMWAPT 4 |
|---|---|---|---|---|
| Peak power (Watts/5sec) | 157.55 | 92.7 | 93.11 | 102.29 |
| Mean power (Watts/sec) | 126.11 | 87.7 | 87.56 | 93.85 |
| Anaerobic capacity (Watts/30sec) | 126.04 | 87.65 | 87.53 | 93.76 |
| Fatigue index (%) | 112.5 | 97.5 | 100 | 97.5 |
| BWRPP (Watts/kg/5sec) | 160.8 | 92.93 | 93.75 | 102.21 |
| BWRMP (Watts/kg/sec) | 126.84 | 87.23 | 96.03 | 93.83 |

*WAnT = Wingate Anaerobic Test; UMWAPT = University of Mary Wrestling Anaerobic performance Test; BWRPP = body weight relative peak power; BWRMP = body weight relative mean power; value > 100 = outcome during the UMWAPT is greater than that of the WAnT; value < 100 = outcome during the UMWAPT is lower than that of the WAnT*

Graph 1: Comparison between peak powers produced during the WAnT in comparison to the UMWAPT (mean±SD).




*WAnT = Wingate Anaerobic Test; UMWAPT = University of Mary Wrestling Anaerobic performance Test; UMWAPT 1,2,3,4 = order of sled pushing sessions during the UMWAPT; significant differences: p≤0.05 (as indicated in table 2.*

All subjects rated the UMWAPT as a more challenging test than the WAnT, yet at the same time, indicated that the UMWAPT accurately simulates a full wrestling match against their most challenging opponent.

**Discussion**

The aim of this study was to establish the UMWAPT as a wrestling specific maximal anaerobic performance test, which allow wrestlers to both incorporate their preferred technique, utilize a wrestling-like position and produce better mechanical outcome than during the WAnT. In addition, the aim of the study was to gather qualitative information of the way the wrestlers

perceived the UMWAPT while comparing it to a wrestling match against their most challenging opponent.

The results of this study clearly show that the UMWAPT allows wrestlers to present ≈60% higher mechanical outputs during the first session in comparison to the WAnT, as well as achieve similar mechanical outputs to those of the WAnT during the second, third and fourth sessions of the UMWAPT.

Sport-specific characteristics of trunk muscles in collegiate wrestlers and judokas were investigated in 2008. This study clearly indicated that the sport-specific characteristics of the cross sectional areas of the trunk muscles and trunk muscle strength obviously differed between the 2 similar sports. In addition, the study indicated that athletes should practice the sport-specific training of trunk muscles and develop sport specificity in their sports. Particularly, wrestlers have to train in trunk flexion and extension motions, and judokas need to strengthen trunk rotation and lateral flexion motions. [10]

In 2015, Asim Cengiz investigated the effect of dehydration on young male wrestlers (age 20.45±2.69 years). Peak power produced during the WAnT was found to be 864.7±85.6 Watts ·5sec-1, body weight relative peak power was found to be 10.7±1.1 Watts·Kg-1·5sec-1, and the fatigue index found to be 55.6±4.4%. [11]

While comparing freestyle wrestling to that of Greco-Roman, it has been reported that peak power was 895±210 and 906±250 respectively. The same study reported body weight relative peak powers if 13.2±2.0 and 13.5±1.6 Watts·Kg-1, respectively. [12]

In a double-blind, counterbalanced, crossover study, 14 trained wrestlers ingested either placebo or 5 mg/kg caffeine and completed four 6-min upper body intermittent sprint performance tests with 30-min recovery periods between consecutive tests. PP was recorded. Peak power reported was 277.2±34.6 Watts. [13]

In 2007, Vardar et al. reported peak power in adolescent elite wrestlers to be 615.4±114.3 Watts, and a body relative peak power of 8.5±1.0 Watts·Kg-1. [14]

In 2003, 20 active international level male wrestlers (ages 22-27 years) participated, in a study aimed at investigating the effect of high dose oral creatine supplementation on anaerobic performance. The study's results indicated body weight relative peak power to be 10.523±1.0 Watts·kg-1. [15]

In 2015, Lunn et al. conducted a study aimed at determining the effect of different pretest pedaling cadences on power outcomes obtained during the Wingate Anaerobic Test (WAnT). The study included 14 young adult men, age 24.9 ± 1.2 years, which were non-wrestlers. Peak power was reported to be 788.3±43.5 Watts. [16]

In 2014, Attia et al. evaluated relative and absolute reliability of the 20-second anaerobic test (WAnT20) versus the WAnT30 and to verify how far the various indices of the 30-second Wingate anaerobic test (WAnT30) could be predicted from the WAnT20 data in male athletes. The highest peak power reported in the study was 999±153 Watts. [17] In 2016, the peak anaerobic power of cyclists and triathletes aged 32.3±3.0 was found to be 933±189.5 and 796±74.6 Watts, respectively. Body weight relative peak power was reported to be 12.4±2.3 for the cyclists and 10.7±1.3 for the triathletes. [18]

In 2015, Sultan Harbili reported national and Olympic cyclists' aged 21.50 ± 3.09 year peak power to be 738.96±116.92 Watts. In addition, the highest fatigue index was reported to be 52.16±10.92%. [19]

In 1989, gender specific norms for active young adults were suggested for the results of the WAnT according to percentiles. At the 90th percentile, peak power for males was suggested to be ≥ 822 Watts. [20]

While comparing the mechanical outputs of the UMWAPT to those previously reported in the professional literature, for wrestlers and non-wrestling athletes, the mechanical outputs achieved by the wrestlers in this study are significantly greater for peak power and body weight relative power.

**Conclusions**

The UMWAPT is the first wrestling specific anaerobic performance protocol offered, and seems to be a protocol that allows the wrestlers to maximize their mechanical outputs while accurately simulating a full and the upmost challenging wrestling match. Allowing wrestler to utilize a technique that is closest to their wrestling technique improves the wrestler's mechanical outputs, presenting with the wrestler's true power potential. The protocol should be further studied with a greater sample size and wrestlers of all ages, sexes and levels. Future research should be conducted to investigate one's ability to determine the optimal weight for a wrestler to compete in according to the results of the UMWAPT.

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# Methodological development of a wrestling shuttle test on the mat

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**ABSTRACT**
PURPOSE: Elite wrestlers have high aerobic and anaerobic capacities. They also acquire their sport-specific movements and techniques while wrestling. However, there is no wrestling shuttle test which requires wrestling-specific movements on the wrestling mats. Thus, this study methodologically developed a shuttle test for wrestlers to evaluate their aerobic and anaerobic capacities on the mat while using wrestling-specific movements. A convenient feature of this wrestling shuttle test is its easy administration in the practice room and without extraneous equipment. METHODS: Twenty-two Canadian wrestlers participated in this study (15 males and 7 females). We designed a wrestling shuttle test using a concept which includes 4 main standpoints; 1: wrestling-specific movements, 2: the international wrestling rules, 3: on the mat, 4: individuality. The wrestling-specific movements can have many directions depending on the wrestling styles with wrestlers and their opponents. Therefore, we decided that wrestlers should move in four directions by running forward, backward, and side-shuffling steps in both left and rightward directions. As shown in the Figure, the wrestling shuttle test was conducted on the wrestling mat. The length of each shuttle is 4 meters between the center circle and 3 designated points (Ⓐ, Ⓒ, Ⓓ) outside the mat circle (passivity zone). This shuttle test involves performing as many shuttle lengths as possible in 3 minutes (incomplete lengths were not recorded). A full cycle of 8 shuttle lengths (right side: lengths 1 to 4, left side: lengths 5 to 8) includes two lengths of each of the four movement directions, and is to be repeated as many times as possible by the wrestler. RESULTS: The normal distribution of scores were observed in this study (wrestling shuttle test: z = 1.042, p value = 0.228). We also confirmed similar results depended on sex (males: z = 0.622, p value = 0.833, females: z = 0.790, p value = 0.561). CONCLUSIONS: This study can suggest that the wrestling shuttle test we developed is an easy and convenient method to conduct measures of aerobic and anaerobic capacities on the wrestling mat.

**Key words:** specific movement test, metabolic demands, combat sports, wrestler

## Introduction

United World Wrestling (UWW) represents the world governing organization for Olympic wrestling styles and oversees international sanctioned events, such as the Olympic Games and World Cups (Greco-Roman, Freestyle, and Women's Wrestling). The UWW has among its responsibilities to establish and disseminate the international rules for the different wrestling styles (United World Wrestling, 2016). International wrestling matches consist of two 3-minute periods with a 30-second rest interval between the periods.
Previous wrestling studies have indicated that elite wrestlers have high aerobic and anaerobic

capacities (Chaabene et al., 2016; James, Haff, Kelly, & Beckman, 2016; Yoon, 2002), which are key physiological components for high performance wrestling (Demirkan, Koz, Kutlu, & Favre, 2015; Kraemer et al., 2001). Laboratory testing of the metabolic demands of athletes is widespread, but it has limitations of being expensive, inconvenient to administer, and requiring special equipment. Laboratory testing protocols often use a bicycle or a running treadmill for its activity and therefore, relate best to specific running and cycling sports. Some sports have used field tests in their respective practice or competition venues, such as, on the court (ground and gym floor), running track, ice arena, tatami, and mats (Chamari et al., 2004; Chino, Saito, Matsumoto, Ikeda, & Yanagawa, 2015; Hoffmann, Reed, Leiting, Chiang, & Stone, 2014; Metaxas, Koutlianos, Kouidi, & Deligiannis, 2005; Santos et al., 2010; Schwesig et al., 2017; Tabben et al., 2014). Field tests have one of their aims to be more sport specific.

Wrestlers move in many directions in a match resulting from the actions and reactions of attack and defense, the tactics used, and the individual styles of the wrestlers. Wrestling movements include side-shuffling to prevent crossing one's legs and to help maintain a stable stance position for attack and defense. Side-shuffling also relates well to short circular movements to create an angle of attack or to prevent the opponent from gaining it. Currently, no assessment tool exists that includes wrestling-specific movements to evaluate a wrestler's aerobic and anaerobic capabilities.

This study methodologically developed a wrestling shuttle test to assess a wrestler's aerobic and anaerobic capacities with wrestling-specific movements. A convenient feature of this wrestling shuttle test is its easy administration in the practice facility (on the mat) and without the need for extraneous or special equipment.

**Methods**

Twenty-two Canadian wrestlers (15 males, 7 females) participated in this study (Table 1), which comprised of completing a wrestling-specific shuttle test we designed. All participants were members of a university's varsity wrestling team (Freestyle and Greco-Roman in practice and match) who had previously signed an informed consent statement indicating the risks of this participation. This research was approved by the Ethical Committee of the institution.

Table 1. Physical characteristics of participations (mean ± SD)

| | Males (N=15) | Females (N=7) | All (N=22) |
|---|---|---|---|
| Age (years) | 20.1 ± 2.2 | 18.6 ± 2.1 | 19.6 ± 2.2 |
| Height (cm) | 177.2 ± 8.2 | 163.2 ± 6.1 | 172.8 ± 10.0 |
| Body weight (kg) | 78.1 ± 13.8 | 61.1 ± 16.4 | 72.7 ± 16.4 |
| BMI (kg/m$^2$) | 24.8 ± 3.8 | 21.9 ± 3.4 | 23.9 ± 3.9 |
| Fat free weight (kg) | 66.1 ± 8.6 | 45.0 ± 6.4 | 59.3 ± 12.7 |
| Wrestling experience (years) | 5.4 ± 2.8 | 4.1 ± 3.0 | 5.0 ± 2.9 |

BMI stands for body mass index.

The test included moving in four directional movements on the wrestling mat (forward running, backward running, left side-shuffling, and right side-shuffling). Each movement was four meters in length from the center of the mat, and the participants were to obtain as many lengths as possible by continuously repeating shuttle lengths within a 3-minute time period (Figure 1).

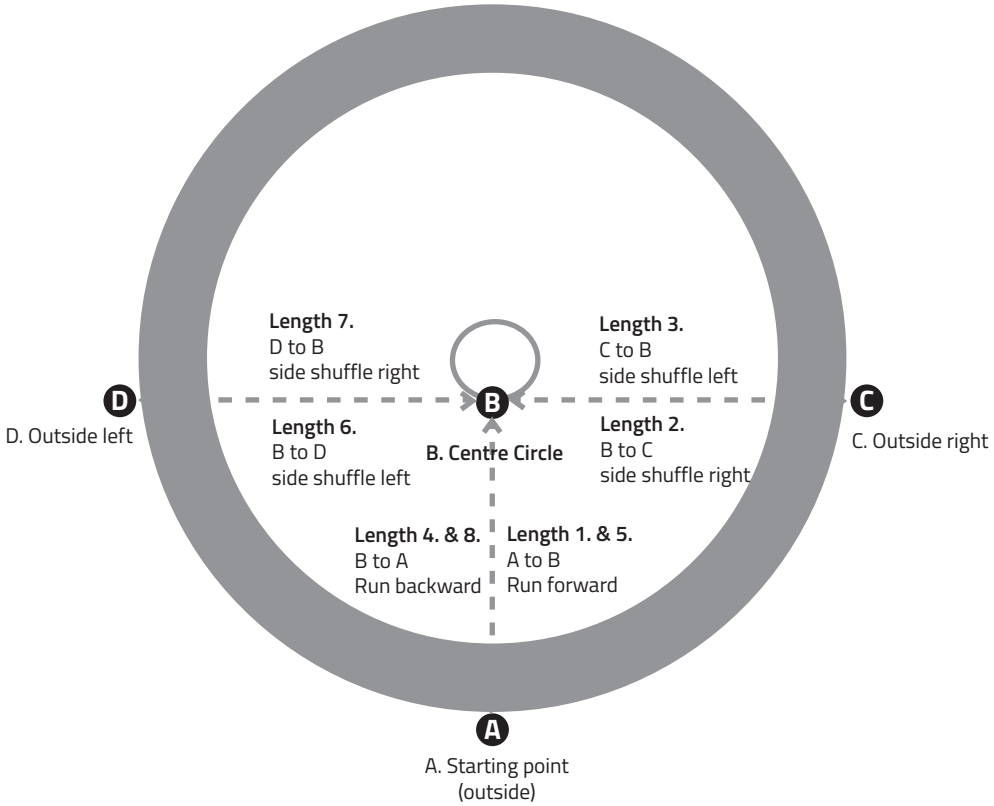


Figure 1. Procedure of the 3-minute wrestling shuttle test

The participants will repeat and continue the above pattern for the duration of the 3 minute time period. Length 1: A. to B. From start point (A.) the participant will run forward to center of mat (B.). Length 2: B. to C. From the center of the mat (B.) the participant will side-shuffle right to the outside of the mat (C.). Length 3: C. to B. From outside of the mat (C.) the participant will side-shuffle left towards the center of the mat (B.). Length 4: B. to A. From the center of the mat (B.) the participant will run backward to the start point (A.). The participant will continue the same pattern to the opposite side of the mat, that is, Length 5: A. to B. From start point (A.) the participant will run forward to center of mat (B.). Length 6: B. to D. From the center of the mat (B.) the participant will side-shuffle left to the outside of the mat (D.). Length 7: D. to B. From the outside of the mat (D.) the participant will side-shuffle right to the center of the mat (B.). Length 8: B. to A. From the center of the mat (B.) the participant will run backward to the start point (A.).

A time clock was visible and was set for a 3-minute count-down with an audible buzzer that sounded at time expiry. The total number of completed lengths was recorded, and only the last fully completed length was counted at the time of expiry. Specifically, the distributions of the wrestling shuttle test were analyzed using the Kolmogorov-Smirnov (K-S) method to confirm for normality.

The wrestling shuttle test was designed specifically for wrestlers and is based upon four features.

**1. Using wrestling-specific movements**

We designed the wrestling shuttle test to include specific movements used in wrestling. Many shuttle run tests only use forward running as the main physical activity action, interspersed

with stops, turns, and starts (Domone, Mann, Sandercock, Wade, & Beedie, 2016; Mayorga-Vega, Aguilar-Soto, & Viciana, 2015). This wrestling shuttle test includes side-shuffling movements that are similar to movement actions in wrestling, such as, moving laterally and evading backwards by circling. Side-shuffling is an important movement in wrestling as it allows the wrestler to move in relation to one's opponent, that is, to move "square," to keep one's opponent in front of you. Many of the movements across the mat are short in distance and repeated continuously.

**2. Considering United World Wrestling (UWW) specifications**

The wrestling shuttle test uses the specifications of the UWW wrestling mat. The length of each shuttle (4 m) allows the participant to cover the distance from the center of the mat to the outside boundary. Using the UWW wrestling mat allows for standardization, and consistency in testing, and is sport specific.

The wrestling shuttle test has a 3 minute time period similar to the 3 minute round in a wrestling match. This corresponds well with other research of aerobic/anaerobic fitness over a 3 minute period (Hoffman et al., 2016; Pettitt, Jamnick, & Clark, 2012).

**3. On the wrestling mat**

The wrestling shuttle test is performed on a mat surface that is commonplace in most wrestling training facilities. This provides a practical and convenient place for testing that is familiar for the coach and athletes. The wrestling shuttle test can easily be administered during a regular practice session and with little equipment. Only a timer/clock, pen and paper are needed. Those administering the test do not need special training and need only to understand how to administer the test.

**4. Individuality**

The individual focus of the wrestling shuttle test provides the participant with direct individual results. The individual nature of the test without a reliance on others, such as a partner, eliminates any chance of inconsistencies due to variances in resistance and cooperation with others. The individual participant is also able to provide one's personal effort and motivation, particularly important during the entire 3-minute period and in the remaining few seconds of the test.

**Results**

Table 2 demonstrates averages and normal distributions of the wrestling shuttle test. The distributions were confirmed to maintain normality. Since the p values were all greater than 0.05, that means they are all normally distributed.

Table 2. Outcomes of the Wrestling Shuttle Test during 3 minutes (mean ± SD)

| | Males (N=15) | Females (N=7) | All (N=22) |
|---|---|---|---|
| Wrestling shuttle length (times) | 94.9 ± 8.9 | 82.9 ± 19.5 | 91.0 ± 13.9 |
| Wrestling shuttles distance (m) | 379.5 ± 35.5 | 331.4 ± 77.9 | 364.2 ± 55.7 |
| Normal distribution | | | |
| Z score | 0.622 | 0.790 | 1.042 |
| P value | 0.833 | 0.561 | 0.228 |

The normal distribution was analyzed by the Kolmogorov-Smirnov test.

**Discussion**

The main purpose of this study was to design a wrestling shuttle test that used wrestling-specific movements, and administered easily and conveniently within a typical wrestling program. The design of the test pattern allows up to two participants tested at one time, each covering half a mat surface (Figure 1). It is possible that altering the test pattern so the participant uses one quarter of the mat surface – keeping the distance of each shuttle length the same – up to four participants can be tested at one time. This would reduce the time to administer to a large group of participants.

An all-out running test for 3-minutes has been shown to indicate aerobic and anaerobic abilities (Hoffman et al., 2016; Pettitt et al., 2012). The average speed of the last 30-seconds is an indicator of critical power (Pettitt et al., 2012). The wrestling shuttle test represents the same 3-minute time period and lends support for future study, particularly to determine how aerobic and anaerobic capabilities can be determined.

The individual feature of the wrestling shuttle test where only the participant is tested eliminates any influence from a partner or opponent who may provide variances in resistance or cooperation. Wrestling matches by themselves do not provide accurate measures of intensity since activity is influenced by several factors, such as tactics, opponent level, etc. Individual motivation to perform well in the wrestling shuttle test is augmented by providing reliable individual and personal data.

A limitation of the study was the sample size of only 22 participants (15 males, 7 females) from a specific Canadian university team. A larger sample size with a wider scope of wrestlers across a region or country could provide information on similarities or differences between countries or from an international perspective. Since wrestling includes separate age and weight divisions for both males and females, there is a need for further study on sample composition. As well, additional consideration on the wrestler's competitive level, or rank at an elite level may provide useful information. Further testing and retesting is required to check for reliability and validity of the wrestling shuttle test. Additionally, further testing will provide more data to evaluate the physiological responses of the wrestling shuttle test.

**Practical Applications**

The wrestling shuttle test can be easily performed with little disruption to a normal training routine. It also has application for training depending on its intended purpose. For example, it may be usedas a conditioning drill by altering the time and intensity. Similarly, as a drill to focus on footwork movement. Wrestling is one of several combat sports, and while each are unique among each other, there does exist common characteristics, and even some have similar holds and techniques, e.g., in judo, sambo, and wrestling. The wrestling shuttle test may have application to combative sports and be easily applied given some have similar mat surface dimensions.

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# Physical and anthropometric profile of international-level Japanese male freestyle wrestlers

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**ABSTRACT**
PURPOSE: The purpose of the study is aimed to compare physical and anthropometric characteristics of international- and collegiate-level Japanese male freestyle wrestlers, belong to the light weight category.
METHODS: Twenty Japanese male freestyle wrestlers belonging to the light weight category (former 55-, 60-, or 66-kg) were categorized into 2 groups. First group composed of 11 international-level wrestlers including 3 Olympic medalists. Second group composed of 9 collegiate-level wrestlers. Body composition was assessed by multi-frequency bioimpedance analysis device with 8-point contact electrodes. Isokinetic concentric knee and hip extension and flexion torque were measured using an isokinetic dynamometer. Morphological data was obtained by means of a three-dimensional scanning method. Twelve circumferences (neck, upper arms, forearms, thighs, lower legs, chest, waist, and hip) and four lengths (arms and legs) were computed. Simple reaction time was evaluated using an electronic device. Comparisons of these variables between the two groups were performed by unpaired t-tests.
RESULTS: The results showed there was no difference in body composition, body circumferences, and limb length between groups other than chest circumference ($p < 0.05$). There was no difference in hip and knee strength and simple reaction time between groups.
CONCLUSIONS: These results suggested that chest circumference is important to become an international-level wrestler. Also, other aspects such as multi-joint motor skills, technical and/or tactical skills may be important for international-level wrestlers.

## Introduction

Wrestling is a combat sport that involves repetitive bouts of high-intensity action in 6 minutes (two 3-minute rounds with a 1-minute rest between rounds). Wrestlers are categorized into a series of weight classes in order to promote fair competition. Therefore, wrestlers require high levels of strength, endurance, and perceptual performance.

Researchers have focused on optimizing talent selection for wrestling to maximize the potential for success in future Olympic Games. A study of the Olympic games in 2004 showed that age at the onset of wrestling as a main sport is quite early (11.2 years old; Vaeyens, Gullich, Warr, & Philippaerts, 2009), so adolescent wrestlers undergo wrestling-specific

changes in their physical qualities. Gerodimos et al. (2013) found that young wrestlers adopted wrestling-specific changes in handgrip strength during the developmental years. Garcia-Pallares, Lopez-Gullon, Muriel, Diaz, and Izquierdo (2011) compared physical fitness between elite and non-elite youth wrestlers and found that maximum strength, muscle power, and anaerobic power were important in the elite wrestlers. Some studies have suggested that dynamic strength in the lower limbs is a key factor for elite adolescent wrestlers. A previous study showed that high school wrestlers showed greater isokinetic peak torque at the knee with age (Housh et al., 1989; Weir, Housh, Johnson, Housh, & Ebersole, 1999). High-level high school wrestlers have greater isokinetic knee strength than their average-level counterparts do (Cisar et al., 1987). In contrast, such findings related to physical aspects in elite male wrestlers post-adolescence have been limited.

For experienced wrestlers, perceptual abilities seem to become more important with age because their training experience is longer, and more complex technical skills seem to be needed. Among these abilities, fast reactions enable wrestlers to fight more effectively by implementing adequate technical and tactical actions as well as allowing them to anticipate any complex moves by their opponent. Elite wrestlers with shorter simple reaction times have been shown to perform more technical and tactical actions during a match (Gierczuk, Lyakh, Sadowski, & Bujak, 2016). On the other hand, another study reported that there were no correlations between reaction time and win-loss record in college wrestlers (Whitley & Montano, 1992), so findings related to perceptual abilities and reaction time remain controversial.

Japan also one of the leading nations for men's freestyle wrestling in the light-weight category. Understanding the physiological factors of international-level Japanese wrestlers could help determine an optimal skill and physical training plan. Therefore, the purpose of this study was to clarify the physiological abilities of elite male wrestlers compared to non-elite wrestlers.

**Methods**

Twenty Japanese male freestyle wrestlers with no history of recent lower-limb injury or neuromuscular disorders belonging to the light-weight classes (former 55-, 60- or 66-kg) were categorized into two groups. Eleven wrestlers (mean age: 23.9 ± 3.8 years; height: 166.2 ± 3.0 cm; body weight: 67.5 ± 4.4kg) performed at the international level, including 3 medalists at the 2012 London or 2008 Beijing Olympic games. Nine wrestlers (mean age: 19.6 ± 1.0 years; height: 168.9 ± 2.6 cm; weight: 66.8 ± 3.4kg) belonged to division-1 collegiate wrestling teams in Japan. They provided written informed consent to undergo experimental procedures. This study was conducted in accordance with the Declaration of Helsinki and was approved by the ethics committee of our institute.

Standing height was measured using a stadiometer (DC-250, Tanita, Tokyo, Japan). Body composition was assessed by a multi-frequency bioimpedance analysis device with 8-point contact electrodes using a commercially available apparatus (InBody 730, Biospace, Inc.). Isokinetic concentric extension and flexion torque of the knee was measured using an isokinetic dynamometer at angular velocities of 180 deg/sec (System 4, Biodex medical Systems, New York, USA). Morphological data were obtained by means of a three-dimensional scanning method (Body line Scanner; BLS, Hamamatsu Photonics KK, Shizuoka, Japan). Eleven circumferences (neck, both upper arms, both forearms, both thighs, both lower legs, chest, and hips) and four lengths (both arms and both legs) were computed. The reference locations were the same as those used in a previous study (Arakawa, Yamashita, Arimitsu, Sakae, & Shimizu, 2015). Whole-body simple reaction time was recorded in five trials using a reaction time measurement system (YB-1000, Yagami, Nagoya, Japan). Participants stood still with their knees slightly bent on a sensory mat in front of the apparatus and lifted off their feet as soon as the red LED light was lit.

The Kolmogorov-Smirnov test was employed to access the normality of the data distribution. F tests were used to determine whether these variances between two groups were equal. When the variances between two groups were equal, unpaired t-tests were performed. Otherwise, Welch's tests were performed. The alpha level was set at 0.05.

**Results**

There were no differences in physical attributes and body composition between the two groups. The chest circumference in international-level wrestlers was significantly greater than those of collegiate wrestlers in the morphological data ($p < 0.05$) (Table 1). There were no differences in isokinetic strength (Table 2) and whole-body simple reaction time (Table 3) between the two groups.

| | International (n = 11) | Collegiate (n = 9) |
|---|---|---|
| Limb lenght (cm) | | |
| Arm R | 70.6 ± 2.7 | 72. 1 ± 1.7 |
| L | 69.9 ± 2.6 | 71. 9 ± 1.8 |
| Leg R | 82.7 ± 1.9 | 83. 7 ± 1.8 |
| L | 82.6 ± 1.9 | 83. 7 ± 1.6 |
| Circumference (cm) | | |
| Neck | 40.0 ± 1.5 | 39. 3 ± 2.2 |
| Chest | 97.7 ± 4.1* | 93. 7 ± 2.6 |
| Hip | 92.1 ± 2.4 | 90. 9 ± 3.2 |
| Upper Arm R | 30.0 ± 1.3 | 29. 9 ± 1.5 |
| L | 30.5 ± 1.3 | 30. 2 ± 1.5 |
| Forearm R | 25.7 ± 1.0 | 26. 0 ± 1.2 |
| L | 26.2 ± 1.0 | 26. 1 ± 1.0 |
| Thigh R | 51.9 ± 1.8 | 52. 0 ± 2.0 |
| L | 51.9 ± 1.7 | 51. 2 ± 2.1 |
| Lower Leg R | 35.7 ± 1.1 | 35. 6 ± 1.4 |
| L | 35.9 ± 1.1 | 36. 0 ± 1.6 |

*p < 0.05

Table 1. Limb lengths and circumferences of international and collegiate wrestlers. R, right; L, left

| Peak torque (Nm/kg) | International (n = 11) | Collegiate (n = 9) |
|---|---|---|
| Ectention (180 deg/s) R | 2.15 ± 0.24 | 2.08 ± 0.19 |
| L | 2.15 ± 0.27 | 2.13 ± 0.20 |
| Flexion (180 deg/s) R | 1.29 ± 0.15 | 1.19 ± 0.14 |
| L | 1.25 ± 0.13 | 1.19 ± 0.15 |

*p < 0.05

Table 2. Isokinetic concentric peak torque of international and collegiate wrestlers. R, right; L, left

| | International (n = 11) | Collegiate (n = 9) |
|---|---|---|
| Reaction time (ms) | 292.3 ± 58.0 | 287.7 ± 22.5 |

*p<0.05

Table 3. Whole-body simple reaction time of international and collegiate wrestlers.

**Discussion**

There were no differences in body height and limb lengths between international and collegiate wrestlers. These results support the findings of a previous study that compared Japanese senior elite and junior elite wrestlers in the light-weight categories (Arakawa, Yamashita, Arimitsu, Sato, et al., 2015). In contrast to the previous study, upper- and forearm circumferences did not differ between the two groups. This result may be because the differences in the populations of the control groups. In the previous study, the control group consisted of wrestler in the junior age categories, and the fat-free mass was smaller in the junior elite group than that in the senior elite group. However, in the current study, the control group consisted of collegiate-level wrestlers, and there were no differences in the fat-free mass between groups. Instead, our results suggested that chest circumference, which was not reported in the study by Arakawa, Yamashita, Arimitsu, Sato, et al. (2015), was the key factor differentiating international-level wrestlers from non-elite wrestlers in the light-weight categories. A greater chest circumference indicates greater chest and back muscle volumes. Changes in chest circumferences are also consistent with training-induced adaptations (Waldron, Worsfold, Twist, & Lamb, 2014). Chest circumference is also related to chest press strength (Reynolds & Day, 2005). A previous study reported that elite senior Greco-Roman wrestlers performed better in pull-up repetition tests and 30s Wingate arm crank peak power tests (Nikooie, Cheraghi, & Mohamadipour, 2017). Callan et al. (2000) also evaluated upper-body power using rope-climbing and the Wingate arm crank test for the U.S. freestyle world team. These physical characteristics of the upper body seem to be of benefit for catching and pulling the opponent's legs during leg attacks. Therefore, our results strongly suggested that upper-body muscle strength is the factor differentiating international-level wrestlers from non-elite wrestlers.

There were no differences in isokinetic peak torque at the knee between groups. This result did not support that of a previous study of adolescent wrestlers. High-level high school wrestlers showed greater isokinetic knee extension and flexion torque than did their average-level counterparts (Cisar et al., 1987). Housh et al. (1989) performed the same isokinetic measurement that was used the current study for high school wrestlers (means: 17.6 years old, 171.1 cm in height, and 68.7 kg in weight), and reported results of 1.72 and 1.06 Nm/kg for knee extension and flexion of 180 deg/sec, respectively. Compared to their results, the current results from collegiate wrestlers seems to be superior (2.08 and 1.19 Nm/kg in right knee extension and flexion, respectively), even though their fat-free mass was almost the same (61.2 and 58.6 kg in the high school wrestlers and the current collegiate wrestlers, respectively). Therefore, it remains doubtful whether dynamic lower-limb strength is truly unimportant to international success. Further study is needed to investigate muscle strength in elite senior wrestlers.

There were no differences in simple reaction times between groups. This result supports those of previous studies in which there was no correlation between reaction time and win-loss record in college wrestlers (Whitley & Montano, 1992) and in which there was no significant difference in simple reaction times between karate athletes and novices (Mori, Ohtani, & Imanaka, 2002). These findings suggest that other perceptual abilities might be important, such as anticipation and specific movement times. However, it is interesting to note that there was large inter-participant variability even in medalists' reaction time. For

example, one medalist had the best reaction time (203 ms) out of 20 participants, but the other two medalists had the 5th highest (270 ms) and the worst (395 ms) reaction times. These medalists may have different preferred wrestling strategies; for example, a medalist with a fast reaction time may prefer defensive strategies because he can react quickly against an opponents' attack. Technical-tactical analyses of men's freestyle wrestling have revealed that world champions use different techniques as their individual winning strategies (Tünnemann, 2016).

**Conclusion:**

In conclusion, this study compared the physiological abilities of international-level male wrestlers to those of wrestlers with a collegiate skill level but similar body compositions. Chest circumference was shown to one of the key factors differentiating international-level wrestlers in the light-weight categories. Many researchers and strength coaches have introduced wrestling-specific training programs based on these previous findings (Kraemer, Vescovi, & Dixon, 2004; Murlasits, 2004). Further study is needed to find a key to international success for wrestlers and to prescribe optimal training programs.

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# Basic and specific fitness tests for freestyle wrestlers realized in the Republic of Macedonia: A review of research

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**ABSTRACT:**
PURPOSE: The main goal was to perform a review of previous studies the tests of which were applied to assess basic and situation-specific motor fitness/abilities of freestyle wrestlers in the Republic of Macedonia. The second goal was to draw some conclusions about the sample of respondents, application of basic and situation-specific motor tests, data processing methods, and outcomes of research. METHODS: The empirical method was applied to analyze all available articles and documents on this topic usage of basic and specific fitness tests for freestyle wrestlers. RESULTS: Based on the review and analysis of the research, we can conclude that all measurement procedures and all records of testing and application of methods for data processing in the analysed studies were in accordance with the standard methodological requirements that apply to these types of testings. In most applied tests a satisfactory degree of measurement features was determined. In freestyle wrestlers we determined a relatively clean and clear existence of the following structure of factors of the basic motor tests: explosive power, dynamometric force, coordination, strength (repetitive and static), balance, flexibility, frequency of movement. In the situation-specific motor tests, four latent situation-specific motor dimensions were isolated: the factor of complex situation-specific ability in standing and parterre positions, the factor of situation-specific ability to perform complex techniques of throws, the factor of situation-specific ability to quickly perform complex tasks in situational martial bridge, factor of situational ability to quickly transition from standing to parterre and vice versa. Basic motor skills – coordination, dynamometric force, power (repetitive and static), frequency of movements, explosive power, balance, and greater flexibility have hierarchically dominant influence on the determination of individually isolated situation-specific latent motor factors. CONCLUSIONS: Based on a previous review research on this topic (Basic and specific fitness tests for freestyle wrestlers realized in Republic of Macedonia), it can be concluded that the application of multivariate methods is very important and useful for determining the factorial structure and measurement features, and for the establishment of relations between the basic motor tests and situation-specific motor tests in freestyle wrestlers. Basic motor skills – coordination, dynamometric force, power (repetitive and static), frequency of movements, explosive strength, balance and flexibility, have hierarchically dominant influence on performance in freestyle wrestling. The findings may find their application in the implementation to further research projects related to the treated problems and they can also be used in the talent identification and selection of young wrestlers, and in rational, objective and cost-effective planning and programming of training process for different age categories in martial clubs and national teams.

**Key words:** basic motor tests, situation-specific motor tests, situation-specific capabilities, reliability, factorial structure, regression analysis, canonical analysis, manifest space

**Introduction**

New overall development processes and trends in the world of wrestling (in particular, the latest changes of rules and the development trend of world wrestling), point to the conclusion that in recent years, the characteristics of sports wrestling have fundamentally changed in the direction of the most intense the so called "total wrestling" characterized by great complexity, dynamics and sub-maximum and maximum loads during a match.

For this cause, one of the primary objectives of the methodology of sports training is the application of rational and effective training programs, which will promote rapid developmental transformation processes in the basic and situation-specific motor skills of wrestlers.

To achieve these goals, i.e. to rationally and effectively influence the development of these capabilities, it is necessary to have exact information on issues related to the basic and situation-specific motor states, on the basis of which you can plan and program directions for their transformations in different annual and perennial periods of training.

To this end, the need for the implementation of research that deals with the basic and situation-specific motor space in athletes-wrestlers in freestyle is very important for improving the theoretical and practical work in wrestling.

In the past, various kinds of scientific, scientific-technical and professional works on wrestling were written and published; however, to determine the guidelines for further research we need to determine which research findings have been so far implemented in practice and with what effects.

Considering the fact that no attempt has been made yet to make a survey and analysis of previous studies that dealt with the basic and situation-specific motor space of the freestyle wrestlers in the Republic of Macedonia, the conception of this research primarily focuses on the analysis of previous research using the tests that were applied for assessing the basic and situation-specific motor space of freestyle wrestlers in the Republic of Macedonia.

**Objectives**

The main objective of this paper was to perform a review and analys of previous research studies which treated the basic and situation-specific motor space and the tests of which were applied to the freestyle wrestlers in the Republic of Macedonia in the period from 1980 to 2016.

The review of the research in this paper is classified into three groups. In the first group the research studies are treated the aim of which was to identify and analyze measurement characteristics of basic and situational motor tests. In the second group studies were treated aiming at determining the factorial structure of the applied basic and situational motor tests in research and in the third group studies were treated that analyzed effects of basic motor tests on the performance on the situational motor tests in different spaces, applied to freestyle wrestlers from the Republic of Macedonia.

**Methods**

For the realization of these objectives empirical method was used, based on previous research of scientists who realized their studies with the Macedonian wrestlers. Also, an attempt was made to give an analytical overview of studies on basic and situational motor space of freestyle wrestlers realized in the country. Previous studies were searched through journals, magazines and collections in the field of sports science, physical education and kinesiology. Certain papers were searched in the library of the Faculty of Physical Education, Sport and Health, and some papers were found using the Google search engine.

**Results**

Determining measurement characteristics of basic and situational motor tests

For the registration of motor manifestations it is necessary to use good measuring instruments (tests) that have satisfactory measurement properties (validity, reliability, sensitivity, accuracy and discriminative value of the tasks of measuring instruments). Besides these features, sometimes test should be, under certain limitations of time and finances, practical and economical.

For the purposes of determining the measurement characteristics of tests, basic descriptive statistical parameters for all tests were calculated; also, the normality of data distribution was tested by the method of Kolmogorov-Smirnov.

To determine the factor validity of the tests, several indicators were calculated, including Pearson's coefficient of correlation between the particles (P) of the tests; coefficient of determination (SMC), which was treated as a lower limit of reliability, Hoteling method of the main components (X). The number of significant principal components was determined under the Kaiser-Guttman Conn's criterion, according to which all characteristic roots were considered statistically significant that had values equal to or greater than 1.00.

Assessment and analysis of reliability of the tests was realized by calculating several reliability coefficients like Spearman-Brown coefficient of determination (SB1), Spearman-Brown reliability coefficient (SB2). Cronbach coefficient was calculated based on the projections of particles on the first principal component (Cronbach-α). In addition, the research of Naumovski and collaborators (2006), reliability was determined based on the classical and image theory.
In clarification of this issue, a research by Dimkov and Gligorov (1997) was conducted with the sample of 32 respondents-freestyle wrestlers, aged 15 to 20 years. The study explored reliability of five composite situation-motor tests. From the analysis of reliability, the tests 'bridge and return to the upright position', 'pirouette off the bridge', 'defence of leg and attack on the same leg' and 'grip on one leg' had a relatively satisfactory reliability, but low sensitivity, and the test 'defence on both legs and perform counter-attack' had unsatisfactory reliability and sensitivity.

Interesting and important research for establishing the measurement characteristics of basic motor abilities was realized by Gligorov (1999). The exploration was conducted on a sample of 65 male freestyle wrestlers, aged 18-19 years, by means of 29 manifest motor tests for the assessment of motor sizes. Most of the applied tests had composite character and were performed 3 to 7 times. In most motor tests satisfactory measurement properties (validity, reliability and sensitivity) were determined.

Gligorov Kamberi, and Kasumi (2014) used a sample of 102 male freestyle wrestlers, aged 18-28 years, to analyse the primary measuring characteristics (factor validity and reliability) of 12 situational motor tests: left-right bridge-rotation (RM), pirouettes of the bridge (PIRM), bridge and return to the upright position (MVIP), leg defence and attack with the same leg (Onni), shulter (Schull), Grind (MEL), the defence of both legs (OD2NOZ), left-right upriser (Auf), coordination without the doll (KOBKU), first situational test without a partner (PSITBP), second situational test without a partner (VSITBP), and complex situational test with a partner (KOMSTP). Situational motor tests MVIP, KOBKU and PSITBP were also applied in research by Maric et al. (1989) ; situational motor test VSITBP was applied in the research by Horvat et al. (1981); situational motor tests: PIRM, RM, Schull, MEL were applied in the work by Chakmuradov (Chakmuradov, 1994); situation motor test KOMSTP was applied in the work by Podlivaev (2004); situational motor test ONNIN was applied in research by Gligorov (1997) and Dimkov and Gligorov (1997), whereas situational motor test AUF was applied in research

by Gontarev and Gligorov (1998). Based on the survey of the results the following main conclusions were drawn:

1. In most applied tests satisfactory degree of measurement features was determined.

2. Satisfactory reliability coefficients were determined for the tests: bridge and return to the upright position (MVIP), leg defense and attack with the same leg (Onni), Shulter (Schull), Grinder (MEL), defense on both legs (OD2NOZ) and second situation test with a partner (VSITBP).

3. A satisfactory level of factor validity was established for the tests: left-right bridge-rotation (RM), leg defence and attack with the same leg (Onni), coordination without the doll (KOBKU), first situational test without a partner (PSITBP), second situational test without a partner (VSITBP), complex situational test with a partner (KOMSTP), Shulter (Schull), Grinder (MEL), left-right upriser (Auf), pirouette off the bridge (PIRM), both legs defence in 10 seconds (OD2NOZ), and bridge and return to the upright position (MVIP).

Naumovski, Gligorov Gontarev and Nasev (2006) used a sample of 65 freestyle wrestlers, aged 18-19 years, to examine measurement characteristics of four composite motor variables (standing long jump – SDM, running 20 meters – T20M, standing triple jump – TRM, and shot put ball throwing from supine position – FM) whose hypothetical object of measurement was explosive power. The data were processed by several methodological and statistical procedures. It was concluded that the tests were valid measurement instruments to assess the factor of explosive power. Also, the following levels of reliability were determined for the tests: an expressed high degree of reliability for the test standing long jump (SDM), a high degree of reliability for the tests running 20 meters (T20M) and shot put ball throwing from supine position (FM), whereas a careful acceptance of application without modification was determined for the test standing triple jump (TRM).

Measurement characteristics were the subject of the research by Gligorov Gontarev, Kasumi and Kamberi (2013), who divided the sample of 130 male students, aged 18-19 years, into two subsamples (65 students from the Centre for Security Personnel Training and 65 freestyle wrestlers). The objective of the survey was to identify, analyse and compare measurement characteristics of four composite bio motor variables (standing long jump – SDM, running 20 meters – T20M, standing triple jump – TPM, and shot put ball throwing from the supine position – FM) whose hypothetical object of measurement was explosive power. The data were processed using several methodological and statistical procedures. The authors concluded that in both subsamples the tests had completely identical subject of measurement and were therefore valid measurement instruments to assess explosive power factor. For the freestyle wrestlers the following levels of reliability were obtained for the tests: an expressed high degree of reliability for the test standing long jump (SDM), a high degree of reliability for the tests running 20 meters (T20M) and shot put ball throwing from supine position (FM); the test standing triple jump was rated as careful acceptance of implementation without modification (TPM).

**Defining the factorial structure of the basic and situational motor space**

In science and theory there are two aspects to the definition and existence of motor skills. One view refers to basic motor abilities, and the other to situation-specific motor skills. Basic motor skills, along with other anthropological features, constitute a basis of every athlete for his/her technical and tactical (informational) upgrades of capabilities needed for high sports achievements. In order to develop the upgrades to the highest individual rate when wrestlers

can exhibit a superior degree of technical and tactical capabilities, it is necessary that the basic motor skills are on the highest individual rate.

For the determination of factorial structure of the tests in the analysed studies, we applied Hoteling's method of the main components, where significant principal components were transformed into varimax, according to the criterion of Guttman and Kaiser. These factors were transformed into oblimin factors, according to the direct criterion of Jennrich and Sampson. For the oblimin factors their parallel and orthogonal projections were calculated. Then the intercorrelations for the oblimin factors were calculated.

The issue of determining latent dimensions of freestyle wrestlers was researched by Gligorov (1997). On a sample of 32 freestyle wrestlers, age 15 to 20 years, he carried out the research to determine factorial structure of five situation-specific motor tests. The author was able to determine the existence of two factors. The first factor was defined by the variables bridge and return to the upright position and bridge pirouette, whereas the second factor was defined by the variables defence and attack with the same leg, grip on one leg and defence of both legs and conducting counter-attack.

Research by Gligorov, Ruzdija and Bogdanov (2008) examined factorial structure of the basic motor tests on a sample of 102 freestyle wrestlers, aged 18-28 years, from the Republic of Macedonia. Twenty-nine manifest motor tests were applied to assess basic motor latent dimensions. The results showed a relatively clean and clear existence of the following factorial structure: explosive power, dynamometric strength, coordination, strength (repetitive and static), balance, flexibility, frequency of movement, an undefined factor. Low and insignificant correlation coefficients were obtained between the isolated factors, suggesting independence of the isolated factors.

In order to get an insight into the factorial structure of some situational motor tests in freestyle wrestlers involved in prominent training process and high ranked matches, Gligorov, Naumovski and Kasum (2010) used a sample of 102 male freestyle wrestlers, aged 18-28 years, and applied 12 situational motor tests. Based on factor analysis, the existence of four situational latent motor dimensions was determined:

- complex situational ability in standing and on parterre,
- situational ability to perform complex techniques of throws,
- situational ability to quickly perform complex movements in martial bridge
- situational ability to quickly switch the standing position to parterre and vice versa.

**Analysis of the relations between basic motor abilities and situation-specific skills**

Relations between basic motor tests and situation-specific motor tests were calculated in the treated research studies by regression analysis of manifest, latent and combined space. Within each solution of the regression analyses additional statistical parameters were calculated. In addition, in some studies, for determining the relations between the basic motor tests and situational motor tests, canonical correlation analysis was applied in manifest and latent space. For this purpose, we calculated: correlation coefficients (LAMDA), canonical correlation coefficients (RC) and statistical significance of pairs of canonical factors (Q).

One of the first studies on the influence of some manifest situational motor variables on motor tasks performance was conducted on a sample of 55 adult (senior) freestyle wrestlers (Kajchevski and collaborators, 1988). Sixteen manifest motor variables were applied and five situational motor tasks (rolls forwards and backwards in 15 seconds, bridge-roll-bridge in 15 seconds, coordination without the doll, coordination with and without the doll and throw technique on the better side). The authors found that the applied system of manifest variables

had no statistically significant impact on situational motor tasks in the treated sample. Also, it was recommended that special attention in future research of this kind should be paid to the definition of situational tests and their measuring characteristics.

Marić and collaborators (1989) used a sample of 73 freestyle wrestlers, aged 18-20 years, with martial experience of more than two years, selected on the basis of their success at republic and federal contests, to explore the connection of some situational motor variables with the performance of the technique throwing by folding a grip on two legs. The authors applied 3 measurement instruments to assess situational motor skills: specific mobility without a partner (MCT), situational test with a partner 2 (MST2) and situational test with a partner 3 (MST3). The criterion variable was the performance of technique throwing by folding a grip with two feet, which was assessed by five competent assessors on a 5-point scale from one (1) to five (5). Based on the results of the regression analysis, the authors recommended the first and third situational motor test for the selection and control of the preparedness of freestyle wrestlers. Moreover, they pointed to the need for further research in order to improve learning and improvement of the techniques.

Gontarev and Gligorov (1998), using a sample of 65 freestyle wrestlers, aged 18-19 years, and 28 basic motor variables, explored the impact of six situational motor variables: rotation bridge the left-right (RM), left-right upriser (AUF), twisting of the bridge (PIR), defending and attacking with the same leg (ONNIN), specific test with a partner 1 (STP1), specific test with a partner 2 (STP2). The results were processed using regression analysis in the combined manifest-latent space. Based on the results, the authors concluded that the system of motor variables (manifest and latent) had a statistically significant impact on the success of criteria variables, i.e. the freestyle wrestlers with better general motor abilities (in particular, coordination, frequency of movements, static power), had better performance of the set of situational motor tasks. The authors recommended the results to be taken into account in the planning and programming of the training process and selection of young wrestlers.

In order to determine the relationship of basic and situational motor abilities, Marić and collaborators (1999) realized a research with a sample of 73 young freestyle wrestlers, aged 18 to 20 years, with sports experience of more than two years. Predictors were eight variables for assessing coordination, five variables to assess explosive strength and three variables for estimation of situation- specific motor skills. Criterion variables were eight techniques performance of freestyle wrestling. Five competent assessors assessed quality of techniques performance. Each judge assessed performance of each technique of each respondent on a 5-point scale from one (1) to five (5). The following structure of the techniques was evaluated: 1. proper posture – one (1) point, 2. phase of entry into a grip – one (1) point, 3. working phase (phase of throwing) – one (1) point, 4. the final stage – one (1) point, 5. general impression (coordinated, fast and smoothexecution of all phases) – one (1) point. The authors concluded that good performance of the techniques in freestyle wrestling was under a high influence of basic and situational coordination. Therefore they recommended that people with a high degree of coordination skills should be selected for freestyle wrestling and that freestyle wrestling can be practiced as a means to develop coordination skills.

Gontarev and Gligorov (1999) applied a system of 28 basic motor tests on a sample of 65 freestyle wrestlers, aged 18-19 years. The test battery hypothetically covered most of the basic motor space (predictors) and six motor situation variables (criteria). Based on the results obtained from the calculations by Hotteling's canonical correlation analysis in the manifest and latent space, the following conclusions were drawn:

- In the manifest space statistically significant association was provided only in the canonical dimension, whereas in the latent space such a connection was established in two canonical dimensions,

- In the latent space, the entire system of motor variables had statistically significant impact on the success in the criterion variable,
- Wrestlers having better motor abilities in general and especially with better coordination, frequency of repetitive movements and static power, were more successful in performance of the established situational tasks.

Interesting and important research was realized by Gligorov (2008), who analyzed the predictive value of 29 manifest motor tests to assess basic motor latent dimensions on performance of 12 situational motor tests applied to 102 freestyle wrestlers, aged 18-28 years. Among other things, the author concluded that:

1. The system of basic motor tests had a statistically significant influence on the results on situational motor tests: 1. left-right bridge-rotation (RM), 2. pirouette off the bridge (PIRM), 3. bridge and return to upright (MVIP), 4. leg defense and attack with the same leg (insulating), 5. Shulter (Schull), 6. Grind (MEL), 7. both legs defence (OD2NOZ ), 8. left-right upriser (Auf), 9. situational test without a partner1 (PSITBP), 10. situational test without a partner2 (VSITBP), and 11. complex situational test with a partner ( KOMSTP). The system of basic motor tests did not significantly affect the performance of a situational motor test (task, assignment) coordination without the doll (KOBKU).

2. The system of basic motor tests significantly influenced the four isolated hypothetical situational latent dimensions that defined the structure of freestyle wrestling. These dimensions were: factor of complex situational ability in standing and ground positions, factor of situational ability to perform complex techniques of throws, factor of situational ability to quickly perform complex situational tasks in martial bridge, and factor situational ability for quick transition from standing to parterre and back.

3. The system of the eight isolated basic motor factors (explosive power, dynamometric strength, coordination, strength repetitive and static, balance, flexibility, frequency of movement, undefined factor) had a significant influence on the isolated situational motor latent dimensions in freestyle wrestling: factor of complex situational ability in a standing position and parterre, factor of situational ability to perform complex techniques of throws, factor of situational ability to quickly perform complex situational tasks in martial bridge, factor of situational ability for quick transition from standing to parterre and vice versa.

4. The results of the canonical correlation analysis in the manifest and latent space to a great extent confirmed the results obtained from the regression analysis.

5. Basic motor skills, coordination, strength, power, frequency of movements and explosive power, had hierarchically dominant influence on the determination of individual motor situational factors (complex situational ability in standing and ground position, situational ability to perform complex techniques of throws, situational ability to quickly perform complex tasks in situational martial bridge, and situational ability for quick transition from standing to floor and back).

**Conclusions**

Based on the review and analysis of research studies treated in this paper, we can conclude that they indicate a certain theoretical and practical importance of research in the field of freestyle wrestling. Generally, several conclusions can be drawn:

- Various mathematical-statistical methods, appropriate for this type of research, were used for the processing of data collected from all the basic and situational motor tests.

- Appropriatness of basic measuring characteristics (primarily validity and reliability) was established for the utilized tests at the level of basic and situational motor abilities and for the specified factorial structure of basic and situational motor tests. Also, a degree of predictive value of motor tests was established for performance of situational tasks in the manifest, latent and combined space.

- The findings of this research can be applied to future scientific research projects aiming to assess the latent structure of motor segment of general anthropological status of respondents dealing with freestyle wrestling. These findings can also be used in the process of training, talent identification and selection of young athletes, in the area of more rational, objective and better cost-effective planning and programming of activities in the field of sport. Also, the findings may be useful in the activities of research institutions in the field of science of sports.

- It is possible to generalize the results of the research only to the hypothetical population that has "the same" features like the sample of respondents in the conducted studies. This is necessary to emphasize since the findings of the research may be a starting point for the continuation of further expert and scientific analyses which should impose more stringent methodological requirements. The first such a methodological requirement for further research would be larger sample sizes – freestyle wrestlers of various age and weight categories and usage of batteries of tests from other areas of anthropological status determination.

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# The impact of emotions on visual-movement performance and effectiveness of competitive activity of elite wrestlers

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**ABSTRACT**
PURPOSE: The aim was to study the impact of emotions on visual processing in movement performance and its effects on the competitive activity of elite wrestlers. METHODS: The peculiarities of visual perception in information-processing conditions were studied in connection with the emotions of elite athletes. Nineteen elite athletes, Greco-Roman wrestlers, aged 19-22 years, were examined. The wrestlers completed the following tests: simple visual-motor reaction; reaction to a moving object; perception speed; and a scale of emotion excitability. Consents for research in written form were given by the athletes according to the recommendations of the Ethics Committee for Biomedical Research. RESULTS: The results indicate significant links between anger and certain aspects of visual perception in elite athletes. It is likely that the emotional factor of anger is a hindrance to concentration and attention in athletes resulting in ineffective information processing and leading to a deterioration of visual perception and effectiveness of competitive activity. CONCLUSIONS: Anger, as an affective emotion, is a negative characteristic in the wrestler's general functional state and potentially jeopardizes his/her competitive performance.

**Key words:** anger, psychophysiological factors, competitive performance

**Introduction**
The changes, occurring with time, in accuracy of moving skills and speed of reaction limit modern wrestling activity [1].
The wide-spread introduction of modern technologies to sport practice brings progress to wrestling science. One of the main ways of these approaches is the use of wrestlers' personality peculiarities, individual-typological characteristics of higher nervous activities included [2].
Athletes' motor realization of skills is linked with different hierarchical levels of the nervous system: afferent, analytic, and efferent part [3,4,5]. However, the productivity of sport activity is linked with psychophysiological condition and coordination characteristics of wrestlers as well [6,7].
In wrestling, the highest value for coordinate movements, determination of the position of the rival, and level of anticipation is assigned to athlete's coordination ability and his/her capability of visual information processing [8].
At the same time, each psychic phenomenon appears to be related to physiological structures – it can influence physiological processes or be conditioned by them [9].

Thus we can assume that visual-movement performance and effectiveness of competitive activity of wrestlers has strong connections with their emotions.
The purpose was to study the impact of emotions on visual-movement performance and effectiveness of competitive activity in elite wrestlers.

**Material and methods**

Participants

Nineteen elite Greco-Roman wrestlers, aged 19-22 years, were examined.
The experimental study was approved by the Ethics Committee for Biomedical Research in accordance with the ethical standards of the Helsinki Declaration. Consents for the research in a written form were given by the athletes according to the recommendations of the Ethics Committee for Biomedical Research [10].

**Instruments/tests and research design**

Procedures

The hardware and software complex for psychophysiological diagnostics Multipsuchometer-05 was used.
The sequence of the study methods: simple visual-motor reaction; reaction to the moving object; perception speed; scale of emotion excitability.

The simple visual-motor reaction was represented with elementary response to the visual stimuli. For determining the balance between acceleration and deceleration of the nervous system, "Reaction to the Moving Object" was assessed as a complex sensory-motor reaction. The method "perception speed" evaluates speed and accuracy of identifying geometric figures and comparing the given fragments with the set-up targets.

The "Scale of emotion excitability" aimed at defining the individual's emotional excitability. It was measured by a list of questions aimed at determining the characteristics of the studied emotional response. The test resulted in the determined parameters: general emotionality, anger, anxiety, emotion control.

Statistical analysis was performed using the program package Statistica 6.1. The data obtained in the research corresponded to the normal distribution of data, so the methods of parametric statistics under the Fisher test criterion were applied.

**Results**

As the efficiency criterion of visual perception we used the parameters of latent period of visual-motor reaction [11]. According to the level of visual response speed, all athletes were divided into two groups. The first group – wrestlers who had a high level of response speed: latent period from 120 ms to 240 ms (7 subjects). The second group – wrestlers who had an average level of response speed: latent period of 240 ms and over (12 subjects). A comparative analysis between the two groups of athletes by the values of simple visual-motor reaction, reaction to the moving object and perception speed are presented in Table 1.
The results indicate that the first group of athletes had significantly lower values of parameters of latent period of visual-motor reaction in comparison to the second group. This fact indicates higher speed of information processing of the first group athletes. The study of reaction to the moving object revealed no differences between the two groups of athletes in any parameter (Table 1). This result was probably caused by the absence of persons who had lower level of response speed.

Table 1. Values of perception and emotional parameters of athletes (n=19)

| Meanings | First group (n=7) | Second group (n=12) |
|---|---|---|
| Simple visual-motor reaction | | |
| Latent period (ms) | 232.75 ±3.79 | 266.39 ±7.25* |
| Stability (%) | 14.62 ±1.03 | 16.25 ±1.73 |
| Reaction to the moving object | | |
| Accuracy (secret unit) | 16.86 ±0.27 | 15.0 ±0.15 |
| Stability (secret unit) | 3.07 ±0.27 | 3.97±0.36 |
| Excitability (secret unit) | -0.71 ±0.48 | -0.40 ±0.24 |
| Perception speed | | |
| Productivity (secret unit) | 59.71 ±4.03 | 45.33 ±4.49* |
| Speed (bit/min) | 16.49 ±0.95 | 13.01 ±1.21 |
| Accuracy (secret unit) | 0.90 ±0.01 | 0.86 ±0.01* |
| Efficiency (secret unit) | 43.55 ±3.70 | 31.45 ±3.56* |

Note: * $p < 0.05$, in comparison with the first group of athletes

Comparison analyses among athletes with different level of visual responses indicate the significant differences in perception speed method between the parameters: productivity, accuracy and efficiency (Table 1). It testifies about higher level of information processing in athletes of the first group and indicates the best possibilities of sensory-motor functions of persons of this group.

The data of values of emotion excitability in athletes with different level of visual-motor reaction are presented in Figure 1.

According to the results for the variable "Scale of emotion excitability", the significant difference between the first and second group of athletes in the parameters of anger were observed.

Summarizing, we can indicate that the first group of athletes are characterized by lower values of latent time of visual reaction, high values of perception speed (productivity, accuracy and efficiency) and lower values of anger. The second group of athletes are characterized by average values of latent time of visual reaction, average perception speed and significantly higher values of anger with regard to the first group persons.

According to the existing concepts [12], the functional mobility, force and balance of nervous process are genetically determined characteristics of the highest nervous system of humans.

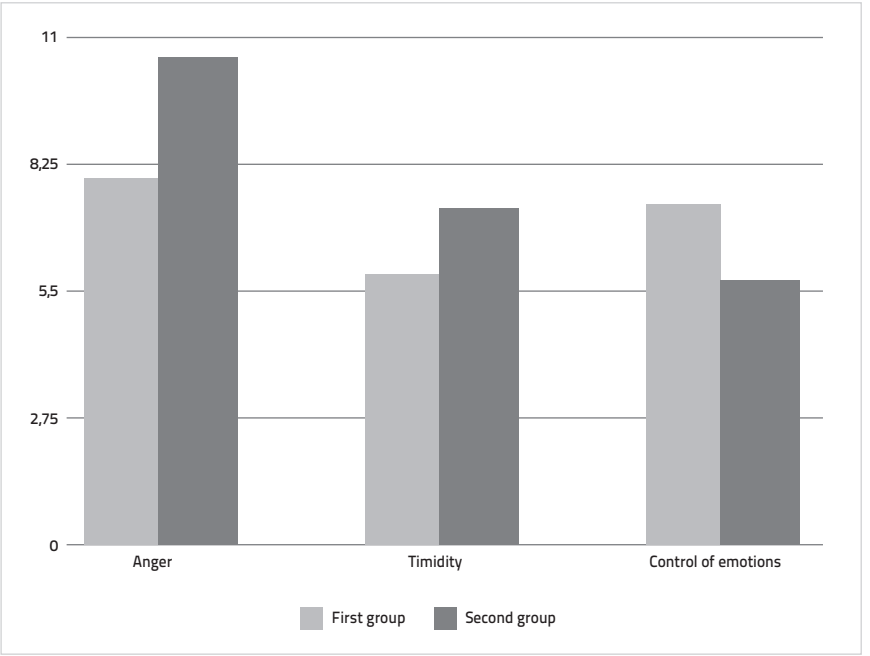


Figure 1. Values of emotion excitability of athletes (n=19)
Note: *p < 0.05, in comparison with the first group athletes

Based on the mentioned, it can be argued that the primary link in formation of emotional reactions can be attributed to the balance of nervous process which is inherent to the athletes with a high level of speed of sensory-motor response.

The manifestation of emotional arousal affects the feasibility of perception and perceptual information processing. This characteristic is very important for the realization of competition activity in combat sport.

Thus, the programs of regulation of emotional states in elite athletes must include individual-typological characteristics of the highest nervous system.

**Conclusions**

The results indicate the significant links between anger and peculiarities of visual perception in elite athletes. The higher the anger in athletes, the lower the rate of response speed and visual perception in general. This link provides a basis for the assertion that anger is one of key factors that have influence on the parameters of visual-motor reaction. Such an emotional factor as anger is undoubtedly a hindrance to focusing attention on key objects. Further, it leads to ineffective information processing and to deterioration of visual perception. Anger as an affective emotion is a negative characteristic and has an impact on general functional state of athletes. Apart from it, anger provokes the deterioration of speed reaction, accuracy, productivity and efficiency of information processing and it causes ineffective performance of coordinated movements. Thus we must recognize that anger is not the mobilization factor in sport activity. We think that anger interferes with the process of reasoning and decision-making: a person is worried, emotionally excited and in panic. As a result – he/she loses control over the situation.

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# Somatotypes and anthropometric profile of elite Serbian Greco-Roman wrestlers

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**ABSTRACT**
The aim of this study was to compare the anthropometric profile of elite Greco-Roman wrestlers by their body mass. Somatotypes of 32 Serbian wrestlers were determined according to the Heath-Carter method, being balanced-mesomorphic in lighter athletes and mesomorph-endomorphic in heavier ones; statistically significant for endomorphy ($r = -0.70$, $p < 0.001$), mesomorphy ( $r= -0.68$, $p < 0.001$), and ectomorphy ($r = 0.79$, $p < 0.001$). Body fat percentage was calculated as: (∑6skinfolds*0.1051)+2.58, including triceps, subscapular, supraspinal, abdomen, thigh, and medial calf skinfolds; showing similar percentages in light and middle-weight categories, while heavier athletes presented higher body fat percentages ($r = 0.73$, $p < 0.001$). Therefore, weight-specific characteristics in body composition was reported in elite Greco-Roman wrestlers.

**Key words:** body composition, weight category, combat sports.

**Introduction**
Greco-Roman wrestling is a weight-categorized sport, thus, the body composition of these athletes determines the weight category in which the athlete competes. Nevertheless, body composition is also a relevant factor which impacts on the athlete's performance. Demirkan et al. (2013) reported that a higher fat free mass is related to a better anaerobic performance in wrestlers, being this component very relevant for success in wrestling competition; moreover, in practice those wrestlers from heavy weight categories might benefit from decreasing their body fat mass. Therefore, body composition is an important factor for elite-sport performance and, moreover, this competition system, based on weight categories, determines morphological differentiation of wrestlers (Jagiełło & Kruszewski, 2009).
For that, more studies describing somatotypes, body composition and performance indicators in elite Greco-Roman wrestlers according to their body mass are needed. In this line, previous studies have found differences in vertical jump power, absolute maximum muscle strength and power and absolute peak, and mean crank-arm Wingate power between weight categories of wrestlers (García-Pallarés, López-Gullón, Muriel, Díaz & Izquierdo, 2011), but similar lactate and glucose dynamics for all weight groups (Karninčić, Krstulović & Baić, 2013).

Furthermore, establishing optimal body composition is an essential part in the talent identification and selection of young athletes, additionally, some aspects such as body fat are modified during the training period (Mirzaei, Rahmani-Nia, Lotfi & Nabati, 2016). Consequently, the knowledge about reference values for wrestlers among weight categories can be useful in adjusting the training program of elite athletes.
Thus, the aim of the present study was to analyze the differences in the anthropometric

profile and somatotypes of elite Serbian Greco-Roman wrestlers by body mass; in order to provide useful information for coaches and athletes of this sport discipline.

## Method

### Participants

In this cross-sectional study, a total of 32 elite Serbian athletes of Greco-Roman wrestling volunteered to participate in this study. The athletes were assigned into three groups according to their body mass: 1) light weight category was composed of 9 athletes under 71 kg, 2) middle weight category consisted in 9 wrestlers from 71 to 85 kg and, 3) heavy weight category from 85 to 130 kg with a total of 14 athletes. None of the subjects were under medical and/or psychiatric treatment when participating in the study. This study obtained ethical approval from the Research Ethics Committee of the University of Novi Sad and was in accordance with the Helsinki declaration. After the participants were informed about the procedure and possible risks involved, written informed consent was obtained from all athletes.

### Procedures

All Greco-Roman wrestlers underwent and anthropometric assessment in the morning, on an empty stomach, through skinfold thickness. Anthropometric measurements were performed following the protocol developed by the International Society for Advanced of Kinanthropometry (ISAK) (Marfell-Jones, Olds, Stewart & Carter, 2006). Anthropometric variables included body mass, height, 7 skinfolds (biceps, triceps, subscapular, supraspinal, abdominal, front thigh, and medial calf), 3 girths (upper arm flexed, thigh, and medial calf) and 3 breadths (humeral and femoral epicondyles and wrist). Skinfold thickness was recorded to the nearest 0.2 mm at a constant pressure of 10 g/mm by using a Holtain skinfold caliper (Holtain Ltd., Crymych, UK). Girths were determined to the nearest 0.1 cm using a flexible anthropometric steel tape measure (Holtain Ltd., Crymych, UK). Skinfolds were measured three times at each site in a rotation system, as described by Heyward (1998), and the mean of the 3 measurements was used in the analyses. Breadths and girths were measured only once at each site by the same experienced evaluator. Somatotypes were determined according to the Carter and Heath method (1990). Body composition was estimated following the four-component model and in accordance with the ISAK recommendations (Marfell-Jones, et al., 2006). Body fat was assessed by applying the following formula (Carter, 1982): Fat%= (∑ 6skinfolds*0.1051) + 2.58; where the 6 skinfolds were triceps, subscapular, supraspinal, abdomen, thigh, and medial calf expressed in millimeters.

### Statistical analysis

To explore the relationships between anthropometric characteristics and the body mass, registered as quantitative variables, the Spearman's correlation test was applied. In order to present the mean and the standard deviation of somatotype and anthropometric characteristics, the body mass variable was codified into 3 groups and a 1-way analysis of variance, followed by Bonferroni post-hoc comparisons, was performed. All analyses were conducted using the SPSS statistical package for Windows (version 17.0; SPSS, Inc., Chicago, Illinois, USA); the level of significance was set at $p<0.05$.

## Results

Heavier athletes presented higher endomorphy ($r = 0.70$, $p < 0.001$) and mesomorphy ($r = 0.68$, $p < 0.001$), with lower ectomorphy ($r = -0.79$, $p < 0.001$); accordingly, heavier athletes had higher body fat percentages ($r = 0.73$, $p < 0.001$). Similarly, the analysis of variance showed significant differences between weight groups for the three somatotype components, all with a p value < 0.001. Somatotypes are presented in Figure 1.

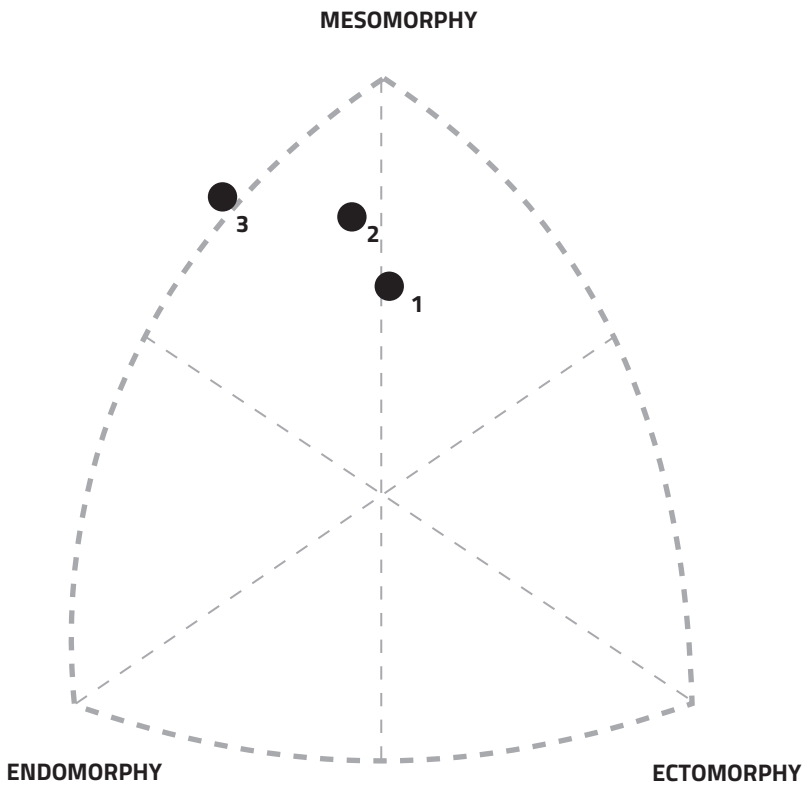


Figure 1. Somatochart of elite Greco-Roman athletes from: 1) light weight categories (n=9), 2) middle weight categories (n=9), and heavier weight categories (n=14).

Multiple comparisons between the light and middle weight categories showed similar values for endomorphy, a close to significant value for mesomorphy ($p = 0.079$), and higher ectomorphy in the light weight category respect to the middle weight group ($0.62 \pm 0.18$, $p = 0.006$).

Moreover, the differences between the heavy weight category and the light and middle weight categories were notable. The heavy weight category had higher endomorphy than light ($1.64 \pm 0.32$, $p < 0.001$) and middle ($1.61 \pm 0.32$, $p < 0.001$) weight groups; higher mesomorphy than the light weight group ($1.42 \pm 0.29$, $p < 0.001$) and close to significance than the middle weight category ($p = 0.078$); and lower ectomorphy than the light ($-1.40 \pm 0.17$, $p < 0.001$) and middle ($-0.78 \pm 0.17$, $p < 0.001$) weight categories.

The mean body fat percentage was $7.17 \pm 0.65$ in wrestlers under 71kg of body mass ($n = 9$), $7.18 \pm 0.52$ in wrestlers from 71 to 85 kg ($n = 9$), and $12.19 \pm 3.35$ in athletes from 85 to 130 kg ($n = 14$). Thus, body fat percentage significantly differed between the 3 weight categories ($p < 0.001$); presenting similar values between light and middle weight groups, and higher body fat percentage in the heavy weight category compared with the middle ($5.02 \pm 0.97$, $p < 0.001$) and light ($5.01 \pm 0.97$, $p < 0.001$) weight categories of elite Serbian Greco-Roman wrestlers.

**Conclusion**

In this study, somatotypes and body fat percentage of elite Serbian Greco-Roman athletes have been analyzed. Our results showed that elite wrestlers present statistically significant differences in the anthropometric profile among weight categories; showing that somatotypes differ by body mass and that heavier athletes presented higher body fat percentage than the lighter ones. Accordingly to these results, previous studies have described that athletes from heavy-weight categories, in both Greco-Roman and Freestyle wrestling, have higher body fat than light and middle weight categories (Sterkowicz-Przybycień, Sterkowicz & Żarów, 2011; Jagiełło & Kruszewski, 2009; Demirkan, et al., 2013).

In our study, elite Serbian Greco-Roman wrestlers from light and middle weight categories had similar body fat percentages, while heavier athletes showed higher body fat component. Similarly, Jagiełło and Kruszewski (2009) described that the higher body mass, the higher difference found in the body composition into direction of body mass gain at the cost of loss of slenderness features. The body fat percentage described in this study, are lower than those reported by López-Gullón, Muriel, Torres-Bonete, Izquierdo and García-Pallarés (2011) and Jagiełło and Kruszewski (2009), but similar to Polish (Sterkowicz-Przybycień et al., 2011) and Turkish (Demirkan, et al. 2013) wrestlers.

According to somatotypes, the lighter Greco-Roman wrestlers were balanced-mesomorphic while the heavier ones were mesomorph-endomorphic. Somatotypes of Greco-Roman wrestlers have not been widely described, however, we can find reference values of Polish wrestlers with similar results (Sterkowicz-Przybycień et al., 2011). The increase of endomorphy and mesomorphy components, and the decrease of ectomorphy as body mass increase, highlights the weight-category specific demands and characteristics in somatotypes and body composition of wrestling.

Therefore, we can conclude that the anthropometric profile of elite Serbian Greco-Roman wrestlers differed among weight categories, with a significant impact in somatotypes and body fat percentages. These specific characteristics by body mass are especially relevant in heavier categories, who showed higher differences than light and middle weight categories. Additionally, the present study provides reference data which could be used in the selection of talented athletes and in establishing adjustment during the training program of elite Greco-Roman wrestlers.

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# Current control of psychophysiological state of elite wrestlers during training process

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**ABSTRACT**
The aim of the work was to elaborate the structure of current control of psychophysiological states of elite wrestlers during training process. The main task of the current control is to provide wrestling teams with scientifically based diagnostics of psychophysiological states of athletes with the estimate of athletes' autonomic nervous system condition, the evaluation and correction of their commitment and willingness and the evaluation and correction of individual training programs. In article different cognitive strategies of information processing in elite wrestlers is discussed with the emphasis on the functional asymmetry of brain. Also, the dynamics of athletes' pre-start, prelaunch reactions (before a competition) is described as manifested in neurodynamic functions and autonomic regulation of heart rate in elite athletes. In support of wrestling teams and based on the experience and scientific methodology, the structured logical model was proposed of current diagnostics of psychophysiological states of elite wrestlers under the conditions of muscular and psycho-emotional tension. Conclusion. Experience our scientific group acquired while working with the Ukrainian national Olympic wrestling teams enabled us to apply the methodology of current control of psychophysiological states for the correction of training process programs based on individual characteristics of elite wrestlers.

**Key words:** perception, information processing, neurodynamic functions, competition activity

**Introduction**
Modern stage of development of high sports achievements is characterized, on one hand, by the development of technologies, which influences stimulation of athletes' capacity, and, on the other, by total ignorance of the accumulated experience of sport scientists acquired in the system of sports preparation of elite athletes [1,2]. Also, a strong need to ban doping should be highlighted here, as well as the related passion of pharmacology for manipulation in sport. This was caused by the ever greater health and life risks athletes have being exposed to as well as by the unfair competition. But good intentions are not enough; in fact, now we have the monopolist in anti-doping control which used this non-transparent system for purposeful exclusion of certain key world leaders in sports. This shows the present crisis of modern Olympic sport.

Based on the current situation, we feel a strong need to return to the beginnings of the system of scientifically-based support for athletes, modern information technologies included. The fundamental data of sports sciences give an unlimited opportunities, based on the past

experience in sports practice, for the development of modern system of scientifically-based support in elite sport [3,4,5,6,7,8]. In terms getting feedback on the relation between influences of training process on individuals and teams and the decisions coaches should make in the process of sports preparation, we see the current control as the most important among the existing types of control in sport. This assertion is based upon a long-term experience of scientifically-based support given to the Ukrainian national teams of Greco-Roman, free styles and women's wrestling. It is the experience of preparing the teams for the XXIX Olympic Games in Beijing (2008), XXX Olympic Games in London (2012), and XXXI Olympic Games in Rio de Janeiro в (2016) and it speaks about high efficacy of the current control in the diagnostics of psychophysiological states of wrestlers and in the correction of training process designs [9,10,11,12,13]. This work has been elaborated under the State plan of scientific study in physical education and sport in the period 2006-2016. Besides, this study reflects practical work done as the scientifically-based support and accompaniment to wrestling teams during their preparation for main competitions in this period.

The aim of the study was to present the structure of the current control of psychophysiological state of elite wrestlers during training process.

**Material and methods**

**Participants**

Participants in the study were 82 members (aged between 18 and 29 years) of the Ukrainian national teams of Greco-Roman, free style and women's wrestling who were on the teams during the period 2006-2016. Before the study, each of the wrestlers was interviewed on whether he or she agreed or disagreed with the results of the investigation to be used for scientific purposes. From all the athletes the written consent to participate in the study was received, as had been recommended by the Ethics Committees for Biomedical Research in accordance with the Ethical Standards of the Helsinki Declaration.

**Instruments-tests and research design. Procedures**

In this work separate methods were used of a long-term process of scientifically-based support of the wrestling teams. The methods' complexes were being gradually formed by different tasks which occurred during training and competition conditions. We used the computer hardware and software «Multipsychometer-05» for psychophysiological analyses and cardiomonitor «Polar-RS800CX» for the registration of autonomic regulation of heart rate accompanied with the statistical program «KubiosHRV» [14]. For the psychophysiological diagnostics in the current control condition we used only informative and not long-lasting tests. To assess emotional states of athletes, we used the 8-color variation Lusher tests modified by L. Sobchik (paired comparison method) [15]. By these tests we studied capability, fatigue and anxiety of the nervous system.

Also, the simple visual-motor reaction, functional mobility of the nervous system processing, and the reaction to a moving object were studied.

**Results**

The main tasks of the current control of psychophysiological states of elite athletes of combat sports are: diagnostics of psychophysiological states of athletes; determination of functional states of the autonomic system of the organism; evaluation and correction of psychological fitness (psychic readiness) of the athlete; analysis of technical preparation of athletes; and and development and correction of individual training programs for athletes.

As already known, the psychical reactions which arise in athletes during training and competition activities are conditioned by the changes of psychophysiological functions

[16,17,18]. That is why we prefer (and recommend) to determine not psychical but psychophysiological states of athletes. In literature modern sources we can hardly find the term "psychophysiological states", but these states reflect the real conditions which occur during sports activity [19,20].

According to E. Iliyn, the psychophysiological states are defined as states related with both the cognitive and emotional (psychic) and physiological structures of humans [21]. All psychic states of humans accompany physiological process or promote changes at the physiological level.

We understand psychophysiological states as functional states of psychophysiological functions.

During the diagnostics of psychophysiological states, one must consider basic factors of sports preparation of athletes which has effects on success in sports activity.
Factor one – level of technical mastery. Technical preparation of talented athletes is characterized by individual peculiarities of movement skills' performance and technical mastery gives an advantage over the rivals.

Factor two – functional state of athletes which is a foundation of physical activity in sport with the mobilization of reserves of the organism.

Factor three – strategy and tactics of sports activity. Athlete must have a clear idea about the his/her opponents, action plan and algorithms of behavior in different conditions of the competition activity.

The named factors have some limitations. The improvement in technical mastery depends on the formability of the nervous system which should allow the process of formation of new movement skills [22,23]. However, the presence of the dominant center at the level of cortex slows down this process due to inertia.

The efforts to increase functional performance of athletes are limited by the available reserves of the organism. The tactical and strategical improvements also depend on many factors and are limited too.

The diagnostics of psychophysiological states bring additional information about the functional states of athletes: first, the psychophysiological function gives information about biological basis of individual typological characteristics of higher nervous activity, which can be used in the differential diagnosis of the functional state of the human body [24]; second, the psychophysiological functions are characterized by the process of formation and improvement of specific skills, reflecting the functional state of the organism and being responsible for the technical level of athletes [25]; thirdly, due exhaustion of nerve centers in the conditions of muscular activity as a primary link, the psychophysiological functions may be a sensitive indicator of fatigue and overstrain in athletes [26].

The values of psychophysiological states in Greco-Roman wrestlers during the training camp (21 days) are presented in Table.1. Decline in abilities of perception and information processing in can be seen in wrestlers due to psycho-emotional fatigue. These states can transform to psychical anxiety as the indicator of stressful situations [27]. At the same time, we can see an increase in the level of tension of the psychophysiological function regulation.
This tendency is observed in the basic fatigue of the organism and can be compensated by the corrections in training program and by the usage of recovery aids.

As seen in Table 1, the latent time and dynamism has not been changed significantly during training process.

Table 1. Psychophysiological states in Greco-Roman wrestlers during the training camp, Mean±SD (for [11])

| Values | Start | Average | End |
|---|---|---|---|
| Color test of Lusher | | | |
| Capability, secret unit | 10.92 ±0.60 | 10.71 ±0.72 | 10.28 ±1.22 |
| Fatigue, secret unit | 1.92 ±0.45 | 2.28 ±0.45 | 3.71 ±0.26* |
| Anxiety, secret unit | 1.23 ±0.37 | 1.00 ±0.39 | 2.42 ±0.31*** |
| Balance of nervous process | | | |
| Accuracy, secret unit | 2.91 ±0.22 | 2.87 ±0.27 | 2.47 ±0.29 |
| Excitation, secret unit | -0.70 ±0.51 | -0.94 ±0.52 | 0.93 ±0.42*** |
| Latent period of visual-motor reactions | | | |
| Latent period, ms | 259.03 ±6.21 | 262.55 ±6.61 | 264.56 ±6.95 |
| Functional mobility of nervous process | | | |
| Dynamism, secret unit | 71.51 ±3.00 | 75.31 ±2.50 | 71.53 ±6.63 |
| Capacity of the visual analyser, secret unit | 1.82 ±0.05 | 1.89 ±0.07 | 1.89 ±0.11 |
| Limited speed of information processing, ms | 326.92 ±4.06 | 343.57 ±2.42* | 341.42 ±3.20* |

*p<0.05, regarding the start of the camp; **p<0.05, regarding the average of the camp

Some parameters statistically changed during training: time limit of the speed of information processing and excitation. This result indicates decreasing excitation of nervous system and a decline of functional mobility of the nervous process as the indicator of the reduction of perception and information processing performance of elite athletes.

The changes in neurodynamic functions during competition activity indicate links between the psychophysiological states and efficiency of technical preparedness. In Table 2 the values of simple and complex visual-motor reactions of wrestlers during competition activity are presented.

As seen in Table 2, the visual-motor reactions revealed the differences between the successful and unsuccessful wrestlers during the competition activity. Thus, the successful wrestlers, who made a throw, had increased values of time reaction with regard to the unsuccessful wrestlers (a throw not made). This fact indicates the increased speed of information processing in successful wrestlers.

Table 2. The wrestlers' visual-motor reactions during the competition activity (n=34), Mean±SD

| Visual motor reactions | Wrestlers who made a throw | Wrestlers who failed to make a throw |
|---|---|---|
| Simple visual-motor reactions, ms | 259.2 ±37.7 | 292.6 ±34.3* |
| Complex visual-motor reactions, ms | 354.3 ±28.9 | 396.7 ±32.6* |

* p < 0.04

The prelaunch reactions occur before the important competitions and last over a certain period of time, usually a day before the competition. Optimality of psycho-emotional reactions is determined by physiological changes of athlete's organism. There is a link between the level of competition liability and the degree of emotional stress [28,29].

For physiological mechanisms the prelaunch reactions have conditional reflex nature. Manifestations of prelaunch reactions are associated with the excitation and inhibition of the central nervous system, which is reflected in the activation of the neuromuscular and circulatory system. The prelaunch reaction is one of the forms of emotional stress where the very competition activity is a stress-factor.

According to the recognized classification, there are three forms of prelaunch reactions – prelaunch «fever», prelaunch «apathy», and «combat readiness». Prelaunch «fever» is characterized by the predominance of nervous system excitation and activation of the sympatho-adrenal system. Prelaunch «apathy» is a result of overexcitement and the development of the nervous system braking. «Combat readiness» is characterized by the optimal level of the nervous system excitation, autonomic shifts, mobilization of glycogen, and by the most favorable ratio of concentration of glucocorticoids and catecholamines in the blood [30,31].

However, the peculiarities of prelaunch reaction as manifested in neurodynamic functions and autonomic regulation of heart rate in elite athletes in an extreme competition activity has insufficiently been studied.

Our results of elite athletes monitoring show a decline in the whole spectrum of cardiac oscillations under competition conditions. This fact indicates to the links between psycho-emotion tension and the level of regulatory mechanisms as a cause of mobilization of functional reserves of organism [32,33,34].

For the practical application of the results to elite wrestlers' sports preparation and competition [12], the quantitative-qualitative scale for the determination of psychophysiological ratings have been elaborated (Table 3).

Table 3. A quantitative-qualitative scale for the determination of psychophysiological ratings of elite wrestlers

| Values | Level of psychophysiological rating | | | | |
|---|---|---|---|---|---|
| | High | Above average | Average | Below average | Low |
| | 5 | 4 | 3 | 2 | 1 |
| Color test of Lusher | | | | | |
| Capability, secret unit | ≥15 | 14.9-13.4 | 13.3-10.4 | 10.3-6.1 | ≤ 6 |
| Fatigue, secret unit | ≤ 0.1 | 0.2-0.6 | 0.7-2.3 | 2.4-5.9 | ≥ 6 |
| Anxiety, secret unit | ≤ 0.1 | 0.2-0.9 | 1-2.4 | 2.5-4.9 | ≥ 5 |
| Balance of nervous process | | | | | |
| Accuracy, secret unit | ≤ 5 | 3.9 | 2.9 | 1.9 | ≥ 1.3 |
| Latent period of visual-motor reactions | | | | | |
| Latent period of a simple visual-motor reaction, ms | ≤ 237 | 238-261 | 262-285 | 286-336 | ≥ 337 |
| Functional mobility of nervous process | | | | | |
| Capacity of the visual analyser, secret unit | ≤ 1.4 | 1.5-1.6 | 1.7-1.9 | 2-2.2 | ≥ 2.3 |
| Heart rate variability | | | | | |
| Low frequency oscillation of cardio intervals (LF), ms $^2$ | ≤ 405 | 406-2012 | 2013-4399 | 4400-8330 | ≥ 8331 |
| High frequency oscillation of cardio intervals (HF), ms $^2$ | ≥ 5531 | 5530-3200 | 3199-1677 | 1676-831 | ≤ 830 |
| LF/HF, ms $^2$ | ≤ 0.3 | 0.4-1.1 | 1.2-2.0 | 2.1-4.9 | ≥ 5 |

All the values presented in Table 3 have quantitative-qualitative assessment. Due the absolute meanings each of parameters corresponds to point (from 1 to 5). For the estimation of psychophysiological rating of an individual wrestler, we calculated points which he/she scored.

According to the scientific group experience acquired in work with the national wrestling teams (all Olympic disciplines) of Ukraine we elaborated the structural-logical model of current diagnostics of psychophysiological states of elite athletes.

The basic elements of this model are: neurodynamic, psychical, regulatory and activity-stylistic components.

Neurodynamic component of psychophysiological states consists of two subsystems: neurodynamic and psychomotor. The psychomotor one has the following characteristics: simple and complex sensory-motor reactions and parameters of tapping-test. The neurodynamic component is characterized by the properties of functional mobility and balance of nervous process, strength and endurance of the nervous system.
Psychic component indicates psychic states and peculiarities of the manifestation of cognitive functions presented by the following parameters: perception, attention, memory and different kinds of thinking. The psychic states include information characteristics: level of anxiety, capability, fatigue, autonomic coefficient.

Regulatory component is presented by the parameters of heart rate variability. The heart rate variability comprises statistical, spectral and entropy characteristics.

Activity-stylistic component has three characteristics: motivation, stress resistance and functional asymmetry of brain. Motivation has two types of indices: achieve success and avoid failures. The dominance of the cerebral hemispheres contains the following properties: symmetry and asymmetry of the cerebral hemispheres and the dependence on and independence from the influence of the external environment.

**Conclusions**

The diagnostics of psychophysiological states of elite wrestlers is a very important task in the system of current control of functional states at all stages of sports preparation. Nowadays we are facing with a big challenge of advancing the methods of psychophysiological state correction based on the individualized approach to athletes in order to maximize sporting achievements.
Experience our scientific group acquired while working with the Ukrainian national Olympic wrestling teams enabled us to apply the methodology of current control of psychophysiological states for the correction of training process programs based on individual characteristics of elite wrestlers.

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# Creatine kinase activity effects on coordination and physical ability tests in elite classical style wrestlers

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**ABSTRACT**
The aim was gaining the knowledge if the creatine kinase activity (CK) in plasma, which is the index of muscle fibres injuries, has some influence on the movement coordination and physical ability tests results. Eight elite wrestlers took part in the study and they performed a set of 7 efficiency tests during 2 days. The CK activities were marked in mornings – before tests. The lack of statistically significant correlations between test results, expressed by both – the absolute values and by points "T" scale, and the CK activity in plasma was stated. However, it seems that the efficiency tests, especially those engaging upper limbs and the trunk muscles, should not be conducted during large training loads employment because the tests results might be dependent on the level of disturbances of the muscle fibres homeostasis elicited by performed earlier physical effort. Gained results point at the lack of statistically significant relationship between the functional state of muscles and the coordination and physical abilities tests results. It may be elicited by too small examined group. It seems that movement coordination tests (especially those engaging upper limbs and trunk muscles) should not be performed during the large training loads employment. Results reached in such a period may be dependent on the degree of muscles fibres homeostasis disturbances caused by performed earlier physical effort.

**Key words:** creatine kinase, tests, ability, elite wrestlers

**Introduction**
The physical effort may be the agent causing changes in the membrane permeability or even mechanical injuries of muscle fibres what leads as a consequence to the efflux of intracellular protein to the blood. The creatine kinase is one of those proteins. It is an enzyme located mainly in skeletal muscles. The activity of the above enzyme increases in plasma after the effort performance in a degree dependent on the scale of muscle cells damage and it is regarded as a sensitive and specific index of muscle fibres injury [5]. The time, intensity and the kind of performed muscle contractions are factors influencing the post effort increase of the CK activity in plasma. There was stated that the most evident post effort changes are elicited by the eccentric contractions which may cause the mechanical injuries of muscle fibres [7]. The sport success is difficult to accomplish and it demands special practice system containing the systematic control over the athletes training. Wrestling belongs to the group of sports demanding many movement abilities, both kinds – physical and coordination ones. The level of the above abilities was the issue of a long term researches conducted over the Polish National Wrestling Team [3,9-12]. The level of movement coordination and physical abilities of wrestlers of the specific weight categories in various training periods, its changes during a few years training observation and its connection with obtained sports results was examined basing on the general and special physical tests set [9-12]. The short version of the set,

containing 6–7 efficiency tests was compiled after many modifications. The results gained by wrestlers were correlated with anthropometric and physiological indices; however, the influence of the functional state of muscles on test results had not been evaluated yet. The aim of this work was to establish if the creatine kinase activity (CK) in plasma, reflecting the muscle fibres damage range, has the influence on results of movement coordination and physical ability tests performed by elite wrestlers the special motoric ability tests performed by elite wrestlers.

**Materials and methods**

Eight wrestlers of the classical style took part in the research. Their characteristics were: age 22.2±1.6 years; body mass 76.0±9.6 kg; body height 174.7±7.1 cm; training practice 9.3±2.9 years. All of the subjects accepted the research conditions alike the Board of Ethics by Institute of Sport which ratified the research protocol. All of the athletes had the national champion sport class. The examinations were performed during the training camp. Athletes had 2 following days to accomplish the set of 7 motor abilities tests. Six of them containing a maximal vertical jump [8], a turnover race, a parallel bars pull up, bending and straightening of propped arms (before noon), 20 m run and a maximal load chest throw (in the afternoon) were performed on the first day. The second day was left for the 1500 m run (before noon). Results reached in the respective tests (time, number of repetitions, work performed) were evaluated using the 100-points "T" scale [9]. The blood for the creatine kinase activity determination was taken from the earlobe each morning, (CK; EC 2.7.3.2) before test. The enzyme activity was determined in the centrifuged plasma spectrophotometrically at 340 nm, using the commercial kit (Analco, Poland) and expressed in U·l-1. The statistical analysis was conducted using the t-Student test for dependent variables and by calculation of the simple correlation coefficients values according to Pearson. The level of $p<0.05$ was accepted as the statistically significant.

**Results**

The movement coordination and physical abilities tests results, evaluated in the "T" scale, were individually differentiated (Table 1). The average point valuation has exceeded the number of 50 points in every test. The highest number of points (73.6) was reached during the bars pull up and the lowest (51.3) during the 20 m run.

Table 1: The tests results expressed in points of "T" scale and the creatine kinase in plasma (n=8)

| Coordination and physical abilities test | Points in the "T" scale x±SD | Range |
|---|---|---|
| 1. Maximal vertical jump | 59.2±8.2 | 43.5–73.0 |
| 2. Turnover race | 54.8±5.4 | 46.0–60.0 |
| 3. Bars pull up | 73.6±10.4 | 54.0–85.5 |
| 4. Bending and straightening of propped arms | 67.8±8.4 | 60.5–78.5 |
| 5. 20m run | 51.3±6.6 | 41.5–59.0 |
| 6. Maximal load chest throw | 56.3±7.1 | 46.0–67.5 |
| 7. 1500m run | 52.4±3.5 | 46.5–57.5 |
| CK activity in plasma | | |
| 1st day, morning | 723±359* | 254–1134 |
| 2nd day, morning | 520±270 | 245–907 |

*Significantly higher in comparison to 2nd day of examinations ($p<0.01$)

Every morning of tests the CK activity in plasma was exceeding the upper limit of the physiological level (to 80 U·l-1). High activities of this enzyme in plasma were the effect of training and physical loads used during the day preceding tests.

Table 2: Values of correlation coefficients between movement coordination tests (in the absolute values and in points scale) and the CK activity in plasma

| Coordination and physical ability test | r value | |
|---|---|---|
| | Result | Points |
| 1. Maximal vertical jump (cm) | 0.56 | 0.56 |
| 2. Turnover race (time) | -0.38 | 0.39 |
| 3. Bars pull up (work*) | -0.15 | -0.01 |
| 4. Bending and straightening of propped arms (work*) | -0.46 | -0.51 |
| 5. 20 m run (time) | -0.05 | 0.05 |
| 6. Maximal load chest throw (kg) | -0.21 | -0.23 |
| Sum of points from the 1st day | | -0.08 |
| 7. 1500 m run (time) | -0.29 | 0.28 |

*The number of repetitions multiplied by the athlete's body mass

Values of coefficients of the correlation between coordination and physical abilities tests (results - expressed in points scale) and the CK activity in plasma are presented in Table 2. They show the lack of statistically significant relationships and run from r=-0.51 to r=0.56. The relationship between the sum of points gained by athletes during the 1st day and the CK activity was also not significant.

**Discussion**

Some significant, individual differences of the CK activity in plasma are the effect of various response of skeletal muscle on physical loads. It is the confirmation of results gained by Schwane et al. [7], who have shown that some examined subjects have displayed especially high CK activity in plasma (so called high-response) after the eccentric effort. The wrestlers training encompasses exercises demanding the eccentric work which often causes high CK activity in plasma [4]. Hence the reason of high post exercise increase individually differentiated activities of the CK in plasma in the 1st day of examinations were training loads applied the day before. Four of examined subjects were characterized by a particularly high CK activity: from 967 to 1134 U·l-1 (high-response) and the reaction of other athletes was moderate (the CK activity from 254 to 519 U·l -1). The coordination and physical abilities tests performed on the 1st day were not the strong effort impulse for examined athletes. It was confirmed by the significantly lower (about 30%) activity of the CK in plasma noticed on the second day morning. The CK activity decrease was similar in all subjects and independent on absolute activities of CK in plasma. It was pointed by the correlation between this enzyme activities on the 1st and 2nd day of studies ($r=0.98$; $p<0.05$). Decreased the CK activity in plasma despite of the performance of 6 coordination and physical abilities tests proves the adaptation of the organism to the heavy physical effort. There was stated that the training diminishes the range of the post exercise CK activity changes in plasma what points out the growth of the muscle fibres tolerance on the effort impulse [1,6].

**Conclusions**

Positive correlation coefficient values were connected with tests in which legs muscles were involved (the maximal vertical jump, a turnover race, 20 and 1500 m runs). However, where tests results were expressed in absolute values (time reached in running tests) the correlation

coefficients were negative. Hence, we can assume that the functional state of muscles may influence the running speed. Only in a case of the maximal vertical jump the correlation coefficient value was stable, independently on correlated data. The highest negative correlation was observed as considering the bending and straightening of propped arms, in both measured qualities alike: points (r=-0.46) and performed work (r=-0.51). It is presumed that the performance of the above exercise might be dependent on the functional injury of muscle fibres caused by previous training. Negative correlations between results expressed both in points and absolute values and the CK activity in plasma were stated also in other tests involving the work of upper limbs and trunk. It may suggest that the upper body muscles were more seriously damaged as a consequence of previous training. It cannot be excluded that the lack of statistically significant relationships between results of coordination and physical abilities tests and the CK activity in plasma flows from the fact that intra-muscle enzymes efflux to blood does not have to be accompanied by the lowering of mechanical muscles work indices [2].

**Practical implications/advice for athletes and coaches**

Gained results point at the lack of statistically significant relationship between the functional state of muscles and the coordination and physical abilities tests results. It may be elicited by too small examined group. It seems that movement coordination tests (especially those engaging upper limbs and trunk muscles) should not be performed during the large training loads employment. Results reached in such a period may be dependent on the degree of muscles fibres homeostasis disturbances caused by performed earlier physical effort. Nevertheless, this subject requires further researches.

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# Physical condition profile of Serbian Greco-Roman style wrestlers

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**ABSTRACT**
INTRODUCTION: Main task of fitness and conditioning program is to improve athletic performance through general, basic and specific skills training programs needed for the successful performance of athletes in competition and in everyday training (Milanović, Jukić, Šimek, 2003). In the Greco-Roman style of wrestling, wrestlers are allowed to use only hands and upper body for the implementation of techniques, yet strength of the lower extremities is of great importance to perform techniques. PURPOSE: The aim of this study was to determine whether there were some significant qualitative differences in the conditioning readiness as manifested in the area of functional abilities of wrestlers from the Serbian international and national level programs. METHODS: Sample consisted of 27 wrestlers who were divided in two groups (international group - 1; national group - 2) and were able to correctly do the tasks set in the tests, as well as participants were medal winners at the national, international competitions. International group (1) was a group of wrestlers from the Serbian Greco-Roman national team. National group (2) was a group of wrestlers from the Serbian wrestling clubs. Their functional capacity was examined with a graded exercise test protocol on a treadmill. Four variables were measured: relative maximum oxygen consumption VO2max (ml/min/kg); relative oxygen consumption at the anaerobic threshold VO2AnT (ml/min/kg); maximal heart rate HRmax; heart rate at the anaerobic threshold HRAnT. Data analyses were conducted using the SPSS.20 computer software. Univariate analysis of variance (ANOVA) was used for analyzing the differences between the groups. RESULTS: Results showed no statistically significant difference between the analyzed groups. CONCLUSIONS: By getting familiar with the basic diagnostics and conditioning readiness of athletes, wrestling and conditioning coaches will be able to plan and program workouts for their athletes in a better way.

## Introduction

Wrestling coaches and participants have become keenly interested in learning what separates successful from less successful wrestlers so that the training regimens may be developed that will allow all athletes to reach their full potential (Roemmich, and Frappier, 1993). The main task of fitness and conditioning programs is to improve the readiness of athletes in everyday training and competition (Milanović, Jukić, Šimek, 2003). In Greco-Roman style of wrestling, wrestlers are allowed to use only their hands and upper body for the implementation of techniques and strenght of the lower extremities is of great importance to perform those techniques. Nagle, Morgan, Hellickson, Serfass & Alexander, (1975) quoted bz Roemmich & Frappier (1993) claimed that physiological variables alone can account for approximately 45% of the variance seen between successful and less successful FS wrestling Olympic contenders. The amount of aerobic energy needed for active muscles during a single wrestling match increases and contributes to sustaining efforts throughout the whole match with 10 to 25% (Kell, 1997; Marić, Baić & Aračić 2003).Wrestlers who entered the fight for the medals may have 4 to 5 matches on average. Yoon (2002) stated that a higher aerobic capacity should allow athletes to maintain higher intensity activity during the match, delaying

the accumulation of metabolites associated with fatigue, and improve the recovery during the rest period between 2 consecutive mathes where the spacing can be 15 minutes. Requirements of such physical activity on aerobic energy are challenging. Field and laboratory tests of functional abilities or cardio-respiratory readiness use maximal relative oxygen consumption (VO2max) as a widely accepted measure marker (Baechle & Earle, 2008). However, it is well known that the anaerobic threshold (AnT), regardless of its precise definition, represents the subject's aerobic work capacity in a more accurate way than VO2max, especially in well trained athletes (Antonutto & Pampero, 1995; Faude, Kindermann & Meyer, 2009). Relative oxygen consumption at anaerobic threshold (VO2AnT) is reported as a marker which distinguishes the successful and less-successful wrestlers (Nikooie, Cheraghi & Mohamadiopur, 2015). Sports in which direct contacts are permited such as wrestling, it is difficult to control the intensity to which athletes are subjected during each specific training session. This difficulty results from the interaction between different subjects, as it depends on how they act, their loads may increase or decrease without the subjects being aware of it (Morales, Álamo, García-Massó, Buscà, López, Serra-Añó, González, 2014). Scientists and coaches in wrestling use heart rate monitors to observe the loads and levels off fatigue (Kramer, Fry, Rubin, Triplett-Mcbrige, Gordon, Koziris, Lynch, Bolek, Meuffels, Newton & Fleck, 2001; Jovančević, Tripunović, Štajer, Vujkov, Trivić & Drid, 2012; Barbas, Fatouros, Douroudos, Chatzinikolaou, Michailidis, Draganidis, Jamurtas, Nikolaidis, Parotsidis, Theodorou, Katravasas, Margonis, Papassotiriou & Taxildaris, 2011; Theophilos, Ioannis,Nikolaos, Athanasios,Konstantionos & Bahman, 2011). In wrestling specific tests,heart rate values are used as markers and to calculate the index of the wrestlers specific radiness (Marinković, Štajer, Jezdimirović, Bjelan & Obadov, 2012; Štajer, Marinković, Radanović, Dokmanac, 2013). The aim of this study was to determine whether there is a significant qualitative difference in the conditioning readiness in the area of functional abilities of wrestlers from Serbian international and national level programs.

**Material and methods**

Sample consisted of 27 wrestlers who were divided into two groups: International group-(1) a group of wrestlers from Serbian Greco-Roman national team (8) wrestlers with average: age 23.63 ± 4.13 years; body weight 77.89 ± 9.33kg and body height 174.23±4,78cm and National group-(2) a group of wrestlers from Serbian wrestling clubs (19), with average: age 22.79±3,89 years; body weight 75,42±9,75ks and body height 173,64±5,16cm. Sample inclusion criteria were considered: (1) wrestlers considered as participants, medal winners at the national and international competitions were included; (2) if were able to correctly do the tasks set in the tests; (3) wrestlers were below heavy weight category (100kg). Before the start of the testing, a medical examination and a medical questionnaire was done to ensure that they were free from cardiac, respiratory, renal and metabolic diseases. The study was conducted in accordance with the Declaration of Helsinki. Ethical permission was sought from and given by the faculty institutional review board. Assessment of functional capacity was examined with the help of Cosmed equipment - treadmill and Cosmed Quark CPET (cardio pulmonary exercise testing) breath for breath, gas analyzer. Participants were assigned to incremental running-to-exhaustion test protocol (1-min warm-up walk at 6 km/h followed by running at 8 km/h with progressive work load increment rate of 1,5 km/h every 60 sec until exhaustion and finishing with 3-min recovery walk at 5 km/h). Progressive work load increments were finished when the participants were physically too tired to continue running, with subjective rates of perceived exertion (RPE; Buckley & Borg, 2011). Primary outcome measures were: (1) maximum relative oxygen consumption VO2max (ml/min/kg); (2) relative oxygen consumption at the anaerobic threshold VO2AnT (beats/minute). Data analyzing was conducted using the SPSS.20 computer software. Univariate analysis of variance (ANOVA) was used for analyzing the differences between the groups. The level of $p<0.01$ was considered significant.

**Results**

Participants successfully completed incremental running-to-exhaustion test protocol and their descriptive values can be seen in (Table 1).

| Group | | 1 | | | | 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | N | M | SD | Min. | Max | N | M | SD | Min. | Max |
| VO $_{2max}$ | 8 | 50,51 | 3,77 | 46,31 | 56,76 | 19 | 53,97 | 7,69 | 39,28 | 67,36 |
| VO $_{2AnT}$ | | 42,99 | 2,62 | 38,75 | 45,22 | | 46,34 | 6,68 | 36,14 | 58,30 |
| HR $_{max}$ | | 183,33 | 1,86 | 181 | 186 | | 190,32 | 8,96 | 171 | 202 |
| HR $_{AnT}$ | | 169,86 | 5,67 | 161 | 176 | | 175,89 | 10,94 | 155 | 192 |

Legend: N - number subjects, M - arithmetic mean value, SD - standard deviation value, Min - minimum value, Max - maximum value;VO2max (ml/min/kg) Maximum relative oxygen consumption; VO2AnT (ml/min/kg) relative oxygen consumption variable at anaerobic threshold; HRmax maximal heart frequency; HRAnT heart frequency at anaerobic threshold

We found that exercise tests did not affect none of the markers of cardio-respiratory readiness (Table 2)

Table 2.

| | Group | M | F | P |
|---|---|---|---|---|
| VO $_{2max}$ | 1 | 50,51 | 1,447 | 0,240 |
| | 2 | 53,97 | | |
| VO $_{2AnT}$ | 1 | 42,99 | 1.855 | 0,185 |
| | 2 | 46,34 | | |
| HR $_{max}$ | 1 | 183,33 | 3,499 | 0,074 |
| | 2 | 190,32 | | |
| HR $_{AnT}$ | 1 | 169,86 | 1,907 | 0,180 |
| | 2 | 175,89 | | |

Legend: N - number subjects, M - arithmetic mean value, F-the relationship and p-F-statistically significant relations

**Discussion and conclusion**

When looking for reports on VO2max in other studies, values can range from 37 to 67(ml/min/kg) (Chaabene, Negra, Bouguezzi, Mkaouer, Franchini, Julio & Hachana, 2016). Reviewing the available research at the given moment Horswill (1992) reported that Olympic, collegiate and school wrestlers have similar VO2max. Roemmich & Frappier (1993) reported differences between successful and less successful school boys and cadet wrestlers for cardio-respiratory readiness in favor of successful wrestlers. Top-elite and elite cadets compared with their amateur peers had higher VO2max values by 11.4 to 12.5% (Demirkan, Koz, Kutlu & Favre, 2015). Yoon (2002) in paper reported that VO2max values of wrestlers from Brigham Young University team (56,3±2,0 ml/min/kg) and Korean national wrestlers (60±5,1 ml/min/kg-Yoon unpublished observation) are above reported values for national and international wrestlers (53 to 56 ml/mi/kg). Mirzaei,Curby, Rahmani-Nia & Moghadasi, (2009) found that mean VO2max values of 70 elite Iranian junior freestyle wrestlers were 50,56±4,7 ml/min/kg. Looking at the mean VO2max values of our surveyed groups, we can say that they are somewhere in the middle of displayed results compared to other studies. Where the national group shows a slightly higher result. Study with detailing differences between weight classes, have reported that there are noticeable differences between the heavy weight classes (99-122 kg) 36,9±4,4 ml/min/kg vs. light weight classes (59-65 kg) 52,8±5,9 ml/min/kg and heavy weight vs. middle weight classes (71-88 kg) 48,0±6,7 ml/min/kg , (Ohya, T., Takashima, Hagiwara, Oriishi, Hoshikawa, Nishiguchi & Suzuki, 2015). Our wrestlers in the study can be considered as middle weight classes. International group (77,89±9,33 kg) and

National group (75,42±9,75 kg ) and si compared with Ohya, and colleagues (2015) results, we can report that their values are noticeably lower than ours. This can be considered as expected, as scientific evidences shows that external loading can affect peaking VO2max values (Horswill, 1992; Yoon, 2002). Ohya, and colleagues (2015) used bicycle-leg cycling for external loading. Callan, Brunner, Devolve, Malligan, Hesson, Wiber & Kearney (2000) also showed that external loading can affect peaking VO2max values for free-style wrestlers. Test-protocol data revealed higher values are in favor to treadmill running (54,6±2,0 ml/min/kg) than for bicycle-leg cycling (41,2±6,1 ml/min/kg). These displayed values of treadmill running are slightly higher than our values. Nagle and colleagues (1975) quoted by Roemmich, and Frappier (1993) found a significant relationship between aerobic fitness and wrestling performance. Their successful wrestlers had a significantly lower heart rate at each minute of a 5-min sub-maximal exercise test and reached a steady state significantly faster than the less successful wrestlers. Our data has shown a similar effect but without the presence of statistical significance. Callan, and colleagues (2000) HRmax values were higher, on average for those athletes who performed the treadmill protocol (186±7,0 beats/minute) than for those athletes who performed bicycle-leg cycling protocol (175±6,1 beats/minute). HRmax values of elite freestyle wrestlers preparing for the 2000 Olympic trials recorded in the case study of Utter, O'Bryant, Haff and Trone, (2002) and obtained from treadmill running protocol did not significantly change during the seven months of the preparing process, but resting heart rate HRrest declined from 59 to 49 (beats/minute). Therefore it can be said that training regimens which were used during the preparation process affected the adaptive processes of wrestlers. In a tournament sett Kreamer and colleagues (2001) exploring the physiological and performance responses of free-style wrestlers in multiple wrestling matches within a single day and on successive days, record that HRmax values of wrestlers were between 174±1,4 (beats/minute) and 183±2,5 (beats/minute) after finishing fights. During a similar research conducted by Barbas and colleagues (2011) on Greco-Roman wrestlers HRmax values were between 188,6±3,0(beats/minute) and 193±3,5(beats/minute) after finishing the fights. With the help of these sampled values during and after a wrestling match the testing protocol is possible to carry out and the studies in order to determine correlation between treadmill test and wrestling match rules. Our research has not come up to similar results. Theophilos, and colleagues (2011) evaluate Greek National top-level Greco-Roman wrestlers (74kg weight classes) in a simulated competition. Concetration of lactate in the blood, HRmean and HRmax values during the match were sampled, the differences between three-two-minute rounds were analyzed. Both HRmean and HRmax from the 1st round 138±4 (beats/minute)/143 (beats/minute) were significantly lower than the values from the 2nd round 172±5 (beats/minute) and 3rd round 183±6,3 (beats/minute)/193 (beats/minute). This study results confirmed that the Greco-Roman wrestling according to the given rules in the time of the competition, begins aerobically while it finishes anaerobically. In conclusion, they state that wrestling aerobically while it finishes anaerobically. In conclusion, they state that aerobic wrestling training with a simultaneous increase in anaerobic threshold could contribute to a benefit in tactical especially in the last round of a Greco-Roman wrestling competition. Members of the Polish national team female and male freestyle wrestler, volunteered in study to assess the aerobic fitness and to determine whether there are gender differences in the physiological responses to graded exercise (Hübner-Woźniak, Kosmol & Gajewski, 2009). Total oxygen uptake at the anaerobic thresholds was similar in men and women, but when expressed as % VO2man it was significantly higher in females. The authors concluded that the use of VO2AnT and % VO2max can be used as valid marker for determining the difference between successful and less-successful wrestlers. International group vs. National group did not show differences in VO2AnT. In literature it can be found that researchers classify wrestlers according to their physiological characteristics (Anaerobic Alactate, Anaerobic Lactate and Aerobic Power type) and tactical styles of confrontation in a match (Power-Strength, Tempo, Game-combinational

wrestlers) (Sawczyn, Jagiełło, Fetisov & Mishchenko, 2012; Tropin and Pashkov, 2015). "Power-Strenght" wrestlers are highly effective attackers with their speed-strenght tactical approach, most rely on a lactate lac 40% and lactate power 36%. "Tempo" wrestlers increase quantity of attacks with every minute of the match. They are predisposed to use anaerobic glycolytic 35% and aerobic power processes 39% "Game-combinational" wrestlers have high efficiency of techniques and almost equally distributed energy predisposition to alactate lac 36%, lactate power 29% and aerobic power processes 37%. In conclusion, the present findings which are obtained from running-to-exhaustion test protocol did not affect none of the cardio-respiratory readiness markers. Our wrestlers have similar aerobic profiles with the senior wrestler of the other countries. Familiarity with the basic diagnostics and conditioning readiness of their athletes, wrestling coaches and conditioning coaches will be able to better plan and are program workouts for their athletes.

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# Proposal for a new regulation of unofficial weight categories in the age group of schoolboys

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**ABSTRACT**

INTRODUCTION: Wrestling weight categories are created to ensure approximately equal condition for competitors in wrestling bouts during competitions. This study presents a review of the distribution of participants into weight categories among schoolboy wrestlers during last six years at the Croatian national Greco-Roman wrestling championships. PURPOSE: The main goal of this research was to propose new unofficial weight categories of schoolboy wrestlers who participate in the national championships. METHODS: The number of wrestlers in each weight category was analysed during the Croatian national Greco-Roman wrestling championship in the last six years. Descriptive parameters were calculated and Chi-square test was conducted at the statistical significance level of $p \leq .05$. RESULTS: A smaller number of wrestlers was revealed in lower categories, while the number of wrestlers in middle and higher categories was bigger. The analysed results showed significant frequency deviation from the expected number of wrestlers in each weight category of the age groups of schoolboys. Significant deviation was found in seven out of eleven weight categories. A smaller number wrestlers in lower weight categories and a higher number of wrestlers in the official middle and heavy weight categories is probably due to the increased number of children with higher body weight in Croatia. Reason for the decreasing number of wrestlers every year can be withdrawal from wrestling in the first five years of training. Withdrawal from wrestling can be caused by unreal expectations, insufficient motivation, excessive participation in wrestling tournaments, body mass reduction for competitions and by a small number of weight categories at championships. CONCLUSSION: Correction of weight categories is important to prevent withdrawal from wrestling, to increase motivation and decrease occurrence of body mass reduction in young wrestlers. Therefore we propose to retain the existing weight classes, according to UWW, and to introduce four new weight categories (50 kg, 53 kg, 62 kg and 100 kg) as the unofficial weight categories at national, regional and municipal competitions for the age group of schoolboys.

**Key words:** wrestling, Greco-Roman style, weight class, official and unofficial weight categories, sport law

## Introduction

As well as in many combat sports like judo, box, taekwondo, sambo and others, weight categories are a very important component of wrestling competition. The weight categories are created to ensure approximately equal condition for competitors. The use of weight categories is based on an assumption that differences in body weight can create an unfair advantage for a larger wrestler, therefore the establishment of unofficial weight categories is a rational solution (Barbas, Curby, Mirzaei, Podlivaev, & Tünnemann, 2013). Wrestling weight

classes were defined by the international wrestling rules (United World Wrestling, 2017) and they can be improved by the national Regulation of the system, condition and organisation of wrestling competitions. The number of categories has been changed over years; at the 1896 Olympic Games there was only one weight category without limits, whereas the number increased to 10 weight categories in 1985. According to the official wrestling rules (UWW, 2017) age categories were classified as follows: schoolboys, cadets, juniors and seniors. Category of schoolboys refers to the wrestlers 14-15 years of age (even 13 years with medical and parental certificate). Dependent on age, young wrestlers are competing in up to ten or twelve weight categories. In the age group of schoolboys, according to the official wrestling rules (UWW, 2017), there are ten official weight categories. Some countries have modified weight categories from the official ones for the needs of their national schoolboys' wrestling championships. Distribution of wrestlers per category depends on age, sex, selection procedure, number of categories, genetics and some other socioeconomic parameters. The number of wrestlers in each category at official competitions can vary, which depends on many factors such as competition periodization, injuries, wrestlers selection, withdrawing, transfer to other sports, etc. The increasing number of schoolboy wrestlers, especially in heavyweight categories, genetics imposes a need of introducing an unofficial 100 kg weight category. Furthermore, an extremely high number of wrestlers in middleweight categories and a smaller number of them in lightweight categories is a signal to review the existing weight categories. Considering the existing state, it is necessary to conduct research on the distribution of wrestlers into schoolboy weight categories in Croatia, especially because of the withdrawal from the sport.

Overview of available literature reveals thatfew research on wrestlers' weight category distribution was conducted. However, a research on schoolboys' anthropological characteristics in Croatia was found. The main goal of this research was to establish whether the number of wrestlers per category deviated from the expected number of young wrestlers at the Croatian national Greco-Roman wrestling championships.

**Methods**

The data was collected from the official bulletins after the Croatian national schoolboys' Greco-Roman wrestling championships (2012, 2013, 2014, 2015, 2016, and 2017). The sample of variables consisted of the number of schoolboys (age 13-15 years) in the eleven categories at the Croatian national Greco-Roman wrestling championships over the last six years. The data were analysed by the Statistica 10 program software package (Statsoft, USA). Descriptive statistics was calculated. To determine a probable deviation of the observed from the expected frequency Chi-square test was used at the significance level of $p \leq .05$.

**Results**

An average number of schoolboys who participated in the Croatian national championship over the past six year was 9.45 wrestlers per category. The distribution of participants per category was normal. A higher average number of wrestlers was in the weight categories of 53 kg and 59 kg (an average of 21 wrestlers in 53 kg and 19.3 wrestlers in 59 kg category). Opposite to that, a small number of wrestlers was observed in lower categories (32 kg, 35 kg, and 38 kg). Comparing the average number of wrestlers in lightweight categories with the heavyweight category (100 kg), which is not an official weight category according to UWW (2017), a higher number (5.5 wrestlers on average) was observed in the latter over the past six years at the Croatian national schoolboys' wrestling championships.

Table 1. Descriptive parameters and distribution of schoolboys Greco-Roman wrestlers per category over the last six years at the Croatian national wrestling championships

| Year | 32 kg | 35 kg | 38 kg | 42 kg | 47 kg | 53 kg | 59 kg | 66 kg | 73 kg | 85 kg | 100 kg* | Number of wrestlers | Average number of wrestlers |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2012 | 0 | 1 | 3 | 8 | 13 | 14 | 21 | 18 | 9 | 13 | 5 | 105 | 9.55 |
| 2013 | 0 | 1 | 4 | 7 | 15 | 14 | 17 | 22 | 11 | 8 | 9 | 108 | 9.82 |
| 2014 | 1 | 1 | 3 | 4 | 7 | 18 | 23 | 18 | 10 | 7 | 7 | 99 | 9.00 |
| 2015 | 0 | 1 | 2 | 4 | 11 | 9 | 21 | 18 | 15 | 10 | 3 | 94 | 8.55 |
| 2016 | 0 | 0 | 3 | 5 | 4 | 10 | 18 | 14 | 10 | 8 | 4 | 76 | 6.91 |
| 2017 | 1 | 2 | 3 | 10 | 12 | 27 | 26 | 26 | 20 | 10 | 5 | 142 | 12.9 |
| | 0.3 | 1 | 3 | 6.3 | 10.3 | 15.3 | 21 | 19.3 | 12.5 | 9.3 | 5.5 | 624 | 9.45 |

Legend: *unofficial weight category at the Croatian national Greco-Roman wrestling championship in the age group of schoolboys.

Descriptive parameters show a decreasing number of wrestlers from the year 2012 to 2016, but a significantly larger number of schoolboys (142 wrestlers) appeared again at the Croatian national Greco-Roman wrestling championship in 2017.

Table 2. Chi-square test results

| Schoolboys (Greco-Roman) from 2012 to 2017 | | | |
|---|---|---|---|
| Category | Mean | Chi-Square | p |
| 32 kg | 0.3 | 52.91 | 0.000* |
| 35 kg | 1 | 45.47 | 0.000* |
| 38 kg | 3 | 26.76 | 0.000* |
| 42 kg | 6.3 | 7.44 | 0.189 |
| 47 kg | 10.3 | 6.41 | 0.268 |
| 53 kg | 15.3 | 29.66 | 0.000* |
| 59 kg | 21 | 89.98 | 0.000* |
| 66 kg | 19.3 | 62.60 | 0.000* |
| 73 kg | 12.5 | 10,43 | 0.063 |
| 85 kg | 9.3 | 3.09 | 0.684 |
| 100 kg | 5.5 | 12.34 | 0.030* |

Legend: category – weight class; mean – average number of participants at the Croatian national schoolboys' wrestling championships over the past six years; Chi-square test – results of the Chi-square test; *a statistically significant variable

Chi-square test results showed a significant frequency deviation ($p=\leq 0.05$) from the expected number of participants in seven out of twelve categories in schoolboy wrestlers (Table 2): 32 kg, 35 kg, 38 kg, 53 kg, 59 kg, 66 kg and 100 kg.

**Discussion**

The significant deviation from the expected frequency is obvious in three lightweight, three middleweight categories and in one heavyweight category. Official classes are caracterized by a progressive increase by 3 kg (32-35-38 kg), 4 kg (38-42 kg), 5 kg (42-47 kg), 6 kg (47-53-59 kg), 7 kg (59-66-73 kg) and 8 kg (73-85 kg). In a previous research (Slačanac, Baić, Sertić, Cvetković, & Pisačić, 2007) a deviation of body weight is visible from the official weight category. In that study, an average bodyweight deviation from the official weight categories is approximately 2 kg. When analysing previous research (Biletić, Baić, & Slačanac, 2012; Slačanac, at al., 2007) a larger number of schoolboy wrestlers is obvious in lightweight categories than in heavyweight categories as well as a higher number of wrestlers in middleweight categories (53 kg, 59 kg and 66 kg) than in all other classes. A small number of wrestlers in lightweight categories and a higher number of wrestlers in heavy weight categories can be a result of thte increased number of children with a higher body weight in Croatia. Also, training process can impact anthropological status, so that changes in anthropological status of schoolboys are statistically significant and positive after fifteen months of training process (Slačanac, Baić, & Cvetković, 2010). Considering age of schoolboys, we can say they are in a sensitive phase of growth and development, therefore it is necessary to carefully manipulate their participation in competitions. Insufficient mental preparedness (especially too high expectations) and excessive participation in competitions can be causes for withdrawal of young wrestlers from the sport. Increased number of unofficial weight categories and a decreased weight span between classes can diminish excessive competiting. Previous research (Slačanac, Starčević & Sajković, 2016) has demonstrated that schoolboy wrestlers may have issues with weight cutting. Weight cutting produces many harmful effects and can be dangerous especially for schoolboys who are in a sensitive phase of grow and development. So, proper, wrestler-friendly weight category distribution can prevent and decrease a weight reduction phenomenon and parents fears (primarily of eating disorders).

Many research studies have confirmed the existence of heavyweight wrestlers even at young age (Slačanac, at al., 2007; Biletić, at al., 2012; Cvetković, Slačanac, Menčik, & Palijan, 2011; Cvetković, Slačanac, & Vračan, 2008). In Croatia (as well as in some other countries like Hungary, Slovakia, Ukraina and others) a need has been recognized for the introduction of a heavyweight category (100 kg), which in not an official category according UWW rules. This weight category even at the age of schoolboys is important because it prepares wrestlers for their later (as cadets, juniors and seniors) competitions in heavyweight category. Senior wrestlers in the 120 kg class begin with wrestling practice at the age of 11.89±3.51 years, which is a statistically significant lagging behind the wrestlers in all other categories, especially the middleweight ones (Baić, Karninčić, & Šprem, 2014). By relating the schoolboy age category (14-15) and the wrestling beginning age of elite wrestlers in the 120 kg class, we can assume that heavy weight schoolboys do not have enough competition at this age. Therefore, it is very important to retain this weight category (100 kg) in the competition system of school boys, even to recognize it as the official one.

Due to the findings of our research, the visible deviation of body weight from the official categories in previous research (Slačanac, at al., 2007), and the increased number of children with a higher body weight in Croatia, it is our proposal to revise the existing weight categories system. In accordance with that and with the cadets' categories as well as with weight categories in some other countries (Hungary, Serbia, Slovakia, Germany and Ukraina), we suggest the following body weight categories for schoolboys: 32 kg, 35 kg, 38 kg, 42 kg, 47 kg, 50 kg, 53 kg, 56 kg, 59 kg, 62 kg, 66 kg, 73 kg, 85 kg, 100 kg. Furthermore, the UWW rules (2017) define Olympic and non-Olympic senior Greco-Roman and freestyle weight categories (for men's and women's wrestling). Based on this model (Olympic and non-Olympic weight categories), we propose all the official and new unofficial weight categories for the national

Greco-Roman wrestling championships in the age group of schoolboys. Respecting the UWW rules, we propose to retain the existing categories according to UWW and to introduce four new weight categories (50 kg, 53 kg, 62 kg and 100 kg) as the unofficial weight categories at for the national, regional and municipal wrestling championships. The mentioned weight categories can be regulated by the introduction of changes in the "Regulation of system, condition and organisation of wrestling competitions" (HHS, 2017) of the Croatian Wrestling Federation regarding national, regional and municipal competitions.

**Conclusion**

Significant weight deviations were found in seven out of eleven weight categories at the national schoolboys championships in Croatia over the last six years. Also, a considerably higher number of schoolboys in middleweight categories and a smaller number in lightweight categories was found. Only in the last year a significantly higher number of schoolboys appeared at the national championship. A decreasing number of schoolboys at the national championships in Croatia can be a consequence of withdrawal of schoolboys from wrestling. Withdrawal from wrestling can be caused by unrealistic expectations, insufficient motivation, excessive tournament participation, or body mass reduction for competitions. It is especially important to introduce a new heavyweight category as the unofficial one because a significantly higher number of schoolboys was observed in heavyweight categories than in lightweights categories. We propose to retain the existing weight categories and to introduce four new unofficial weight categories (50 kg, 53 kg, 56 kg and 62 kg).

Given that more children are involved in the wrestling practice and competition than adults, new, unofficial weight categories are necessary for young age wrestlers (especially for beginners). We can create a pyramidal system of weight categories: six Olympic and eight non-Olympic categories for seniors, eleven for cadets, fourteen for schoolboys and young boys, as well as sixteen weight categories for young boys beginners. National wrestling federations can regulate this issue by their national legislative, subject to the maximum respect for the UWW regulations regarding international competitions .

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# Characterization of specific effort in female wrestlers: lactacidemia, FC, VFC and rate of perceived effort (BORG).

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**ABSTRACT**
The characterization of the effort will mark the lines of work. Heart Rate Variability (HRV) is the result of interactions between the autonomic nervous system-SNA- (with its sympathetic-vagal balance) and the cardiovascular system. The relationship between Lactate and Borg values is directly related to the literature. The PURPOSE of this work was to describe and characterize the effort during an Olympic Fights match and to relate the analyzed parameters. METHODS: 9 female wrestlers (n=9), members of the national wrestling team in the cadet and junior categories (age n=16,33, SD=0;71 ), were the object of study, during 3 days of testing. All subjects performed the same tests: first day recording baseline HR, second day baseline HR recording and a standardized training with a real monitored Olympic Wrestling match. The third day: baseline HR recording. With all this we obtained the values of VFC, Lactate and Borg scale during the confrontation. The time constant of the approximation of heart rate recovery was also analyzed by an interactive monoexponential regression process. RESULTS: The Lactate peak was at minute 3 (Mean: 14.03 mmol / l and SD: 3.5). The values of the BORG scale were higher at the end of the second round ($p < 0.001$). High and significant correlations were detected between the perception of effort and lactacidemia ($p \leq 0.005$) in all cases; CONCLUSIONS: A high glycolytic involvement in the Olympic wrestling match is confirmed. The Borg scale can be a useful tool for monitoring the intensity of combat. A single confrontation is insufficient to generate changes in HRV.

**Key words:** Olympic wrestling, Heart Rate Variability (HRV), autonomic nervous system (SNA), cardiovascular system, lactate and Borg values

**Introduction**
The characterization of the effort will mark the lines of work. Heart Rate Variability (HRV) is the result of interactions between the autonomic nervous system-SNA- (with its sympathetic-vagal balance) and the cardiovascular system. The relationship between Lactate and Borg values is directly related to the literature.

**Methods:**
The characterization of the effort in young female athletes was carried out following the pattern of a day of competition: Arrival of the athletes to the wrestling mat: placement of heart rate meters; Standardized warm up; Measuring the HR at rest, remain 8 minutes sitting; Lactate measurement prior to combat; Presentation of the BORG scale, scale of perceived

effort: before, at rest and at the end of combat; Specific maximum effort test, a combat in real conditions; Recovery measurement, lactate and FC: lactate measurement at 0 ', 3', 5 and 10 minutes after the end of the match. Data processing methods: descriptive statistics were computed (arithmetic means and standard deviations). The ANOVA analysis of the repeated measures, reflected statistically significant differences, so that the analysis of the main effects will be carried out by the Bonferroni test. The level of significance was set at $p<0.05$.

**Results and Discusion**

Table 1. descriptive values of the sample

| N= 9 | Age | High (cm) | Weight (kg) | % fat | % Muscle | % Faulkner | IMC |
|---|---|---|---|---|---|---|---|
| Media | 16,33 | 166,1 | 57,72 | 19,53 | 43,46 | 15,13 | 23,4 |
| Des. Tip. | 0,71 | 3,41 | 10,13 | 4,93 | 3,61 | 3,09 | 2,77 |

As can be seen, it is a homogeneous sample, in which all athletes are of the same age group, and the biggest difference between all of them is the weight. The study subjects present the following characteristics.

The key to the analysis of lactate dynamics is presented in the attached table, where the relationships between the different lactate measurements taken during the test are collected by means of the paired comparison. These measures refer to the following scheme:
Previous Lactate: Lactacidemia level before starting the maximal specific test, ie before the start of the confrontation. Lactate min 0: Lactacidemia level at the end of the confrontation. Lactate min 3: Lactacidemia level at 3 minutes after the end of the confrontation. Lactate min 5: Lactacidemia level at 5 minutes after the end of the confrontation. Lactate min 10: Lactacidemia level at 10 minutes after the end of the confrontation. Data processing methods: The ANOVA analysis of the repeated measures, reflected statistically significant differences, so that the analysis of the main effects will be carried out by the Bonferroni test.

Table 2. Lactate descriptor

| N=9 | Lac before | Lac min 0 | Lac min 3 | Lac min 5 | Lac min 10* |
|---|---|---|---|---|---|
| Mean | 1,36 | 9,10 | 8,59 | 8,19 | 8,05 |
| SD | 0,33 | 2,62 | 2,26 | 2,08 | 2,29 |

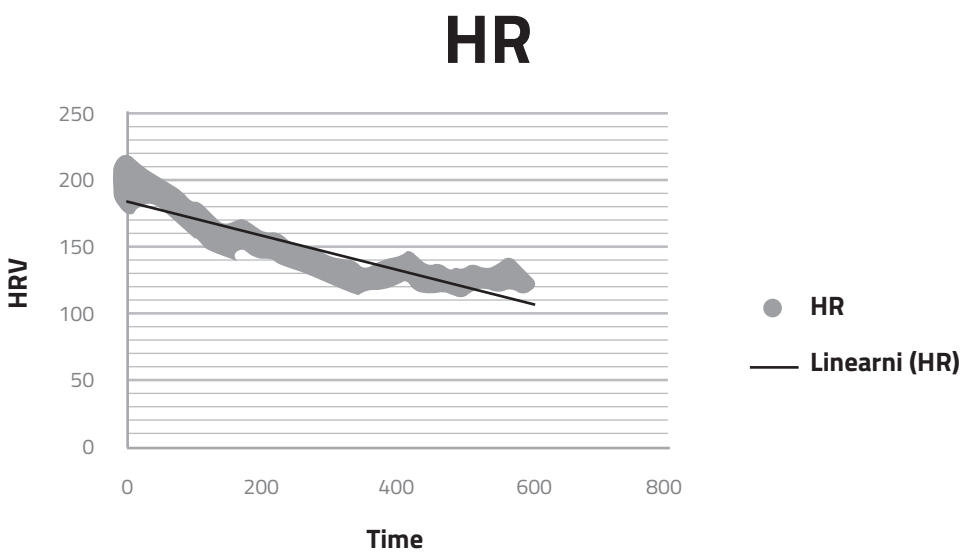
*statistically significant divergence et $p < 0.05$

There were statistically significant differences ($p < 0.05$) between the previous lactate level and the final lactate level, after 10 minutes of recovery, compared to the other measurements performed during the test.

Heart rate values: The values of maximum heart rate obtained during the confrontations are not the same as those that can be obtained in a treadmill test. If we talk about your Reserve FC, we would be close to 95% of your reserve HR during the match. The values obtained by the athletes are not as high as one would expect, either because it is a combat during training, or because of the youth of the same, that interferes in their maximum performance: they feel more tired than they really is it so. The values obtained in the measurement of the Heart Rate during the combat (average: 193.87 bpm and SD: 12.19), which shows us the intensity of the combat. Although we must take into account that, both in absolute and relative terms, HR is significantly higher in women than men in the same workload (Brooks and Fahey, 1984; McArdle, Katch and Katch, 1991: Astrand and Rodhal, 1992), we can observe HR max. During the high combat as in the case of Judith that contrast with values the reduced values of Laura. These variations of HR to a submaximal load, such as fighting combat may be due to factors such as age (Tureley and Wilmore, 1997), stress or anxiety (Carrillo et al., 2001), the different intensity of each combat or Also by the deficient aerobic conditioning. During submaximal

exercise, increased aerobic conditioning results in a proportionally lower HR for the same exercise rate (Villar, 2004), in general, for a given amount of work, HR increases less in a physically fit subject, Than in one, unfit (Wilmore and Costill, 1988). Therefore this value alone can give us little information about the physical condition of our fighters, we will need to relate it to the values of recovery, lactacidemia, perceived effort and technical score to get an idea of their physical condition. The analysis of HR in recovery phase after a submaximal effort has usually been used as an indicator of cardiopulmonary status. More rapid recovery from HR to resting state indicates better cardiopulmonary status (Chen, 2005). It is assumed that recovery HR is faster when the subject's aerobic condition is better, so the percentage of the subject will increase when the fitness level rises (Dennis and Noakes, 1998 in Lamberts et al., 2004).

Graph 1. Cardiac recovery curve




The athletes with higher speed of recovery of the FC after a fight of "equal" characteristics would demonstrate a better physical condition. The failure of the measurements of several athletes during the recovery does not allow comparing both data, even so the information that it provides would be relative since we do not know the intensity of the effort of each athlete in each combat which can cause different behaviours of the recovery curve. BORG: The spreadsheet presented to the athletes, before starting the fight, during the break between rounds and just at the end of the maximum test of specific effort (combat), collects values from 0 (min) to 20 (max).

As for the average values of each moment: BORG begin: At the beginning of the match. No previous effort; BORG R1: At rest, after 3 minutes of intense combat; BORG fin: After the second period of 3 minutes; There is a gradual increase in the effort perceived by the sports, which gives us an idea of the work that they carried out; The final values are far from level 20, which would be the maximum on the scale of BORG, or may be for the youth of athletes, who fail to quantify their effort correctly.

Table 3. BORG scale description:

| N=9 | BORG Previous | BORG Break | BORG end match |
|---|---|---|---|
| Average | 6,27 | 11,82 | 15,82 |
| SD | 2,82 | 2,16 | 2,20 |

**Conclusions:**
The athletes who were successful in the confrontation are those with higher levels of lactate showed, this statement not being statistically significant. The levels of means of% FC of reserve obtained by assault by the athletes are above the average of the data obtained in the bibliographic review. The athletes who achieve higher values of lactacidemia in the first rest are those that clarify lactate before in the minutes 0 ', 5' and 10 'of the recovery, presenting better metabolic conditions to continue with another specific task.
A single combat does not show significant changes in the sympathetic or parasympathetic nervous system, which cannot be affirmed if the athletes carried out several combats on the same day. The HRV is not statistically modified between the pretest and basal postest. If a small increase of the RMSSD, STDRR and LF / HF from the pretest to the posttest is shown, not being statistically significant. Athletes with a greater Decay, recover before those with higher values. A single confrontation is insufficient to appreciate the adaptations of the SNS and SNP.

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# Psychological factors and their relation with performance in women's Olympic wrestling

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**ABSTRACT**
PURPOSE: It is scientifically proved that the psychological profile (spiritual power) of the wrestler has the same and even more importance with the natural characteristics of the athlete. Purpose of this research is to define the psychological factors that affect the performance in modern women's Olympic wrestling. METHOD: One hundred elite female wrestlers from 13 different countries participated voluntering in this research (n=100) , their ages were between 18 and 29 years old and they participated in the «Dan Kolov-Nikola Petrov» tournament that took place in Sofia, Bulgaria and in the Hitit University championship that took place in Corum, Turkey in 2016. The athletes were asked to complete a specially designed, closed-type questionnaire consisted of 13 questions with 16 variables. Each question was related to a specific psychological characteristic, that can contribute in wrestling performance. The questionnaire was translated into four languages (English, French, Russian and Bulgarian) and a seven point scale was used to record the answer. The reliability of the questionnaire was tested with Cronbach coefficient alpha=0.82. The descriptive statistics and factor analysis were used for statistical analysis of data. RESULTS: The results of this study showed that in most athletes will, self-confidence, tactics, concentration, calmness and aggression were the most important and decisive factors for high performance. Regarding the Emotional intelligence and perception, the mood and passion women have positively increased indicators while the rapid alternation of emotions and adaptation to the realities indicators, are significantly lower. These findings can be very useful for coaches and scientists in their continuous efforts to improve performance in the women's Olympic wrestling.

**Key words:** wrestling, women, psychology, performance

**Introduction:**
Psychology in sport is an important performance parameter in training and in the matches too. The psychological factor is very important in any sport especially in wrestling. Training is the only way for a wrestling female athlete to improve her weaknesses and fill in the gaps in her technique and tactics, physical condition and mental-spiritual state. The mental preparation and psychological habits acquired by the athlete in training are transported to the match and they determine at a maximum degree her performance. The psychology of the person that wrestles, either male or female, greatly affects the physical performance (eg power, speed strength etc.) and also the technique and tactic. It is well documented that performance in female wrestling is influenced by various factors including the physical strength and power, flexibility, endurance, superior technique and strategy. Moreover, it is a common belief that the wrestler's psychological profile is of the same importance - if not more- as physical strength and technique (Gould et al 1987, Popov 1994, Barbas 2003). Highlen & Bennett (1979) also found that good wrestlers have less stress and anxiety and more confidence. Gould et al (1981) found that successful wrestlers were more confident and more often focused their attention on thoughts related to the match before contest. Moreover, each wrestling athlete should be able to forgive herself and continue after any unsuccessful attempt in the match, which requires personal control and self-confidence

emanating from previous successful attempts, the training process and by good cooperation between coach and athlete (Barbas 2015). Due to the late introduction of women's wrestling in the program of the Olympic Games compared with that of men's the latitude and the need for further research on female wrestling and especially on psychology in relation to women's wrestling are great as the amount of research about the performance and the psychology of male wrestlers is significantly greater than the amount of research related to psychology and its relationship with performance in women's Olympic Wrestling. Purpose of this research was to define the psychological factors that affect the performance in modern women's Olympic wrestling.

**Method**

One hundred elite female wrestlers from 13 different countries participated volunteering in this research (n=100) , their ages were between 18 and 29 years old and they participated in the «Dan Kolov-Nikola Petrov» tournament that took place in Sofia, Bulgaria and in the Hitit University championship that took place in Corum, Turkey in 2016. The athletes were asked to complete a specially designed closed type questionnaire consisted of 13 questions with 16 variables. Each question was related to a specific psychological characteristic that can contribute in wrestling performance like courage, will, self-confidence, tactics, concentration, calmness, alertness, aggressiveness, determination, talent, adaptability, imagination, perceptiveness, perception, initiative and ingenuity. The questionnaire was translated into four languages (English, French, Russian and Bulgarian) and a seven point scale was used to record the magnitude of the relationship between each psychological attributes and performance in wrestling, with the seventh grade representing the strongest connection. The reliability of the questionnaire was tested with the Cronbach coefficient a = 0.82. The descriptive statistics and factor analysis were used for statistical analysis of data.

**Results**

The relative frequencies of female wrestlers' opinions on the relevance of psychological characteristics are presented in Table 1

Table 1. Relative frequencies (%) of the views of female wrestler on the contribution of each psychological characteristic of performance in Olympic Female Wrestling.

| Variables | None | Very Little | Little | Neutral | Enough | Large | Important |
|---|---|---|---|---|---|---|---|
| Will | 0 | 0 | 0 | 3 | 3 | 16 | 78 |
| Self-confedence | 0 | 0 | 2 | 2 | 7 | 26 | 63 |
| Tactics | 0 | 0 | 0 | 4 | 8 | 26 | 62 |
| Concentration | 0 | 0 | 0 | 2 | 7 | 29 | 62 |
| Calmness | 0 | 0 | 0 | 2 | 12 | 24 | 62 |
| Aggressiveness | 2 | 0 | 0 | 7 | 16 | 25 | 50 |
| Alertness | 0 | 0 | 0 | 3 | 19 | 29 | 49 |
| Determination | 0 | 0 | 0 | 4 | 9 | 39 | 48 |
| Courage | 0 | 0 | 2 | 3 | 12 | 37 | 46 |
| Talent | 5 | 3 | 6 | 4 | 13 | 28 | 41 |
| Adaptability | 0 | 0 | 4 | 5 | 22 | 28 | 41 |
| Imagination | 2 | 0 | 3 | 9 | 20 | 29 | 37 |
| Insight | 0 | 2 | 4 | 13 | 15 | 31 | 35 |
| Perception | 2 | 0 | 0 | 12 | 25 | 28 | 33 |
| Initiative | 3 | 3 | 2 | 9 | 29 | 28 | 26 |
| Ingenuity | 0 | 4 | 3 | 15 | 35 | 19 | 24 |

It is obvious that for most female wrestlers will, self-confidence, tactics, concentration, calmness and aggressiveness were the most important performance factors. Alertness, determination, courage, talent, adaptability, imagination and insight proved to also have a great contribution to performance, while the other psychological parameters examined the issues seem not to contribute significantly to performance in female wrestling.

The average values (with a maximum possible degree 7) of the aspects of the issues concerning the significance of the variables for the high performance in wrestling illustrated in Figure 1.

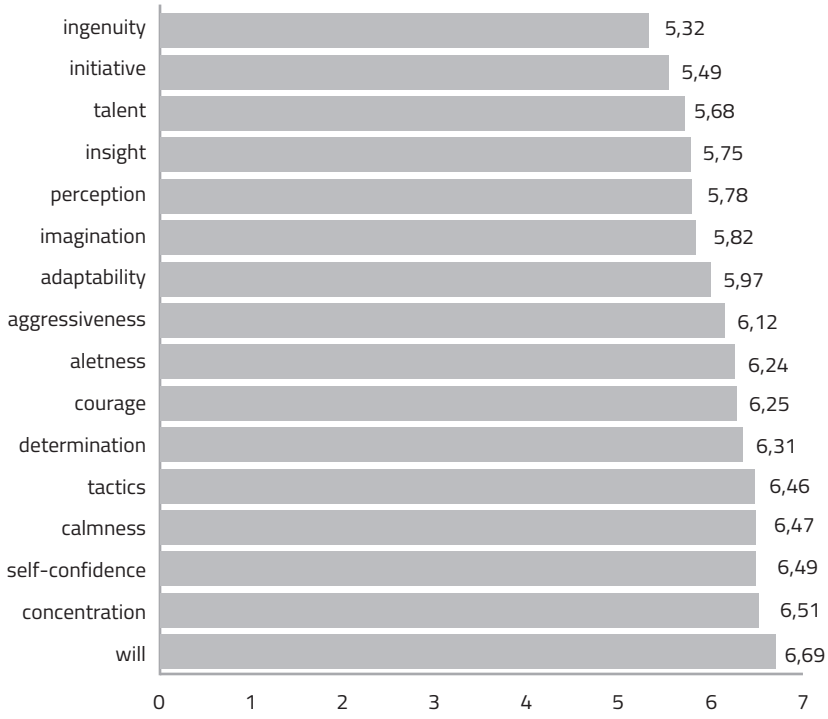


Figure 1. Average values of subject aspects regarding the important characteristics for high performance in women's wrestling

As can be seen in Figure 1, between the psychological aspects associated with performance will, concentration, self-confidence, alertness, self-confidence, calmness, tactics, determination, courage, alertness and aggressiveness have the highest scores.

**Discussion**

So the female wrestling athletes have positively increased indicators of Emotional Intelligence while for the fast switch of emotions and adaptation to real circumstances are significantly lower as the initiative and ingenuity are getting the lowest position among the factors that contribute to performance in Women's Olympic Wrestling. The psychological and physical fatigue are the two major opposing factors for a victory not only for women's wrestling but in Olympic wrestling in general because when physical endurances reach their limits (a common thing during wrestling matches) psychological strength and integrity and will to win are those that give strength to the a female or male wrestler to continue. According to Barbas (2015) the release of energy during the match although initially considered a result of physical work and of the athlete's physiology, in the end it is greatly associated with the psychological-spiritual situation of the athlete and the factors that determine the amount of energy the athlete will

be available to use in the match are the mood and the desire to wrestle. That could be the reason that will was ranked first among major psychological parameters that affect performance in women's wrestling. Concentration, confidence and calmness also ranked high, as they are important factors for the excellent technical performance of wrestling throws and moves in general. Finally, the importance of tactics that is defined as the ability of the female athlete to organize activities for a specific purpose is apparent not only in wrestling but in all sports. These considerations also apply in accordance with the findings of previous studies (Gould et al, 1981 Highlen & Bennett, 1979).

**Conclusions:**
As concluded from the above survey wrestling athletes agree on the importance of psychological factors for high performance in wrestling and they even give more importance to the psychological characteristics of will, concentration, confidence, calmness and the ability of the female wrestler to organize movements in order to achieve a particular goal. The findings of this research may be useful for coaches and scientists and contribute to their efforts to continuously improve performance in the Women's Olympic Wrestling

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# ‘Official’ or ‘Unofficial’ were the European championships in Greco-Roman wrestling in the beginning of the 20th century

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**ABSTRACT**
PURPOSE: In the second half of the 60s and the beginning of the 70s of the 20th century occasionally the word “unofficial” begins to appear in some specialized publications, when referring to the European wrestling tournaments or World wrestling championships. The reason why such an adjective is added before the names of competitions is unclear, the criteria for choosing such a modifier are subjective, and no arguments are offered in support of this choice of words. The current research paper looks for an answer to this historiographical issue. DISCUSION: Some of the possible reasons have been analyzed, i.e. whether a legitimate international organization managed the competitions and what the exact dating of the first European and World Greco-Roman Wrestling tournaments is in historical records. A comparative analysis has been conducted on the competitions held, based on the number of participating nations and wrestlers, the geographical location of the hosting organization, the distribution of medals won by each nation, etc. Enough examples have been found of Olympic and world champions who were at the same time “unofficial European champions.” CONCLUSION: We think that tournaments succeeded in their goal, namely, to popularize the Greco-Roman style of wrestling, and the experience gained in terms of management and competition skills facilitated the development of the Greco-Roman wrestling style. The solution to the issue is to discontinue the use of the modifier “unofficial” as it is outdated, misleading, and illogical.

**Key words:** wrestling history, 20th century, medals

**Introduction:**
In the second half of the 60s and the beginning of the 70s of the 20th century occasionally the word “unofficial” begins to appear in some specialized publications, when referring to the European wrestling tournaments or World wrestling championships. This raises the question on what grounds or due to what reasons such changes were introduced. In the official documents of the World Wrestling Federation no arguments supporting this addition can be found. The specialized literature on wrestling history does not provide solid support for that, either.

Before the beginning of WWI 15 European championships in Greco-Roman wrestling had been held. Most of the researchers focus mainly on the management and the administration of such events by a legitimate international organization. The decision on what year to consider as the period during which the International Wrestling Federation was established, has been changed three times up to date. It becomes obvious that all events that are considered “official” were held after 1921, which was the first year that had been chosen as the year the International Wrestling Federation was founded. In the late 60s, President Roger Coulon suggested a change in this dating and the beginning was set in 1912. In 2006, based on historical arguments (11) the Congress of FILA accepted that the International Wrestling Federation was created in 1905.

**Discusion:**
Wrestling is a sport in which traditions in competitions are established prior to administrative authorities that manage such competitions. As a rule, administrative bodies are formed because they are pragmatically needed, i.e. for the management and supervision of different competitions. On the other hand, wrestling as a sports discipline is an example of continuity – the technical and methodological knowledge and skills as well as the experience gained by professional wrestlers in competitions is adapted and used in a most rational way.

Towards the end of the 19th and in the beginning of the 20th century several European national federations (unions) were created[1]. They all included people with solid experience, knowledge and ideas how to further develop wrestling as a sport. Rather often wrestling competitions were organized with no strict rules and/or unified weight categories. At the Stockholm Olympics in 1912, 171 participants from 18 countries took part in the wrestling competitions; the participating nations had already had well-established national sport structures.[2](9) Those nations were the most renowned strongholds of the Greco-Roman wrestling style in Europe and as such some of them had been hosting European championships for years, which later were named "unofficial" tournaments.

Historical records show contradiction in the dating of the first European tournaments in Greco-Roman wrestling as well. For the European competitions a major discrepancy of some 50 years exists, starting from Vienna (1898), then Milan (1925) up until Prague (1947). There is a similar problem with the dating of the World Championships – Vienna (1904), Vienna (1910), Helsinki (1921), and Stockholm (1950). (1;2;3;4;5;7;8)

Further confusion is added by defining some of the competitions as "unofficial". On the occasion of the 80th anniversary of the modern Olympics the following publication was issued FILA – Documentation of International Wrestling Championships (1896 – 1976), in which all European tournaments held from 1898 until 1924 as well as the World Championships held up to 1920 are defined as "unofficial." This distinction was made by Dr. Per Stromback, FILA Vice President, who published a history of the Federation on the occasion of its 75th anniversary. There is a note to the list of the world wrestling championships in this publication stating that all championships organized prior to 1921 were "unofficial."

Prof. Rayko Petrov's position on the issue, himself also a FILA Vice President, was diametrically opposed to that of the above publications. In his works he states categorically that the First European Championship was held in Vienna, 1898, and the First World Championship was organized in 1904 also in Vienna.

A number of works also published different lists of achievements. The wrestler who had won the greatest number of medals from unofficial European championships was Hans Heinrich Egeberg (DEN, 4 gold and 1 silver). A separate list was made for the official champions, which was topped by Kustaa Pihlajamaki from Sweden with 7 gold medals (until 1981). (10)
A serious resource such as the one published by Deutscher Ringer-Bund states that in 1925, in Milan, the first official European championship was held, monitored by an international authority. According to the UWW – Wrestling Database until WWI 14 world championships were held, among them 8 were official, and the remaining were "unofficial." The European championships were, as a rule, "unofficial" but surprisingly there was one official tournament held in March 1911 in Budapest. A comparative analysis of three European championships was made, held in three consecutive years in Budapest – the number of participating nations, competitors and categories were compared. (3) We do not see any reason why such a distinction has been made.

[1]Germany – 1890, Sweden – 1900, Italy – 1902 , Holland – 1903, the UK – 1904, Hungary – 1905, Norway – 1909
[2]Austria - Österreichischer Athleten-Union, Bohemia - Cesky Ustredni Svaz Tezkoathleticky, Denmark - Dansk Athlet Union, Finland - Finlands Gymnastik-och Idrottsförbund, Germany - Deutscher Reichsverband für Schwerathletik, Hungary - Magyar Athletikai Szövetség, Sweden - Svenska Atletikförbundet, Italy - Federazione Atletica Italiana, and others.

| European Championship | Number of competitors | Number of participating nations | Categories | Most successful countries by the number of champions |
|---|---|---|---|---|
| Budapest 1910<br><br>unoffical European Championship | 57 | 9 | 70<br>85<br>+85 | 1. Denmark<br>2. Germany<br>3. Holland |
| Budapest 1911<br><br>European Championship | 21 | 4 | 66,6<br>73<br>93<br>+93 | 1. Hungary<br>2. Denmark<br>3. Germany |
| Budapest 1912<br><br>unoffical European Championship | 43 | 5 | 60<br>67,5<br>75<br>82,5<br>+82,5 | 1. Hungary<br>2. Finland<br>3. Germany |

Table 1.

The juxtaposition official/unofficial (competitions) is artificial and is applied by many authors in a manner that shows no objective reason in selecting one adjective over the other. Up to date, there is no acceptable argument to define the European and the World championships from the beginning of the 20th century as "unofficial":

In the years from 1896 until WWI a total number of 40 competitions in Greco-Roman wrestling were held, among them 4 Olympic competitions, 8 World championships, 6 "unofficial" world tournaments, 1 European tournament, 14 "unoffical European Championships", 7 Middle European Championship. The medals in these competitions are predominantly distributed among the following nations: Germany, Austria, Bohemia, Hungary, Denmark, Russia, Belgium, Finland, Holland, and Sweden.

If we compare the geographical location of the country hosting an "unofficial" European or World championship, a clear trend can be seen that such competitions were organized in Central and Northern Europe. Actually, 1/3 of all the competitions before WWI (except for the Central Europe championships) were held in the Austro-Hungarian Empire (which then included Austria, Bohemia, and Hungary).

Sufficient representation of European nations can be seen, i.e. in the so-called unofficial competitions the number of participating nations reached 25, while in the official competitions up to 29 countries took part.

Paradoxes: Georg Hackenschmidt was the first amateur European champion in heavy weight lifting (1898), and on August 1, 1898, in Vienna he became the first European champion in Greco-Roman wrestling. According to the current definitions we should add the adjective "unofficial" to his titles. (1;6)

There are numerous examples of wrestles with Olympic and world titles who, simultaneously, are "unofficial" European champions:

| Hans Heinrich Egeberg (DEN) | | | | | |
|---|---|---|---|---|---|
| 1908-12-08 | World Championship | Greco-Roman | Seniors | 75.0 | 1. |
| 1907-05-20 | World Championship | Greco-Roman | Seniors | 85.0 | 1. |
| 1910-03-05 | unofficial European Championship | Greco-Roman | Seniors | 85.0 | 1. |
| 1909-09-18 | unofficial European Championship | Greco-Roman | Seniors | 80.0 | 1. |
| 1909-02-27 | unofficial European Championship | Greco-Roman | Seniors | | 1. |
| 1902-01-01 | unofficial European Championship | Greco-Roman | Seniors | without | 1. |
| Frithiof Martensson (SWE) | | | | | |
| 1908-07-20 | Olympic Games | Greco-Roman | Seniors | 73.0 | 1. |
| 1909-02-27 | unofficial European Championship | Greco-Roman | Seniors | 82.5 | 1. |
| Ernesti Vaere (FIN) | | | | | |
| 1920-08-15 | Olympic Games | Greco-Roman | Seniors | 67.5 | 1. |
| 1912-07-06 | Olympic Games | Greco-Roman | Seniors | 67.5 | 1. |
| 1911-03-25 | World Championship | Greco-Roman | Seniors | 73.0 | 1. |
| 1912-05-04 | unofficial European Championship | Greco-Roman | Seniors | 82.5 | 1. |
| Edvin Johanson (SWE) | | | | | |
| 1920-08-15 | Olympic Games | Greco-Roman | Seniors | 82.5 | 1. |
| 1912-07-06 | Olympic Games | Greco-Roman | Seniors | 75.0 | 1. |
| 1913-05-01 | unofficial European Championship | Greco-Roman | Seniors | 75.0 | 1. |
| Ewald Hegewald (ALL) | | | | | |
| 1913-07-27 | World Championship | Greco-Roman | Seniors | 67.5 | 1. |
| 1909-09-18 | unofficial European Championship | Greco-Roman | Seniors | 62.5 | 1. |
| Theodor Schibilski (ALL) | | | | | |
| 1905-04-08 | World Championship | Greco-Roman | Seniors | 68.0 | 1. |
| 1909-09-18 | unofficial European Championship | Greco-Roman | Seniors | 70.0 | 1. |
| Oedoen Radvany (HUN) | | | | | |
| 1920-09-04 | World Championship | Greco-Roman | Seniors | 67.5 | 1. |
| 1913-05-01 | unofficial European Championship | Greco-Roman | Seniors | 67.5 | 1. |
| 1912-05-04 | unofficial European Championship | Greco-Roman | Seniors | 67.5 | 1. |
| Anders Ahlgren (SWE) | | | | | |
| 1912-07-06 | Olympic Games | Greco-Roman | Seniors | 82.5 | 2. |
| 1913-07-27 | World Championship | Greco-Roman | Seniors | 82.0 | 1. |
| 1913-05-01 | unofficial European Championship | Greco-Roman | Seniors | 82.5 | 1. |
| Gyula Ruzicska (HUN) | | | | | |
| 1914-05-31 | unofficial European Championship | Greco-Roman | Seniors | 75.0 | 1. |
| 1911-03-24 | European Championship | Greco-Roman | Seniors | 73.0 | 4. |

Table 2.

The differing interpretation of one and the same historical facts is due to the different approach applied by the authors. The lack of standardized criteria, the misinterpretation of the actual state and the level of development of sports in the beginning of the 20th century as well as the use of contemporary models and requirements when analyzing events that were held more than a century ago lead to the incorrect assumptions and subjectivism. As a result, more often than not misinformation is disseminated.

We are of the opinion that there are no grounds for the "official/unofficial" (competitions) juxtaposition because the defining criterion should be the goal that these championships had set – to popularize the Greco-Roman style of wrestling and the result that was achieved – the accumulated managerial expertise and competitors' experience further boosted the development of the sport. Among the names of the champions in those "unofficial" European and World competitions are those of wrestlers and activists who played a crucial role in the spreading of the Greco-Roman wrestling style in Europe; the championships are an undisputed historical fact.

**Conclusions:**
Having analyzed the above historiographical issue, we do not seek a radical change in the ranking of champions, nor do we want to revise the specialized literature. We believe that the solution is to simply discontinue the use of the adjective "unofficial" as it should be considered outdated and illogical. A possible step in this direction could be to edit the official website of the UWW – Wrestling Database, being the major resource of statistical and historical information, and thus delegitimize further use of the misleading modifier.

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Information is based on data retrieved from UWW: https://unitedworldwrestling.org/DataBase

# 12th World Universities Wrestling Championship Greco-Roman style - Competition technical analysis

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**ABSTRACT**
PURPOSE: The purpose of this study was to make the 12th World Universities Wrestling Championships Greco-Roman style competition technical analysis. There were 250 participants from 26 countries participating in Corum / Turkey held on 25-30 October 2016. METHODS: The observation form prepared before the competitions with recorded by two researchers, technical analysis of the recordings were obtained. During the competitions, the scores obtained, warnings, winning types, successful techniques recorded in the technical analyze form. In statistical analysis, the percentage distributions for each parameter and match percentage rates were calculated. RESULT: The number of technical points taken for all weight groups in wrestling competitions was 341points. The most number of techniques were 157 with light weight and the maximum numbers of competitions were 38 with light weight group. The highest number of techniques was achieved in lightweight groups with 157 and with the maximum number of matches was made with 38 in the light weight group. The least number of techniques was made with 63 technique in the heavyweight groups and the least number of competitions was made with 18 matches in the heavy weight group was also seen. The highest number of victory was won by score in the heavyweight group (83%); the highest number of victory was won by technical pin in the lightweight group (21%). In the lightweight weight groups have not been winner by pin. The highest score was made with passive punishment point in lightweight group 28%, middleweight group 38% and heavyweight group 33%. The highest scores in the second row were obtained from the techniques of snap down spin behind with 16% at light weight, high dive takedown at 16.5% in middle weight, and move out of the mat and high dive takedown score at 22% in heavyweight groups. CONCLUSION: As a result; the most effective technique in Greco-Roman style given by the referee was passive punishment point in all weight groups. In this case, the wrestlers need to be more active in the bilateral struggle. In particular, it is suggested to fight tempo wrestling with their arms and chest by fighting against each other and struggle in the standing position.

**Key words:** World Universities wrestling, Greco-Roman style, competition analysis

**Introduction**
It has been argued that some of the rule changes made to make wrestling more active may or may not bring benefits to the wrestling sport. Changes made on the Greco-Roman style are not welcomed by wrestlers. In this study; it seems that the result of the rule changes made the differentiation of the score techniques.

It is connected with constantly increasing competition on the basis of introduction of

achievements of science and technique in the training process and improvement of technique of training of sportsmen (Shatskikh, 2013; Bromber et al., 2014; Iermakov et al., 2016; Tropin et al., 2016).

Analyzing the tendency of the development of wrestling in recent years, most of experts agree that for the development of wrestling, including as the element of the program of the Olympic Games, it is necessary to make effort for the increase in effectiveness of wrestling duels at preservation of high intensity of fight throughout the whole fight (Sandberg et al., 2007; Vardar et al., 2007).

With every passing year the competition for prize places is becoming more acute at international competitions on Greco-Roman wrestling. It is connected with constantly growing competitiveness on the base of science and technical achievements' introduction into training process and with perfection of sportsmen's training methodic (Malkov., 2006; Hughes and Bartlett, 2002).

Ortega et al., (2006), they have explained that they have contributed to the development and acquisition of information to improve the technical analysis of the competition. There are many indicators available for statistical analysis of sport performance. The estimates made inform the changes of the performances of the coaches and the sportsmen.
Mirvic et al. (2011) reported that after the events, feedback provided effective results in the use of positive transformations to improve performance of athletes. Mirvic et al. (2011) explained that this information gathered after the competition is open to discussing objectively, validly and consistently, and developing new possibilities by analyzing and evaluating the basic items of coaches and athletes.

The analysis of competition functions has become an urgent situation in modern developed wrestling. Furthermore, the maintenance of individual problems in training has always been an important study direction for researchers (Tropin, 2013; Ryan and Sampson, 2006). After the preparation period, sports events are a very important test area for athletes and coaches. Because; end of the any training process the achievements are evaluated according to the results of the sport competition (Mizerski, 1972).

This study's objective was to analysis of Greco-Roman wrestling technique during a 2016 12th World Universities Wrestling Championship. The specific aims were to: (1) calculate tournament successful technique rates in Greco-Roman wrestlers; (2) characterize the general technique of Greco-Roman tournament; and (3) compare the between past tournament techniques to new Greco-Roman tournament techniques.

**Material & Method**
The 12th World Universities wrestling competitions were held in Corum / Turkey on 25-30 October 2016 with 250 participants from 26 countries (Hitit University, 2016). The competition technical analysis study covers a total of 88 competitions made in 8 kilo groups. The 88 matches were recorded by 2 researchers with the pre-prepared observation form and technical analyzes were obtained from the recordings made. The types of winning matches, points earned techniques, techniques made on the ground and in the stands; objections and received warnings were recorded in the developed technical analysis form. The statistical analyzes of the percentile distribution for each parameter and the percentages per game were calculated.

World universities Greco-Roman competitions were made in 3 minutes of 2 periods. In the competitions, kilograms were grouped and distributed as 59, 66 and 71 kilos light weight, 75, 80 and 85 kilos medium weight and 98 weight and 130 kilos weight as heavy weight.

**Results**

In Table 1, shown below, the weights are listed in groups as light, medium and heavyweight.

Table 1. Distribution of kilo groups

| Kilograms | Group |
|---|---|
| 59 KG, 66 KG, 71 KG | Lightweight |
| 75 KG, 80 KG, 85 KG | Middleweight |
| 98 KG, 130 KG | Heavyweight |

In Table 2, the group with the highest score according to weight groups was lightweight with 157 techniques. The group with at least match was a heavyweight group with 18 matches.

Table 2. Distribution of technical and match numbers scored by each weight groups

| Weight groups | Number of technical points scored | Number of matches by groups |
|---|---|---|
| Lightweight | 157 | 38 |
| Middleweight | 121 | 32 |
| Heavyweight | 63 | 18 |
| Total | 341 | 88 |

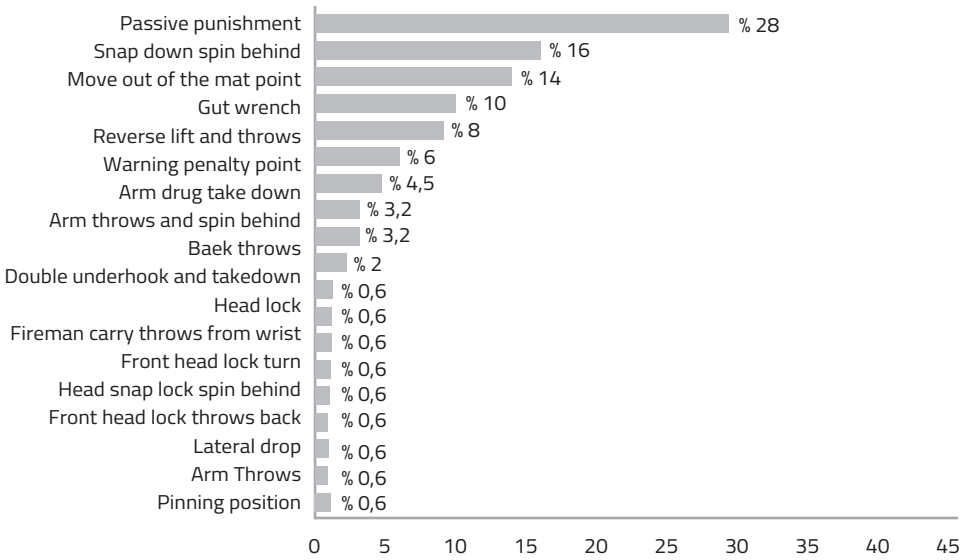


Figure 1. The percentage distribution of lightweight wrestler successful technique

In Figure 1, the technique with the highest score was the passive punishment points obtained by reducing the competitor to passive status a rate of 28%. After that with the order of the most point taken from 16% point from snap down and spin behind technique and 14% of the point taken from move out of the mat techniques.

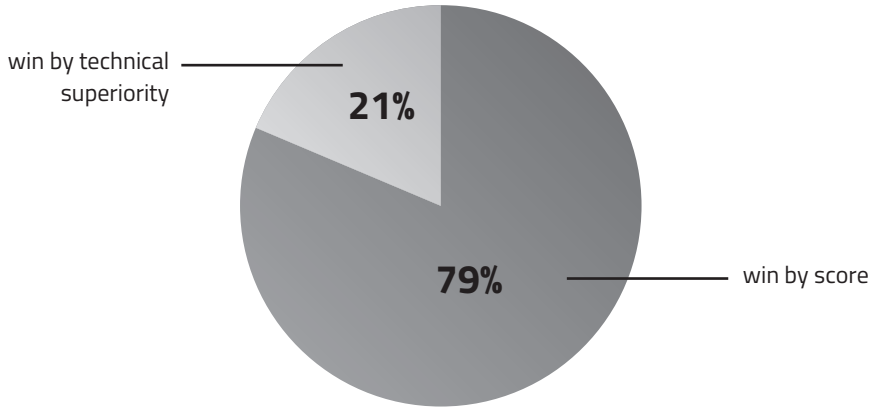


Figure 2. The percentage distribution of lightweight wrestlers' winning type

In Figure 2, lightweight wrestlers 79% won by score, while 21% won by technical superiority. In these weight groups there is no winner by pin.

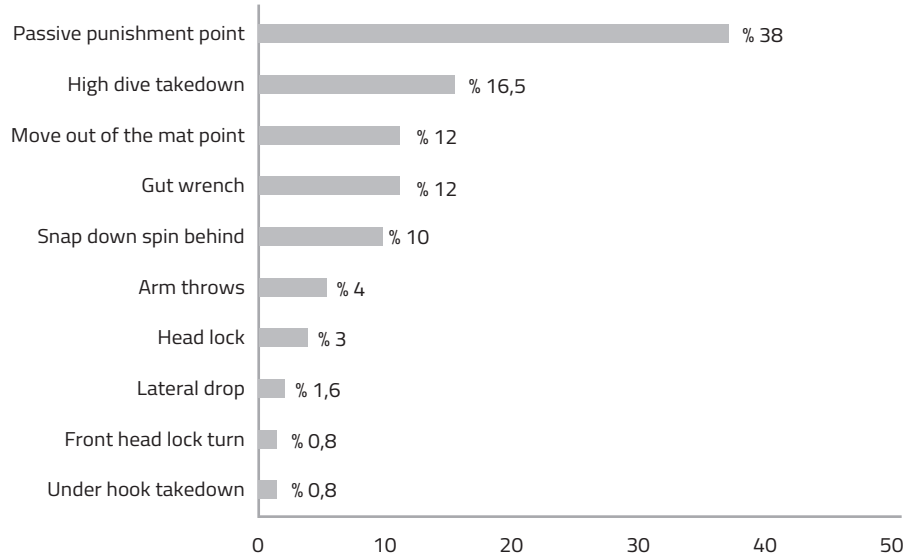


Figure 3. The percentage distribution of middleweight wrestler successful technique

In Figure 3, the middleweight wrestlers had the highest score of 38% with a passive punishment point. Later on, the techniques were made it with 16.5% high dive and takedown, 12% move out of the mat point techniques.

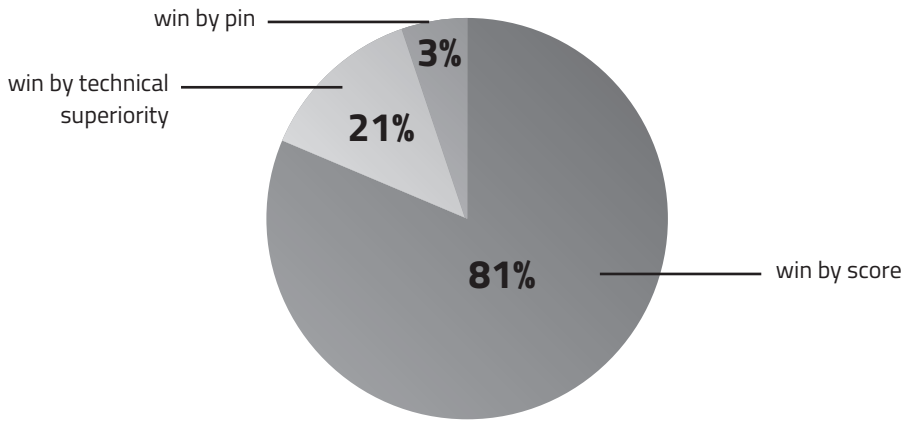


Figure 4. The percentage distribution of middleweight wrestlers' winning type

In Figure 4, middleweight wrestlers 81% won by score, while 15.5% won by the technical superiority and 3% won by the pin.

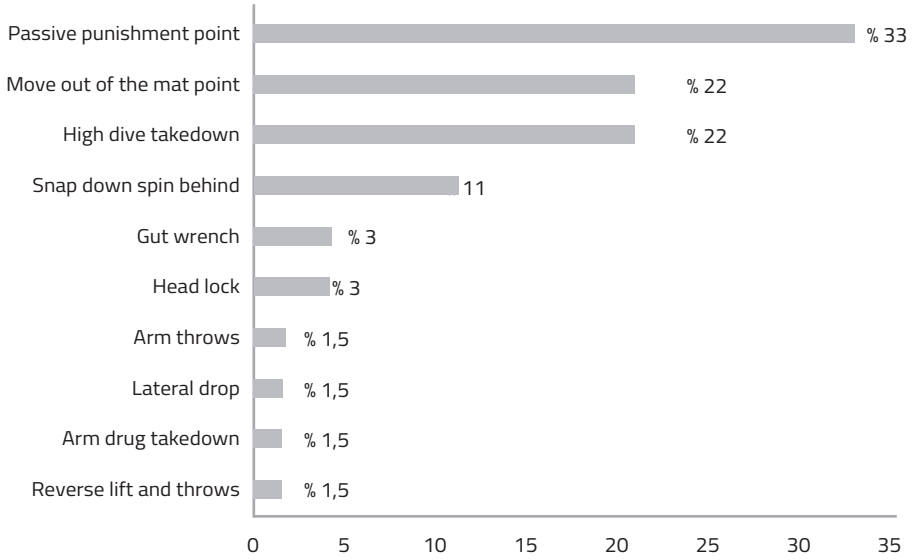


Figure 5. The percentage distribution of heavyweight wrestler successful technique

In Figure 5, the heavyweight wrestlers got the most points from 33% of the passive punishment point. After that orderly 22% each point got from move out of the mat and high dive takedown techniques.

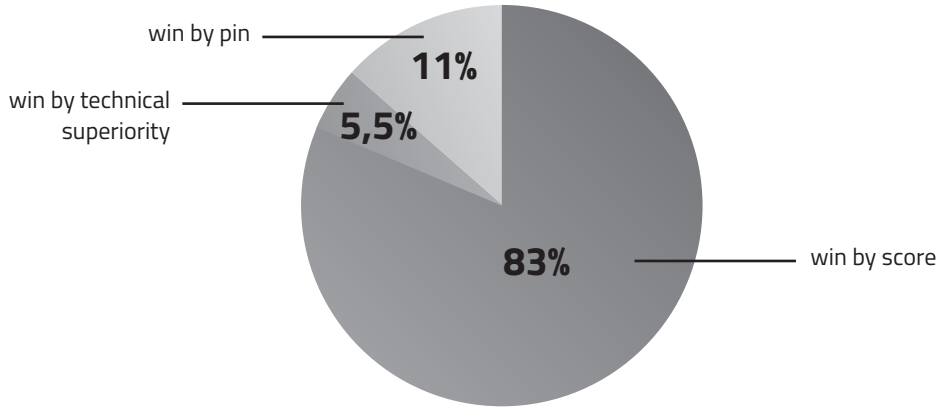


Figure 6. The percentage distribution of heavyweight wrestlers' winning type

In Figure 6, heavyweight wrestlers 83% won by the score, while 11% won by the pin and 5.5% have won by with the technical superiority.

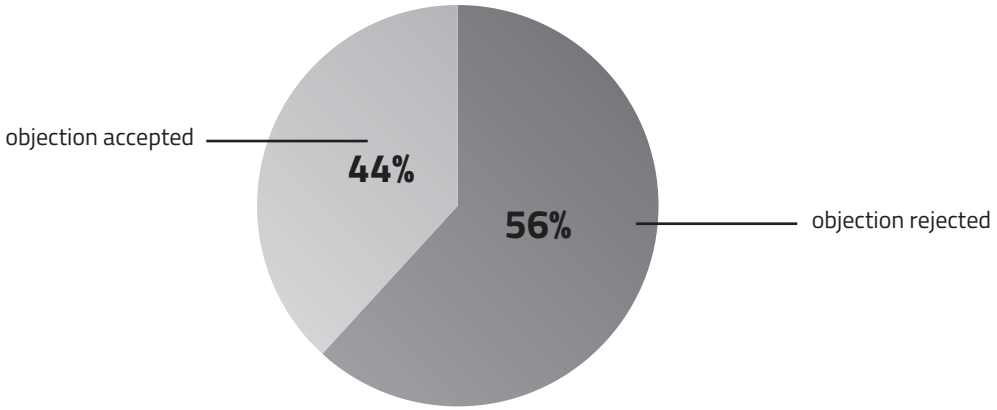


Figure 7. The percentage distribution of coaches' total objections against referee decisions.

In Figure 7, a total of 88 matches made in tournament, 56% of the objections made by the coaches to the arbitration committee were rejected while 44% were accepted.

| Rang | Equipe | 130 kg | 59 kg | 66 kg | 71 kg | 75 kg | 80 kg | 85 kg | 98 kg | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TUR | 6 | 8 | 10 | 8 | 8 | 9 | 7 | 10 | **66** |
| 2 | BLR | 9 | | 9 | 10 | 6 | 8 | 9 | 8 | **59** |
| 3 | IRI | 8 | 9 | 8 | 8 | 8 | 6 | 6 | 6 | **59** |
| 4 | RUS | 8 | 6 | 1 | 6 | 2 | 8 | 8 | 8 | **47** |
| 5 | HUN | 10 | 3 | | 3 | | 10 | 10 | 6 | **45** |
| 6 | POL | 6 | 4 | 36 | 2 | 9 | 3 | | | **30** |
| 7 | KGZ | | 10 | | | | 4 | | 3 | **27** |
| 8 | KAZ | 4 | 6 | | 9 | 4 | | | | **19** |
| 9 | MDA | | 8 | 4 | | | | | 2 | **18** |
| 10 | GER | 4 | | | 4 | | 6 | | 4 | **18** |
| 11 | GEO | | 2 | 8 | | 6 | | | | **16** |
| 12 | AUT | | | | | | | | 9 | **9** |
| 13 | UKR | | | 2 | 6 | | | | | **8** |
| 14 | FRA | | | 6 | | | | | | **6** |
| 15 | GRE | | | | | | | | | **3** |
| 16 | ESP | | | | | | 2 | | | **2** |
| 17 | SET | | | | | | | | | **0** |
| 17 | ROU | | | | | | | | | **0** |

Figure 8. International Senior 12th World Universities Wrestling Championship GR Style Ranking(University Sport Federation, 2016).

Figure 8. shows countries participating in the Greco-Roman tournament and the results of the competition. The Turkey's national team received 66 points in total and took first place, the Belarusian national team received 59 points and took second place and Iranian national team received 59 points and took third place.

**Conclusion**

The review of Greco-Roman wrestlers' performances at Olympic Games 2008 and Olympic Games 2012 permits to make conclusion that no matter how the level of technical preparedness is, how efficient technique is used by a wrestler, it is impossible to apply any technique without appropriate tactical preparedness (Tropin, 2013). The rule changes that we make in our work often affect the technical and tactical work of the wrestlers.

Soyguden et al., (2015) reported that Turkish U-23 Greco-Roman wrestler, techniques with the highest score on the Greco-Roman style were arm throws, head lock, move out of the mat, high dive and take down, snap down spin behind, throws, front throws and gut wrench techniques. Mirzaei and Akbar, (2008); In their study with the elite Iranian Greco-Roman wrestlers, they found that the Greco-Roman wrestlers scored the most points from the techniques of head lock, arm throws, under hook takedown, arm drug and gut wrench. Our study showed that similar result but we have found only one techniques of passive punishment point whose wrestler used because of the Greco-Roman wrestling rules.

Soyguden et al. (2015) found that in Turkish U-23 Greco-Roman wrestler and this study Greco-Roman wrestling most technique performed 83% on the standing position and 17% technique on the ground position. At the 2011 World Senior Wrestling Championship in Greco-Roman style most technique performed 71% on the ground position and 29% technique performed on the standing position (Dokmanac et al., 2012). In this study conducted in 2015, it is thought that more points taken on the standing position are caused by the rule change made on the Greco-Roman style. Again we can see in our study showed that most point taken from on the standing position and passive punishment points.

Some changes in the rules of wrestling cause changes in the technical and tactical work of the

wrestlers. Especially the changes made in the Greco-Roman style have had negative effects on the wrestlers. In the study we have done, this rule is seen from the points taken as the result of the changes.

As a result; the most effective technique in Greco-Roman style given by the referee was passive punishment point in all weight groups. In this case, the wrestlers need to be more active in the bilateral struggle. In particular, it is suggested to fight tempo wrestling with their arms and chest by fighting against each other and struggle in the standing position.

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# Comparison of female wrestler and female judokas' weight loss situations

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**ABSTRACT**
AIM: The aim of this research is to compare the women wrestlers and judoist weight loss situations in Turkey. MATERIAL AND METHOD: According to the voluntary principle, 153 women wrestlers and 132 women judoists were filled out the questionnaire developed by the researchers. Statistically t-test and chi-square test were used. RESULTS: The average age of starting to wrestling for women wrestlers was 13.67 years old, and the average age for starting to judo was 11.36 years old. There was no significant difference in age, height and body weight among women wrestlers and judoist ($p > 0.05$). There was a significant difference between the sport branch starting age and starting age of losing weight ($p < .001$). In the group of those who continuously lose weight before the competition; 60.08% were in wrestlers, 53.0% in judoist and 57.2% in total in the group. In the group of 36.8% of the athletes declared that they did not lose weight. The athletes of 38.9% who lose weight before the competition were succeeded in the match and 39.9% athletes who didn't lose weight before the competition were also succeeded in the match. While the rate of those who started to lose weight 9 days or more before the competition was 45.5%, the rate of those who started to lose weight 5-8 days ago was 27.3%. There was no significant difference in the days of starting weight loss before the competition compared to the sport branch ($p > .05$). CONCLUSION: Similarities and differences were found in weight loss situations for women wrestlers and judoist. Although, the percentage rate of athletes who succeeded in non-weight loss matches was higher, but they lose weight unconsciously. It has come to the conclusion that both athletes in the two branches should be aware of the weight loss.

**Key words:** women wrestler, Judoist, weight loss situations

**Introduction**
Combat sports (wrestling, boxing, judo, taekwondo, karate, etc.) constitute 25% of Olympic sports branches and sports branches where body weights are divided into categories in order to allow athletes to compete on equal conditions (Evans, 2011). Combat athletes lose weight prior to competition, they have problems due to weight loss, and they are known to face in the future (Yarar et al., 2016). Most athletes competing in this branch lose weight for tactical purposes due to reasons such as the fact that the athletes competing in a subcategory necessarily have a stronger, faster or better competitors in different weight category (Artioli et al ., 2010). When losing weight, some of the athletes perform this process in a short period of time near the competition and others in the long run.

The weight loss of athletes within a short period of time; they affect the liver, muscle glycogen and total body protein negatively (Şenel, 1992). Extreme weight loss reduces competitiveness and disrupts health. It has been found that rapid weight loss caused Turkish national wrestlers to lose anaerobic power, aerobic power and force parameters (Paker, 1996). Weights losses

over a short period of time may cause not provide a functional advantage as well as weaken performance (Eckerson, 1994). Wrestlers and judoist will increase their success if they use correct method and give more time to weight loss. In this study, it is aimed to compare weight loss situations in female wrestlers and female judoist in Turkey.

**Method**

This research was conducted on female wrestlers and female judoist participating in Turkish championships at different dates. A total of 153 female wrestlers and 132 female judoists were included to answer the questionnaire developed by the researchers. A total of 20 questionnaires were prepared by the researchers and asked to wrestlers and judoists. Percentage distributions were taken statistically and t-test and chi-square methods were used for the determination of the differences. It was accepted as $p < 0.05$ for significance level.

**Results**

Table 3. Anthropometric Features of Female Wrestlers and Judoists

| | Branch | N | Mean | St. Error | t-test |
|---|---|---|---|---|---|
| Age (Year) | Judo | 132 | 21.29 | 1.96 | -0.23 |
| | Wrestling | 153 | 21.17 | 2.04 | |
| Body height (cm) | Judo | 132 | 165.16 | 6.67 | -0.16 |
| | Wrestling | 153 | 165.20 | 5,56 | |
| Body weight (kg) | Judo | 132 | 59.54 | 8.96 | -0.25 |
| | Wrestling | 153 | 59.68 | 6.99 | |
| Age to start losing weight (year) | Judo | 132 | 11.36 | 1.97 | -12.90** |
| | Wrestling | 153 | 13.67 | 2.94 | |
| Age to start losing weight in the sports branch (year) | Judo | 132 | 13.06 | 2.19 | -4.46** |
| | Wrestling | 153 | 14.01 | 2.35 | |

Table 4. Distribution of Weight Loss Pre-Competition Status by Women Athletes in Branches

| Branch | | Continuously weight loss | Athletes who do not lose weight | Sometimes weight loss | Total |
|---|---|---|---|---|---|
| Judo | N | 70 | 33 | 29 | 132 |
| | % | 53.0 | 25.0 | 22.0 | 100.0 |
| Wrestling | N | 93 | 31 | 29 | 153 |
| | % | 60.8 | 20.3 | 19.0 | 100.0 |
| Total | N | 163 | 64 | 58 | 285 |
| | % | 57.2 | 22.5 | 20.4 | 100.0 |

Chi-Square 1.17 $p>0.05$

Table 5. Distribution of Judo and Wrestlers Weight Loss during Competitions

| Branch | | 1-3 kg weight loss | 4-6 kg weight loss | > 6 kg weight loss | Total |
|---|---|---|---|---|---|
| Judo | N | 8 | 48 | 40 | 96 |
| | % | 8.3 | 50.0 | 41.7 | 100 |
| Wrestling | N | 50 | 35 | 40 | 125 |
| | % | 40.0 | 28.0 | 32.0 | 100 |
| Total | N | 58 | 83 | 80 | 221 |
| | % | 26.2 | 37.6 | 36.2 | 100.0 |

Chi-Square 29.15 p<0.001

Table 6. Effect of bodyweight reduction and without bodyweight reduction according to Wrestlers and Judoist

| | | Without weight loss + with weight loss | | | Only with weight loss | | |
|---|---|---|---|---|---|---|---|
| Branch | | Percentage with weight loss successful in the match | Percentage without weight loss successful in the match | Other | Percentage with weight loss successful in the match | Percentage of without weight loss successful in the match | Other |
| Judo | N | 50 | 61 | 21 | 44 | 36 | 16 |
| | % | 37.9 | 46.2 | 15.9 | 45.8 | 37.5 | 16.7 |
| Wrestlin | N | 53 | 66 | 34 | 42 | 52 | 31 |
| g | % | 34.6 | 43.1 | 22.2 | 33.6 | 41.6 | 24.8 |
| Total | N | 103 | 127 | 55 | 86 | 88 | 47 |
| | % | 36.1 | 44.6 | 19.3 | 38.9 | 39.8 | 21.3 |
| | | Chi-Square 1.81 p>0.05 | | | Chi-Square 4.00 p>0.05 | | |

Table 7. The Distribution of Causes of Weight Loss in Judoist and Wrestlers

| Branch | | To be strong against the opponents | To increase the chances of winning | Fear of defeating upper weight kilo | Other* | Total |
|---|---|---|---|---|---|---|
| Judo | N | 28 | 48 | 4 | 16 | 96 |
| | % | 29.2 | 50.0 | 4.2 | 16.7 | 100 |
| Wrestling | N | 35 | 41 | 21 | 28 | 125 |
| | % | 28.0 | 32.8 | 16.8 | 22.4 | 100 |
| Total | N | 63 | 89 | 25 | 44 | 221 |
| | % | 28.5 | 40.3 | 11.3 | 19.9 | 100 |

* (The request of the coach, increase the team's chances of winning, fear of competitors etc.)

Chi-Square 12.57 p< 0.05

Table 8. Distribution of Weight Reduction in Judoist and Wrestlers

| Branch | | without weight loss | Under Coach control | Under Doctor + Coach control | Under Experienced athletes control | Athletes own method | Total |
|---|---|---|---|---|---|---|---|
| Judo | N | 60 | 30 | 3 | 4 | 35 | 132 |
| | % | 45.5 | 22.7 | 2.3 | 3.0 | 26.5 | 100 |
| Wrestling | N | 45 | 43 | 6 | 15 | 44 | 153 |
| | % | 29.4 | 28.1 | 3.9 | 9.8 | 28.8 | 100 |
| Total | N | 105 | 73 | 9 | 19 | 79 | 285 |
| | % | 36.8 | 25.6 | 3.2 | 6.7 | 27.7 | 100 |

Chi-Square 11.36 p<0.05

Table 7. Weight-loss methods in Judoist and Wrestlers

| Branch | | Training | Sauna and training | Dehydration and diet | Drug use | Total |
|---|---|---|---|---|---|---|
| judo | N | 28 | 45 | 5 | 20 | 96 |
| | % | 29.2 | 44.8 | 5.2 | 20.8 | 100.0 |
| Wrestling | N | 38 | 46 | 15 | 26 | 125 |
| | % | 30.4 | 36.8 | 12.0 | 20.8 | 100.0 |
| Total | N | 66 | 89 | 20 | 46 | 221 |
| | % | 29.9 | 40.2 | 9.0 | 20.8 | 100.0 |

Chi-Square 13.89 p<0.05

**Discussion and conclusion:**
It is stated that the athletes engaged in the combat sports are 12-13 years old to participate in the competition, the average age of starting to lose weight is 13-15 years old and they lose weight on average 15 times during the season (Bradley et al., 2006; Oppliger et al., 2003; Wilmore And Costill, 2004). An average age in our study: judoists 21.29 years and wrestlers 21.17 years. Body height average of the athletes; Judoist is 165.16 cm and wrestling is 165.20 cm, while body weight average is judo 59.54 kg and wrestling is 59.68 kg. There was no significant difference between female judoist and wrestlers in age, height and weight. (p>.05). The female judoists age of starting to the judo branch was 11.36 years old, while the wrestlers age of the starting to the wrestling branch was 13.67 years old. Again, the mean age of starting to lose weight was found to be 13.06 years for judoists and 14.01 years for wrestlers (Table 1). There was a significant difference between the age of onset of sports branch and the age of starting weight loss in female judoists and wrestlers at p <.001 level. In a study conducted in Turkey, it was found that the age of starting weight loss was 13.9 in the first survey and 13.7 in the second survey (Aydos et al., 1995). In another study, the age of starting to lose weight is 14.83 years in Turkish male wrestlers (Aydoğan, 2007). In another study, the age of onset of the judo sports branch was 12.16 years old and the age of onset of the sports branch of the wrestlers was 16.61 years old (Imamoglu et al., 2008). In this study, the age of wrestlers starting to wrestle decreased according to the study of Imamoglu et al. (2008).
Imamoğlu et al. (2008) reported that continuous weight loss before their competition; 54.9% in wrestlers and 45.5% in judoists. In our research, we found that continuous weight loss before the competition; 60.08% for wrestlers and 53.0% for judoists. Those who did not lose weight in total were found to be 22.5% (Table 2). There was no significant difference between judoists and wrestlers pre-competition weight loss behaviors (p> .05). According to the study conducted by Imamoğlu et al (2008), it was determined that weight loss increased in both branches.

When we look at the amount of weight loss in this study, the maximum weight loss in judoists were found to be 4-6 kg with 50% and with weight loss of 1-3 kg with 40% weight loss in wrestlers (Table 3). A significant difference was found in the amount of weight loss (p> .001). Imamoğlu et al. (2008), the highest weight loss in judoists were 27.3% with 4-6 kilo, while the weight of 1-3 kilo in wrestlers was found highest with 33.3% and this difference was not significant (p> .05).

In this study, 36.1% of the participants weight loss before the competition that were successful in matches and 44.6% of those who did not lose weight before the competition and was successful in matches (Table 4). There was no significant difference in the effect of success on weight-loss evaluation (p> .05). Weissinger et al., (1991) conducted a study; in a survey of perceived performance changes with weight loss and survey applied to 125 high school wrestlers, a result was found that athletes perceived that weight loss increases performance.

In many wrestlers, body fat reduction with weight loss increases exercise capacity. For this reason, wrestlers use many different weight loss methods during the season (Wessinger et al., 1991, Wood et al., 1988). According to the Aydoğan study (2007), 33.37% of the wrestlers stated that a healthy weight loss should be done under the supervision of a specialist doctor. The second most common opinion is weight loss with their individual methods. In our study 36.8% athletes declared that they don't weight loss. While the rate of weight loss in coach control was 25.6%, the rate of weight loss was 27.7% by its own method (Table 6).

In studies conducted that weight loss; A decrease in muscle strength of athletes (Rashidlamir et al., 2009), shortening the performance schedule (Timpmann et al., 2008), reduced plasma

fluid and blood volume (James and Shirreffs; 2013), in submaximal study (Heart rate, low pulse volume and low cardiac minute volume) (Aghaei et al., 2011), decrease in oxygen consumption (Weiss et al., 2007), Impaired thermoregulatory mechanisms and electrolyte imbalance, decreased liver glycogen storage (Rossow et al., 2013; Yang et al., 2014; Alpay et al., 2015), it has been shown that it affects the performance negatively depending on the reasons such as. Many athletes dealing with sports such as wrestling, weightlifting, boxing, and judo use diuretics to lose weight and descend to a lower level. These drugs cause fatigue, muscle fatigue and cramps (Aksoy and Gülgün, 1993). In that case, some of the athletes may face fatigue, muscle fatigue and cramps due to weight loss with drug.

As a result, similarities and differences were found in the weight loss situations in women wrestlers and judoists. It has come to the conclusion that both athletes in the two branches should be aware of the weight loss.

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# Developing coordination abilities of wrestlers by means of three kinds of body submerging

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**ABSTRACT**
Achieving significant success in wrestling requires a high level of coordination abilities. In wrestling these abilities should be developed at the same time with strength abilities, because success on the mat depends on all these abilities. Reserves relating to the ways and means of developing coordination abilities become very quickly exhausted. Standard training conditions of wrestlers have been recently slightly changed, and water environment has been introduced. PURPOSE: of the investigations herewith was to: establish the effect of the special set of coordination complex exercises performed by wrestlers in natural and in water environment. METHODS: The experiment was carried out with 31 wrestling champions class, who were divided into two groups: the control group and experimental group. Training session of each of the groups comprised of set of exercises developing movement coordination. Wrestlers from the control group (n=16) performed a set of coordination complex exercises. In the experimental group (n=15) an analogical set was used but performed in water with three kinds of body submerging: at the water surface, under the water and on the bottom of the swimming-pool. Technical elements and fragments of fights were performed during the training. The ability to maintain balance was evaluated in two ways: in the vertical and horizontal body position. The balance keeping (s) was assessed on a decreased support surface, and with eyes closed. The attempts were affected in the natural environment and in water. RESULTS: Results showed improved movement coordination as a consequence of the performed set of proposed exercises. The time of maintaining vertical position was longer than when performing attempts in horizontal position, and that applied both to attempts in natural conditions, as well as in water. CONCLUSIONS: In order to develop movement coordination among those practicing martial art sports, it is suggested that exercises in a swimming-pool with various kinds of body submerging should be applied during training sessions (e.g. with wrestlers). This specific and versatile environment enables competitors to obtain immediate information serving the evaluation of the results of future reactions.

**Key words:** coordination abilities, free style wrestling, classical style wrestling, sambo, coordination complex exercises, balance attempts, exercises in water

## Introduction

The efficacy of the techniques applied by athletes practicing martial art sports depend in large measure on the level of coordination abilities. The leading abilities are: the speed of adequate reaction, space and time orientation, and the ability to maintain balance. These abilities are, to a large extend, conditioned genetically, but they are also subject to evolution during the training process. The level of their development depends largely on the age at which the training was initiated, as well as on appropriately selected means and training methods. The overview of the literature reports a high standardization of those means and training methods

irrespective of: the age, level of advancement, practice period, hierarchy of the leading abilities of the athletes, and other significant conditions [1-2, 4]. A considerably more comprehensive literature, though, involves martial art sports which are included in the program of the Olympic Games. These publications certainly do not cover the contemporary knowledge used in practice, since this one often outpaces the theory and constitutes the secret of the workshop of the coach. An increasing number of general theory publications indicate that the so far initiated reserves are gradually becoming exhausted. These included the applied training means, and particularly those directed at the development of coordination abilities.
Our own investigations [3, 5] prove that non-specific physical load increases the level of kinaesthetic sensations definitely more than a specific load. Similar effects may have been induced by the change in the standard environment. An empirical confirmation of this thesis was obtained thanks to the Polish National Team of classical style wrestlers who, due to their training sessions conducted in water, were able to accelerate their bio-psychical regeneration, and as a result, to „refreshing" kinaesthetic sensations. On such grounds the idea of changing the environment in order to rise the level of coordination abilities of those practicing martial art sports originated. Until now, swimming in the course of training athletes of such disciplines of sport has been solely used as a form of body regeneration. At the same time the idea surged, number of questions arose: 1. Do changes from the standard environment to water environment effect, and to what extend, the development of coordination abilities? 2. Can one increase the favourable influence of water environment by applying a specially selected set of exercises with various degrees of body submersion? 3. Should exercises around the horizontal body axis, that is axis around which technical elements in martial art sports are more rarely performed, be included in the set? 4. What exercises the set should include?

Obtaining answers to the questions above was of considerable theoretical importance, not only for athletes of martial art sports, and it was of even greater practical importance. It concerned particularly the rising of the level of movement abilities which are decisive for the success in the martial art sports. Thus, a pedagogical experiment was carried out whose purpose was to: 1. Define the effect of the special set of exercises applied in standard training conditions and in water on the level of coordination abilities of the athletes. 2. Establish the effect of the applied set of exercise on the level of the balance keeping ability.

**Materials and methods**
The experiment was carried out with 31 students from the university in Grodno, who were athletes of the champion class (aged 18-22), and who practiced various martial art sports (classical and free style wrestling, sambo, judo). Those tested were divided into two groups: control (n=16) and experimental (n=15). The experiment involved one training microcycle (12 two-hour sessions). Each of the training session included a special set consisting of 9 groups of exercises (movement tasks) which developed coordination abilities (tab.1). Competitors from the control group performed the set in standard training conditions, that is on the mat. The experimental group performed the set in the water with three kinds of body submersion: on the surface, under the water, at the bottom of the pool. While performing the set, irrespectible of the environment, the following methodical principles were applied: 1. Various forms of breathing was used in the exercises: free, with a halt, controlled, cyclical. 2. The exercises were performed at first in one spot, next with a translocation, and finally in a combination. 3. Each of the exercises was repeated from 10 to 20 times (depending on the capacities of the tested individual). The ability to maintain static balance was evaluated in two attempts: with the vertical and horizontal body position.* The time of balance keeping was assessed on a smaller supporting surface, and with eyes closed (s). The attempts were carried out prior and after the execution of each of the motor tasks, in natural training conditions and in water.

*In the vertical position the tested athlete was standing on the toes of both of his feet, with feet close together, with arms alongside bent in the elbows, and palms turned inward. The horizontal position consisted of standing on the toes of both feet close together, with the body bent forward, with arms bent in the elbows, and palms turned inward.

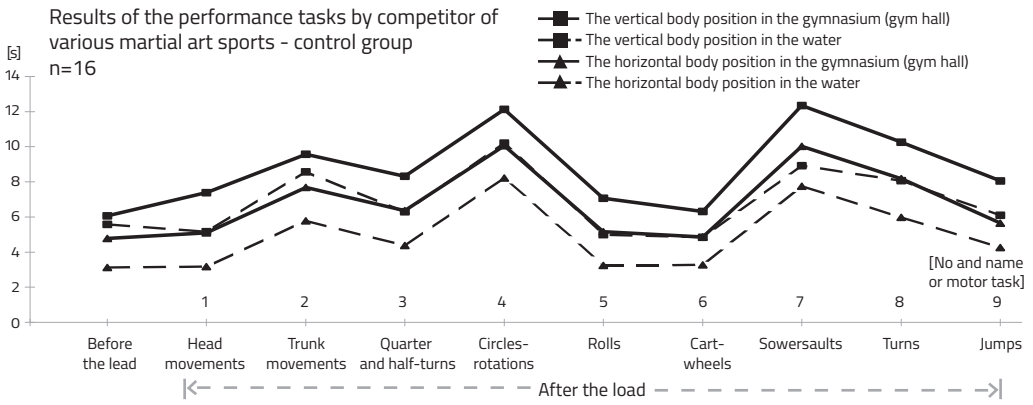
Table1. Special set of exercises (movement tasks) for developing the coordination ability of the control and experimental groups

| No | Exercises | Means of execution | Starting position |
|---|---|---|---|
| 1. | Head movements | Bows (forward, backwards, to the side - left, right)<br>Turns (left, right) 1,2<br>Circles (left, right) 1,2 | Standing, standing with bent trunk, sitting, lying down |
| 2. | Trunk movements | Bends (forward, backwards, to the side - left, right)<br>Turns (left, right) 1,2<br>Circles - rotations (left, right) 1,2 | Standing, standing with bent trunk, sitting, lying down |
| 3. | Quarter and half – turns | Left, right complete turn 1,2 | Crawl position, back stroke position, side - left, right |
| 4. | Circles – rotations | Forwards 2 (inclined forwards 1), backwards backwards 1) | Crawl position, back stroke position, side - left, right |
| 5. | Rolls | Forwards, backwards 1,2 | Crawl position, back stroke position, sade - left, right |
| 6. | Cart – Wheel | Forwards, backwards 1,2 | Sideways - left, right |
| 7. | Somersaults | Forwards, backwards 1,2 | Sideways - left, right |
| 8. | Turns | Left, right (using legs and arms) 1,2<br>Left, right (using legs and arms) 1,2<br>Forwards, backwards (using legs and arms) 1 | Vertical (uprigth, upside down, tuck position<br>Horizontal |
| 9. | Jumps | On one leg, both legs (half turn) 2<br>Hops, falling forward, diving forward, half turn 1 | Onto pedestal, of pedestal, out of the water<br>Into the water |

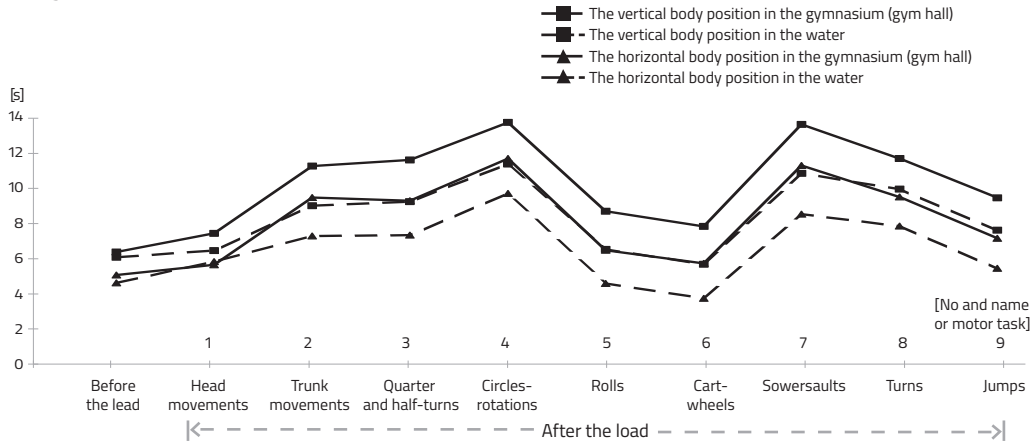
Note: 1. Executed in the water. 2. Executed in the gymnasium (gym hall).
Each exercise can be performed, either individually and in combination.

**Results**

The performance of various attempts (movement tasks), affected in a different way the ability to keep the balance in a vertical body position of those tested from the control group (fig.1). A considerable deterioration in the performance of the attempts was noted when various rolls from squatting position, side rolls, or jumps were introduced. Those exercises which stimulated the balance apparatus lowered the ability of the athlete to maintain a vertical body position, and specifically when the supporting surface was limited (the attempt required standing on the toes). It is interesting that the performance of various forms of somersaults (forward, backward, sideways) favoured the lengthening of the balance keeping time. The curve representing the results of the average balance keeping time in vertical body position in the gym, and in the water was quite similar, but in all of the 10 tasks worse results were obtained when tasks were performed in water. A nearly analogous tendency of the results appeared when performing attempts in the horizontal body position, both in water and in the gym. A slightly different curve course of the average results was observed among athletes of the experimental group (fig.2).



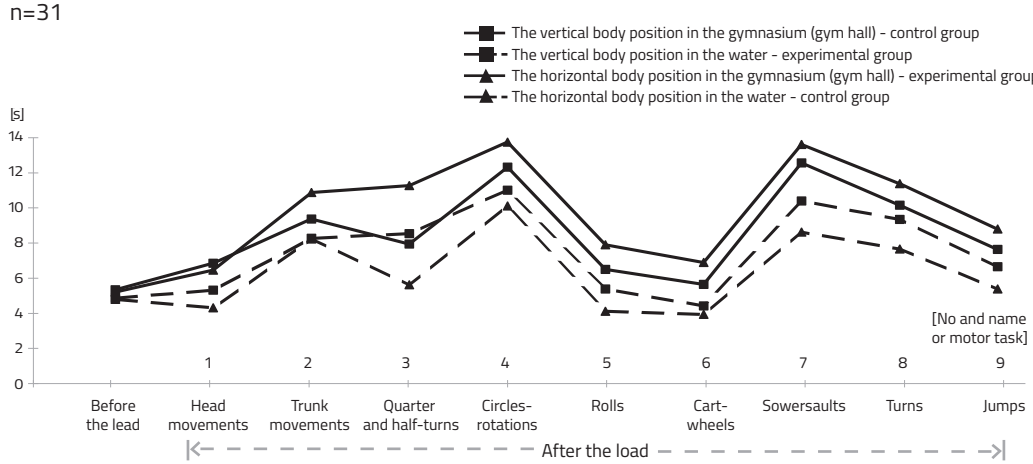
Results of the performance motor tasks by competitor of various martial art sports - experimental group
n=15



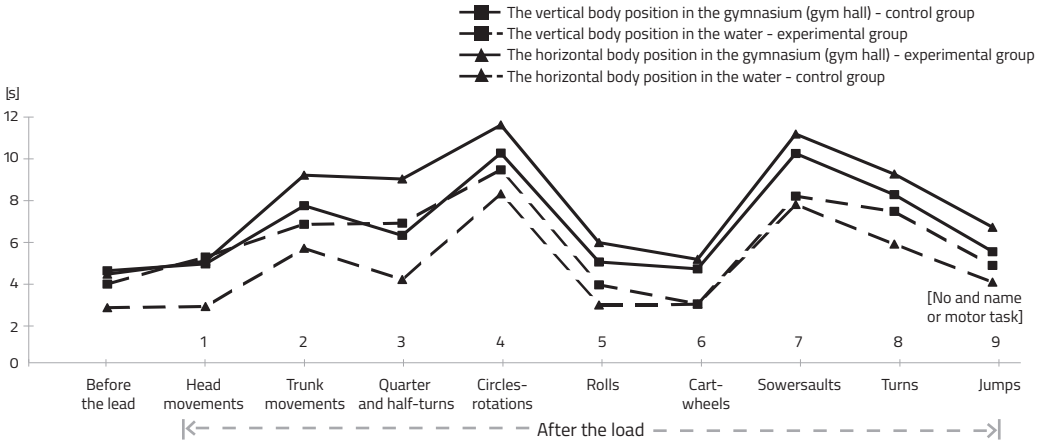

Firstly, all the curves, therefore those concerning the vertical and the horizontal body position, both in the gym and water, showed a very similar course. Secondly, the curves presented higher values. Thirdly, the execution of motor tasks after turns, rolls from a squatting position and sideways, and after jumps caused a lesser decline in balance keeping time. Fourthly, similarly to the control group, the balance keeping time in the vertical and horizontal position in the gym was always longer in the water. It proves that the execution of exercises in the water, hence in the environment where training sessions are rather seldom carried out, and particularly with such a varied content, stimulated strongly the balance apparatus, thus extending the time of the vertical and horizontal body position maintaining.

The comparison of the average results of the control and experimental groups, separate for the values of balance maintaining in vertical position (fig.3) and in horizontal position (fig.4) confirms the before observed tendencies. However, the predominance of the results obtained by the experimental group in nearly all attempts (fig.3), both in the gym and in the water in the vertical body position, is clearly visible. A quite similar inclination of results is being observed in the case of the horizontal body position (fig.4).

Results of the performance motor tasks by competitor of various martial art sports - control and experimental group
n=31



Results of the performance motor tasks by competitor of various martial art sports - control and experimental group
n=31




**Discussion**

The results of the short-term experiment carried out among athletes of champion class reveal a favourable influence of the environmental change on the level of the coordination abilities. It was manifested by an improvement, that is extension of the balance maintaining time in the vertical and horizontal position. It is common knowledge, though, that obtaining any improvement of the coordination abilities of the competitors of the highest rank is not easy. There is now doubt, whatsoever, that the increase of such abilities recorded with the aid of time attempts of balance keeping does not reveal the entirety of the investigated phenomenon. Carrying out tests concerning other coordination abilities, as well as special technical skills, could have also demonstrated their improvement. This is the hypothesis which may be verified in various researches dealing with the development of co-ordination abilities. Slighter increases of results as far as the time of balance maintaining in horizontal position may be explained by the fact that for a human being a vertical body position is more typical since it is more commonly assumed in the everyday life. Even if the horizontal position occurs quite often among those practicing martial art sports, the proportion of the training time to the time of the everyday activities is too small to affect in any way the domination of this position. The results obtained demonstrate that the proposed original set of special exercises together with the attempts evaluating the ability to maintain the body balance may be used in the training of athletes practicing different martial art sports. A considerably higher increase of the coordination ability level may be expected among younger athletes at a lower level of sport advancement and after an extended time of the application of the proposed set of exercises.

**Conclusions**

1. The special set of exercises applied in the experiment, both in the gym and in water, affected the level of the balance maintaining ability of the athletes in a varied way. Its considerable improvement was observed among the investigated of the experimental group. 2. The attempts serving to assess the ability to maintain balance in the vertical and horizontal body position used in the researches, as well as the special set of exercises focusing on the development of coordination abilities, are appropriate to be applied in the training of athletes at divers levels of advancement, and practicing various martial art sports. They account for a reserve to be availed of. 3. Performing technically complex exercises with three stages of body submersion may increase the level of kinaesthetic impressions of the athletes, and through that may favour a better „feeling of the opponent". It is of utmost importance in the success achieving.

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# Criteria of selection of candidates for wrestling

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**ABSTRACT**
The selection of right candidates is crucial in every sport, including wrestling. Its correct solution ensures the development of the discipline itself and success for athletes. The increasing level of sport requires the participation of increasingly versatile wrestlers. Only such athletes can now be successful in the international arena. In some countries, natural selection was based on accepting all candidates and after some time rejecting those who did not achieve proper sports results. In most countries the selection was based on the checking of the candidates in respect to the various predispositions for wrestling. A number of different tests and trials were proposed for this purpose. It is not known which of these were scientifically verified and were used in a number of other countries. PURPOSE: of this study was: 1. An attempt to summarize the output collected in the criteria of selection of candidates for wrestling. 2. Presentation of the results of a pedagogical experiment aimed at determining the objectivity of tests in the selection of candidates for wrestling. 3. Presentation of own set of candidate selection tests for wrestling. RESULTS AND CONCLUSIONS: 1. The existence of a large number of proposals from various authors was found but none of them was checked for their reliability. 2. An annual pedagogical experiment was conducted on 121 persons, including 96 wrestlers and 25 children and using 13 anthropometric measurements and 7 fitness tests. Those wrestlers qualified for further training achieved higher scores in all tests used. Based on the results obtained, a set of fitness tests for the selection of candidates for wrestling was proposed. 3. Based on the 21-year long research conducted on wrestlers of the Polish National Team in the classic and free style, a set of 22 tests with high reliability ratios of the most important movement abilities necessary to achieve high sports results was developed. For the results of each test, a "T" scoring scale was developed to unify the results collected in different units and to evaluate the wrestler's performance level. 4. The proposed set includes tests to evaluate objectively the level of fitness required to be successful in all weight categories of wrestlers. Contemporary high requirements in this discipline regarding the coordination abilities required and their correct relationship to physical abilities were taken into account. 5. The table lists 7 sets of tests of performance for the evaluation of candidates for wrestling, including 3 own, which sum up the elaborations by foreign and Polish authors. They allow the coach to select a set that is most suitable for specific club conditions.

**Key words:** set of fitness tests, evaluation level of movement abilities, classic and free style wrestling, reliability indexes, pedagogical experiment, fitness and coordination abilities

## Introduction

The problem of selection is crucial in every sport discipline. Its correct solution ensures the development of the discipline and the success of sports athletes. The increasing level of sport requires the participation of increasingly versatile and talented athletes. Only such athletes can be successful in the international arena nowadays. How has the problem of selection been solved so far? In some countries, natural selection was based on accepting all candidates, then

conducting training sessions for a certain period of time, and finally rejecting those who did not exhibit specific predispositions to wrestling; they were too slow or unable to master the material, and failed to achieve appropriate sports results. This system, although expensive, was though quite effective. In most countries that are leaders in the discipline, preference was given to testing as a selection process, i.e. objective testing of the diverse predispositions of the candidates to wrestling.

***1. Criteria for selection of wrestlers***

Establishing criteria for selecting candidates for wrestling is a complex, up to now unresolved issue. Different criteria were used in this selection. Some coaches used their own criteria. Unification or reduction of their numbers is essential for the further development of this discipline. First, a brief review of the literature. Z. Wazny defined the requirements for the athletes by the individual sports disciplines. They provided guidelines for the selection of athletes to combat sports. Selected candidates should have at least an average level of the following factors: morphological, physical fitness, movement coordination, specific mental characteristics. It was a general definition of the criteria indicating the direction of their studies and search. More concrete guidelines were presented by W. Rudzinski and T. Ulatowski [3], proposing for consideration: speed, strength, endurance and agility. It is not known whether the given order of abilities was listed according to the hierarchy of their importance.

*1.2. Criteria of selection proposed by wrestling specialists*

Z. Dmowski [1] proposed an Iowa-Brace test to evaluate the future abilities of wrestlers, including the help of a half-rotation and full rotation. At the same time he recommended carrying out a Bulgarian physical fitness test consisting of: pull ups on the bar, bending and straightening arms on the handrails, long jump, 40m distance run and fighting. Instead of the last attempt, he proposed to perform two flips to the front and back in one direction. Based on the Bulgarian proposals, T. Trojanowski [1] recommended checking the following in children: flexibility, strength of the arm and leg muscles, jumping abilities, movement coordination and agility. A comprehensive set of 13 attempts/tests to select candidates for wrestling (classic and free style) was proposed by N. Sorokin [4-5]. Almost half of them were related to: strength, flexibility and agility, and one to speed. According to this set 12-year-old boys should be selected to wrestling.

*1.3. Criteria proposed by martial arts expert, E. Tumanjan*

The selection of candidates to martial arts disciplines was comprehensively treated by E. Tumanjan [12]. Generalizing the experience of Soviet judo coaches, he proposed the use of numerous methods. The most common were: information through announcements, invitation of experienced athletes of the section directed to candidates in classes, mass testing of children during physical education classes at school. Some coaches preferred natural selection: they invited children to the section for 2-3 months, during which they set high demands (morning gymnastics, heavy load, etc.). The weak children could not withstand the demands and they dropped out. Some coaches considered it necessary to take into account the intellectual development of children, i.e. progress in school learning. Yet another group of coaches preferred disinterestedness and courage, coordination or agility as well as the ability to conduct a fight (such as knee combat, etc.). G. Tumanjan [12] argued that the criteria given were practical and their justification was proven by facts. Based on these assumptions, some recommendations may be formulated. If they were more concrete, it would be possible to establish a hierarchy of their importance. Valuable were the selection recommendations made by G. Tumanjana [12], which include the following qualifications and conditions: 1. Occurrence of a sharpened sense of honor and ambition. Individuals with these properties withstand the hardships of sports training and are able to face each other and overcome increasingly difficult obstacles. 2. The proximity of the place of residence to the place of training. This allows less time and energy wasted on commuting, and as a result more frequent, longer and more effective training sessions. 3. High level of endurance. Strength is needed in order to achieve

high sports results. This ability is hardly subjected to training, as it is largely conditioned by innate properties. Having sufficient strength, training tasks are carried out more economically, heavy loads are better withstood, forces are regenerated more quickly. All these factors are conducive to exercises of high volume of training work and high results during the competition. 4. Coordination abilities. During the fight, the wrestler performs a large number of movements in a variety of support conditions and planes. This requires a high level of coordination. The progress in developing this capacity depends to a great extent on the inherent genetic conditions. 5. High body growth. There is every reason to believe that the height of the body is conducive to great sports achievements. According to the study [2-3] the height indices of the wrestlers of the classical and free style were higher, the higher their level of athletic performance. For example, the average body height of medalists of the 1968 Olympic Games was higher in each weight category than the body height of other participants in the Olympic tournament. The ratios of the latter exceeded the average body height of the representatives of the former USSR. Some coaches believed that even short and middle height candidates should be accepted to the discipline in order to teach them the ability to fight against opponents of different growth. Height of the body is a stable characteristic of man. For the height of the body, the genetic condition (birth factor) accounts for 81% and the weight (body weight) accounts for 78%. Based on the height of the body of 8-12 year olds, it is highly probable to predict their height in adulthood. By the age of 12, the boy reaches 86% of his future growth. Also the growth of the child's parents can serve to determine the future height of the body. In determining the relationship of accelerated growth of children with the height of their parents, it was found that in 31% of cases high body growth in both parents or at least in one of them was observed. 6. Affiliation to a sports family. German and Japanese researchers have found that 50% of the offspring of outstanding athletes can be expected to exhibit talent and skills. The vast majority of the mentioned conditions take into account the so called stable characteristics of a man which are genetically conditioned. They make it possible to accurately predict future sports results. Using them as complementary, it is necessary to take into account the performance of top Polish wrestlers in both styles, based on 21-year studies which applied the original set of high reliability tests: r = 0.921-0.993 [10, 249]; and r = 0.791-0.969 [11, 146].

*1.4. Pedagogical experiment*

An annual pedagogical experiment was conducted to determine the diagnostic value of selected performance tests and anthropological indicators [2,3]. Its purpose was: to find out which indicators differentiate young wrestlers qualified for further training and those who were rejected? The experiment was carried out on 96 wrestlers aged 12-15 who trained at AZS-AWF Warsaw and 25 children (age 10-13) from WKS "Gwardia". In total, 121 subjects were included in the experiment. The tests consisted of 13 anthropometric measurements and 7 performance tests. Those from AZS-AWF qualified for further training and WKS "Gwardia" were characterized by higher anthropometric indices than those who were rejected. Particularly significant differences occurred in: height and body mass, length of upper limbs, forearm and lower leg circumference. For further training, individuals with higher indices: length, circumference and body mass, were qualified. In the body height range, the results obtained confirm the earlier conclusions of the study, G. Tumanjan [12]. Athletes qualified for further training from both clubs outperformed those rejected individuals in all fitness tests. The most difference were the results of the following tests: 60m run, forward bending of the torso, forward throw of a 2kg medical ball from behind the head (AZS-AWF), forward long jump (WKS group " Gwardia"). Based on the presented results of the study, a set of fitness tests for the selection of candidates for wrestling was determined.

*1.5. Set of fitness tests as criteria for selection for wrestling*

A set of general and special fitness tests for advanced wrestlers developed by leading Polish coaches under the supervision of W. Starosta and J. Tracewski [6-7] made it possible to

establish the hierarchy of importance of individual abilities and average fitness model of wrestlers of different weight categories. Therefore, part of the set (tests available for beginners) can serve as selection tests. For the results of each test, a "T" scoring scale was developed to unify the results obtained in different units and measure the candidate's performance level. Theoretical and practical material (coaching experience) accumulated so far is extensive and rich. Some of its fragments are convincing, but its whole (with regard to various indicators: somatic, mental, fitness) is still insufficiently justified. Of necessity we have to rely on the set of fitness tests most similar to the final version. This is a multi-variant proposal based on test sets of various authors (tab. 1). Only one of the proposed variants was verified and checked for diagnostic accuracy on a large group of highly advanced wrestlers over a 21 year- period. Among the sets of other authors we presented two of our own. They were based on the analysis of the results of 4-year and 21-year long research on fitness abilities of leading Polish wrestlers. Selection criteria were based on a set of advanced wrestling performance tests. Both sets were prepared taking into account the hierarchy of movement abilities necessary for a wrestler to succeed in this discipline. This set includes also tests used in the study of 10-year-old children whose aim was to develop criteria for sport selection in general (8). For all tests a set of point scales "T" was developed. On the basis of the set of general fitness tests and special wrestlers [6-8] the proposed set for participants of the Warsaw Youth Olympics (WOM) in wrestling was also developed. It was compulsory for participants of the finals in this event. The proposed variants generalize the experiences of the various authors and summarize the knowledge gathered on the subject. Choosing the right variant is left to the coach. Despite the proliferation of proposals at different times and independently of each other, there is a convergence in many tests. Undoubtedly it raises their value.

Table 1. Physical criteria for selection of candidates for wrestling - sets of tests proposal of different authors

| Movement abilities | Bulgarian selection test [1] | Bulgarian after Z. Dmowski [1] | Warsaw Youth Olympics ( for competitors Set 2) | N. Sorokin [4-5] | A. Glaz [9] | W. Starosta [9] |
|---|---|---|---|---|---|---|
| Agility-coordination | 1.Jump with full rotation | Combined flips, 2Forward and backward (test used in Poland instead of a fight) | 1.Max rotation in a jump 2.Run with flips | 1. Flip forward 2. Flip backward 3. fight for a ball ( 3x) | 1. Max rotation in a jump or run with a slip | 1.Max rotation in a jump 2.Run with flips |
| Strength | 2.Pull ups on bars 3.flexing arms with a frontal support 4. Lifting legs while hanging on a ladder 5.standing on hands against a ladder 6. squats on one leg | 2.Pull ups on bars 3. flexing arms with a frontal support. 4. Long jump with 2 legs | 3..Pull ups on bars 4. twisted bends of the trunk on an inclined bench ( without loads) 5. rope climbing | 2. strength of the left and right arm (dynamometer) 3.flexing arms with a frontal support 4.Pull ups on bars 5. keeping legs hanging on wheels in a right angle 6. strength of the muscle of the back | 2.Pull ups on bars 3. forward throw of a 2kg medical ball from behind the head 4. . Long jump with 2 legs | 3.Pull ups on bars 4. forward throw of a 2kg medical ball from behind the head |

| Movement abilities | Bulgarian selection test [1] | Bulgarian after Z. Dmowski [1] | Warsaw Youth Olympics ( for competitor s Set 2) | N. Sorokin [4-5] | A. Glaz [9] | W. Starosta [9] |
|---|---|---|---|---|---|---|
| Speed | | 5. 40 m run | 6. 30 m run | 7. 30 m run | | 5. 30 m run from a flying start |
| Endurance | | | 7. 1000m run | | | 6. 1000m run |
| Suppleness | 7.forward bending of the trunk<br>8. backward bending of the trunk<br>9. max leg outstretch in a sitting position | | 8. backward bending of the trunk in a supine position | 8. gymnastic bridge<br>9. forward bending of the trunk<br>10. backward bending of the trunk | 5. forward bending of the trunk | 7. backward bending of the trunk in a supine position |

**Discussion**

The authors are aware that they have not ultimately solved the complex problem of selecting candidates for wrestling. They have come close to its final shape. The presented material forces us to reflect and rethink, as well as to carefully modify the existing up to now system of training wrestlers. These modifications should include a hierarchy of objectives. Among them is the decision: whether to be more successful in the senior group or to focus on the high scores of cadets, younger juniors or just juniors without worrying about how seniors will perform in international arenas? Achieving success in all age groups, with low efficiency of children's physical education at school, will be very complex. Some progress regarding the effectiveness of training of young wrestlers can be achieved through introducing better teaching in the early period, i.e. skillful conducting of early specialization.

**Conclusions**

1. There was a large number of proposals from various authors, but none of them was checked for their reliability. 2. An annual pedagogical experiment was conducted on 121 people, including 96 wrestlers and 25 children taking into account 13 anthropometric measurements and 7 fitness tests. Wrestlers qualified for further training achieved higher scores in all tests used. Based on the results obtained, a set of fitness tests for the selection of candidates for wrestling was proposed. 3. Based on the results of 21 year-long studies conducted on wrestlers of Polish National Team in classic and free style, a set of 22 tests with high reliability ratios of the most important abilities necessary to achieve high sports results was developed. For the results of each test, a "T" scoring scale was developed to unify the results collected in different units and to evaluate the wrestler's performance level. 4. It is extremely important to note that the proposed set includes tests that allow an objective evaluation of the level of fitness required in order to be successful in all weight categories of wrestlers. They also include contemporary high demands related to the coordination skills needed in this discipline and their correct correlation with physical abilities. 5. The table contains 7 sets of tests (tests) of efficiency for the evaluation of candidates for wrestling, including 3 own concluding studies by foreign and Polish authors. It allows the coach to select a set that is suitable for specific club conditions.

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# Wrestling as a timeless and complete educational system of physical education

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**ABSTRACT**
PURPOSE: The aim of this study was to highlight the timelessness, humanitarian character and the multifaceted nature of wresting regarding the physical education. These three elements combined with the philosophical analysis of education and the role of physical education are pillars to prove the hypothesis that wrestling is a timeless and complete physical education medium. METHODS: This research methodology was based on the historical analysis, the philosophical and analytical research and literature research, specialized in the impact of wrestling activity on human psychosomatic world. Analysis of ancient philosophical texts in combination with modern psychological theories (Theory of Maslow, Depth Psychology) contributes to documentation and to define the aims and objectives of education in general and physical education in particular. RESULTS: The analysis of the wrestling sport in technical and theoretical level demonstrates the full harmonization and satisfaction of the methodological data. The above process led to the development of a model implementation of physical education in general and specifically wrestling in the education process. CONCLUSIONS: It was found, that wrestling practice timelessly contributes to the physical education process globally. The specific nature of psychological reactions that are caused by wrestling meets the requirements of modern education and thus makes wrestling a useful tool for education.

**Key words:** Physical Education, psychology, human studies, history, combat sports, wrestling

**Introduction**
Throughout the civilized world physical education is considered as one of the main pillars of the educational process. Even under the state constitutional provisions it should be ensured the implementation of physical education in education. A natural consequence of physical education is the competition activity, which constitutes the quality and reliability indicator of the methods of the pedagogical process.

The contemporary reality presents a totally different picture compared with the above case. The fragmentation and specialization brought about by technological civilization combined with the element of unrestrained competition and speculation have led to the complete isolation of physical education-pedagogy process from the competition activity. The latter, especially, following trade rules has a negative impact on the character of the participants, according to plethora of scientific research (1, 2, and 3).

From our side, of course, as scientists of physical education and sport, observing this situation, it is imperative to deepen to this problem, searching beyond the experience of daily practice, theoretical foundation that will give the opportunity to redefine each practice. In fact, as skilled

scientists in the field of combat sports and knowing the role they have played in the field of physical education over the centuries, it is necessary an in-depth analysis of history and their practical application in full relevance to the philosophical and practical role of education in society.

The latter is very important because of the particular characteristics governing athletic implementation of these sports, namely the controlled violence. These characteristics are likely to provoke a certain kind of risk expulsion from the formal beginning of the athletic principal and lead to the logic of the arena. This position is not far from the reality, as it has witnessed a decline in popularity of wrestling which is the gentler form of violence application regarding all combat sports (4). This is evident from the decision of the International Olympic Committee to put under consideration the matter of wrestling participation in the Olympic Games schedule, citing TV viewing ratings. Indeed, it is characteristic that viewing rating is associated with spectacular visuals or violence rate contained. However, an athletic event is not limited to these two features, but it offers the opportunity to manifest psychic elements, such as militancy, determination, patience, sportsmanship, honesty, respect, mutual respect, emotional control. The uneducated person in physical education prefers to other virtuosic or violent displays, which come in connection with his mental state, namely, competitiveness, speculation, sovereignty, uncontrolled fear. Acquiring education requires empirical familiarity with what we call physical education generally and combat sports especially, with wrestling being the basis of such sports as it will be tried to be proved in the present study.

**Methodology**

To reach the above position this research was based on historical analysis, philosophical and analytical research and literature search. The aim is to highlight the timelessness of wrestling, humanitarian nature and the multifaceted nature of physical exercise in this. These three elements combined with the philosophical analysis of education and the role of physical education are pillars to prove the hypothesis that wrestling is a timeless and complete physical education medium.

**Historical analysis**

The beginning of wrestling phenomenon is inseparable from the meaning of wrestling itself. According to the Greek pre-Socratic philosopher Heraclitus, the term of creation itself is related to an ongoing struggle between opposites, in which the dynamic equilibrium is associated with harmony and evolution of the world (5). Thus, wrestling is timeless and displayed along with the phenomenon of life. Initially, by the above findings the human intellect perceives the existence of wrestling phenomenon in human nature itself and within the framework of cultural events it organizes wrestling competitions in religious rituals. These events unfolded in athletic competitions (6) refining the primitive instinct of wrestling with the natural elements for the survival, transforming violence into ethos.

All of the above relates the conception of sports events by the human intellect with the beginnings of the existence of the human race. For this reason, the data about the birth of wrestling come from ancient legends and traditions, namely archetypal knowledge institutions, which tend to penetrate in the depth of the human soul and kept intact through the centuries (7).

Regarding the historical data on the conception and practice of wrestling the available information is limited. For this reason, studies around the issue of wrestling practice might be considered as incomplete and inaccurate (6). However, by the historical record mainly from the era of dominance of Greek and Roman civilization, enough information about wrestling styles, training methods, exercises, techniques and moral values can be derived.

Analyzing archaeological data, we could divide the historical analysis into three periods: the pre-olympic, the Olympic and the post-Olympic period, whose names derive from the establishment of the ancient Olympic Games.

More specifically the pre-Olympic period includes data dating from 3000 BC approximately, to the start of the first historically recognized Olympic Games. The archaeological evidence consists of elements belonging to the Sumerian, Egyptian and Minoan-Mycenaean civilization and cultures in the Far East (6,8). Moreover, valuable information and reports on sports events is received that appears in written sources of the period and mainly in Homer's epics. In all the above wrestling practice and its use in the training of young people is evident. Also, it is very important the finding that wrestling technique is identical to the current form (6).

Olympic period include elements dating from 776 BC which is the official date of commission of the Olympics, although games were held in Olympia from much earlier times (9). In this period the archaeological evidence and written sources are sufficient, and the use of wrestling in the pedagogical process is dominant both in Ionic organized states, through the phenomenon of "palaestra" which is the main area of youth education, and in the Doric type organized states (Sparta, Crete) in the process of "agogi" where wrestling is a key parameter of young men and women education. Then, during the creation of Alexander's empire and the Roman Empire it is observed the spread of palaestra's phenomenon as a key element of free public education.

Finally, in the post-Olympic period data are referred relating to the period of the abolition of the Olympic Games until nowadays. At this time, the wrestling engagement form passes through three stages. In the first stage the institution of palaestra is maintained. In the second time stage during the Middle Ages (west) and the Ottoman conquest (east), we observe the disappearance of the phenomenon of the palaestra. Now, wrestling continues to be a constant preoccupation of citizens and especially young people, but with a more folk character (festivals, celebrations). Also, wrestling techniques observed in numerous military manuals as essential to the practice of soldiers and are the basis of war fighting art (10). In the third time stage of the Renaissance and the Enlightenment we observe the development of sports clubs and the revival of the Olympic Games, with wrestling to pass slowly over the folk level in the areas of sports clubs and modern sports organization.

From the above, it is evident the continuous appearance of wrestling phenomenon, as a basic component of physical education, from the beginning of the historical period of humanity until today. It should be added to this, the observation that in all regions of the world, where human activity is developed, (regardless of the level of the region's culture) the wrestling is part of the tradition and transmitted from generation to generation, but it appears that the teaching does not require in all cases an organized state or Community institutional authority to oversee (11). So, it can be evident the timeless prevalence of the phenomenon of fighting on the physical development of man.

**Philosophical analysis**

In Platonic philosophy, education, as an integral part of the state, relates to roaming the human soul in order to complete ontologically. The meaning of roaming indicates the spiral motion that the entire process follows, who's each cycle creates the conditions for advancement to the next level. The objective is the formation of character, according to the example of values raised by the current social system. According to the above observation, it becomes clear the correlation and the value of the process to highlight the notion of the person in society. This notion comes to overcome the disruptive effect of the individual and it constitutes the mainly expression of socialization (12).

According to the Platonic philosophy, the human soul can divided into three parts:

a) The appetitive (epithymetikon) part of the soul, associated with events related to physical needs.
b) The spirited (thymoeides) part of the soul, associated with events related to the emotional needs and acceptance by society.
c) The logical (logistikon) part of the soul related to the events relating to the human intellect sector.

The above categorization shows that each part cannot be seen and understood as a separate entity. Through the harmonious coexistence, and the three parties contribute to the integrated action of human nature. (12, 13)

The Platonic theory continues by supporting the potential capacity of the soul in the knowledge viewing. According to this principle, the soul has the knowledge instrument available. The logical part satisfies the requirements of knowledge acquisition through proper guidance.

For Plato, based on the above two principles the education is aimed at learning the proper management of pleasure and sorrow, making it necessary, before the mental maturity of man, from childhood. In this period of human life, these two dialectically opposed situations occur with the greater intensity. The proper management from this age sets out the conditions of transformation of caused addiction, to conscious state through intellectual maturation mediated over time (12).

These positions agree with the psychological theories and observations made in the 20th century by great psychologists such as Sigmund Freud, the Eric Fromm, etc. This is the psychological theory of the sublimation of instincts. According to this theory, repressed instincts, the most powerful of which is libido, are those which develop their potential in the fields of human intelligence, leading to the achievements of the human spirit. According to ancient Greek philosophy, the above technical note becomes an educational tool aimed at the controlled management of the instincts and person's integration into the community.
Physical education thus comes to train human control over natural desires, methodically exposing him to them. As we understand it plays a very important role in the education process.

Finally, to determine the physical needs of human, the classification made by American psychologist Abraham Maslow, about the motives of human behavior was followed (14). The Comparison of the data classification pyramid motives with the tripartite distinction made by Plato about the soul leads in the figure 1 below.

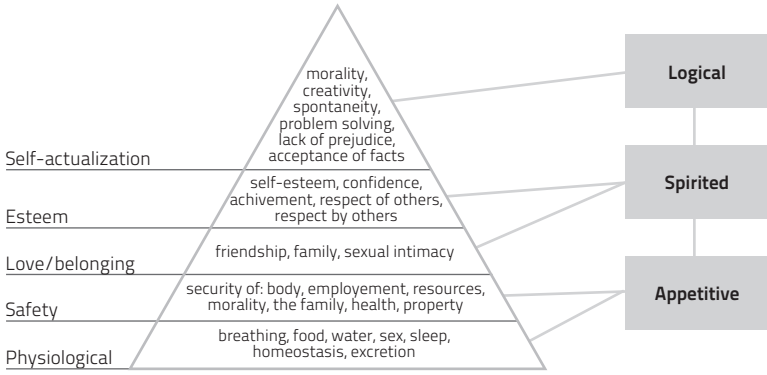



Figure 1. Correlation between the pyramid of Maslow and tripartite nature of the soul

Through the process of physical education the following goals can be achieved:

a) The proper management of natural resources (food, water).

b) Customary exposure to adverse conditions (rain, cold, heat, etc.) increases the resilience of the body and enhances the feeling of self-confidence.

c) Socialization through friendship and being a member of a team.

**Literature review**

Wrestling based on the literature review presents a holistic practice character that seems to cover all the requirements dictated by the classification of Maslow's motivation, exposing the trainee to a variety of physical and emotional stimuli.

Specifically, in the management of natural resources wrestlers because of constant control of their body weight due to their separation into weight classes were found to maintain better nutrition habits in relation to non-athletes (15).

In the development of physical condition scientific observations show that young athletes of wrestling reach higher grades in the 'eurotest' measurements than young people who present a common for their age physical activity (16). Other scientific evidence which shows that full body training is achieved through wrestling practice is the book by J. Murrey, P.V. Karpovich, considered to be fathers of the theory of weight training in coaching process. In their book Weight training (1956) they argue that the wrestling is the most complete all-round body strength development system (17).

Another factor that indicates the all-round development of human perception are measurements that indicate the development of both cerebral hemispheres regardless of the dominant hand of each athlete (18). According to researchers, the wrestling requires, besides the skilful execution of certain movements and handles that focus on a goal, the constant adaptation to the movements of this objective and a simultaneous perception of the position of the two rivals in the field. This requirement, according to the scientists who have conducted the research, leads to the activation of the right hemisphere and properties of the left side of the body, whether or not applied (18, 19). Corresponding measurements showed that athletes with equally developed cerebral hemispheres perform better in wrestling (20). Also, according to a second research, athletes exercised in wrestling have greatly increased perception of space, observation and orientation in relation to endurance athletes (21).

In the field of security and sense of emotional control wrestling satisfies the requirements of motivation in these situations through the special requirements that body to body fight provokes. This motive is related to the fight of existence and the human need for survival. On a physical level the instincts of survival coincide with stressful situations. In these cases human presents the following symptoms (10):

a) Blood leaves the skin and goes to big muscles and internal organs, to help them and protect them.

b) The lips and mouth close.

c) The breathing is rapid and deep.

d) Change of posture, shoulders dropped and the balance goes to the toes.

e) The weight goes from leg to leg.

f) The jaw descends to protect the larynx.

g) Eyebrows swipe to protect the eyes and provide smaller target.

h) Hands close in fists alone. Many times the knots whitewash because of tension.

i) Monosyllabic answers are given, as the primitive part of the brain activates (the limbic lobe) for battle.

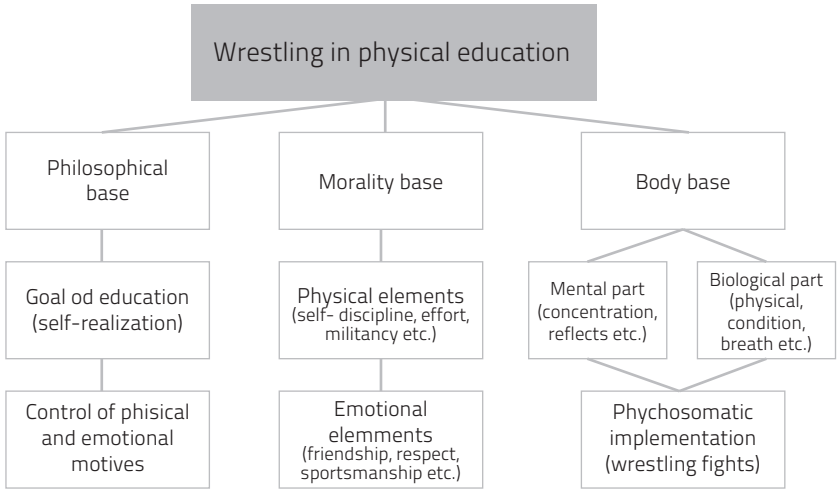
j) Loss of memory.

Without previous neurological and cognitive processing, these reactions will inevitably occur. The athletic wrestling through a mild form of confrontation, with handles and locks, gives a first painless combat experience. The young man accepts the brutality of battle mentally and encouraged to control his reactions, activating simultaneously in full power his physical forces. Controlled exercise and acceptance of violence initially leads to decomposition of the body which gradually restored to a new state (22).Continuous training gradually leads to the control of physical and emotional reflex reactions. The above control does not depend upon the conditions of the external environment, but becomes physical experience. This physical experience is embossed into the body itself, helping it to adapt to all kinds of situations in everyday life. From the above findings, strengthening of self-confidence, namely mental conditions necessary for the cultivation of a sense of security in any external conditions and situations becomes apparent.

Finally, according to various studies on the contribution regarding the process of physical education in the moral development of young people, different views are observed (1). In other words, other studies show reduced moral conscience between athletes and non-athletes whereas other improved (3, 23, and 24). In addition, significant difference is presented between different sports regarding the moral level of consciousness that they grow, with team sports lagging behind individual sports (24). However, researchers agree that moral development is related to the theoretical development and training of coaches in ethical issues and group guidance. The above statement has positive effects on the moral development of athletes (1, 25).

**Results**

The presentation of the literature and philosophical analysis of the objectives of education and physical education led to a conceptual application model as an extension of the model proposed by the Polish professor of combat sports R.M. Kalina, on the martial arts of the East (26)




Analyzing the above figure 2 indicates the identification of the philosophical base of wrestling training with the principles and process of education goals. The moral basis is combined with the principles and objectives of physical education goals while the training methodology shows the technical means the professor of physical education has in disposal to achieve the objectives and principles of philosophical and base morality. The major difference of the presented model, as opposed to sports of performance, is that coaching does not focus on

improving performance but human's comprehensive development. The improvement, moreover, of performance is presumed, to the possible limits that can be achieved by each individual through physical exercise. It is indeed significant that moral data, firstly, and physical data, secondly, are derived by the philosophical base.

**Conclusions**

This analysis was an effort to determine the role wrestling practicing can play on physical education of young people on contemporary reality. Simultaneously, an attempt was made to determine the concepts of physical training and education, as elements of a civilized society. It was showed that wrestling can be an excellent and comprehensive education system that meets all, without exception, the terms set by the education process through physical education. Finally, the emergence of the theoretical model developed lays the foundation for further research of the issue of the educational application of wrestling aimed at revival of wrestling popularity.

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# Level of kinaesthetic differentiation of movement amplitude in polish national team wrestlers in various training stages

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**ABSTRACT**
Directly physical contact with an opponent, linked with a speed and precise movements, executed in various technical-tactical combinations, calls for a high level of movement coordination in wrestlers. Kinaesthetic differentiation are the very important part of the movement coordination, because sensations influence the high precision of movements. Only kinaesthetic differentiation relevant to individual and favourable technique, can help to learn an master technique. Thus, it is important to keep on verifying these sensations by a competitor with the aid of a coach and other people involved in training. PURPOSE: The of this study was to investigate the relation between the precision of re-producing of the given bending angle of a limb and training stage, as well as to determine which limb is dominant. METHOD: The test for measuring the ability of kinaesthetic differentiation of a movement amplitude has been used. There were two sets for measuring: a kinaesthesiometer linked with a set of goniometers and computer. 107 wrestlers of Polish National Team were subject to this examination. That group consisted of classic style younger juniors (cadets), juniors and seniors, and free style younger juniors. Measuring was carried out once during the preparation period of training. CONCLUSIONS: 1. The precision of movement amplitude reproduction varied depending on training stage. The highest precision was recorded in seniors, and the lowest in classic style juniors. 2. Some statistically insignificant differentiation of the results for both upper limbs were observed. Left hand was more precise. 3. The highest symmetry of movements precision was observed in classic style younger juniors. 4. The results seem to confirm the versatile technical preparation of the wrestlers, i.e. symmetrical performing of exercises may result in better sport results in competition.

**KEY WORDS:** kinaesthetic differentiation, movement amplitude, top-level wrestlers, training stage.

**Introduction**
Direct physical contact with an opponent, combined with speed and precise of movements executed in various technical and tactical combinations calls for a high level of movement coordination in wrestlers. Kinaesthetic sensations (differentiation) are an important part of the ability because the exceptional precision of movements appears due to those sensations. Each exercise involves specific kinaesthetic sensations. That is why mastering a technique is enhanced only by adequate kinaesthetic sensations, that is the ones relevant to individual and

optimum technique. Having taken into consideration the characteristic features of the sport practised by the tested, based on numerous research, a correlation between precision of movements (better functioning of kinaesthetic analyser) and the degree of sports advancement has been observed [2-6]. Moreover, precision of movements increased if they were accompanied by tactile sensations [7]. An increase of the level of kinaesthetic sensations was also observed regardless of the kind of exercise and its duration in the first part of the strain applied in the research. Its final stage was characterised by decrease of kinaesthetic sensations. Big strain both of strength and endurance type aggregate the precision of kinaesthetic sensations. That is why it is inadvisable to teach and master technically complex exercises at the final part of training sessions [6]. All the existing observations point out to the necessity of constant review of kinaesthetic sensations made by the athlete, the coach and other persons participating in the training process [1, 8, 9, 10] The aims of the study was: 1. Looking for correlations between the movement reproduction precision to be mastered and the training stage of wrestlers. 2. Determining the dominant, as far as kinaesthetic sensations go, limb in wrestlers.

**Material and Methods**

107 of Polish national team wrestlers at different training stages were subject to the examination. The group consisted of classic style seniors, juniors and cadets (younger juniors) and free style cadets (younger juniors) (tab.1). Measuring was carried out once during the preparation period.

Table 1. Style, age and sport class of tested free and classic style wrestlers n=107

| Style | N | Age | Sport class |
|---|---|---|---|
| Classic (n=46) | 15 | Seniors (22-34) | IM, NM, I |
| | 22 | Juniors (18-20) | I |
| | 29 | Cadets (15-18) | I, II, III |
| Free (n=41) | 41 | Cadets (15-18) | I, II |

IM - international master sport class; I – first class
NM - national master sport class: II – second class

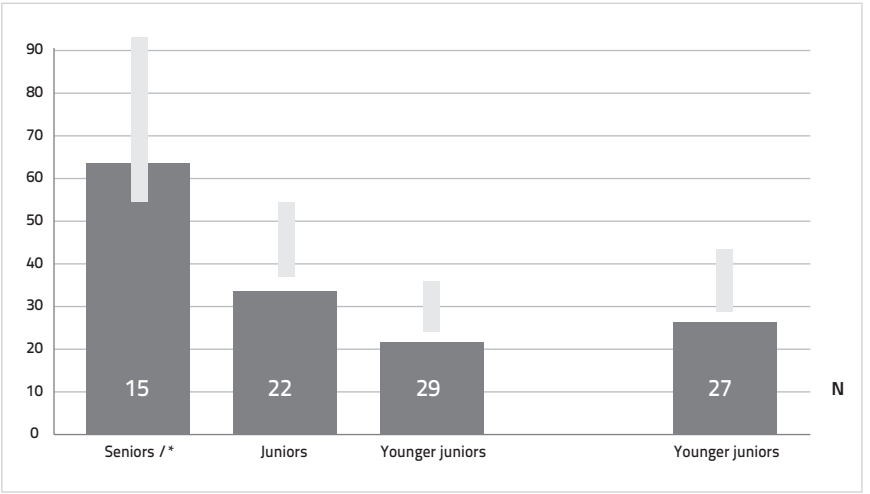
Precision of movement registered on the basis of the ability to reproduce the given bending angle of a limb is one of the objective methods of assessing technical ability of a competitor. In wrestlers, the most important movements, i.e. working movements, are those around cubical joint. The most significant bending angle of upper limb is the angle of 80o. That is why the precision of reproducing the given movement in cubical joint based on the ability of kinaesthetic differentiation of a movement amplitude was measured. There were two sets for measuring: a kinaesthesiometer with a goniometer and a kinaesthesiometer linked with a set of goniometers and a computer. Precision of kinaesthetic sensations was measured by the method of Schulte (1925), Puni [2] and Starosta [11]. The method involved reposition of extremity to the angle specific for a given sport discipline. The examined person at first three times bent his extremity at the assigned angle and then attempted to reproduce this angle "by heart" five times. The accuracy of reproduction of the assigned angle served as a measure of acuity of kinaesthetic sensations or musculoarticular perception. The examined athletes were blindfolded to eliminate bias resulting from sight control. The material was analysed statistically, with consideration of the arithmetic means, standard deviations, and significance of differences between means (t-test of Student).

**Results**

1. Precise of movement amplitude reproduction versus the training stage

In wrestlers, precision of movement amplitude reproduction was measured by the use of two types of apparatus.

Classic style juniors and cadets (younger juniors) and free style cadets (younger juniors) were tested by the use of a kinaesthesiometer with a goniometer. In the group of classic style wrestlers, the fewest mistakes were made by cadets – 24.38o, among juniors the percentage was significantly higher – 33.77o (fig.1). The differences between the results were not statistically significant (tab.2). The figure for free style cadets was 27.9o. The differences of results between cadets of both styles were statistically insignificant, which means that they had similar precision of movements. Classic style seniors and free style cadets (younger juniors) were tested by the use of kinaesthesiometer connected to a set of goniometers and a computer. The precision of movement reproduction for seniors was 63.93o, and for cadets – 99.14o. The differences were statistically significant (tab.2).




* Test made by the use of the computer, kinaesthesiometer and goniometer

Figure 1. Precision of movement amplitude reproduction in national team wrestlers versus the style and training stage (age categories) (n=93).

Table 2. Comparison of the significance of differentiation of the precision of movement amplitude reproduction in national team classic style and free style wrestlers during preparation period n=107

| Style | Classic | | | Free | | | Level of significance |
|---|---|---|---|---|---|---|---|
| Training stage | Seniors /c n=15 | Juniors n=22 | Cadets n=29 | Cadets n=29 | Cadets n=14 | Cadets /c n=14 | |
| x | - | 33.77 | 24.38 | - | - | - | 0.678 |
| | - | - | 24.38 | 27.89 | - | - | 0.986 |
| | - | - | - | 27.89 | - | 99.14 | 0.000** |
| | 63.93 | - | - | - | - | 99.14 | 0.003* |
| | - | - | - | - | 19.00 | 99.14 | 0.000** |

/c - test made by the use a computer, kinaesthesiometer and goniometer

Differences statistically significant for: $p \leq 0.001$**, $p \leq 0.01$*. Younger juniors (n=14) – the same competitors tested by the use of two different sets of apparatus

The results indicate that despite using different apparatus* for wrestlers at different training stages (age categories), the seniors reproduced movements in the most precise way, which may mean their higher level of technical advancement. Those wrestlers presented high level of sports advancement (they had first and master sports class), and took high places in European and World's championships.

* Results of the wrestlers at different training stages tested by the use of two types of apparatus were compared – the differences were significant. Also, the results for seniors and cadets (despite the fact that the tests were made with only one apparatus equipped with a computer) – differed significantly (tab.2).

**Dominant limb**

The analysis of the precision of reproducing given movement amplitude showed slight, statistically insignificant differences depending on the limb making the movement (tab.3) The biggest differences (insignificant, however) were observed in seniors – 13.13o, which may have been due to more precise apparatus used. Within the other groups of classic style wrestlers, the differentiation was the biggest for juniors (6.13o) and the smallest for cadets – 0.58o (fig.2). The precision was slightly greater for left limb.

Table 3. Comparison of the significance of differentiation of the precision of movement amplitude reproduction versus the limb performing the movement (right and left arm) in national team classic style and free style wrestlers n=93

| Style | Training stage | N | X | | | | S | | Level of significance * |
|---|---|---|---|---|---|---|---|---|---|
| | | | R | L | Predominance | | R | L | |
| | | | | | R | L | | | |
| Classic | Seniors | 15 | 38.53 | 25.40 | - | 13.13 | 34.66 | 16.99 | 0.160 |
| | Juniors | 22 | 19.95 | 13.82 | - | 6.13 | 15.12 | 6.60 | 0.129 |
| | Cadets | 29 | 11.90 | 12.48 | 0.58 | - | 7.13 | 9.24 | 0.808 |
| Free | Cadets | 27 | 15.30 | 12.59 | - | 2.71 | 16.22 | 9.98 | 0.527 |

* Differences insignificant for $p > 0.05$

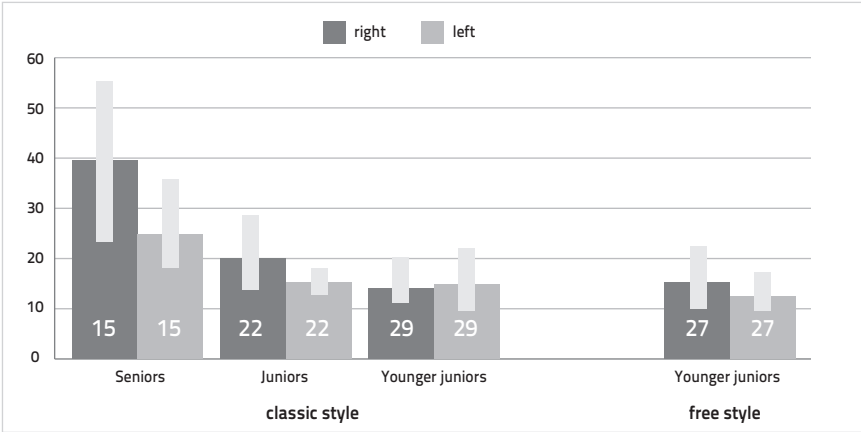



Figure 2. Precision of movement amplitude reproduction in national team wrestlers versus the limb performing the movement. ( n = 93 ).

Results for individual wrestlers of various groups indicated a previously noticed predominance of left arm in classic style wrestlers (48.3%, 54.5%, 53.3%). Free style wrestlers, however, indicated predominance of right arm – 55.6% (fig.3).

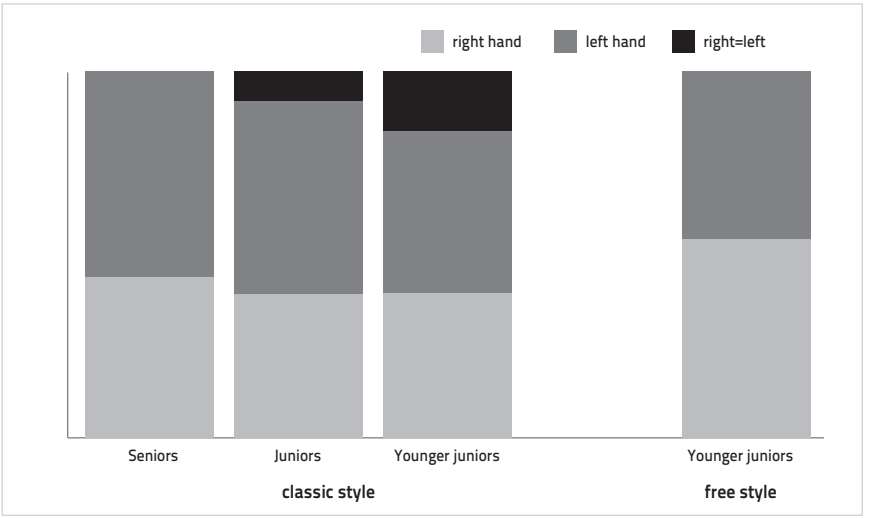



Figure 3. Dominance of upper limb in national team wrestlers at various training stages ( n = 93 ).

Cases of lack of dominance were observed in classic style junior and cadets (younger junior) wrestlers (tab.3). The lack of statistically significant differences of results of kinaesthetic sensations for right and left limb may mean that in wrestling, like in artistic gymnastics, great attention is paid to the symmetry of technical preparation [1]. It masters the precision of performing various technical elements both with right and left limb. The ability to throw symmetrically gives the wrestlers an advantage over wrestlers prepared in one direction (asymmetrically).

**Conclusions**

The precision of movement amplitude reproduction varied depending on the training stage. The highest precision was recorded in seniors and the lowest in classic style juniors. Some statistically insignificant differentiation of results for both upper limbs was observed. Left arm was more precise. The highest symmetry of movement precision was observed in classic style cadets (younger juniors). The results seem to confirm the versatile preparation of wrestlers, i.e. symmetrical performing of exercises, which may enhance achieving better results in competitions.

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# Differences between weight groups of schoolboy Greco-Roman wrestlers in their fitness abilities

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**ABSTRACT**
PURPOSE: The aim of this study was to determine whether there were and what was the structure of probable differences in physical condition preparedness (fitness) of schoolboy Greco-Roman style wrestlers between different weight groups (Lightweight, Middleweight and Heavyweight). METHODS: The study was conducted on a sample of 190 schoolboys (11-13 years old), Greco-Roman style wrestlers. A sample of measuring instruments consisted of 17 tests for the assessment of anthropometric characteristics, motor and functional abilities. Different levels in manifest area of motor and functional abilities of three weight groups were established by univariate analysis of variance (ANOVA). The variables assessing fitness levels and the qualitative differences between them were tested by discriminant analysis. RESULTS: One discriminant variable was obtained that significantly discriminated between the three weight groups of wrestlers. It was defined by strength, coordination of the upper and lower extremities and flexibility. With the increase of weight, from the Lightweight to Heavyweight wrestlers, the results on tests for the evaluation of strength and coordination of the upper and lower extremities progressively declined. On the other hand, in the evaluation of flexibility, the results were grouped in a manner that the Lightweight wrestlers scored the worst, while the Heavy wrestlers were the best. CONCLUSION: The results show the importance of an individual approach to fitness training of schoolboy Greco-Roman style wrestlers as regards different weight groups.

**Key words:** fitness abilities, antropometric characteristics, individual approach, training

## Introduction

Depending on the age group of wrestlers (schoolboys, cadets, juniors and seniors) according to international wrestling rules, the battles are conducted in different weight categories. It is known that fitness preparation of wrestlers differs depending on the style, age or weight groups. This is confirmed by a larger number of studies, in which wrestlers was distributed in different weight groups (Glaz, 1998; Baić, 2006; Biletić 2012, 2012; Biletić et al., 2015), and also in the weight categories (Starosta, 1984; Petrov 1997; Baić et al., 2002; Slačanac et al., 2007).

A condition of adequate preparation for top sporting successes of young athletes is the development and raising fitness levels and these significantly affect on the efficiency of the

athletes in all parts of the competitive activities. In a small number of previous studies in establishing differences in physical condition of schoolboy wrestler, divided according to weight groups, it was concluded that wrestlers already at that age need different and individually develop of physical condition (Slačanac et al., 2007; Biletić, 2012; Biletić et al., 2012, 2012; Biletić et al., 2015). From practice (in Croatia) is known that wrestling coaches do not do the differences in the physical conditioning of wrestlers with such a small difference in age and weight (Biletić, et al., 2015). In this study, which was conducted at age of schoolboy wrestler (age 11-13 years), resulting value of discriminant variable proves a good discrimination between weight groups. With research that considers the problem of difference in weight categories (Slačanac, et al. 2007) it was established that with increase of weight groups leads to a decrease of results in the space of variables to assess strength. However, all these works were related to older age groups of wrestlers (cadets, juniors and seniors) while a smaller number of works made in the younger age groups (Sertić et al., 2009, Slačanac et al., 2007; Biletić 2012; Biletić et al. 2015).

**Methods**

The sample consisted of a 190 male Greco-Roman style wrestlers at the age beetwen 11 and 13, which according to the international wrestling rules represented schoolboys. Thise sample comprised representatives of 12 Croatian wrestling clubs, which was more than 50% of the entire Croatian schoolboys-wrestlers population. Subjects were divided into three different weight groups: Lightweight up to 38 kilograms; Middleweight from 38.1 to 53 kilograms, and Heavyweight over 53.1 kilograms. Participants were measured by 17 variables, out of which 11 described the space of fitness level and those were included in the discriminant analysis of this research. Most of the variables are from the standard set of Physical Education tests (Findak, et al., 1996), used in elementary and high schools of the Republic of Croatia, and from the book "Measuring the basic motor dimensions of athletes" (Metikoš, et al., 1989). Also, the antopometric characteristics of schoolboy wrestlers, according to weight groups, were observed by means of four variables, each from one space of latent dimensions (longitudinal and transversal dimensions of the skeleton, volume and body weight, subcutaneous fat tissue). Coordination abilities were tested before the test that requiredendurance and strength. Data were analyzed by the statistical program Statistica, ver. 12. All variables for the assessment of fitness levels are presented using basic statistical parameters; data goodness of fit was also verified. Differences between the weight groups of participants were determined by univariate analysis of variance, and qualitative differences between them were tested by discriminant analysis.

**Results**

Although the research focuses on the differences in levels of fitness abilities of schoolboy Greco-Roman wrestlers, in the tables are shown parameters of sports experience, number of training sessions in a week and anthropometric variables which were analyzed separately by univariate analysis of variance in order to facilitate the interpretation of the obtained results. Discriminant analysis and ANOVA were used to process the variables assessing fitness abilitiess. For the tests that were measured three times (skinfold of the upper arm, agility on the ground, steps sideways, hand tapping, obstacle polygon backwards, standing long jump and bend astride) the mean value was considered.

Table 1. Descriptive statistical parameters of variables assessing fitness levels of schoolboys (11-13 years old) Greco-Roman style wrestlers

(n = 190)

| Variables | Mean | Minimum | Maximum | Stan.Dev. | Skewness | max D | Kurtosis |
|---|---|---|---|---|---|---|---|
| Age (years) | 12.39 | 9.34 | 15.69 | 1.05 | 0.38 | 0.06 | 0.28 |
| Sports experience (month) | 20.84 | 1.00 | 108.00 | 19.15 | 1.35 | 0.18 | 2.18 |
| No. of training sessions per week | 2.96 | 2.00 | 5.00 | 0.66 | 1.06 | 0.37 | 2.76 |
| Body height (cm) | 156.53 | 133.80 | 188.50 | 10.23 | 0.16 | 0.04 | -0.15 |
| Body weight (kg) | 49.47 | 25.60 | 122.50 | 13.80 | 1.38 | 0.06 | 4.48 |
| Circumference of the forearm (cm) | 23.13 | 12.50 | 32.60 | 2.51 | 0.06 | 0.06 | 1.74 |
| Skinfold of the upper arm (mm) | 14.39 | 3.33 | 40.67 | 7.88 | 1.13 | 0.10 | 1.35 |
| Agility on the ground (s) | 19.30 | 11.77 | 37.71 | 4.42 | 1.15 | 0.08 | 2.32 |
| Steps sideways (s) | 11.02 | 8.33 | 42.03 | 2.48 | 10.39 | 0.24 | 129.92 |
| Obstacle polygon backwards (s) | 12.78 | 7.77 | 26.04 | 3.14 | 1.08 | 0.08 | 1.83 |
| Bend astride (cm) | 50.02 | 22.67 | 223.00 | 16.23 | 6.50 | 0.13 | 67.87 |
| Standing long jump (cm) | 183.84 | 125.67 | 252.00 | 23.64 | 0.10 | 0.03 | -0.05 |
| Hand tapping (no.rep.) | 27.86 | 20.33 | 36.67 | 3.12 | 0.19 | 0.06 | 0.05 |
| Endurance in higher joint (s) | 28.41 | 0.00 | 79.00 | 18.52 | 0.53 | 0.07 | -0.43 |
| Abs in 60 s (no.rep.) | 39.79 | 0.00 | 57.00 | 6.99 | -0.75 | 0.08 | 4.80 |
| Pushups in 60 s (no.rep.) | 26.27 | 0.00 | 97.00 | 14.02 | 0.79 | 0.06 | 2.59 |
| Squats in 60 s (no.rep.) | 47.91 | 24.00 | 69.00 | 9.16 | -0.14 | 0.06 | 0.08 |
| Running 6 minutes (m) | 1115.17 | 0.00 | 2132.00 | 261.94 | -1.99 | 0.16 | 8.45 |

Legend: Mean – arithmetic mean; Minimum – minimum value; Maximum – maximum value; Std.Dev. - standard deviation; Skewness – coefficient of skewness; Kurtosis – curvature coefficient, Max D – calculated the maximum distance between the cumulative frequency of the normal distribution and the cumulative frequency of empirical distribution by Kolmogorov-Smirnov test.

The basic descriptive parameters are usual for this sample of subjects –higher standard deviations and a higher range between the minimum and maximum values in some variables is a consequence of poor odd ratios of strength to body weight.
Discriminant analysis was used to determine whether there were fitness-assessing variables which would significantly discriminate between the three different weight groups of wrestlers.

Table 2. Univariate analysis of variance of variables assessing
fitness levels of schoolboy Greco-Roman style wrestler in three different weight groups (n=190)

| Variables | SS Effect | df Effect | MS Effect | SS Error | df Error | MS Error | F | p |
|---|---|---|---|---|---|---|---|---|
| AGILITY ON THE GROUND (s) | 64.58 | 2 | 32.29 | 3620 | 187 | 19.36 | 1.67 | =0.191 |
| STEPS SIDEWAYS (s) | 1.15 | 2 | 0.57 | 1165 | 187 | 6.23 | 0.09 | =0.912 |
| OBSTACLE POLYGON BACKWARD (s) | 136.31 | 2 | 68.15 | 1722 | 187 | 9.21 | 7.40 | <0.001 |
| BEND ASTRIDE (cm) | 1721.30 | 2 | 860.65 | 48075 | 187 | 257.08 | 3.35 | =0.037 |
| STANDING LONG JUMP (cm) | 1179.05 | 2 | 589.52 | 104457 | 187 | 558.59 | 1.06 | =0.350 |
| HAND TAPPING (no.rep.) | 25.64 | 2 | 12.82 | 1812 | 187 | 9.69 | 1.32 | =0.269 |
| ENDURANCE IN HIGHER JOINT (s) | 9765.11 | 2 | 4882.55 | 55036 | 187 | 294.31 | 16.59 | <0.001 |
| ABS IN 60 S (no.rep.) | 360.83 | 2 | 180.41 | 8886 | 187 | 47.52 | 3.80 | =0.024 |
| PUSHUPS IN 60 S (no.rep.) | 3062.17 | 2 | 1531.09 | 34100 | 187 | 182.35 | 8.40 | <0.001 |
| SQUATS IN 60 S (no.rep.) | 2659.87 | 2 | 1329.93 | 13190 | 187 | 70.54 | 18.85 | <0.001 |
| RUNNING 6 MINUTES (m) | 104014.47 | 2 | 52007.24 | 12863708 | 187 | 68789.88 | 0.76 | =0.471 |

Legend: SS Effect – the sum of squares between groups; df Effect– degrees of freedom between the groups; MS Effect = SS Effect /df; SS Error – the sum of squares between subjects; MS Error = SS Error/df Error; F = MS effect/MS Error; p – level of statistical significance.

Statistically significant differences were obtained by ANOVA in ages and anthropometric characteristics, with an increase from the 'Lightweight' to 'Heavyweight' groups. It was expected considering the age difference at the time of intensive growth and development (Table 2). Anthropometric characteristics had a significant effect on the results on individual tests for the assessment of fitness levels (Biletić, 2012; Biletić, et al. 2015). The variables obstacle polygon backwards ($p = 0.001$), bend astride ($p = 0.037$), endurance in higher joint ($p < 0.001$), abs in 60 s ($p = 0.024$), pushups in 60 s ($p < 0.001$) and squats in 60 s ($p < 0.001$) statistically significantly differentiated between the weight groups, based on the tested significance of differences for each variable (Table 2). It is evident that 'Lightweight' wrestlers scored better in the variable obstacle polygon backwards, endurance in higher joint, abs in 60 s, pushups in 60 s and squats in 60 s, most likely because of their lower bodyweight, given that the skinfold of the upper arm in the Lightweight group was significantly lower than in the Heavyweight category. A higher proportion of body fat in havier groups was surely the limiting factor in reaching better results in strength tests (pushups in 60 seconds, squats in 60 seconds, endurance in higher joint and abs in 60 seconds). On the other hand, Lighter

wrestlers were significantly inferior on the test bend astride, which is most likely the result of their lower body height.

Table 3. Results of discriminant analysis for the three different weight groups of schoolboy Greco-Roman style wrestlers – test of significance and power of the discriminant function (n = 190)

| Discriminant Function | Eigenvalue | Canonical R | Willks' Lambda | $\chi 2$ | df | p |
|---|---|---|---|---|---|---|
| 1 | 0.881 | 0.684 | 0.500 | 126.26 | 22 | 0.000 |

Legend: Eigenvalue – variance of discriminant function; Canonical R – coefficient of canonical discrimination; Willks' Lambda – inverse measure of intergroup variability; $\chi 2$ – the value of Chi-square test; df – degrees of freedom; p – level of statistical significance.

Table 3 shows that the discriminant analysis found one discriminant function, defined as strength and coordination of the upper and lower extremities and flexibility, which significantly differentiated between wrestlers of different weight groups.

Table 4. Results of discriminant analysis for the three weight groups – correlation tests of fitness levels with discriminant function (n = 190)

| Variables | Discriminant Function 1 |
|---|---|
| AGILITY ON THE GROUND (s) | -0.574 |
| STEPS SIDEWAYS (s) | -0.003 |
| OBSTACLE POLYGON BACKWARDS (s) | 0.700 |
| BEND ASTRIDE (cm) | 0.314 |
| STANDING LONG JUMP (cm) | 0.824 |
| HAND TAPPING (no.rep.) | 0.331 |
| ENDURANCE IN HIGHER JOINT (s) | -0.886 |
| ABS IN 60 SEC. (no.rep.) | -0.108 |
| PUSHUPS IN 60 SEC. (no.rep.) | 0.211 |
| SQUATS IN 60 SEC. (no.rep.) | -0.643 |
| RUNNING 6 MINUTES (m) | 0.021 |

From Table 4 it is evident that seven variables (agility on the ground, obstacle polygon backwards, bend astride, standing long jump, hand tapping, endurance in higher joint and squats in 60 s) independently discriminate between subjects. Flexibility scores, assessed by the variable bend astride, were grouped in a manner that the Light wrestlers achieved the worst results, while the Heavy wrestlers were the best. This difference contributed to the difference in the indicator of morphological characteristics, because the result on the test bend astride is highly correlated with anthropometric indicators of longitudinal dimensionality of the skeleton. Comparing the obtained results with the ones from the research conducted earlier on eleven year-olds (Biletić, et al. 2012) and twelve year-old wrestlers (Biletić, et al. 2012), we can see that the results obtained in our study matched and were expected.

**Discussion and conclusions**

One discriminant function, defined as strength and coordination of the upper and lower extremities and flexibility, significantly discrimates among fitness levels of schoolboy Greco-Roman style wrestlers pertaining to different weight groups. The finding is in accordance with previous studies (Biletić, et al. 2012). In the space of anthropometric characteristics, the results were expected and in compliance with principles of growth and development of children of this age. Worse test results on obstacle polygon backwards, endurance in higher joint, abs in 60 s, pushups in 60 s and squats in 60 s of the Heavier wrestlers contributed to the difference in the indicator of morphological characteristics in avil of Lighter wrestlers. Knowledge of these findings will improve quality of talent identification and selection of young wrestlers as well as quality of planning, programming and conducting the transformation processes.

**Practical implications/advice for athletes and coaches**

The results underline the importance of an individual approach to fitness training of schoolboy Greco-Roman style wrestlers; that is, it is inappropriate to subject schoolboy wrestlers of different chronological and biological age, thus of different morphological characteristics and fitness levels, to the same training workloads. In that way some boys-wrestlers may be exposed to inappropriate training, which may consequently bring loss of motivation, injuries and, finally, withdrawal of talents from wrestling (Biletić, 2012; Biletić, et al. 2012; Biletić, 2015).

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# Thermal responses in Greco-Roman wrestlers during training sessions

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**ABSTRACT**
PURPOSE: The purpose of this research was to define how the thermal regulatory system reacts when induced by wrestling drill bouts during a practice in Greco-Roman wrestlers. In other words, the aim was to find out how the core temperature changes throughout a training session. METHODS: Five senior male wrestlers participated in this study (n=5), and they were 20.5±4.1 years old; weighed 75.26±23.44 kg, with the mean height of 173.4± 9.5cm and 7.2±5.4 years of experience in training and competing. Each subject competes in a different weight category. The participants underwent three rounds of wrestling drill along with wrestling throws in forced intensity manner. Each round lasted 5 minutes with 10 minutes rest period between each of them. Core temperature of the wrestlers was measured six times: baseline core temperature - before the warm-up, Core temperature after the warm-up, core temperature after the first bout, core temperature after the second bout, core temperature after the third bout and 10 minutes after the final bout. Besides the core temperature, heart rate and lactate levels were observed. Lactate levels were measured before the warm up, and after the 3rd, 6th and 9th minute after each wrestling bout during a rest period. Heart rate was measured right after the warm up and after each of the wrestling bouts. RESULTS: No significant differences were found in thermal responses after the three wrestling bouts, so the core temperature in wrestlers remained pretty much constant after the warm up. The only difference appears between the baseline core temperature value and the value after the warm up, 36.66°C and 38.7°C, respectively. This is expected due to increased blood flow through muscles and enhanced metabolic reactions (caused by the warm up). Even though the differences were not significant, it can be noticed that the tempereture after the 1st bout was above 39°C in every participant so they reacted quite similarly throughout the entire session. CONCLUSION: The core temperature didn't change significantly throughout a training session in male wrestlers. From the previous results it can be concluded that the greatest temperature change appears right after the warm up is done. Although significant changes were observed in heart rate and lactate levels, it turns out that doesn't affect much the core temperature of wrestlers, which remained relatively high during a training session. Finally we may say that activties during a training session are highly stresfull but the length of bouts and rest periods are long enough to keep the thermal regulatorty system working properly and unharmful for wreslters.

**Key words:** combat sports, wrestling, practice, thermoregulatory system, metabolic reactions.

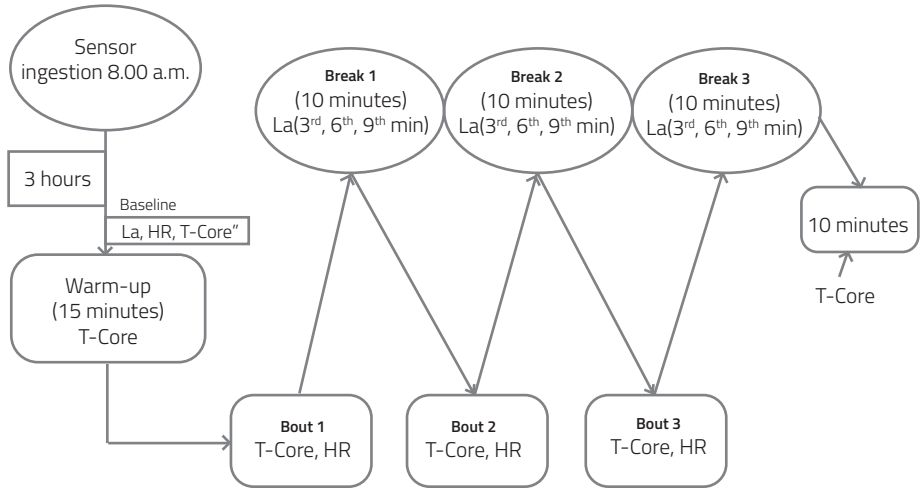
## Introduction

The sport of wrestling has been practiced for approximately 5000 years, making it one of the world's oldest sports. Today, there are two basic styles of wrestling: Greco-Roman and

freestyle which are also called international styles and are practiced worldwide. Freestyle is also practiced by females and is included in Olympic programme as well. Wrestling belongs to the group of combat sports that has high demands for energy supply. It is predominantly an anaerobic sport that requires repeated movements against the opponent's force. The types of movements a wrestler employs and combats throughout a match are intense and varied (Kreamer, W. J., J. D. Vescovi, and P. Dixon, 2004). Accordingly, wrestling is a sport with extremely high reliance on anaerobic glycolisis, ultimately leading to metabolic acidosis and fatigue.

High intensity bouts are mainly predominant in Greco-roman wrestling, consequently inducing high metabolic stress and most probably, rise in core temperature. It is already known that increases in Core temperature (Tc) above 38°C induced by intense exercise may cause central fatigue (Nielsen & Nibo 2003). Up to date research on Tc is very scarce, especially in combat sports (Vujkov et al., 2015).

The aim of this research was primarily to find out how training drills in wrestling affects the thermal responses during repeated bouts in Greco-Roman wrestlers. Furthermore, other metabolic changes, such as lactate levels, and heart rate were observed as well.




According to our findings there is not many researches that investigated T-core in combat sports. This seems to be the second one, there is a one that investigated karate athletes (Vujkov et al., 2015).

**Methods and materials**

*Participants*

In this research five senior Greco-Roman wrestlers have participated (n=5), with the mean age of 20.5 ± 4.1 years, mean body mass of 75.26 ± 23.44 kg, mean height of 173.4 ± 9.5cm and each of them with wrestling experience of 7.2 ± 5.4 years of training and competing. Participants compete in different weight categories and mostly each of them regularly practice not less than 6 days a week (some of them even twice a day). All participants gave their writing consent to participate in this study. The study conformed to the standards set by the Declaration of Helsinki and was approved by the local Ethics Committee. All participants were fully informed verbally and in writing about the nature and demands of the study, as well as the known health risks. Participants were healthy, with no limitations to participate in the study as confirmed through medical screening. Participants followed a usual training and nutrition plan during the study, and were obliged not to change diet and training during the study.

*Experimental procedures*

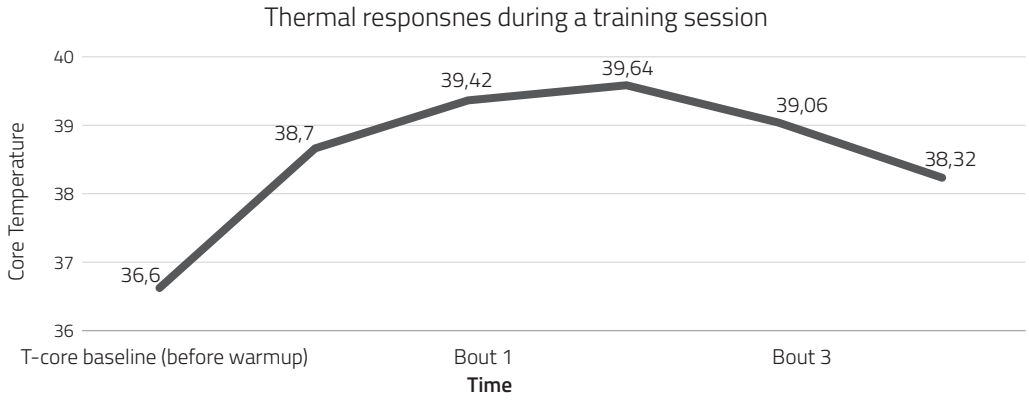
A day prior to research execution, physical and physiological measurements were taken in laboratory conditions. Body mass was obtained to the nearest 0.1 kg using a balance beam scale (Avery Ltd., Model 3306 ABV), whereas height was measured using a stadiometer (Holtain Ltd.) to the nearest 0.5 cm.

On a day the research was executed, participants had to do the sensor ingestion three hours prior to the start of wrestling drills. Before starting a training session, baseline values of T-core, heart rate and lactate levels were measured. Thereafter, subjects needed to do the proper warm-up which consisted of 5 minutes of running (aerobic activity), 10 minutes of acrobatics and dynamic stretching in a sport specific fashion. When the warm-up was done, T-core was re-measured. Then participants underwent three rounds of wrestling drills with throws included and periodically forced intensity. During one round intensity was intentionally changed due to the demands of the drills. Each round lasted five minutes with ten minutes rest periods between each of them. Core temperature of the wrestlers was measured six times. Baseline T-core, as mentioned previously. T-core after the warm-up, T-core after the first round, T-core after the second round, T-core after the third round and ten minutes after the last round in order to investigate how the cool down after 10 minutes affects the athletes' T-core. Lactate levels were measured before the warm-up and after third, sixth and ninth minute after each wrestling bout during the rest period. Heart rate was measured before the warm-up (baseline value) and after each of the wrestling bouts.

T-core was measured with wireless core body temperature recorder (HT150002, HQ Inc, US) and ingestible core temperature sensor, which participants ingested as a pill 3h before the testing in order for pill to make to duodenum. The gastrointestinal pill woud have to be ingested shortly before operational deployment (2-6h) in time to pass the stomach and to enter the duodenum. (Ganio et al., 2009; Kolka et al, 1993; Kolka et al, 1997; Sparling et al., 1992; Edwards & Clark, 2006). Blood samples were taken from the right earlobe for lactate analysis (Accutrend plus, Roche, Germany). Heart rate (HR) was determined during the test, using short-range radio telemetry (Model RS800CX, Polar Electro Oy, Kempele, Finland). These measurements were taken at an average external temperature of 24.33°C and humidity of 39%. All athletes were familiarized with these procedures as part of their regular training process. Figure 1. shows the experimental procedure protocol.

*Statistical analysis*

One-way Repeated Measures Anova with Huynh-Feldt correction was employed to investigate cumulative effect of repeating variables from pre-to-post rounds. All the data are presented as mean and standard deviation. Statistical analysis was performed using the statistical package IBM SPSS 20 (SPSS Inc, Chicago, IL, USA).



**Results**
No significant differences were found in thermal responses during three rounds of wrestling bouts. Baseline T-core value was 36.66°C, T-core after the warm-up=38.70°C, T-core (1st bout)=39.4°C, T-core (2nd bout)=39.64°C, T-core (3rd bout)=39.06°C, T-core(10min after the 3rd)=38.32°C. Figure 2. presents the changes in core temperature throughout a session. Heart rate values: baseline HR = 114.8bpm; 1stbout (end) = 179.6bpm, 2ndbout (end) = 180.8bpm, 3rd bout (end) = 185bpm. Everage lactate levels were: baseline = 2,28mmol/l, 1st bout = 7.88mmol/l, 2nd bout = 6.56mmo/l, 3rd bout = 7.86mmol/l.

**Discussion**
This research examined thermal stress changes in Greco-Roman wrestlers and how it affects metabolic processes and finally its influence on athletes' fatigue.
First it needs to be mentioned that wrestling bouts during training and actual wrestling match are considerably different.

It is certain that all of five participants reacted very similarly regarding the core temperature values through the entire training. Although values approximations might appear due to the small sample size. Nevertheless, we may not ignore the differences which appear in lactate levels and HR values. Lactate levels indicate the fatigue appereance in wrestlers (Drid et al., 2016). In those parameters, participants reacted quite differently. That is the proof of different fitness levels of each athlete. It seems like greater changes in such parameters doesn't affect the thermoregulatory system in athletes. The only greater difference in T-core appears after the warmup, so there is a ''leap'' if we compare the baseline value and value after the warmup, 36.66°C and 38.7°C, respectively. Even though the differences throughout the entire training session were not significant, it has to be noticed that T-core after the first bout was beyond 39°C in every participant. This temperature is not high enough to cause harmful reactions in wrestlers due to the limited activity time, because a moderate increase in body temperature, specifically sceletal muscles temperature, may benefit exercise performance by increasing the speed of metabolic processes (Nybo, 2008).

From previously mentioned results we can conclude that greatest differences appeared between the baseline t-core values and values after the warmup, and between the warmup and the first wrestling bout, after which the t-core remains pretty much constant with only slightly different values until the end of the training session i.e. until the onset of cooldown of athletes.

Due to the lack of research in this field, core temperature should be investigated further so we could get more detailed facts about how the thermoregulatory system works in combat sports.

**Conclusion**
This research proofs that the T-core in wrestlers during a training session ramains relatively high but stable along the entire workout. Once the wrestler is warmed up he can smoothly do the wrestling drills with no greater changes in core temperature. Although the actions in wrestling drills are highly stressful and mainly anaerobic, which can be seen from the previous lactate level and heart rate results, rest periods and wrestling bouts during training are perfectly combined so the way the thermoregulatory system works is very efficient and it doesn't allow athletes to overheat.

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# Comparison of freestyle wrestlers' competitive activity at the European competitions in 2013, 2014 and 2015

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**ABSTRACT**
INTRODUCTION: The analysis of competitive activity is the basic method that provides data about the level of specific preparedness. When it comes to wrestling, the competitive activity represents technical and tactical activities of wrestlers in accordance with the wrestling rules which depend directly on their preparedness. AIM: Considering the fact that the wrestling rules changed in 2013, the aim of this study is to research the specific impact of change in rules on the competitive performance, based on the indicator of technical and tactical top freestyle wrestlers' activity. METHOD: The research sample consists of 402 freestyle wrestling fights divided into 6 categories at three major competitions: 129 fights at the 2013 European Championship in Georgia (55, 66, 74, 84, 96, 120 kg), 127 fights at the 2014 European Championship in Finland, and 146 fights at the First European Olympic Games in Azerbaijan in 2015 (57, 65, 74, 86, 97, 125 kg). Variables represent the indicators of technical and tactical actvity and were analysed with the desrciptive, multivariate and univariate statistical procedures. RESULTS: Generally, the existence of statistically significant differences has been established (MANOVA; $p=0.018$). Partially, the existence of statistically significant differences (ANOVA) has been established with the following variables: the average of number of points in standing position ($p=0.002$), passivity ($p=0.001$), the average of the total number of points ($p<0.001$), the average of number of actions in standing position that carry 1 point ($p<0.001$), the average of number of actions in standing position that carry 2 points ($p<0.001$), the average of fight duration ($p=0.011$), the average scoring value of an action ($p<0.001$). CONCLUSION: When it comes to freestyle wrestling, the results of the research show that the average number of actions and repertoire of applied techniques at the competition hasn't changed, that the attractive techniques are less used and that techniques that carry no significant risk for the attacker dominate. Number of points is significantly higher due to the higher scoring value of actions, and scoring intensity differences turned out to be insignificant due to longer duration of a fight. Number of realized actions per unit time has become even smaller, and the differences are on the verge of the statistical significance ($p=0.052$). However, more frequent award of passivity contributed to the higher dynamism of this wrestling type.

**Key words:** wrestling, free style, European Championship, competitive activity

## Introduction

Nowadays, competitive activity researches are becoming more and more alive in contemporary sport theory and practice and are progressively affirmed as the special research group with the specific methodology (Eduardo and Gonzalez, 2013). Results that describe athletes' competitive activity represent indicators that most directly depict the relationship between preparation process and competition results in the concrete branch of sport

(Tünnemann, 1996). Of course, this type of research makes sense only once it is realized in the condition of a pronounced focus towards the maximum result, i.e. at the most significant competitions (Jovanović et al., 2010). The competitive activity analysis is the basic method which provides data about the level of the specific preparedness of an athlete (Dopsaj, 2009). In wrestling, an exceptional activity dynamics of both competitors with an expressed change in tempo and rhythm of the fight, as well as the change of attack and defense activity is present. Because of that, the identification of competitive activity indicators in martial arts is a methodologically complex task. Success in wrestling is an indicator of a good technical, tactical, psychological, conditional and theoretic preparedness of a wrestler and the competitive activity indicators "reveal" the way in which those preparation factors manifest during a fight (Tünnemann, 1996). Competitive activity in wrestling is the way the competitors in competitive conditions operate in accordance with the wrestling rules. Although the rules of the fight itself change constantly in wrestling, some of the general rules haven't suffered significant changes (Kasum, 2008). The reason for the latest change of rules in wrestling has been imposed on 02/12/2013 when it was suggested that wrestling should be excluded from the Olympic Games program. After the European Championship in 2013, a partial change in rules has occurred, whereby the World Championship in 2013 followed these rules and afterwards, the new rules have been adopted which gained the wrestling its status back at the Olympic Games.

Former competitive activity researches in wrestling had as a goal to research the influence of change in rules on competitive activity production, or to simply notice their development trend. With regard to that, a few works should be mentioned. The famous coach of the Soviet Union's national team, the professor Sahmuradov (1997) has stated that some techniques that had great significance during 60s and 70s, such as some foot sweeps, nearly vanished from the technical and tactical repertoire of a wrestler, and convincingly the most frequent techniques are those of foot sweeps and aufreisser. Podlivajev (1999) has found that relatively simple scoring techniques which carry no big risk, i.e. throws in the parterre and leg sweep throws, and various landings on the back make the basis of the free style wrestling fight in standing position, whereas aufreisser is by far the most frequently used technique in parterre. Tünnemann (1998) has noticed that the number of attractive throws that carry 3 or 5 points, has been constantly decreasing since the Olympic Games in Barcelona in 1992, while the number of less attractive actions is constantly increasing. By analyzing the structure of techniques, he has found that most points are scored by leg attacks, various tosses are somewhat less significant, and aufreisser holds a significant position among successfully performed actions.

Based on the final fight at the European Championship in 2013, more than 50 percent of points was scored by landing on the back (Marković and Kasum, 2013a). A bigger success in the second part of the round has been noticed by observing the realized scoring actions per parts of the round, which means that the preparedness factor at big competitions has a great impact on the match flow. Marković and Kasum (2013b) have ascertained that the trend of narrowing the repertoire of used techniques continued even after the change in rules in the free style wrestling by analyzing the World Championshop 2013. Compared to the EP number of points, number of scored points in fights for the medal hasn't changed significantly, but the number of realized actions dropped by 20 percent. As a consequence to the increase of landing on the back action value to 2 points, the number of technical actions in standing position, as opposed to parterre, has been significantly increased. By analyzing the World Championship 2013, Professor Tuennemann has concluded that the change of rules was necessary since the wrestling lost on attractiveness over the last few years. The increase of the landing on the back technique value to 2 points has led to the decrease in the number of actions that carry 1 point, but also hasn't led to the increase in the number of actions that

carry 3 and 5 points. It can be ascertained that only 40 per cent of the wins was achieved by scoring points at the World Championshop in 2013, whereas that percentage in 2011 was 90 percent. The rules encouraged athletes to be more active during a fight, and therefore contrubuted to a better understanding of a wrestling fight for wider audience (Tunnemann, 2013b). Comparative analysis of free style wrestler's competitive activity at the European Championship in 2013 and 2014, discovers that the number of points at the observed competitions has significantly increased, and even 30 per cent more points has been scored then in the previous year at the European Championship 2014. The change of some scoring techniques value, as well as a larger number of awarded passivity, has significantly influenced a larger number of scored points. However, the number of realized actions remained the same, which benefits the thesis that the competitors' performance hasn't significantly changed, but the fight became more uncertain and more interesting for the audience due to the way of evaluating actions. Factors that influence the free style wrestlers' success have been singled out by analyzing the European Championship 2014 and the First European Olympic Games 2015. It has been ascertained that there are no bigger differences in percentual presence of technical elements between medalists and less successful. Also, dominantly more points are scored in standing position through actions that carry 2 points. Those who succeeded to ajdust to the high intensity of the fight and thereby be efficient thanks to the training process, are to sure to achieve success (Marković and Kasum, 2015). The most discriminating factors that characterize the winner have been singled out by analyzing the First European Olympic Games 2015. The conclusion that the dominance of a winner lies within the constant attacks from the very begining of the fight, was drawn. Generally, winners score more points in standing position compared to the group of respondents who didn't win. Also, the average action value is significantly bigger, but so is the average number of realized actions per fight, therefore they need less time to preform an action. The latest change in rules imposes requests of high tempo fight (Marković and Dopsaj, 2015).

The subject of this work is free style wrestlers' competitive activity which was analyzed based on the European Championships in 2013 and 2014, as well as on the First European Olympic Games in 2015.

The aim of this work is to research the specific impact the change in rules has on the competitive activity visage, based on the indicators of technical and tactical actions of free style wrestlers. Because of that, this work should contrubute to a better overview of an impact the rules have on competitive activity development in wrestling, and therefore provide concrete contribution to further improvement of the wrestling rules.

**Methods**

In this research, which is transversal by nature, data collecting has been carried out by the method of observation, i.e by analyzing the official reports (bulletin) and video materials of the fights during the European Championship 2013 and 2014 and the First European Olympic Games in 2015. By nature, this research belong to the category of not experimental, but natural research. Compared to the type of research, it has characteristics of both fundamental and applied research. The basic method of gaining information was inductive reasoning.

Research Sample

In order to methodologically follow the comparative analysis, it was necessary to choose the most similar categories from all three competitions, and not only the change in number of categories, as well as their lower limit. The research sample consists of 102 free style wrestling fights divided into 6 categories at three big competitions: 129 fights at the European Championship 2013 in Georgia (55, 66, 74, 84, 96, 120 kg, the 60kg category was left out), 127 fights at the European Championship 2014 in Finland and 146 fights at the First European Olympic Games 2015 in Azerbaijan (57, 65, 74, 86, 97, 125 kg, the 61 and 70 kg categories were left out)

**Variables**

Wrestlers' competitive activity within the observed competiions was presented through quantified indicators of frequency of each element's presence and their submodalities. Each competitive activity element's obtained data has been characterized as relativised value, and obtained as a quotient of the number of competitive activity element's earned vlaue and the number of realized fights in the given category:

- number of scored points in standing position; number of scored points in parterre; number of awarded passivities; total number of scored points; number of preformed actions in standing position worth 1 point; number of performed actions in parterre worth 1 point; number of performed actions in standing position worth 2 points; number of performed actions in parterre worth 2 points; number of performed actions in standing position worth 3 and 5, i.e. 4 points; total number of performed actionsl number of shoulder throws; side throws and high amplitude throws (number of throws); number of takedowns, number of pushouts; number of counteractions in standing position; number of counteractions in parterre; number of landings on the back in standing position; number of landings on the back in parterre; number of pin positions.

  Beside these, the following variables have been analyzed as well:
- mean value of duration of the fight (s) – quotient of duration of all fights and number of realized fights in the given category,
- average action value – quotient of total number of scored points, but those that are scored only by performing technical actions in standing position and parterre, and the total number of actions in the given category,
- intensity of scored points (s) – quotient of duration of all fights and number of scored points in the given category,
- intensity of performed actions (s) – quotient of duration of all fights and number of performed actions in the given category.

**Statistical procedures**

Results of all variables are submitted to the calculation of basic descriptive statisctics by measures of central tendency (MEAN) and measures of dispersion (SD, Std. Error). For the needs of establishing the differences between subsamples of the respondents, multiple analysis of variance – MANOVA was used in general meaning, whereas univariate analysis of variance – ANOVA was used in partial meaning. Difference between pairs of individual variables of examined subsamples is tested with t test and Bonferoni criterion. All statistical analysis were accomplished by statistical software SPSS 19.0, while the level of statistical significance is defined by 95 percent and the probability values of a $p < 0.05$ (Hair et al., 1998)

**Results**

Table 1. Descriptive statstics of all variables per year of held competitions.

| Variables: | Mean | | | Std. Deviation | | | Std. Error | | |
|---|---|---|---|---|---|---|---|---|---|
| Year: | 2013 | 2014 | 2015 | 2013 | 2014 | 2015 | 2013 | 2014 | 2015 |
| Points scored in standing position | 4.710 | 6.929 | 6.856 | 1.080 | 0.798 | 1.090 | 0.441 | 0.326 | 0.445 |
| Points scored in parterre | 2.022 | 2.540 | 1.828 | 0.379 | 1.235 | 0.513 | 0.155 | 0.504 | 0.209 |
| Awarded passivity | 0.149 | 0.504 | 0.486 | 0.132 | 0.196 | 0.098 | 0.054 | 0.080 | 0.040 |
| Total number of scored points | 7.053 | 10.105 | 9.253 | 0.810 | 1.080 | 1.195 | 0.331 | 0.441 | 0.488 |

| Variables: | Mean | | | Std. Deviation | | | Std. Error | | |
|---|---|---|---|---|---|---|---|---|---|
| Year: | 2013 | 2014 | 2015 | 2013 | 2014 | 2015 | 2013 | 2014 | 2015 |
| Actions performed in standing position worth 1 point | 3.109 | 0.669 | 0.816 | 0.329 | 0.304 | 0.143 | 0.134 | 0.124 | 0.058 |
| Actions performed in parterre worth 1 point | 0.421 | 0.386 | 0.186 | 0.113 | 0.266 | 0.072 | 0.046 | 0.108 | 0.029 |
| Actions performed in standing position worth 2 point | 0.095 | 2.386 | 2.401 | 0.064 | 0.348 | 0.477 | 0.026 | 0.142 | 0.195 |
| Actions performed in parterre worth 2 point | 0.792 | 1.093 | 0.818 | 0.246 | 0.607 | 0.245 | 0.100 | 0.248 | 0.100 |
| Actions performed in standing position worth 3 or 5 (4) points | 0.453 | 0.366 | 0.316 | 0.234 | 0.147 | 0.108 | 0.095 | 0.060 | 0.044 |
| Total number of performed actions | 4.870 | 4.900 | 4.537 | 0.467 | 0.548 | 0.640 | 0.191 | 0.224 | 0.261 |
| Number of throws | 0.338 | 0.255 | 0.253 | 0.118 | 0.162 | 0.083 | 0.048 | 0.066 | 0.034 |
| Number of takedowns | 0.319 | 0.332 | 0.471 | 0.119 | 0.310 | 0.077 | 0.048 | 0.127 | 0.032 |
| Number of pushouts | 0.724 | 0.613 | 0.802 | 0.134 | 0.271 | 0.152 | 0.055 | 0.111 | 0.062 |
| Number of counteractions in standing position | 0.036 | 0.060 | 0.040 | 0.045 | 0.038 | 0.025 | 0.018 | 0.016 | 0.010 |
| Number of landings on the back in standing position | 2.223 | 2.179 | 1.937 | 0.378 | 0.437 | 0.422 | 0.154 | 0.178 | 0.172 |
| Number of landings on the back in parterre | 0.148 | 0.094 | 0.074 | 0.094 | 0.100 | 0.047 | 0.038 | 0.041 | 0.019 |
| Number of actions in parterre | 0.927 | 1.131 | 0.849 | 0.243 | 0.478 | 0.234 | 0.099 | 0.195 | 0.096 |
| Number of counteractions in parterre | 0.043 | 0.116 | 0.099 | 0.037 | 0.101 | 0.069 | 0.015 | 0.041 | 0.028 |
| Number of pin positions | 0.112 | 0.119 | 0.007 | 0.099 | 0.100 | 0.017 | 0.041 | 0.041 | 0.007 |
| Mean value of duration of the fight (s) | 255.28 | 293.13 | 301.51 | 14.07 | 36.57 | 15.70 | 5.74 | 14.93 | 6.41 |
| Average value of action | 1.38 | 1.94 | 1.91 | 0.07 | 0.14 | 0.05 | 0.03 | 0.06 | 0.02 |
| Intensity of scored points (s) | 36.68 | 29.51 | 33.08 | 5.26 | 6.46 | 5.18 | 2.15 | 2.64 | 2.11 |
| Intensity of performed actions (s) | 52.91 | 60.48 | 67.60 | 6.56 | 10.39 | 10.81 | 2.68 | 4.24 | 4.41 |

Table 2. Results of multivariate analysis (MANOVA)

| MANOVA | Value | F | Hypothesis df | Error df | Sig. | Partial Eta Squared | Noncent. Parameter | Observed Powera |
|---|---|---|---|---|---|---|---|---|
| Wilks' lambda | 0.000 | 56.568 | 30 | 2 | 0.018 | 0.999 | 1697.053 | 0.948 |

Table 3. Results of univariate analysis (ANOVA)

| Dependent Variable | Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared | Noncent. Parameter | Observed Powera |
|---|---|---|---|---|---|---|---|---|
| Points scored in standing position | 19.072 | 2 | 9.536 | 9.567 | 0.002 | 0.561 | 19.133 | 0.951 |
| Points scored in parterre | 1.629 | 2 | 0.815 | 1.265 | 0.311 | 0.144 | 2.531 | 0.233 |
| Awarded passivity | 0.479 | 2 | 0.240 | 11.031 | 0.001 | 0.595 | 22.062 | 0.973 |
| Total number of scored points | 29.766 | 2 | 14.883 | 13.733 | 0.000 | 0.647 | 27.465 | 0.992 |
| Actions performed in standing position worth 1 point | 22.465 | 2 | 11.232 | 152.259 | 0.000 | 0.953 | 304.519 | 1.000 |
| Actions performed in parterre worth 1 point | 0.193 | 2 | 0.096 | 3.267 | 0.066 | 0.303 | 6.535 | 0.532 |
| Actions performed in standing position worth 2 points | 21.132 | 2 | 10.566 | 89.741 | 0.000 | 0.923 | 179.481 | 1.000 |
| Actions performed in parterre worth 2 points | 0.334 | 2 | 0.167 | 1.025 | 0.382 | 0.120 | 2.051 | 0.196 |
| Actions performed in standing position worth 3 or 5 (4) points | 0.057 | 2 | 0.029 | 0.975 | 0.400 | 0.115 | 1.950 | 0.188 |
| Total number of performed actions | 0.487 | 2 | 0.244 | 0.788 | 0.473 | 0.095 | 1.576 | 0.159 |
| Number of throws | 0.029 | 2 | 0.014 | 0.907 | 0.425 | 0.108 | 1.815 | 0.177 |
| Number of takedowns | 0.085 | 2 | 0.042 | 1.093 | 0.360 | 0.127 | 2.186 | 0.206 |

| Dependent Variable | Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared | Noncent. Parameter | Observed Powera |
|---|---|---|---|---|---|---|---|---|
| Number of pushouts | 0.109 | 2 | 0.055 | 1.429 | 0.270 | 0.160 | 2.858 | 0.259 |
| Number of counteractions in standing position | 0.002 | 2 | 0.001 | 0.749 | 0.490 | 0.091 | 1.498 | 0.154 |
| Number of landings on the back in standing position | 0.286 | 2 | 0.143 | 0.836 | 0.452 | 0.100 | 1.673 | 0.167 |
| Number of landings on the back in parterre | 0.018 | 2 | 0.009 | 1.251 | 0.314 | 0.143 | 2.502 | 0.231 |
| Number of actions in parterre | 0.256 | 2 | 0.128 | 1.119 | 0.352 | 0.130 | 2.238 | 0.210 |
| Number of counteractions in parterre | 0.017 | 2 | 0.009 | 1.570 | 0.240 | 0.173 | 3.141 | 0.281 |
| Number of pin positions | 0.047 | 2 | 0.024 | 3.496 | 0.057 | 0.318 | 6.992 | 0.561 |
| Mean value of duration of the fight (s) | 7278.110 | 2 | 3639.055 | 6.128 | 0.011 | 0.450 | 12.256 | 0.814 |
| Average value of action | 1.194 | 2 | 0.597 | 64.564 | 0.000 | 0.896 | 129.129 | 1.000 |
| Intensity of scored points (s) | 154.059 | 2 | 77.029 | 2.401 | 0.125 | 0.242 | 4.802 | 0.409 |
| Intensity of performed action (s) | 648.046 | 2 | 324.023 | 3.628 | 0.052 | 0.326 | 7.256 | 0.578 |

Table 4. Results of difference analysis (t-test), only the variables where a difference was determined by univariate analysis

| Dependent Variable | (I) comp. | (J) comp. | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower | Upper |
| Points scored in standing position | 2013 | year 2014 | -2.219 | 0.576 | 0.005 | -3.772 | -0.666 |
| | | year 2015 | -2.146 | 0.576 | 0.006 | -3.699 | -0.593 |

| Dependent Variable | (I) comp. | (J) comp. | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower | Upper |
| Awarded passivity | 2013 | year 2014 | -0.355 | 0.085 | 0.002 | -0.584 | -0.125 |
| | | year 2015 | -0.337 | 0.085 | 0.004 | -0.566 | -0.108 |
| Total number of scored points | 2013 | year 2014 | -3.052 | 0.601 | 0.000 | -4.671 | -1.433 |
| | | year 2015 | -2.200 | 0.601 | 0.007 | -3.819 | -0.581 |
| Actions performed in standing position worth 1 point | 2013 | year 2014 | 2.440 | 0.157 | 0.000 | 2.017 | 2.862 |
| | | year 2015 | 2.293 | 0.157 | 0.000 | 1.871 | 2.715 |
| Actions performed in standing position worth 2 points | 2013 | year 2014 | -2.291 | 0.198 | 0.000 | -2.825 | -1.757 |
| | | year 2015 | -2.306 | 0.198 | 0.000 | -2.840 | -1.772 |
| Mean value of duration of the fight (s) | 2013 | year 2014 | -37.845 | 14.069 | 0.050 | -75.74 4 | 0.055 |
| | | year 2015 | -46.224 | 14.069 | 0.015 | -84.12 3 | -8.324 |
| Average value of action | 2013 | year 2014 | -0.556 | 0.056 | 0.000 | -0.706 | -0.407 |
| | | year 2015 | -0.536 | 0.056 | 0.000 | -0.685 | -0.386 |
| Intensity of performed actions (s) | 2013 | year 2014 | -7.575 | 5.456 | 0.556 | -22.27 3 | 7.122 |
| | | year 2015 | -14.695 | 5.456 | 0.050 | -29.39 2 | 0.002 |

**Discussion**

Change in rules have always been a great challenge for the coach, wrestler, officials, but also the people who deal with detailed research of the complete impact of such changes on further development of a sport (Eduardo and Gonzalez, 2013). With the introduction of new rules, physical, technical, and also tactial preparedness in training process changes and adapts significantly so that the best results possible could be achieved.

One of the main reasons for intruduction of new rules was a wish for the fight to become more atractive and dynamic, and so that a higher number of points could be scored. It can be now said that, after the rules have changed in 2013, a significantly higher number of points is scored during the fight $p<0.001$ (Table 3) compared to the individual differences between the year 2013 and 2014 on level $p<0.001$, and compared to the differences between the year 2013 and 2015 on level $p=0.007$ (Table 4). When it comes to descriptive indicators, this would mean that 7 points were scored on average per fight at the European Championship 2013, 10.1 points at European Championship 2014, and 9.3 points at the First European Olympic Fames 2015 (Table 1).

By analyzing the indiviual segments of technical and tactical action of the fight, it can be seen that the causes of generally significant difference of total number of scored points per fight are the difference of scored points in standing position $p=0.002$, as well as the number of awarded passivity $p=0.001$ (Table 3). That is to say, for the variable "scored points in standing position", a difference between 2013 and 2014 on level $p=0.005$, and between 2013 and 2015 on level $p=0.006$ was determined. For the number-of-awarded-passibity variable, a difference between 2013 and 2014 on level $p=0.002$, and between 2013 and 2015 on level $p=0.004$ was determined (Table 4). Furthermore, as the elements of the technique in standing position, a significant difference in average number of performed actions that generally carry 1 and 2 points $p<0.001$ should be mentioned (Table 3), as well as individually, i.e. between the observed gropus for both variables $p<0.001$ (Table 4).

Duration of the fight has also sufferred structural changes in 2013. Significantly statistic differences in average values of duration of the fight $p=0.011$can be noticed (Table 3). Individual differences between 2013 and 2014 on the verge of significance $p=0.050$, and difference between 2013 and 2015 on level $p=0.012$ were noticed as well (Table 4).When the obtained average values of duration of the fight are comapred to other research results, which include partially the same sample of the competition (European Championship 2013 and 2014), the idential obtained results of sample that was included could be noticed (Marković and Kasum, 2013b; Kasum and Marković, 2014). With the change in number of rounds and their duration, the volume of the fight remained the same, but has significantly increased the total encumbrance during the fight. In connection with that, by comparing the average value of duration of fights at these competitions, the following results were obtained: at European Championship 2013, the average duration of a fight was 255 seconds, which is 70.88% of the maximum duration of a fight which is 360 seconds, at European Championship 2014, the average was 293 seconds i.e. 81.32%, whereas at the First European Olympic Games 2015, a fight approximately lasted for 302 seconds i.e. 83.88% of the entire fight (Table 1). During the first year, after new rules were enforced, duraion of the fight was increased by 11%, whereas during the second year, that number increased by another 2%. This shows that the factor of physical preparedness gained on its importance (Marković and Kasum, 2015).

All significant differences entail significant changes in average value of realized actions $p<0.001$, but also the intenisty-of-performed-actions variable is brought to the varge of statistical significance $p=0.052$ (Table 3). Average values of realized actions at the European Championship 2013, and other competitions in the research have a significant difference of achieved vales on level $p<0.001$. In the intensity-of-performed-actions variable, a difference on the verge of statistical significante $p=0.050$ between 2013 and 2015 can be noticed (Table

4). Compared to the research that entails European championships 2013 and 2014, identical values of obtained results of average-value-of-actions variable were determined as well (Kasum and Marković, 2014). Significant increase of the fight duration, as well as the same number of performed actions led to a decrease of intensity of realized action to the point of statistical significance. On average, 52.9 seconds were neccessary in order to realize an action at the European Championship 2013, 60.5 seconds at European Championship 2014, wherease 67.6 seconds were necessary for each action at the First European Olympic Games 2015 (Table 1).

The increase of the landing on the back technique value from 1 to 2 points led to an increase of technical action worth 2 points' value, but the number of realized landings on the back hasn't changed. Number of actions in standing position worth 1 point which dominated at the European Championship 2013, has been reduced for 70-80%. In 2013 the average number of those actions was 3.1 only to drip to 0.67 in 2014 and then reach 0.82 actions per fight in 2015. Number of actions in parterre worth 1 point has been constantly in dropping from 0.42 (year 2013) to 0.19 actions per fight (year 2015). Dominance of actions worth 1 point from 2013 turned into a dominant representation of actions worth 2 points in standing position in 2014 and 2015. In 2013, there was, on average, 0.095 actions worth 2 points, while in 2014 there was 2.386, and in 2015 2.401 such actions per fight. In 2013, in parterre there was 0.792 actions worth 2 points, in 2014 1.093, and in 2015 0.818. In total, the mean value of scoring technique has risen from 1.38 points in 2013 to 1.94 points in 2014, and to 1.91 point in 2015 which is confirmed by former researches (Kasum and Marković, 2014; Marković and Dopsaj, 2015). With the increase of scoring value of actions that carry small percentage of risk, there has been a drop in realization of actions worth 3 points, i.e. 4 points, but also actions with high amplitude of throws which are now worth 4 points as well. Therefore, in 2013, there has been 0.453 most attractive throws, in 2014 there has been 0.366 throws worth 4 points, while in 2015, there has been 0.316 of these throws per fight. It can be clearly seen that, during the biggest competitions, elite wrestlers rely on techniques that are more simple and safer for them (Marković and Kasum, 2013a; Marković and Kasum, 2013b; Kasum and Marković, 2014; Marković and Kasum, 2015; Marković and Dopsaj, 2015). However, it should not be forgotten that techniques that have the highest scoring value represent the basis for atractive wrestling (Tünnemann, 2013a) and even the most recent rules haven't iniciated the increase in number of such techniques.

Referees are constantly pressuring wrestlers to take over active fight, therefore, because of the passivity, they award 30 seconds during which the competior is required to try to realize an action. The realization of the task negates the second warning, while the incompletion of the required tasks automatically earns the opponet 2 point. An extraordinary difference in number of awarded passivity was noticed, which reflects the seriousness of referees to work towards the aim of improving wrestling (Kasum and Marković, 2014). At the European Championship 2013, 0.149 passivities per fight was awarder, at the European Championship 2014 0.504 passivities, and at the First European Olympic Games 2015 0.486 passivities (Table 1) which illustrates significantly greater insistence on activity during the fight.

Although statistically significant differences in presence of technical action groups haven't been established, based on the descriptive statistic indicators, some difference can be notices (Table 1). It can be noticed that the trend of decrease in number of realized attractive throws in standing position is continued, and that there's been an unexpected drop in landings on the back in standing position, which is confirmed by former researches (Marković and Kasum, 2013b; Kasum and Marković, 2014; Marković and Kasum, 2015; Marković and Dopsaj, 2015). There has also been a drop in realization of landings on the back in parterre, while the realization of takedowns has been increased. In other tested variables, the fixed trend has not been notices compared to the tested competitions. However, obtained results confirm that

the most common techniques at the rested competitions were landings on the back in standing position, procedures in parterre, as well as pushouts.

When a difference in points obtained by introducing the rules about the increase of action value and increase of sanctioning the passive fighting is subtracted from the current value of total number of scored points in obtained fight at the European Championships in 2014 and 2015, there would be quile similar data about the scored points at the competitions (Kasum and Marković, 2014). Beside the visual increase of scored points and dynamic of the fight, we remain concordant with the findings of other researchers that in free style wrestling, the reperoire of applied techniques is being narrowed and that attractive techniqes are less used, but the techniques that carry no significant risk for the attacker are dominating (Шахмурадов, 1997; Podlivajev, 1999; Tuennemann, 2013b; Marković and Kasum, 2013b; Kasum and Marković, 2014; Marković and Dopsaj, 2015; Marković and Kasum, 2015). These results indicate that the new rules contrubuted to visually more interesting fight, in terms of higher number of scored points and more frequent awarding of passivity. Because of this, the fight became more interesting, but not more simple and understandable for wider audience, thereby the most attractive and the most valuable scoring-wise wrestling throws are still less used at the biggest competitions.

**Conclusion**

The free style wrestlers' competitive activity analysis at the European Championship 2013 and 2014, as well as at the First European Olympic Games in 2015, is presented through comparion of summed up values divided into 6 categories from afore mentioned competitions, which are used as a sample before and after the change in rules happened towards the end of 2013.

It can be concluded that significantly more points are scored in a fight after the change in rules, on account of the number of awarded passivities and number of scored points in standing position. The increase of scoring technique value – landing on the back, has exclusively contributed to a larger number of points in standing position. Therefore, the average value of realized action has increased, but the number of actions in a fight hasn't. As a consequence, the intensity of realized actions has been reduced due to the increase of duration of a fight.The trend of drop in number of realized attractive throw in standing position continues. There has also been an unexpected drop in landings on the back in standing position, but in parterre as well, while the realization of takedowns has been increased. However, the most common techniques are landings on the back in standing position, actions in parterre, and pushouts. This confirms that the repertoire of techniques in free style wrestling is becoming narrow, that attractive techniques are less used and that techniques that carry no significant risk for the attacker are dominating.

The basis of attractive wrestling is represented by techniques that have the biggest scoring value, and these rules didn't iniciate the increase in number of such techniques. The results indicate that the new rules contributed to visually more interesting and more dynamic fight for the audience. However, the rules must be simplified so as to be more understandable and to attract wider audience's attention as much as possible.

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# ABSTRACTS

# Investigating the effectiveness of the partial and traditional (total) assay in teaching/learning complex technical ordinary activities in children wrestling

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**ABSTRACT**
All athletes do workout but few are those who stand out. The secret of these athletes is not they do more training, but they do better quality workout. The wrestling belongs to the technical sports that require a compound and complex motor skills in racing conditions. The search for more effective methods for the improvement of technical - tactical actions is a serious concern of wrestlers novice coaches. PURPOSE: Main goal was to investigate which of the two methods of teaching (partial or total) is effective for learning activities at beginner level .: 22 wrestlers took part M.C. age = 12,15 ± 1,26 years. Group A (n = 12 - partial method) and GROUP B (n = 10 - Total method) TECHNICAL selected: Dropping through the back with tying the hand to kneeling. Throwing shoulder by means of hand-foot lacing The experiment duration was 9 weeks The 1 to 2, the 29-30 and 61st-62nd day control tests were conducted. The content of the training (volume, intensity and charge) was the same in both groups. For the evaluation used three (3) methods: A) Evaluation of satisfactory implementation B) Performing (10 throws) the best time C) Factor Analysis of Technical Efficiency in sparring. Group A - performed 8300 repeats. in three phases: (48% technical energy was divided into 5 parts, 37% in two portions and 15% of the total process. The B group, put 4700 repeats in two stages: first, the technical effects disintegrated in 5 parts 17 % and the second 83% following the total. RESULTS: Cismas assessment A group Interim measurement: 6.8. Final measurement: 7.5. B Group Interim measurement: 7 Final measurement: 7.4 ▪ The results of the 10 throwing A group Interim measurement: 23,5s Final measurement: 18s B team Interim measurement: 21s, Final measurement: 19s ▪ In contest conditions the A team had much better performance with respect to the (DSS) by 63% compared with the B group improved by only 32% CONCLUSIONS: 1. for learning and perfecting complex technical-tactical actions advantageous partial teaching method in all assessment tests. 2.The result of learning the total process appears best in the early stages, however, the momentum of improvement decreases as proceeds of training.3. Separate the complex technical-tactic, allow athletes to better assimilate the critical link is given and to the perform effectively .4.In race conditions, partial method improved (63%) compared with those who exercised the total (32%).

**Key words:** wrestling, throwing, technical-tactical action, teaching method, total process, partial method, the technical evaluation process, efficiency ratio technique

# Model features of sensorimotor reactions and specific perception in wrestling

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**ABSTRACT**
PURPOSE: study and comparative analysis of elite wrestler's psycho-physiological features for prognostication of their successfulness and optimization of training. METHODS: Participants: 37 athletes involved in wrestling, divided into groups. The first group (n=14, age – 20.40±2.01 years) representatives of the Greco-Roman wrestling. The second group (n=12, age – 20.70±1.39 years) freestyle wrestlers. The third group (n=11, age – 20.80±1.07 years) consisted of sportsmen, practicing in women's wrestling. All participants were elite sportsmen. We used a complex of tests: assessment of sensorimotor motor responses (simple and complex), and specific perceptions. RESULTS: we confirmed similarity of sportsmen's functional state owing to likeness of results in most used tests'. Wrestlers of the first group had better indicators of a simple motor response, they performed quicker the desired choice of five colors, chose better the required half of the screen. Wrestlers of the second group had a better response to the moving object and the response of differences, tempo assessment. While copying the line and matching the shape, sportsmen of the third group had significantly less deviation from the preset templates. Analysis of correlation structures also confirms the closeness and stability of athletes' state, a small intension in adaptation of mechanisms during the execution of tests. Comparison of contribution of psychophysiological indicators in the education system established psychophysiological qualities are the most important for success in wrestling – reaction to the auditory signal, reaction of selecting half of the screen, copying the tempo and the line, speed of the line. CONCLUSIONS: we have proved the importance of wrestlers' psycho-physiological features as factors of success. The high level of the participants' preparedness led to the closeness of the results of many used techniques. An analysis of the correlation structure confirms the similarity of athletes' condition, illustrates the high level and stability of their training. Evaluation of the contribution of individual qualities in the system allowed to identify the main features depending on the type of wrestling. A promising area of optimization of training in wrestling is improving the most important psycho-physiological qualities.

**Key words:** elite wrestlers, functional state, psycho-physiological features.

# Applying model of individual zone of optimal functioning in Serbian wrestling national team

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**ABSTRACT**

PURPOSE: This study was aimed to determine usefulness of idiosyncratic, individually tailored theoretical and methodological framework considering relations between performance and success most often named "Individual zone of optimal functioning" (IZOF, Hanin, 2000).

METHODS: 12 Serbian wrestlers from national team, with range of experience from 5 to 25 years, retrospectively provide data about their best ever and worst ever performance through interview, brief check list of symptoms and metaphor generation method. Insight into the relations between anxiety state and its outcomes was examined relaying on meta-experiences. RESULTS: Qualitative analysis shows that interview and metaphoric generation data yielded 150 state descriptors that comprises all psychobiosocial modalities. The form/modality dimension, content and intensity vary according to time and context dimensions. Although emotional form, followed by cognitive form, is most salient modality in perceived gain or loss, content of emotions is very different across these two situations. Optimal pleasant and unpleasant states (e.g. like self-confidence, excitement, nervousness, anger and determination) dominate in best performances description, while dysfunctional pleasant and unpleasant states, as dejection, apathy and opponent underestimation are common in description of worst performances. Descriptors also vary depending on whether they indicated on states before, during and after the competition. Meta-experience data provide support for "in-out" zone notion and indicate on different coping mechanism in response to stress reduction. CONCLUSIONS: Model of individual zone of optimal functioning provides in-dept informations about highly individualized subjective experience considering competition performances. Since IZOF model provide good recommendations which interventions are appropriate for every athlete individually, it is useful to implement it in practice with sport clients.

**Key words:** IZOF model, metaphor generation method, meta-experience, wrestling.

# The investigation of loneliness levels of wrestlers in athletes' education centers

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**ABSTRACT**
PURPOSE: The aim of this study is investigation of loneliness levels of wrestlers in Athletes Education Centers. Some different demographic values were considered as age, gent, athlete age, and family and family income level. MATERIAL AND METHOD: The group of the research is in the making 175 wrestlers who are boarding and day pupil athletes of Athletes Education Center in Sivas, Tokat, Yozgat and Samsun. There are two scale in this research. First of them is personal information form and second of them is UCLA Loneliness Scale in the research as a data collection tool. DATA ANALYSIS: Percentage, frequency were used, on the other hand independent t test and one way anova test were used due to determine of different of variation in the analysis of data. RESULTS: As a result different of loneliness levels were find between young wrestlers and experiences wrestlers, the young wrestlers are more loneliness level than the experience wrestlers, because of their ages are less than the experience wrestlers. CONCLUSION: Similarly it is seen that the young wrestlers must be newly separated from their parents' families and their adaptation problems for a different orientation is effective on their loneliness levels.

**Key words:** Loneliness, Athletes Education Center, Wrestler

# The tradition of master-apprentice in Turkish wrestling: instance of hikmet kesen (master) - recep kara (apprentice)

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**ABSTRACT**
PURPOSE: Wrestling is a essential element for Turkish societies. Wrestling have been fueled by understanding and existence of Turkish societies. It is seen that master- apprentice relationship which has been seen as traditional format in Turkish societies has been also continued in wrestling. Master - apprentice relationship is important that able to be successful and exemplary sportsman. In this research master- apprentice relationship was examined in wrestling which is one of traditional sports. In this context instance of Hikmet Kesen (master) - Recep Kara (apprentice) was introduced. The research is important that to known and sustained of master- apprentice relationship in wrestling which is one of traditional sports. METHODS: Literature search and face to face meeting methods were used as data collection tools in the research. According to obtained knowledge in the research is shown that the tradition of master- apprentice relationship have an important place in wrestling which is a traditional sports as well as in a lot of cultural elements. CONCLUSIONS: In this context the master (Hikmet Kesen) have an important place that the apprentice (Recep Kara) able to be success and exemplary sportsman.

**Key words:** Wrestling, Master-Apprentice Relationship, Hikmet Kesen, Recep Kara

# Creation of wrestling competition analysis form according to the latest competition rules

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**ABSTRACT**
PURPOSE: The wrestling, the oldest sports branch in the history of the Olympics, has faced a danger of dropping out of the Olympic Games with a decrease in its watching pleasure and popularity. In this context, many test tournaments have been accomplished and competition rules have been revised in order to increase the watching pleasure of wrestling prior to the 2016 Rio Olympic Games and to make the competitions watchable by the spectators. The rules finalized by the United World Wrestling (UWW) have been made, therefore, easier to comprehend by the spectators. There are competition analysis forms for many sports branches in the literature. Since the rules are fixed ones in these branches, the competition analysis forms do not show any variation for this reason. However, with the change of rules in wrestling competitions, it has become a necessity to change also the competition analysis form. In this context, the purpose of this study is to creation of wrestling competition analysis form according to the latest competition rules. This form was obtained based on the UWW's latest competition rules for applying in all styles of Olympic wrestling (freestyle, Free-Style Women, Greco-Roman).Additionally, development of this form and bringing universality to the latest wrestling rules will make it easier for researchers working on wrestling competition analysis in the world, as well as helping coaches and managers to record their wrestlers in competitions and the competitors to compete against them. CONCLUSIONS: As a result, thanks to this form it will be possible for the wrestler to decide on which period of the competition, how many minutes, where and how he/she applies the technique, from which side he/she applies the technique laterally, and how many points he has received.

**Key words:** Wrestling, Competition Analysis Form, Wrestling Competition Rules

# The investigation of aptitude test of wrestlers in Turkey

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**ABSTRACT**
PURPOSE: The aim of this study is to determine whether elite wrestlers in Turkey are subjected to an ability test when they begin their wrestling. METHODES: A total of 200 volunteer athletes who actively wrestling in sports clubs in different cities of Turkey participated in the research. In the prepared questionnaire, wrestlers were asked questions such as "Did your coach perform any aptitude tests when you started the sport" and "If your answer is yes, what kind of tests did your coach perform to determine your abilities?" and each wrestler's questionnaire form was recorded and evaluated. SPSS 22.0 computer program was used for statistical analysis. RESULTS: It was determined that no aptitude test was performed when 158 (75%) of the 210 athletes wrestling actively began to wrestle in Turkey. On the other hand the aptitude test was evaluated to 42 (%25) wrestlers, 17 (10%) of them were evaluated in the wrestling competition, 17 (10%) were evaluated by physical structure and 8 (5%) were evaluated by running test. According to the findings, it is understood that the scientific aptitude test has not been performed to the beginner wrestlers in Turkey. CONCLUSION: Considering that wrestling is the sport branch that receives the highest number of medals in Turkey, it is predicted that if the aptitude test is determined with the scientific methods, the success will increase.

**Key words:** Sport, Wrestling, Wrestler, Aptitude test

# Comparison of skin infections of wrestlers in different climatic regions of Turkey

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**ABSTRACT**
PURPOSE: The aim of this study is to provide the comparison of the commonly seen skin infections of wrestlers in terms of different climatic regions in Turkey. METHODS: Three hundred nineteen volunteer athletes who actively wrestle in the sports clubs in different climatic regions (eastern, central and coastal regions) of Turkey participated. The questions in the survey of "Personal History and Dermatological Examination Findings of Athlete" which was prepared before starting the research were asked by the dermatologist at the time of examination and the examination findings of each wrestler were recorded in this questionnaire form and then evaluated. RESULTS: During the physical examination of 319 Turkish wrestlers in our study, skin infections were detected in 216 (67.71%) cases. In the eastern region, a total of 80 (61.09%) wrestlers were detected to have skin infections and of those, 44 (33.84%) had fungal infection, 37 (42.52%) had bacterial infection and 13% (10) had viral infection, respectively. In the central region, a total of 71 (81.59%) were detected to have skin infections and of those, 37 (42.52%) had fungal infection, 18 (20.68%) had bacterial infection and 16 (18.39%) had viral infection, respectively. In the coastal region, a total of 65 (63.71%) wrestlers were detected to have skin infections and of those, 50 (49.01%) had fungal infections, 11(10.78%) had bacterial infection and 4 (3.92%) had viral infection, respectively. CONCLUSIONS: It was understood that there were skin infections in the wrestlers living in three different climatic regions of Turkey. According to this result, fungal infections in the coastal and eastern regions, bacterial infections in the central and eastern regions and viral infections in the eastern and central regions were detected to be more common.

**Keywords:** Skin infection, Wrestlers, Climatic region

# Differences in performed actions of winners and defeated female cadet wrestlers in a standing position

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**ABSTRACT**
PURPOSE: Wrestling is very intense polystructural acyclic activity in which female wrestlers have the possibility to win or be defeated based on their current performances. For this reasons, athletes and coaches must understand the demands of wrestling in competition as well as the significance of the informations collected by notation analysis at the competition, which are later analyzed in purpose of improving wrestling performances on a higher, better level. The purpose of this research is determining differences in performed wrestling technical actions of winners (W) and defeated (D) female cadet wrestlers in a standing position at European cadet championship for male and female cadets. METHODS: The sample of subjects consists n=267 throwing technique from which the winners achieved n=203, and defeated contestants n=67 throwing techniques. The sample of variables are all from standing throwing techniques which were successfully applied during the fight, and the judges, based on that efficiency, gave adequate points. The data were collected based on notation analysis of videos at European championship for cadets, held in Sarajevo (Bosnia and Herzegovina) in 2010. in all weight categories for cadets. In order to identify differences in accomplished perormances between winners and defeated contestants, the Wilcoxon rank test was used, at the level of statistical significance of $p \leq 0.05$. RESULTS: The results of Wilcoxon rank test showed that the winners dominate in comparison to defeated wrestlers in the following techniques in the standing position: Take down (p<.001) W=70,9% - D=29,1%, Push out techniques (p=.013) W=84,6% - D=15,4%, Throw with both legs locked (p=.002) W=92,3% - L=7,7%, A Fireman's carry (p=.011) W=90,0% - D=10,0%, Pulling down (p=.014) W=100,0% - D=0,0%, Side throws (p<.001) W=99,4% - D=5,6%, while in counterattack techniques in standing position (p=.157) and Sholder throw with no significant difference (p=.157). CONCLUSION: The value of the data collected indicate that, in cadet phase on this level of competition, individual wrestling techniques significantly dominate over other wrestling techniques. By far the most effective techniques, used by winners and defeated contestants, is Take down technique, and after it, Side throws. It is clear that the contestants inexperience, technical exellence and fitness levels contributed to the differences between winners and defeated contestants. Based on the results, this type of collecting data about performance levels is repeatable, and based on this, coaches can design new programs of training that will improve the performance of contestants, both in attack and in defense.

**Keywords:** tehnical action, attak, deffese, championship, video analysis

# An ancient sports institution of Turks: The example of Ottoman wrestling *tekkes*

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**ABSTRACT**
PURPOSE: This study examines the functioning of the institutions that may now be called "Wrestling Training Centers" or "Sports Academies" which were once organized under the name of "Wrestling Tekkes (Wrestling Lodges)" in the Ottoman period (1299 - 1923) and their contributions to the wrestling. The sports branch first formatted and institutionalized by the Ottoman Empire with the experience inherited from the previous Turkish states is wrestling. The wresting tekkes were also among the social service buildings first built by the Ottomans in the lands conquered by the Empire. The tekkes used to constitute a widespread and deeply-organized qualifying & support system, especially in the Balkans. Those were recorded in the documents which are called "Ottoman Archives" today. Aiming at adding value to the world wrestling with the world sports literature, this study has various orientations such as objective, historical, subjective, psychological etc. In this study, we will try to explain and exemplify all the arguments under this subject only as a representation instead of trying to prove them. METHODS: Conducted using the history scanning method, this study is mainly based on the Ottoman archive documents. These original archive documents, most of which will be used for the first time, has been classified in accordance with the format proposed by the International Council on Archives (ICA). RESULTS: Apart from those which were taken over from the predecessor Turkish states, the first wrestling tekke of the Ottoman Empire was built in 1332-36. Until 1699, dozens of new ones were added and from then on, the activities of the existing tekkes continued until 1827 without opening ones. Only three of all the tekkes closed on this date was reopened in 1861; however, they lost their function in 1913 and were officially closed on 30 November 1925. CONCLUSIONS: These institutions, which represent the organization of the wrestling in the Ottoman Empire, constitute a local government structure that approaches the West to the extent that it steers away from Eastern traditions. These tekkes which are very close to a club with a contemporary analogy however, goes beyond them since the tekkes also incorporate the social security dimension, played a decisive role in the development of sports in the Balkans and Anatolia. They served as the first organizational structures which are abstracted from war education and headed entirely towards the sports, especially the wrestling.

**Key words:** Wrestling Historical, Ottoman Empire, Lodge (Tekke), Wrestling School

# The place of wrestling and wrestlers in the Ottoman state tradition

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**ABSTRACT**
PURPOSE: The most important place where we must look if we want to find traces of the wrestling in the past is the inheritance of knowledge we have carried up to now with many methods. This gigantic collection of resources called "history" is not only necessary to understand the past, but also an important building stone to build the future on a proper foundation. This study sought an answer to the question where the wrestling and the wrestlers were positioned by the Ottoman palace administration (1299-1923). The study aimed to find the answer to this question with reference to 624 years of rule by the Ottoman Empire and introduce such answer to the world wrestling literature. METHODS: Within the research, the screening method was employed, and certain binding resources, notes of travelers and Ottoman manuscripts were referenced. Moreover, the study was mainly based upon the archive documents in which the financial and spiritual support given by the Ottoman khans to the wrestlers were recorded and archived by the palace officials. RESULTS: In the Ottoman Empire, the wrestling was considered both as a way of sharpening vigilance and war techniques until modern times, and a sign of blessing of the physical skill and spiritual power. The palace had a magical esteem towards the wrestling and wrestlers, and the only sports branch that gathers the public and the palace together became wrestling. From the New Age to its fall, the Ottoman Empire officially employed numerous wrestlers from all ethnic and religious backgrounds including those within its borders and outside its borders such as India, Pakistan and Central Asia, and thus always revived the wrestling. CONCLUSIONS: As it was written, the tradition of wrestling in the Ottoman Empire contained both a code of morality and forms of honor of the past. In the Ottoman Empire, where there are social layers and classes designated with definite lines, the viziers and even sultans competed in equal conditions during the competitions. Apart from many national, religious and economic events, the sultans ordered the organization of wrestling events three days a week, gave great support to the wrestlers from their personal properties, and established a material and spiritual patronage by granting various high reputations to the aged wrestlers.

**Key words:** Wrestling, Wrestler, Ottoman State Tradition

# Effect of a two-week beta-alanine supplementation on plasma carnosine and lactic acid in trained-wrestlers

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**ABSTRACT**
PURPOSE: Some studies have reported that β-alanine supplementation can increase high-intensity intermittent exercise performance and training adaptations. In this study, we investigated the effect of β-alanine on lactate acid and carnosine in trained wrestlers. METHODS: 19 trained-wrestlers (mean age ± SD 22.52±2.31 yrs. height173.38 ± 4.86 cm, weight 76.22 ± 9.07 kg) participated in this design and randomly divided into supplementation (s) and placebo (P) groups. S group consumed 1000 mg β-alanine and P group consumed placebo for 2 weeks. Blood samples were taken, before the first and 6 minutes after the last HIIT test for detection of plasma lactate and carnosine. SPSS software and independent t-test method were used for analyzing data ($p<0.05$). RESULTS: The S group, taking β-alanine, showed a significant decrease in lactic acid ($p=0.00$) and a significant increase in carnosine plasma ($p=0.02$), While these changes weren't observed in the P group. CONCLUSION: According to the results, β-alanine supplementation for 2 weeks may be associated with increase buffering system via an increase in carnosine and decrease lactic acid during high-intensity interval training in wrestlers. We recommend that β-alanine supplementation may be useful for wrestling athletes.

**Key words:** beta-alanine, carnosine, lactic acid, wrestling

# The development and initial validation of the Russian version of mental toughness questionnaire

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**ABSTRACT**
PURPOSE: Research on mental toughness (MT) in sport performance (Loehr, 1994; Goldberg, 1998; Connaughton, 2008; Gucciardi et al., 2015 etc.) has been limited by lack of a valid measure for the construct in Russian. The questionnaire «Complex Assessment of Mental Toughness and Adaptation in Sport» (Russian acronym - «COMPAS») was developed and initially validated to assess MT in athletes. The purpose of current study was to examine the factorial and construct validity of the nine-factor model of MT. METHODS: A diverse sample of competitive Russian athletes (novice, intermediate and elite level) completed the questionnaire (N = 414; 60.6% male; 39.4% female; Mean age ± SD = 20.11±6.8 y.o.). The sample consisted of different sports: game sports (35.48%); martial arts & combat sports (28.15%); cyclic (16.72%) & complex coordination sports (16.72%); applied (12.32%), shooting (8.5%) & strength sports (3.52%). The first version of COMPAS consist of 60 items in Likert Scale. The items were created according to the results of a) content analysis of MT studies (including MT-questionnaires) b) semi-structural qualitative interview with the multiple Olympic champions (from Russia; N=8) (Akhmerova et al., 2015). We tested the factorial validity with confirmatory factor analysis using EQS 6.3. Construct validity evidence was gathered by examining the relationship between the subscales of the COMPAS and the subscales of the Russian versions of questionnaires (SPSS 20.0 was used): State and Trait Anxiety Inventory - STAI (Eliseev, 2001), Sport Motivation Scale - SMS (Kasatkin et al., 2012), Sport Imagery Questionnaire – SIQ (Veraksa et al., 2014), Multidimensional Perfectionism Scale - MPS (Gracheva, 2006).

In addition we compared MT-skills in elite athletes in wrestling (N=23; freestyle & Greco-Roman wrestling) and striking types of combat sports (N=19; boxing, kickboxing, taekwondo) (via Mann-Whitney U test). RESULTS: The final version of COMPAS consists of 49 items that assess 9 subscales of the MT: «coping with negative emotions and rumination», «activation & relaxation skills», «imagery», «engagement & flow», «self-efficacy», «goal settings & time management», «handling pre-competitive pressure», «relationships with the coach», «amotivation». Fit indices from confirmatory factor analyses provided partial support for the hypothesised measurement model, with equal or better fit demonstrated than evident in initial validation. The comparative fit index values were close to acceptable guidelines for all subscales. Statistically significant bivariate correlations revealed that the subscales of the COMPAS were related to the subscales of STAI, SMS, SIQ, MPS. Difference in MT-skills in elite athletes of wrestling and striking types of combat sports were analyzed: wrestlers demonstrate better abilities in goal settings & time management skills ($p<.01$). CONCLUSION: Our findings suggest that the COMPAS is valid measure of mental toughness in sport contexts, and can be applied in future psychological research and applied practice in Russian speaking athletes.

**Key words:** sport psychology, psychodiagnostics, mental skills

# Strength and training profiles of top Greco-Roman wrestlers in Finland

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**ABSTRACT**
PURPOSE. The study presents strength and training profiles of five Finnish Greco-Romanian wrestlers (59kg, 66kg, 75kg, 85kg, 98kg) who competed in Qualifying Tournaments for Rio de Janeiro Olympic Games held in 2016. METHODS: Athletes maximal strength (1 RM) was measured in 90° squat, bench press and power clean. Training diaries recorded with specifically developed mobile application were analyzed for 6 months before last Olympic Qualification Tournament (non-qualified) or 6 months before Olympic games (qualified). RESULTS:Strength tests: squat 160-200kg (2.0-2.7 x BW), bench press 120-205kg (1.8-2.4 x BW), power clean 100-145kg (1.5-1.9 x BW). Regression analysis between maximal strength and weight category: r2 = 0.86 in squat, r2 = 0.71 in bench press and r2 = 0.77 in power clean. As an average the wrestlers practiced 10h 15min/wk (1.5h/d). The greatest number of training hours in a week was 21h (3.0h/d) during the study period. In total, training consisted of 44% wrestling, 37% strength and conditioning and 19% active recovery exercises (low intensity exercises). Wrestling sessions included 30% technique exercises, 25% matches, 16% situation battles, 15% technical and tactical matches and 13% throwing series. Strength and conditioning training included 49% endurance, 29% strength and 22% speed and explosiveness. CONCLUSION:The level of strength among Finnish top wrestlers was high (compared to athletes competing in other sports) but the strength did not discriminate those wrestlers qualified to Olympic Games (2 out of 5 wrestlers) from those who did not (3 out of 5). More variation between studied wrestlers was found on how much time was spent in different training objectives than in the amount of hours totally practiced.

**Key words:** technique exercises, squat, bench press, endurance

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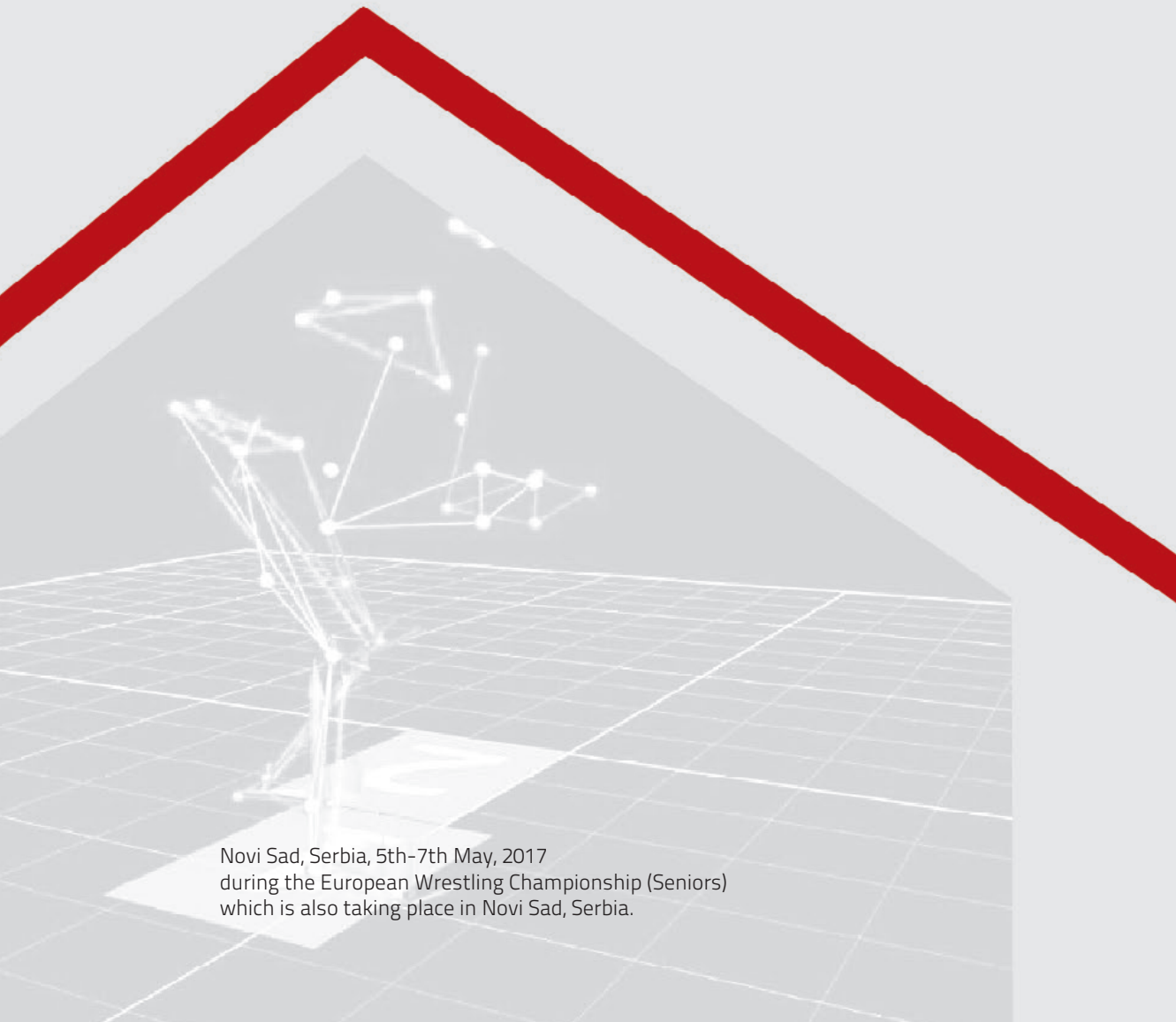

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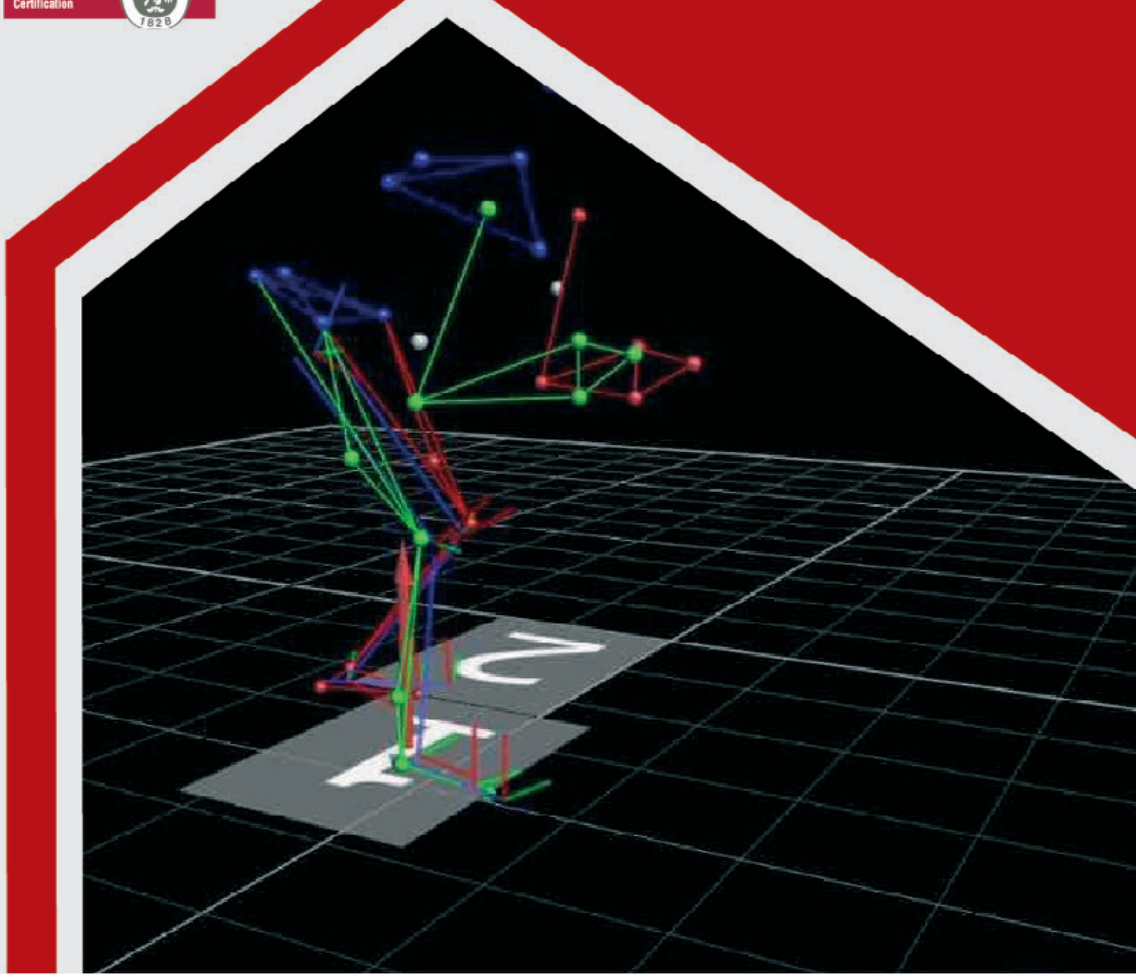

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