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Editor's Comments

Welcome to the World Championship issue of the International Journal of Wrestling Science!

On the cover is **Stevan Micic (photo by Tony Rotundo)** who won the first freestyle world championship for host country Serbia. Micic, who also wrestled for the University of Michigan, took a remarkable path to the gold medal as he had to beat a two-time world champion and reigning Olympic champion in Zaur Uguev, followed by the champion in Zelimkhan Abakarov in the semis, both of whom had beaten him previously. He then defeated 61 kg reigning world champion Higuchi Rei in an intense final.

This issue also contains proceedings from the UWW Scientific Symposium at the 2023 Senior World Championships in Belgrade. Organized by the International Network of Wrestling Researchers (INWR) working with the Serbian Wrestling Federation and the Scientific Commission of United World Wrestling, the symposium is entitled, *"Using Sport Science to Help Wrestlers and Coaches."* held on September 20, 2023.

Sincerely yours in the advancement of Wrestling,

David Curby EdD
Director of the International Network of Wrestling Researchers
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FREESTYLE WRESTLERS REACTION TIME DIFFERENCES BETWEEN DIFFERENT WRESTLING SPECIFIC VISUAL STIMULI AND KINETIC RESPONSES

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Abstract
PURPOSE of the current study was to examine the differences between the reaction time of wrestlers attacking the left leg, the right leg or both legs given a different kinetic visual stimulus. METHODS: The sample consisted of 19 wrestling athletes, male and female, who voluntarily participated in the research, seven were adolescent girls with an average age of 16 ± 1.95 years while 12 were young men with an average age of 20.27 ± 2.27 years. “Barbas 3D Wrestling Dummy” was used to produce stimuli and to apply the responses to these stimuli on it. Two in-floor force plates were used, the athletes stood on them so that the first occurrence of force at the onset of the motor response after the stimulus was recorded. An extensometer attached to the dummy's ankles and an accelerometer placed on the dummy’s back were used to observe the timing of the onset of the stimuli during the measurements procedure. RESULTS: In all comparissons the “type of stimulus” factor showed statistically significant main effect with the mean reaction times of attacking the left leg being lower than the ones of attacking the right leg or both legs, also the mean reaction times when the attack occurred on the right leg were shorter than the ones of the attack on both legs. CONCLUSIONS: The different kinetic responses as well as the differences concerning the source of stimuli and the target of the response could be the major causes for the current results. More research is needed before we can safely assume that our results are valid for other wrestling athletes too as gender, age, physique, type and intensity of stimulus as well as the kinetic response critically influence reaction time.

Keywords: Wrestling, Reaction time, Visual stimulus

INTRODUCTION

By its nature, wrestling is a demanding, complex sport that requires the simultaneous and harmonious cooperation of body and mind. A wrestling athlete should have a high level of developed physical abilities (strength, speed, endurance, power, flexibility, etc.), a good level of technical and tactical skills, as well as highly developed psychological skills and emotional intelligence (courage, self-confidence, commitment, etc.) (Cieslinskil et al., 2021, Gkrekidis and Barmpas 2017).

Reaction time is one of the most decisive elements for good performance and success in sports and especially in the sport of wrestling (Kaya, 2016, Iri et. al., 2016). In a wrestling match the athlete is required to react as quickly as possible to the movements of the opponent's limbs or torso and to make immediate decisions under the pressure of his opponents as the time frames for a successful attack, defense or counterattack in wrestling are really short (Gierczuk, et al., 2017 Kaya, 2016; Yoon, 2002)

Reaction time is defined as the time between the occurrence of a stimulus and the occurrence of the motor response by the athlete. Reaction time is divided into two parts, the pre-motor time which is the time between the stimulus and the onset of muscle activity and the motor time which is the time between the onset of muscle activity and the onset of visible movement (Zervas, 2011).

Double and single-leg takedowns, either high crotch or low, are amongst the most common attack moves in freestyle and women’s wrestling (Capriano 1993, Tünnemann and Curby 2016). Like in almost every attack during a wrestling

match, the attacking wrestler reacts to the opponent's move and performs the attack. In the sport of wrestling, quick and precise reactions are essential for seizing attack opportunities and effectively countering an opponent's movements. If the opponent is forced to move his left leg back and the right leg is left in front while he/she is on balanced there is an attack opportunity for a single leg attack on the front leg and vice versa. In the same sense, if the defending wrestler is forced to rise his/her trunk, the attacking wrestler has the opportunity to attack both legs with a double-leg takedown.

But do the wrestlers react with the same speed in all the above situations? To comprehensively understand the dynamics of reaction times in different wrestling attacks starting from different stimuli, further research is needed. Identifying such differences can provide valuable insights for coaches and athletes in optimizing their training strategies and tactical approaches during matches. The aim of the current study was to examine the differences between the reaction time of wrestlers attacking the left leg, the right leg or both legs given a different kinetic visual stimulus for every attack.

METHODOLOGY

Sample

The research sample consisted of 19 wrestling athletes, male and female, who voluntarily participated in the research. Of the 19 sample members, 7 were adolescent girls with an average age of 16 ± 1.95 years while 12 were young men with an average age of 20.27 ± 2.27 years. The athletes selected were from different parts of Greece, the girls were all members of the national team, and so were three of the boys in their age and weight categories while the rest of the participants were national level athletes. The selection of the athletes was based on their training and competition level as well as their ability to attend the measurement site on the dates of the research. All measurements were carried out in the Biomechanics Laboratory of the Faculty of Physical Education and Sports Science of the Democritus University of Thrace, which is located in Komotini. All participants were familiar with the use of the techniques used as responses to the stimuli and their application on the dummy.

Description of the instruments used

"Barbas 3D Wrestling Dummy" was used in the experiment process to generate stimuli and to perform techniques on it as a response by the participants (Figure 1) (Barbas, et al., 2017). At the neck and the ankles of the dummy were tied ropes, the other end of which was tied to an improvised wooden construction that resembled the wooden cross of a puppet. The rope tied to the neck was attached to the end of the vertical wood of the structure while the ropes of each of the two legs were attached to the left and right ends respectively of the horizontal wood of the structure. The ropes and the structure served to produce a visual stimulus related to the sport of wrestling as will be referred below.

An accelerometer (K-Beam, Kistler) was placed on the back of the dummy, which according to the procedure described below was used to observe the time of occurrence of one of the stimuli (Figure 1). Moreover, two in-floor force plates (Kistler) with NEXUS software (Vicon) were used on which the athletes stood so that the first occurrence of force at the onset of the motor response after the stimulus was recorded. All data was sent to an electric computer on which the analysis was performed. In addition, an extensometer (CD-60, Interfels) attached with an extension of thin rope to the dummy's legs at the ankles was used to observe the timing of the onset of two of the stimuli in the measurement procedure (Figure 1).

Figure 1. Barbas 3D Wrestling dummy with the ropes, the extensiometer and the accelerometer

Procedures
During the tests, participants were asked to respond as quickly as possible to a stimulus. Both the visual stimuli and the responses were kinesthetically related to wrestling. The visual stimuli given to the subjects were three. One visual stimulus was the light lifting of the doll's torso by pulling the corresponding rope using the wooden structure, while the other two visual stimuli were the pulling backwards of the doll's left or right leg respectively. The subject did not have eye contact with the operator of the wooden structure so that he could not tell which of the ropes he was about to pull.

Each stimulus had only one response. When the stimulus was to lift the dummy's torso (TMU), subjects had to respond by performing a double leg takedown. When the stimulus was pulling the dummy's right leg back (RLMB), subjects performed a single leg takedown. When the stimulus was pulling the left leg of the dummy back (LLMB), subjects performed a low outside slide single leg takedown.

The subjects found the position of their feet on the two force plates according to their wrestling stance (e.g., left or right foot in front) and this position was marked so that it was maintained throughout the measurement. The exact position of the dummy's legs was then marked so that their positions were also kept the same after the pulls throughout. The athlete then performed a trial attempt for each stimulus with the corresponding response. Then the actual measurements began. Each subject performed five consecutive attempts with each visual stimulus (e.g. five attempts with a torso pull, then five with a right leg pull, etc.). The order in which each set of five trials was performed was changed randomly for each participant according to the examiners' instructions. There was a 10-second break between each attempt and a half-minute break between each set (quintet of attempts).

Statistics
Means and standard deviations for reaction time to each stimulus were calculated for the three trials. To test the variation of reaction time values across the different measurements, analysis of variance was applied for repeated measures (3x3), with repeated factors being the trial (1st, 2nd, 3rd) and the type of stimulus (RLMB: Right leg movement backwards, LLMB Left leg movement backwards, TMU: Trunk movement upwards). Comparisons were made between the left or right leg attack, between the right leg attack and the attack on both legs, and between the left leg attack and the attack on both legs. For all statistical analyses, the level of statistical significance was set at $p<.05$.

RESULTS
Descriptive Statistics
The means and standard deviations of the reaction time to a motor stimulus in each measurement condition are presented for the three trials in Figure 2 and Table 1.

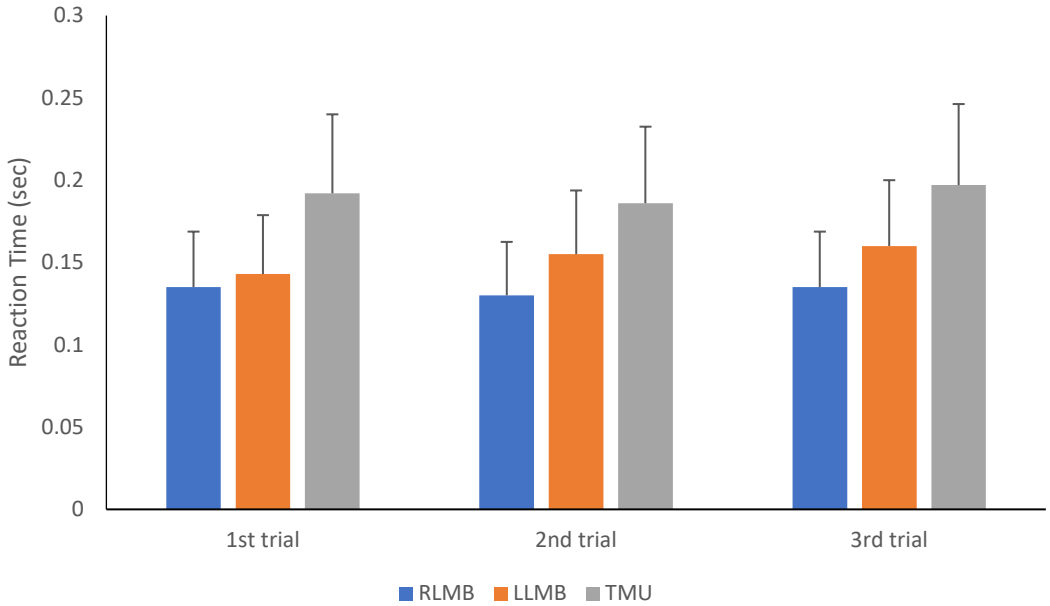

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Figure 2: Means of reaction time to motor stimulus in each condition for the three trials.

Table 1. Means and standard deviations of reaction time to motor stimulus in each measurement condition are presented for the three trials (RLMB: Right leg movement backwards, LLMB Left leg movement backwards, TMU: Trunk movement upwards).

	1st Trial		2nd Trial		3rd Trial	
RLMB	0,135	±0,023	0,130	±0,031	0,135	±0,041
LLMB	0,143	±0,042	0,155	±0,045	0,160	±0,045
TMU	0,192	±0,042	0,186	±0,042	0,197	±0,045

Comparison of reaction times to motor stimulus between an attack on the left or right leg. From the results of the analysis of variance for repeated measures, it was found that there was no statistically significant interaction between the factors "type of stimulus" and "trial" ($_{F2,34}$=0.677, p=.515, η^2=.038). On the contrary, there was a statistically significant main effect of the factor " type of stimulus " ($F_{1,17}$=27.479, p<.001, η^2=.618). While there was no statistically significant main effect of the factor "trial" ($F_{2,34}$=1.048, p=.362, η^2=.058). Therefore, reaction times differed significantly between attacking the dummy's right leg (LLMB) and attacking the left leg (RLMB) but not between the three trials, with the mean reaction times when attacking the left leg being shorter (Figure 3).

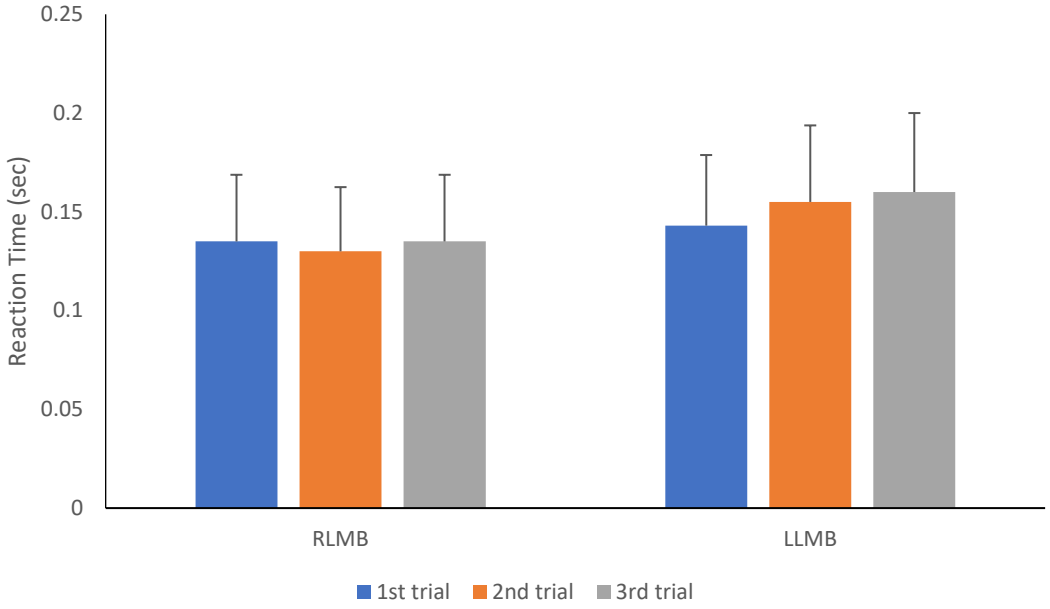

Figure 3. Mean reaction times to a motor stimulus attacking the left or right leg (RLMB or LLMB).

Comparison of reaction times to a motor stimulus between an attack on the left leg or both legs. From the results of the analysis of variance for repeated measures, it was found that there was no statistically significant interaction between the factors "type of stimulus" and "trial" ($F_{2,34}$=0.103, p=.903, η^2=.006). On the contrary, there was a statistically significant main effect of the factor "type of stimulus" ($F_{1,17}$=114.910, p<.001, η^2=.871). While there was no statistically significant main effect of the factor "trial" ($F_{2,34}$=0.611, p=.548, η^2=.035). Therefore, reaction times differed significantly between attacking the dummy's left leg (RLMB) and attacking both legs (TMU) but not between the three trials, with the mean reaction times being shorter when attacking the left leg with the stimuli being pulling the right leg backwards (Figure 4).

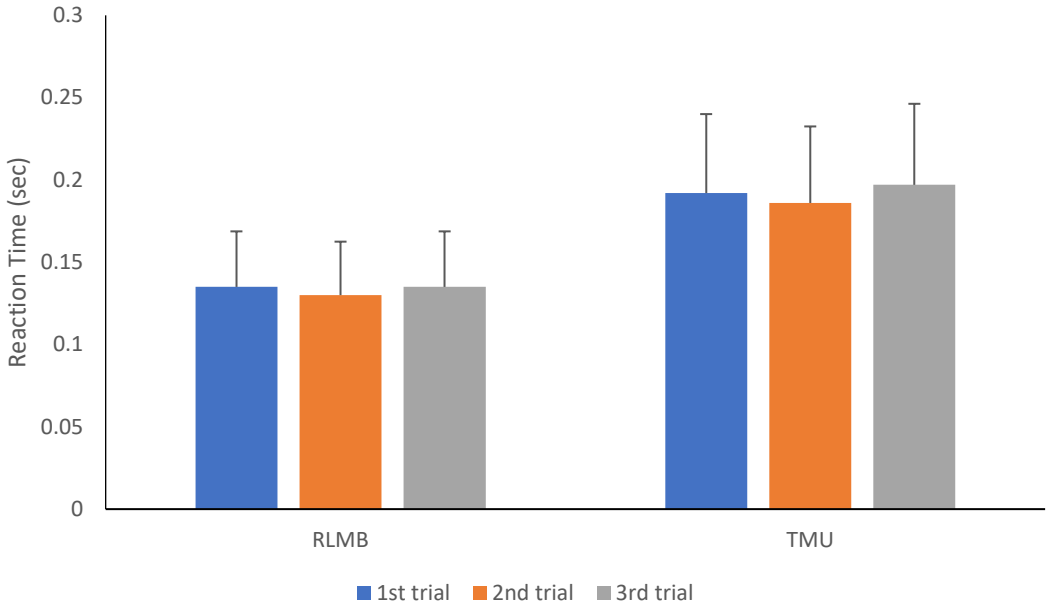

Figure 4. Average reaction times to a motor stimulus with an attack on the left leg or both legs (RLMB or TMU).

Comparison of reaction times to a motor stimulus between an attack on the right leg or both legs. From the results of the analysis of variance for repeated measures, it was found that there was no statistically significant interaction between the factors " type of stimulus " and "trial" ($F_{2,34}$=0.677, p=.515, η^2=.038). On the contrary, a statistically significant main effect of the factor " type of stimulus " was found ($F_{1,17}$=27.479, p<.001, η^2=.618). While no statistically significant main effect of the factor "trial" was found ($F_{2,34}$=1.048, p=.362, η^2=.058). Therefore, reaction times differed significantly between the attack on the right leg (LLMB) and the attack on both legs of the dummy (TMU) but not between the three attempts, with the mean reaction times when the attack was performed on the right leg being shorter (Figure 5).

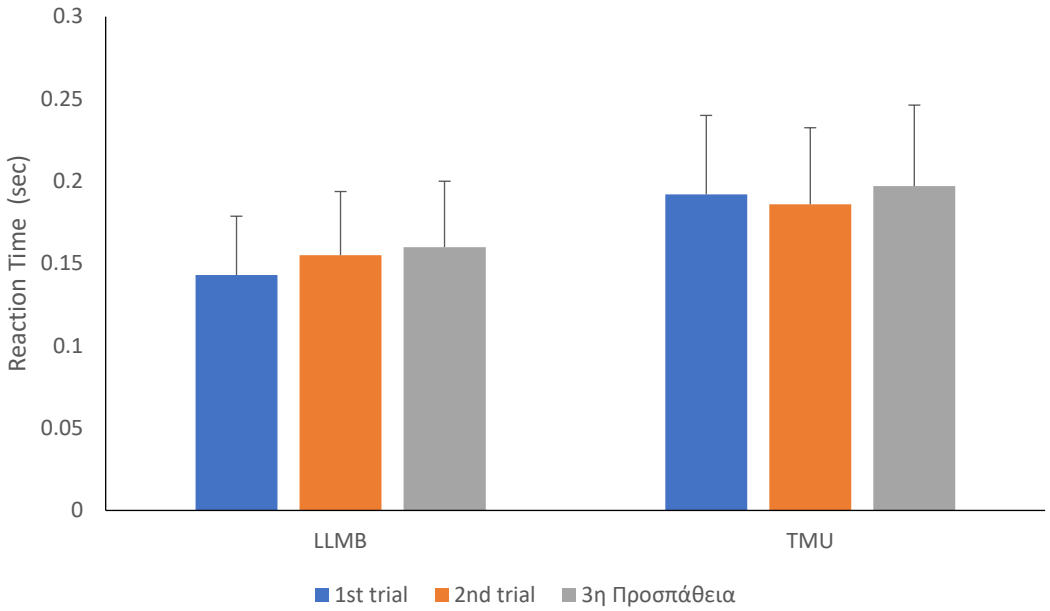

Figure 5. Average reaction times to a motor stimulus with an attack on the right leg or both legs (LLMB or TMU).

Discussion

As mentioned above the “type of stimulus” factor had a statistically significant main effect. The subjects had the shortest reaction times attacking the right leg of the dummy than when they were attacking the left or both legs. There could be several causes for this. First of all, the different kinetic responses between the two legs (single leg

or outside slide low single leg takedown) could affect the reaction times of the subjects. For the single leg takedown, the subjects were moving straight towards the dummy kneeling between the dummy's legs while for the low outside slide, they were moving to the "outside" of the dummy kneeling outside the dummy's legs. Perhaps the reaction times were also influenced by the side each athlete was used to attack the opponent, as there are wrestlers who attack more often the one side than the other, a factor that could affect their performance in the reaction time evaluation.

The slowest reaction times were observed when the stimulus involved the rise of the dummy's trunk and the subjects were required to attack both legs (TMU). One possible explanation for this observation could be the intensity and duration of the stimulus, as longer and more intense stimuli tend to elicit faster reaction times (Kolinski, 2012, Rolf & Rinkenauer, 1998). In comparison, the motor stimulus in the left or right leg attacks involved a greater intensity and duration, as pulling one of the dummy's legs back produced a visually more intense and sustained effect than the upward movement of the torso, which was momentary due to the dummy's springs. Another contributing factor to the longer reaction times in the TMU stimulus could be the complexity of the task, as participants had to respond to a stimulus caused by the torso while attacking the legs. In contrast, in attacks with a motor stimulus on one leg, the response was directed towards attacking the opposite leg, which may have led to better concentration and quicker reaction times.

The reaction times in the current research proved to be shorter than those in the studies of Celnek et al., (2015) and Kaya (2016) that also evaluated the reaction time of wrestlers. In the research of Celnek et al., (2015) participants were asked to respond to the sound stimulus by moving only their arm, in Kaya's (2016) research participants were asked to respond to the sound stimulus by moving only their leg while in the present research participants were asked to respond by moving their whole body as in a realistic wrestling condition. Which could be one of the possible reasons for the differences between the mean reaction times. In addition to the differences between the body part that was asked to respond to the stimulus in the present and previous studies, there were also significant differences in the motor pattern of the response. Nevertheless, we cannot compare our results with those from the above-mentioned studies as there are several differences in the kind of stimulus, the response as well as in the age, the gender and the athletic experience of the subjects.

The same reasons serve as limitations and we cannot safely assume that our results are valid for other wrestling athletes than the ones that participated in the current study as gender, age, physique, type and intensity of stimulus critically influence reaction time (Kolinski, 2012; Rolf and Rinkenauer, 1998; Jain et a.,l 2015; Woods, 2015). Further research is needed with a larger sample and more variety in stimuli and responses.

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COMPARING PRACTICES OF WRESTLING IN THE USA AGAINST A GLOBAL MODEL FOR INTEGRATED DEVELOPMENT OF MASS AND HIGH-PERFORMANCE SPORT

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ABSTRACT
Referencing domestic and global practices, this study provides information on what might be implemented as best practices to advance the sport of wrestling in the USA. The authors utilized the model of integrated elite and mass sport development from past research, which formed the foundation for a questionnaire and interview schedule for US wrestling coaches and administrators to generate a snapshot of perceptions of the current sport system and possibilities for its further development. Survey questions based on more than 200 published sources were validated by six experts including academicians, executives from sport governing bodies, coaches and administrators. To determine the areas for improvement, the questionnaires were completed by 102 coaches. Possible advancements were further identified through semi-structured discussions with 10 wrestling administrators and experts. Results suggest possible enhancements at micro-, meso- and macro-levels of the proposed model for better international performance as well as greater national sport participation.
Key words: USA, wrestling, high performance, mass participation, sport development

INTRODUCTION

Until the outstanding Tokyo 2020/2021 Olympic Games performance of nine medals, USA Wrestling (USAW) performance in Olympics had been declining during the past half a century. The Greco-Roman style of wrestling has particularly been a weakness for Team USA, never earning more than 3 medals, or 13 % of all available medals at Olympic Games, prior to the Tokyo performance (olympics.com, 2021). According to national surveys (NSGA, 2016), mass wrestling participation has been stagnant following the overall sports participation trend in the US over the past 30 years, while the country's population has been increasing. However, according to USAW, membership grew steadily over 30 years, from 90,658 in 1988 to 259,414 in 2019 and the number of teams increasing from 6,854 in 2012 to 18,771 in 2019 (USAW, 2019). While the USAW (2019) data on memberships, teams, and clubs are optimistic, the NSGA (2016) survey data on wrestling participation is not. Even if the growth has been achieved, it is still to positively influence international US performance, mass sport participation, national health, and other problematic socio-economic indicators. As USAW (2021) strives to be the world's best sports organization and provide quality opportunities for its members to achieve their full human and athletic potential guided by the Olympic movement principles, it is increasingly expected to develop both elite and mass wrestling contributing to community wellbeing and harmonious development of each citizen (Harris & Dowling, 2021; Smolianov, Zakus & Gallo, 2014). This study makes a hypothesis that the US wrestling system can be improved and explores opportunities for US wrestling to advance both high performance (HP) and mass participation by comparing US practices with an ideal global model of sport development.

METHODS

Participants: Wrestling coaches (recreational to elite) and administrators throughout the US.

Instruments-Tests: The authors built the model of integrated elite and mass sport development from past research and formed the foundation for a questionnaire and interview schedule for US wrestling coaches and administrators to generate a snapshot of perceptions of the current sport system and possibilities for its further development. The survey was used in 15 previous studies to evaluate and advance systems of various sports in different countries, most recently to evaluate the sport of karate in Russia (Dolmatova & Smolianov, 2021). Figure 1 represents the each level that the sport was evaluated using the survey (micro, meso, and macro) and the Elements (1-7) that fall under each level.

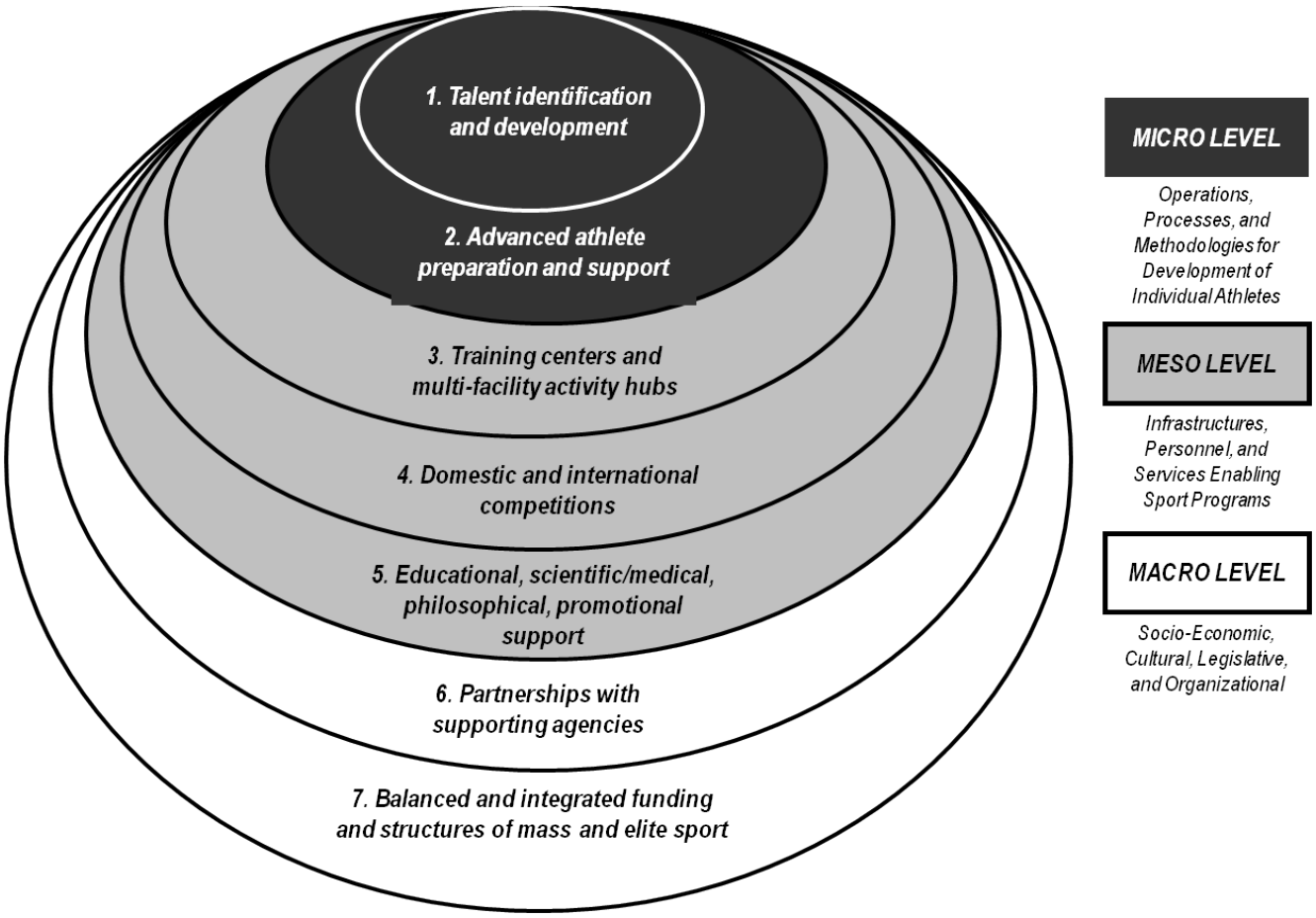

Figure 1. Ideal-type Model of Integrated High Performance and Mass Sport Development

Procedures: The survey was distributed via email to a sample of 2,000 wrestling coaches and administrators at all levels of participation from recreational to professional throughout the US. Email addresses were collected from various web pages, including USAW, and affiliated regional associations, universities, high schools and wrestling clubs. Interviews were conducted based on the responses from the participants who are willing to be interviewed.
Research Design: Descriptive, cross-sectional, qualitative survey.

Statistical Analysis: Cronbach's α statistic was used to assess the internal consistency of the items within the model. Using this statistic to evaluate sport governing organizations, Winand et al. (2010) suggested interpreting Cronbach's α values above 0.4 as "slightly consistent" and those above 0.7 as "consistent." The values indicate consistency in each element with minimum α value 0.734 and maximum α value 0.924.

RESULTS

Fully completed questionnaires were returned by 102 participants for a response rate of 5% similar to previous studies used to validate this method (Smolianov, et al., 2014; Zeeuw et al., 2017; Dolmatova & Smolianov, 2021). Additionally, 10 regional US wrestling administrators were interviewed on the seven elements of the model to suggest possible advancements to the future of US wrestling. The respondents' average age of was 45 and coaching experience was 24 years; 96.5% were male and 3.5% were female; 69% of respondents had bachelor's degree and at least 46% had higher graduate degrees.

Survey responses for each Element are presented as both average scores and aggregated percentages of perceived current practices. Aggregated percentages of responses allow appreciation of the distribution of coach responses**.**

Element 1: Talent Search and Development

More respondents had overall negative (32%) then positive (24%) perceptions regarding this element, indicating some of the most important areas for improvement. Training is based on clear guidelines for multiple development stages recommended by USAW according to only 39% of the surveyed coaches. Responses revealed a need to attract more potential wrestlers from outside the sport's participation base (40% negative) and offer wrestlers with potential to represent the country better conditions to train full time with high performance standards (also 40% negative). As wrestling is part of the US educational system, it is surprising that 38% of coaches believed that wrestling training should be better integrated with high school/ college/university education while only 22% thought this practice is in place often or always.

Element 2: Advanced Athlete Support

Similar to Element 1, there were more negative (34%) than positive (20%) responses about Element 2. The positive responses indicated successful doping control practices and individualized lifestyle plans for physical and psychological health of elite wrestlers. All other practices were perceived more negatively than positively in this Element, reflecting the need to improve educational, career, multidisciplinary and scientific support of wrestlers.

Element 3: Training Centers

There were twice as many negative (47%) than positive (24%) responses regarding wrestling facilities in the US. With the highest overall proportion of negative responses (47%), there is concern about training centers' affordability, the distance from wrestling facilities to homes, and other athlete support services.

Element 4: Competition Systems

Based on responses, the USAW attempts to integrate professional and amateur tournaments into a progressive plan of competitions gradually preparing athletes for peak performances and tries to coordinate all domestic and international competitions for all ages and levels, between and within all possible organizations. Competitions could be better structured at lower levels (44% negative vs 39% positive), and sponsorship incomes should be used to develop more events for mass participants (36% negative vs 18% positive).

Element 5: Intellectual Services

Responses about this Element were more positive than negative covering a number of factors. The USAW fosters research on important aspects of wrestling (53% positive vs 33% negative), communicates principles of sportsman at multiple levels (55% positive vs 14% negative), contributes to national values and identity by inspiring participants to strive for excellence (44% positive vs 35% negative), and demonstrates vision and leadership in improving all aspects of the participants' well-being through wrestling (38% positive vs 35% negative). However, specialists engaged in the development of wrestling should be better educated according to 59% of respondents who were negative vs only 20% who had positive perceptions about item one, which is consistent with coaches' perception of their lacking education indicated in Element 1.

Element 6: Partnerships with Supporting Agencies

This element is the least developed requiring a lot of improvement in communication and coordination of all possible partners contributing to US wrestling development: negative perceptions (40%) dominate, with 17% of positive responses and 45% of neutral views. Particular efforts are needed for better partnerships with medical, scientific, military, philanthropic and sponsoring organizations, lotteries and other agencies outside of the sport industry (49% negative and 16% positive). There is a need for better support of wrestling by educational sector, consistent with earlier discussed elements, and, again, surprising, given wrestling programs are in schools, colleges and universities (42% negative vs 11% positive). Critically important was also the score that the role of clubs/community programs in wrestling development is not very strong (55% negative vs 24% positive). If wrestling needs better support by both educational sector and communities, opportunities for growth are enormous. Additionally, it was reported that there is insufficient support for wrestling development from various levels of government (24% negative vs 5% positive) and there is too little media coverage of wrestling (43% negative vs 7% positive).

Element 7: Balanced and Integrated Funding and Structures of Mass and Elite Sport
Statements of this Element were perceived negatively by 36% and positively by 21% of the respondents, with some of the past positive and negative aspects of wrestling development. The sport has great potential to positively influence national well-being as wrestling participants are viewed diverse as general population (55% positive vs 28% negative). However, the proportions of negative responses were more than twice greater than positive responses indicating lack of economic support of the sport through business and individual tax incentives resulting in clubs, physical education and high-performance academies being too expensive to benefit society to the full potential through wrestling.

DISCUSSION – CONCLUSIONS
The consistent messages from the survey ratings and open responses were that more public and private resources are needed for systematic development of wrestlers at elite and particularly at mass participation levels. Additionally, further partnerships are to provide better coaching and promotion for the sport, as well as more facilities, events and programs for beginner and intermediate levels of wrestling.

At micro-level, in order to attract more potential wrestlers and at the same time integrate best practices from other sports, wrestling programs could be developed under one roof and in cooperation with a full spectrum of disciplines in addition to American football (i.e. judo, karate, gymnastics, etc.), which could contribute to the development of wrestling. In order to offer more US wrestlers conditions for training and competing full-time, and at the same time contribute to the society and secure lifelong jobs, wrestlers could be employed by sponsoring companies and lead the development of sport, including programs and events for all employees' health and productivity (China Post, 2021; Smolianov, at al., 2014).

At meso-level, to make training centers' affordable and reduce travel time from wrestling facilities to educational, medical, room & board, and other services, campuses of schools, colleges and universities should share resources so that mass participants train next to elite athletes. Using best practices of integrated facilities and services at multi-sport schools and colleges in China and Russia and at IMG academies in the US, USAW could help better connect clubs, schools, universities, community centers, and commercial partners for mass and elite wrestling programs available for all in each community. Fostering public-private cooperation to develop programs at underutilized public schools, parks, and sport and recreation facilities has great potential for more effective and efficient use of tax and donation dollars, as done in New York City (NYC) and described by Pennington (2011).

To improve and increase mass competitions, all federal, state and municipal departments and all organizations subsidized by tax payers from US military branches, police, post, firefighters to public libraries, childcare, schools, colleges and universities. Governments should help these public organizations develop mass competitions within and among all organizations, involving commercial companies in each industry at local, state and national levels. This had been done in the USSR and currently done in China, where athletes are given paid time to train, compete and lead all other employees enjoy healthy productive lifestyle. Government officials of different levels lead this process and ensure that sufficient resources and both material and moral rewards are devoted to stimulate training and competition among all types of organizations (China Post, 2021). USAW could help multi-sport events for all, such as State Games, lead the world in a truly mass wrestling event participation representing all possible organizations across the US.

At macro-level, partnerships with supporting agencies, particularly public funding could be improved using the afore-mentioned competition system. Intensifying efforts to educate and convince government officials to provide more subsidies and tax incentives for the development of the sport and particularly wresting through school PE, as done with judo in Japan, could save healthcare costs (Hillman, Erickson & Kramer, 2008; Merle, 2018). Better supported by Olympic wrestlers, could be such initiatives as the Sports & Fitness Industry Association's (SFIA, 2014) lobbying to increase the PE budget nationally, and to pass legislation that will allow Americans to use Pre-Tax Medical Accounts for physical activity expenses.

Funding and structures of mass and elite wrestling could be better balanced and integrated. Approximately 60% of the revenue that USAW received in 2018 came from mass participants and 40% from elite athletes, while 55% of the budget was spent on elites and 45% on masses (USAW, 2021). More money could be devoted to increasing mass participation, particularly by attracting more corporate and public resources to such programs as State Games and Beat the Streets. Beat the Streets (2019) is a partner of USAW that impacts over 6,000 participants and 208 teams annually with a total of $15 million invested in the sport and 42,000 hours of on the mat programming and helping youth development in underserved communities. Potentials of this program are great given the size of the country and economy. USAW could strive to develop wrestling in every state as done in NYC where USAW

contributed to Beat the Streets close to $10,000 during 2016-2018 supporting over 3,200 young participants annually (Beat the Streets, 2019). Wrestling programs should be better financed to reach and provide more opportunities to athletes from lower-income families.

PRACTICAL IMPLICATIONS/ADVICE FOR ATHLETES AND COACHES

All wrestling disciplines could be offered as part of physical education, fitness tests, and after school programs. The guidelines for lifelong fitness and health given to coaches and taught at school could include the different wrestling disciplines and fitness tests and programs useful for wrestling. American Development Model integrated with Fitnessgram could include wrestling test exercises and recommended performance results for each age from six to over 70 years old (Matveev, 2008; Smolianov & Smith, 2019). Taekwondo clubs show best practices in integrating fitness, coordination and knowledge tests into graduate stressless multi-belt athlete progression. Healthy methods of training and injury prevention of the past should be practiced at all levels of wrestling. For example, Olympic-style weightlifting can be used in the water, compounded yoga-style and weight machine exercises can be focused on strengthening while stretching. Conditioning could be done outdoors utilizing contrast temperatures, uneven surfaces and other natural conditions to prevent injuries and illnesses. Osteopathic stretching should be integrated into each training session. Meal plans for performance and bodyweight objectives should focus on immune-strengthening and rational sequencing and cross-promoting of natural foods. All these skills should be taught to wrestlers from young ages for their lifelong healthy habits (Dolmatova, Smolianov & Smith, 2020; Smolianov & Smith, 2019). US wrestling coach education of the future should be master degree specializing in the sport that is affordable and required from beginner level participation (Smolianov, et al., 2014).

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POSSIBLE ROLE OF EACH ARM IN WRESTLING TIE-UPS

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ABSTRACT
Leg attacks are the most important skill in wrestling. We defined a scenario wherein wrestlers push or pull their opponents to execute a setup and leg attacks as a “tie-up.” In tie-ups, the wrestlers use their arms to gain control over their opponents; however, little is known about the role of each arm in this tie-up. This study clarifies how wrestlers use their arms during tie-ups. We surveyed 120 Japanese collegiate wrestlers using a questionnaire. The survey items covered how wrestlers used their near arm (NA) and far arm (FA) in tie-ups, and their competition level. The chi-square test was used to investigate the relationship between arm use and competition level as well as opinions related to the NA and FA. There was no significant association between wrestler arm use and competition levels regarding the NA and FA. Regarding arm use, pushing was considered important for the NA, while pulling was considered important for the FA (p<0.001). In the free description questionnaire for the NA, keywords such as “sensing the opponent's movement,” “measuring the distance to the opponent,” and “touching the opponent” appeared frequently; for the FA, most keywords were related to “pulling movement.” Wrestlers use the NA to push the opponent and sense their movement and the FA to pull the opponent. It is essential for wrestlers and coaches to understand the role of each arm when practicing the setup and overall movement during tie-ups.
Keywords: Wrestling, tie-up, role of arm, questionnaire, setup, combat sport

INTRODUCTION
Wrestling employs weight classes; thus, many wrestlers engage in weight cutting to increase the proportion of lean body mass to overall body weight (Steen & Brownell, 1990). In a prior investigation, no differences in body composition, isokinetic contraction muscle strength, or reaction time were identified between elite and university student wrestlers (Yamashita et al., 2018). Consequently, winning wrestling matches relies on skill, proficiency, and advanced tactics. Wrestlers who achieve a high performance often earn points through leg attacks (González, 2011; Tünnemann, 2016; Tünnemann & Curby, 2016); thus, the ability to execute successful leg attacks in freestyle wrestling is one of the primary factors determining match outcomes. Disrupting the opponent’s balance and anticipating their movements are crucial for effectively executing a leg attack against a skilled opponent; English-speaking wrestlers usually refer to this as a “setup.” We previously found that the setup before a leg attack improved the success rate of the leg attack and increased the number of points awarded to the attacker during men’s freestyle wrestling (Ito et al., 2019). Thus, this setup is an efficient method to improve the success rate of the leg attack.

The scenario wherein wrestlers push or pull their opponent to execute setup and leg attacks is defined as a “tie-up.” In tie-ups, wrestlers use their arms to gain control over their opponents and break their balance. In judo, each arm has a different role (Jones, 2018; Inokuma & Satō, 1979). In wrestling, a wrestler’s stance usually involves placing one leg about one foot in front of the other — referred to as a staggered stance — so that each arm has a different role. Although coaches and athletes understand that sustaining an advantageous tie-up is crucial for successful setups and leg attacks, little is known about the role of each arm in this situation. This study aimed to clarify the role of each arm in tie-ups to improve wrestler performance.

METHODS
We conducted a survey using a questionnaire (Google Forms, Alphabet Inc., U.S.A.) and collected responses from 120 Japanese collegiate wrestlers. Only wrestlers assuming a staggered wrestling stance were included in the analysis; those with more judo than wrestling experience were excluded. A total of 110 participants were included in the analysis. Participants were divided into "high-performance" (57 participants) and "other" (53 participants) groups depending on whether they had won prizes at national competitions. The arm nearest to the opponent was called the near arm (NA), and the furthest arm was called the far arm (FA) (Figure 1). The survey items covered what is the most important movement and how wrestlers use their NA and FA in tie-ups through selection of

predetermined options and a free description section. From the predetermined options, participants chose from "pull," "push," "stop," and "relax" for each arm. The wrestlers provided responses regarding their competition levels from the following predetermined options: "Has won prizes in senior national competitions," "Has won prizes in age category national competitions," "Has won prizes in age category region competitions," "Has won prizes in age category prefecture competitions," and "Experienced in participating in age category prefecture competitions." In the free description section, the wrestlers indicated how many years of experience they had and how they used their NA and FA in the tie-up.

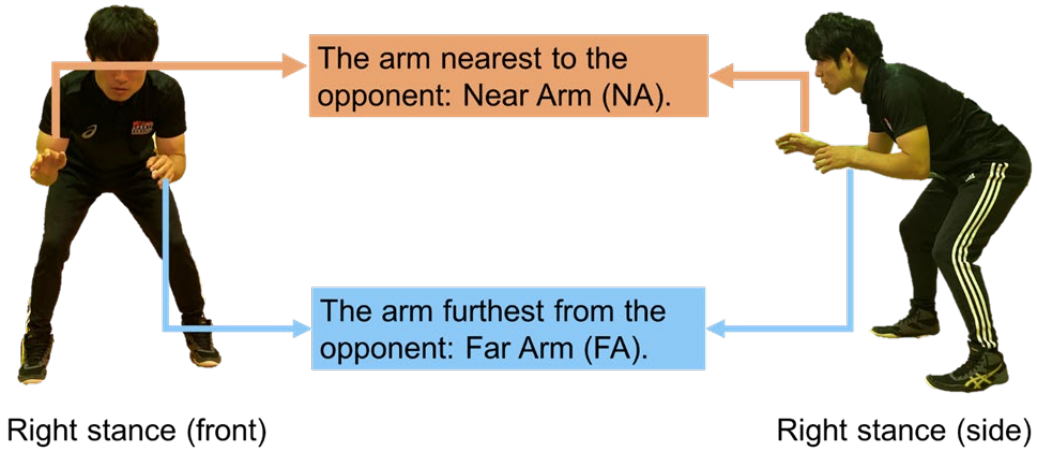

Figure 1. Typical example of a wrestler's stance. A wrestler's stance usually involves placing one leg about one foot in front of the other; thus, there is a near arm (NA) and far arm (FA).

Our analysis was conducted using specialized statistical software (SPSS Statistics version 28, IBM Corp., Armonk, NY, USA). From the predetermined options selected, the chi-square test was used to investigate the relationship between arm use and competition level as well as the relationship between the most important movements for the NA and FA. The free descriptions were divided into several groups based on keywords. The first author, who has many years of experience as a wrestler, coach, and researcher, extracted and grouped the keywords. A *p*-value <0.05 was considered statistically significant. This study was approved by the Human Research Ethics Committee of Waseda University.

RESULTS

The number of participants with 1-5, 6-10, 11-15, and 16-20 years of experience was 29, 30, 42, and 9, respectively.

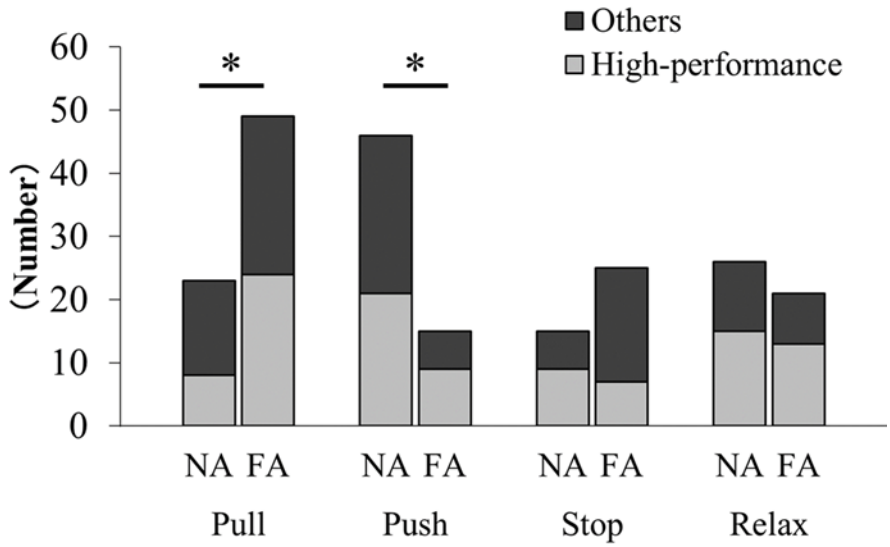

Figure 2. The number of answers regarding how each arm is used. The black and gray areas represent the others and high-performance groups, respectively. There were no significant differences between the groups. Asterisks

indicate a significant difference between the number of answers related to the most important movement during tie-ups for the near arm (NA) and far arm (FA) (p<0.001).

Table 1. Number of each keyword used in the free description

category	Keywords	NA		FA	
		Subtotal	Total	Subtotal	Total
Feeling the distance between the opponent and movement of the opponent	Distance	8		0	
	Sensor	1		1	
	Feeling the pressure from the opponent	2		0	
	Touching	3	17	1	2
	Wait and see	1		0	
	Judging the opponent's movement	1		0	
	Detecting the opponent's movement	1		0	
Pushing the opponent	Pressure	5		1	
	Putting pressure on the opponent	5	14	0	2
	Pushing in	4		1	
Pulling the opponent	Pulling up	1		5	
	Pulling	2		3	
	Snap down	1	4	4	15
	Pulling arm	0		1	
	Pulling towards myself	0		2	
Relaxing	Relaxing	10	10	6	6
Supporting the NA	Supporting the NA	0	0	9	9

DISCUSSION

Although there were no differences regarding the role of each arm between competition levels in this study, the intentions for using the NA and FA were different, suggesting that use of the arms is a rather general and basic technique that is not affected by the level of competition.

This study revealed that athletes focused on pulling the opponent with the FA, while pushing the opponent, feeling the distance between the opponent, and feeling the opponents' movement with the NA. Before executing the leg attack, wrestlers try to execute a setup to cause the opponent to lose balance, which improves the success rate of leg attacks (Ito et al., 2019). The most effective and fundamental setup movement involves pushing an opponent with the NA. In this case, opponents usually try to push back, as a point is lost if they step outside the mat circle (United World Wrestling, 2023). At this moment, an attacker can break the opponent's balance by pulling the opponent back. Thus, by sensing the opponent's movement while pushing with the NA, they should decide when to pull or relax in response to their opponent's pushing movement.

In a previous study comparing the upper limb stretch reflex in the NA triceps muscle between wrestlers and nonathletes, wrestlers showed a characteristic stretch reflex response (Ito et al., 2022). The wrestlers could modulate the triceps stretch reflex in task dependency, suggesting that the reflex response can be adjusted to respond "quickly" and "in response to the opponent's movement." This result suggests that they have specific physiological characteristics obtained from long periods of arm usage. Both the physiological characteristics and

results of the questionnaires in the present study suggest that NA would have roles of not only pushing the opponent, but also sensing the opponents' movement in wrestling tie-ups. It is essential for wrestlers and coaches to understand the role of each arm when practicing the setup and overall movement during tie-ups.

Although the wrestlers' subjectivity of the use of arms during tie-ups and reflex characteristics of the wrestlers' upper limb stretch reflex have been clarified, the actual role of each arm remains unclear. Video analysis is needed to reveal how wrestlers use their arms in tie-ups during the actual game. In judo, video analysis of matches has focused on *kumite* (tie-ups in wrestling) immediately before nagewaza, which is throwing technique (Ito et al., 2014; Ito et al., 2015; Ito et al., 2019). In the future, it will be necessary to examine what movements each arm is performing during the match by examining videos of wrestling matches.

Moreover, we will need to examine the relationship between wrestling performance and electromyographic (EMG) or biomechanical properties in actual tie-up movements. In wrestling, quantitative evaluation is sometimes difficult, as attaching markers or sensors interferes with the practical movement. Although several studies have identified the physical characteristics of wrestlers (Demirkan et al., 2015; Yamashita et al., 2018), few have focused on their specific movements (Yamashita et al., 2020). However, various types of wearable sensors for biomechanical and EMG analyses have recently been developed and utilized in sports (Taborri et al., 2020). In judo, markerless motion capture systems have already been used to evaluate throwing techniques (Cetinić et al., 2022). We believe that it is necessary to clarify the behavior of EMG activity and joint motion during practical tie-ups in wrestling. In this study, the participants were male Japanese collegiate wrestlers. The types of techniques and tactics used differ among countries, sexes, and generations (Ito et al., 2019; Tünnemann & Curby, 2016). In the future, it will be necessary to conduct surveys targeting wrestlers from various countries, sexes, and generations.

CONCLUSIONS

The present study using questionnaires suggests that wrestlers use the NA to push the opponent and sense their movement and the FA to pull the opponent. It is essential for wrestlers and coaches to understand the role of each arm when practicing the setup and overall movement during tie-ups.

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Disclosure of interest

The authors report no conflict of interest.

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MODERN METHODS OF ASSESSING AND PREDICTING WEIGHT INDICATORS IN QUALIFYING AND ORIENTATION FOR SPORTS WRESTLING

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Purpose: To develop a sample weight-height index based on the prediction of age-related growth of height in the selection and early orientation of sports wrestling types.
Methods: Methods such as analysis of scientific-methodical literature, pedagogical observations, pedagogical testing, pedagogical experience, instrumental method, as well as mathematical-statistical analysis of the results of the research were used in the study.
Level of study of the subject: According David Curby, Baum R.M, Platonov V.N, Fukuda D , Kelly J, Albuquerque M, Stout J, & Hoffman J, on the issue of selection and orientation from foreign scientists to sports wrestling classes and. Kerimov F.A., Khalmukhammedov R.D., Tajibaev S.S., Mirzanov Sh.S., Mirzaqulov Sh.A., Artikov Z.S., Matnazarov X.Y. and other scientists from our country on the issue of qualifying for sports wrestling and early detection of abilities, they conducted scientific research on the selection of Sports and wrestling types.

To develop an effective system of sorting and directing future wrestlers to different weight weights based on the definition of model descriptions (weight-height indexes) for those engaged in sports wrestling of weight-height indicators of highly qualified wrestlers in the selection and orientation of children to different stages of long-term training in the selection and orientation of sports wrestling;

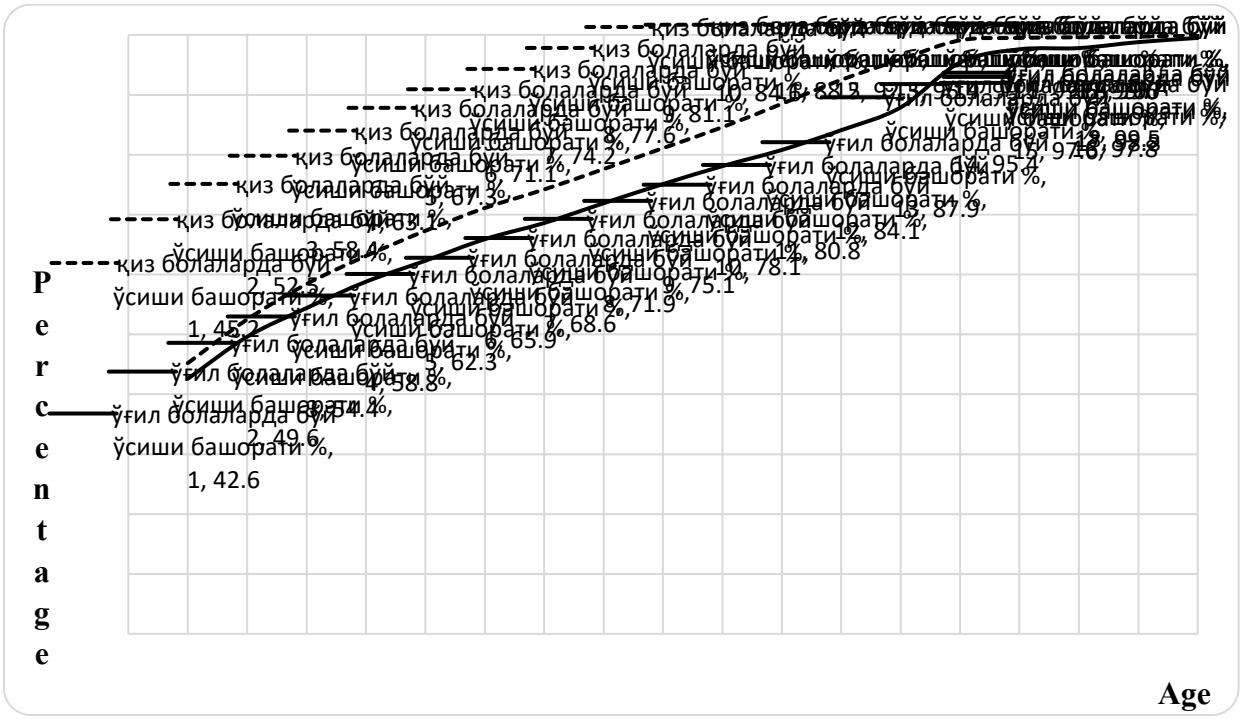
RESULTS

It is of particular importance to predict the height growth and weight of children in the system of qualifying for sports wrestling. In particular, the length of the body of children from the age of 1 to 18 years (Shvarsu V.B, Khrushevo S.C) in percentages (%) of the sides of the account. The growth rate of 1% in boys is 42,66% when the child is born and reaches the age of 1 year, that is, 45,24% in girls are all life-long growth, that is, when the child reaches the age of 1 year, the percentage above (%) of the figure is growing. When children reach the age of 2 years, there is an increase of 49,62%, while in girls this figure is an increase of 52,58%. At the age of 3 years, there is 54,47% growth in boys, 58,41% growth in girls (listed in Table 1).

Table 1. Body length in boys and girls from the age of 1 to 18 years (%of the final body length in adults) (Shvarts V.B., Xruschov S.V., 1984)

Age, year	Body length, %	
	Boys	Girls
1	42,66	45,24
2	49,62	52,58
3	54,47	58,41
4	58,85	63,19
5	62,36	67,35
6	65,94	71,17
7	68,67	74,22
8	71,97	77,60
9	75,18	81,17
10	78,17	84,64
11	80,88	88,50
12	84,13	92,50
13	87,94	95,91
14	95,41	99,10
15-16	97,64	99,53
17	98,89	99,71
18	99,59	100

When the child is 4 years old, there is an increase of 58,85%, in girls 63,19%. At the age of 5 years, there is an increase of 62,36% in boys, 67,35% in girls. If the height increase of boys when they reach the age of 6 years is observed 65,94%, in girls 71,17% is observed. The growth rate of height in boys at the age of 7 years is 68,67%, in girls 74,22% is observed. If the growth of height in boys 8 years old is observed 71,97%, in girls this indicator is observed 77,60% growth in boys. If there is 75,18% growth in boys at 9 years of age, there is an increase in boys at 81,17% growth in girls. In 10-year-old children, 78,17% of height growth is observed, 84,64% of height growth status is observed in girls. In 11-year-old boys, there is an increase in height of 80,88%, in girls there is an increase in height of 88,50%. If the growth process of the 12-year-old boy children's height is observed to increase by 84,13%, then in girls 92,50% growth is observed. In 13-year-old boys, there is an increase in height of 87,94%, in girls this figure is 95,91% growth in girls. In 14-year-old boys, there is 95,41% growth in height, in girls there is 99,10% growth in height.



Comments: - - - - - girls height growth percentage indicator. −−− Boy child height growth percentage indicator

Figure 1. Boy and girl predict the height length of children caller computer program

In boys aged 15-16 years, there is a 97,64% increase in height, in girls there is a 99,53% increase in height. 17-year-old boy observed 98,89% growth in children, 99,71% growth in girls. 18-year-old boy observed 99,59% growth in children, 100% growth in girls.

If we measure the height at birth of a child in the percentage of growth of the height listed in Table 1, it allows us to determine the length of the future height. On the basis of the percentages indicated in Table 1 above, a computer program was created by us, the program works on the basis of the numbers listed in the table above, if each child is entered the height.

In order to predict the length of the height in the selection of children in the sports struggle the table that predicts the growth of boy in age-related percentages developed by V.B. Shvers, S.V.Khrushchev, was used. As a result, a computer program was created that predicted the growth of boy. In today's Modern Struggle, the process of individualization of the fighting technique, the choice of tactics, the selection of prospective children according to the length of the height (see Figure 1) is carried out with the help of the prediction of the length of the height.
Given the scale to predict height growth in age-related percentages (%) in advance. The figures in the first column indicate the age of the children (see Figure 1). In the second column, the percentage (%) is indicated. Today, it is important to predict the height and weight of children in the system of determining the weight of children in sports wrestling types. In particular, the percentage of body length (in%) of children from the age of 1 to 18 years is calculated.

The optimal model feature was developed by analyzing the height length of the wrestlers who won and won the 2017-2018 World Championship held on sports wrestling types (see Table 2).

Table 2 Analysis of weight and height of participants of the World Wrestling Championship (2018)

№	Weight (kg)	Participants (n)	Height ($\bar{X}$ ±σ)
1	57	22	160,5±4,3
2	61	25	163,6±5,7
3	66	30	169,3±6,3
4	74	40	173,2±7,6
5	79	20	177,6±8,4
6	86	14	180,8±6,9
7	97	11	185,5±9,5
8	125	7	188,7±9,9

According to the data based on the analysis of scientific methodological literature, a number of changes were made in the transfer of children engaged in sports wrestling from Group to group:

- first, tests according to the weight of the children developed regulatory requirements;
- secondly, children who qualify for sports wrestling departments know in advance the norms for the transition from group to group at the end of the year;
- thirdly, it allows you to know the individual shortcomings and timely diagnosis, depending on the weight of the children;
- fourthly, in the process of sorting children are collected information on the characteristics of the model of preparation of high-qualification wrestlers;
- fifth, it provides an opportunity to present theoretical practical recommendations on the precise use of model descriptions of his activities in training and competitions in the process of qualifying for the types of

Name	Weight category and height growth indicators	11 age	12 age	13 age	14 age	15 age	16 age	17 age	18-35 age
I-v I	**Height growth indicator (sm)**	**134**	**139,3**	**145,6**	**158,0**	**161,7**	**161,7**	**163,8**	**164,9**
	Lighter (kg)	27-30		32-35		42-46		46	55
K-v M	**Height growth indicator (sm)**	**137**	**142,5**	**148,9**	**161,6**	**165, 3**	**165,3**	**167,5**	**168,6**
	Medium light (kg)	33		38		50		50	60
M-v J	**Height growth indicator (sm)**	**140**	**145,6**	**152,2**	**165,1**	**169,0**	**169,0**	**171,1**	**172,3**
	Light weight (kg)	36		42		55		55	66
H-v M	**Height growth indicator (sm)**	**143**	**148,7**	**155,4**	**168,6**	**172,6**	**172,6**	**174,8**	**176,0**
	Half medium (kg)	40		46		60		60	73
A-v D	**Height growth indicator (sm)**	**145**	**150,8**	**157,6**	**171,0**	**175,0**	**175,0**	**177,2**	**178,5**
	Middle weight (kg)	44		50		65		66	81
A-v A	**Height growth indicator (sm)**	**148**	**153,9**	**160,9**	**174,5**	**178,6**	**178, 6**	**180,9**	**182,2**
	Half heavy (kg)	48		55		71		73	90
O-v A	**Height growth indicator (sm)**	**151**	**157,0**	**164,1**	**178,1**	**182,2**	**182,2**	**184,6**	**185,9**
	Heavy (kg)	52		60		77		81	100
D-v A	**Height growth indicator (sm)**	**154**	**160,1**	**167,4**	**181,6**	**185,9**	**185, 9**	**188,2**	**189,6**
	High weight (kg)	55		65		83		90	
Q-v A	**Height growth indicator (sm)**	**158**	**164,3**	**171,7**	**186,3**	**190,7**	**190,7**	**193,1**	**194,5**
	Absolute (kg)	+55		+65		+83		+90	+100

wrestling and transferring from group to group.

Predicting the weight category and weight in the selection of 11-year-old children for the types of sports wrestling, we have become 8 Weight groups in the research group, the Republican competitions in the weight category are

formed on the basis of the weight category indicated in the championships of Uzbekistan for the types of sports wrestling, in addition to measuring the height of children, it can also be seen before the age of 18 years of height, and this is one of the most important processes in the selection process.

Table 3. **Weight class and height length estimates (on the example of sports wrestling) when choosing 11-year-olds for sports wrestling.**

The data obtained showed that when measuring 27-30 kg of the boy's height, the height of the boy was 134 sm, it is considered the lightest weight in the Republican stage of 12-year-old children. 134 sm child will be 18 years old 164 cm the height length of the winners of today's high-performance light weight 55-60 kg is also 164-165sm. This data, shown in Table 2 and Table 3, showed the effectiveness of the methods of not only forecasting, but also measuring the height, weight of children in the selection of children, as well as the selection of children in the types of sports competitions.

One of the problems facing sports wrestling today is that the content of contingents participating in sports competitions is not the same in all weights. This makes it possible to prepare reserves for all weight categories in the composition scan of sports wrestlers for the coming years (listed in Table 3) by sorting out the heavyweight wrestlers and using the methodology that created us when compiling the composition for all weight categories.

In our research group, special attention was paid to weight-bearing indicators in the selection of each child for sports wrestling types. In order for the weight category in the fight types to be transferred between competitors, which are equal in relation to the physical capabilities of the wrestlers, the weight limits of the wrestlers have the right to compete in competitions within the limits established by certain rules. The results of the study, which we conducted, show that in the struggle, children's physical capabilities, technical and tactical indicators were associated with their weight.

CONCLUSIONS

The fact that the selection of children for the types of sports wrestling and its consideration as a continuous process that covers all the main stages of long-term training in the early orientation is offered separately by a number of specialists, in addition to the fact that at the first stage it is characterized by the direction of sports, the ability, by determining the exact weight-height indicators in the process of sorting the assessments and forecasts, it was shown that it was necessary to direct highly qualified athletes model characteristics of children corresponding to the types of sports wrestling to the same type of sport or other types of wrestling.

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TRANSFORMATION OF DIGITAL TECHNOLOGIES IN THE TRAINING SYSTEM OF HIGHLY QUALIFIED WRESTLERS

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ABSTRACT

PURPOSE: This study is an example of a significant contribution to the system of modern sports training of highly qualified wrestlers through the transformation of digital technologies in the training process.

METHODS: wrestlers (n=28) of high qualification participated as subjects. The qualitative kinematic characteristics of the speed-strength indicators (SSI) of individual muscle groups of various body segments were recorded using a universal dynamographic stand. Recording of speed-strength indicators was carried out with the help of a specially developed and patented program for the analysis of special strength indicators of athletes "Sila - 1"(strength). The coefficients of multiple correlations were also calculated as a measure of contingency between the physical, technical and functional training of wrestlers.

RESULTS: showed that in the course of the experiment, using quantitative instrumental methods by objective recording of the qualitative kinematic characteristics of the speed-strength indicators of individual muscle groups of various body segments in the experimental groups at the end of the experiment, despite the identity of the rates of development of the studied initial indicators of the SSI of highly qualified wrestlers, we observe all normative indicators of the experimental group have higher results, as evidenced by the arithmetic mean of these values, as well as the significance of the difference (<0.01).

CONCLUSION: it was revealed that the transformation of digital technologies in the training process of highly qualified wrestlers is a new promising methodological approach of the modern system of sports training. The use of quantitative instrumental methods of objective registration of individual muscle groups of various body segments in sports training determines the dynamics of the athlete's condition. This information can help the coach make timely adjustments to the athlete's individual card, necessary to improve the motor potential of wrestlers and their performance, which in turn will have a positive effect on the ability of athletes to effectively demonstrate special strength qualities in specific technical and tactical actions, both in the training process and in the competitive period.

INTRODUCTION

At the present stage of development, the world community has actively taken a course towards digitalization and informatization of all processes and areas of human life. Digital technologies represent a long-term vector for the development of human civilization. They are based on such key factors as speed and versatility, which makes them applicable in almost any area of human activity. Digital technologies have also found their application in modern sports - the analysis of an athlete's behavior and monitoring of his activities make it possible to use all the most modern developments (Goncharova, 2023; Izaak, 2005; Kerimov, 2022). Today, world sport has entered a period of more intensive development, where the training of a high-class athlete to a large extent depends on the effectiveness of the long-term training system, which can be defined as a rationally organized process of training, education and training of athletes, which should be based on modern digital technologies (Goncharova, 2008; Platonov, 2004; Shustin, 2021).

Numerous studies are being carried out in the world to improve all aspects of the training of qualified athletes (Iordanskaya, 2006; Komarova et al., 2018), in particular, against the background of the growth of sports achievements, the role of sports science has increased (Shiyan, Kerimov, 2023) on the use of information technologies in the training process (Kerimov et al., 2023) and in the competitive activity of athletes (Platonov, 2004; Shustin, 2021), interest in the use of digital technologies has increased both to obtain urgent objective information and to use them in the long-term training process (Umarov et al., 2018). With the help of digital technologies, it is possible to track, evaluate, correct and predict the course of sports activities and its results over many years of improvement (Sinyavsky et al., 2021; Landa, 2020).

The problem of building sports training is one of the most difficult in sports (Platonov, 2004;). In the theory of sports, a formalistic concept has developed that reduces the construction of training to the “construction” of its content from separate “building blocks” (Verkhoshansky, 2005). As such, there are “sets” of microcycles or mesocycles of various types, which form the corresponding cycles of a larger scale (Issurin, 2019). The training process is a specific extremely complex structural phenomenon.

The last decade is characterized by an unprecedented growth in sports achievements and their high density at a sub-record level, tougher competitive struggles at the largest intercontinental competitions, a significant increase in the volume and intensity of loads, etc. All this requires a revision of the forms and principles of building sports training to optimize the training process (Verkhoshansky, 2005; Issurin, 2019). Modern sport is characterized by the transience of technical and tactical actions that require maximum muscle effort from the athlete in the face of time pressure (Goncharova, 2018).

Optimization of the training process implies the achievement of the planned result with minimal time and energy. Specifically, in relation to sports, this means the selection of effective means of training and their distribution within a particular stage (period, cycle) in order to achieve the required sports result with the amount of training work minimized to the possible limit. Thus, the load volume acts as the main criterion for optimizing the training process (Platonov, 2022; Kerimov & Umarov 2023).

At present, the modern system of sports training management is considered by us as a process of directed influence on the athlete's neuromuscular apparatus, which ensures the optimal training effect. The complexity and versatility of the training process in the long-term training process raises the problem of obtaining objective information, searching for new methods that allow the most complete realization of the athlete's motor capabilities, which is impossible without a targeted monitoring system using modern digital technical means (Goncharova, 2020; Kerimov, 2023).

In the long-term training process, digital technologies are the basic components - organizing the collection, storage, processing and dissemination of information; ensuring continuous monitoring of the dynamics of indicators; forecasting by the degree of development of results; implementation of feedback reflecting the compliance of the actual results with the set qualitative goals; quality supervision through reliable and prompt evaluation; determination of qualitative and quantitative characteristics of indicators of physical development and physical fitness; development of criteria that allow making managerial decisions on the correction of the educational and training process; quality management of the entire preparation process (Davydov, 2002; Kaldarikov, 2014; Liguta, 2018).

Optimization of the training process using digital technologies implies the targeted achievement of the planned result with minimal expenditure of time and energy in the athlete training system (Wolf, Paizieev and Kerimov, 2015).

METHODS

The main attention in the work is paid to IT technologies and instrumental methods for the development of speed-strength qualities (Goncharova, 2022). As an instrumental research method, it is advisable to use a universal dynamographic stand (UDS). For an effective educational and training process, a rational system of applying training and competitive loads in the process of targeted systematic training is extremely important; this will be facilitated by the information obtained with the help of the UDS. Registration of the characteristics of the level of speed-strength readiness is carried out with the help of UDS. A universal dynamographic stand allows you to register the characteristics of the efforts of athletes in isometric and explosive modes. The program allows you to calculate the following data and indicators:

F_{max} - the maximum value of the explosive force of the muscles in the explosive isometric mode;
t_{max} – time to reach the maximum explosive force in isometric mode;
J - coefficient characterizing the explosive strength of muscles in isometric mode;
J - speed-strength index = F_{max} / t (kg/sec);

0,5 F_{max} – half of the maximum explosive force (kg);
Q = 0,5 F_{max} / t_1 (kg/sec);
Q - starting strength;

G – accelerating force;
t_1 - time to reach the starting force (sec);
t_2 - time to reach the highest point of the accelerating force (t_{max}- t_1).

The software interacts with a hardware computing device based on strain gauge sensors that allow determining the force of impact on the sensor of a certain muscle group of an athlete. The developed and patented computer program "Sila-1" provides the researcher with the opportunity to measure special speed-strength indicators of various muscle groups in athletes, produce statistical measurement results, receive calculation results in an Excel file with a graphic image and, as a result, reproduce the dynamics of athletes' indicators for purposeful correction of the training process.

The systemic organization of monitoring special speed-strength indicators of athletes with the help of UDS has the potential to be carried out on various large muscle groups: speed-strength indicators of the ankle joint extensor muscles (left and right legs); speed-strength indicators of the extensor muscles of the knee joint (left and right legs); speed-strength indicators of the back extensor muscles; biceps muscles of the hands; triceps muscle of the hands; and other muscle groups of various segments of the body. Meanwhile, in this work we will make a brief review of the following of them: the extensor muscles of the knee joint (left and right), (Fig. 1); extensor muscles of the ankle joint (left and right), (Fig. 2). The remaining results will be presented in our subsequent publications.

In the process of managing the training process using the UDS, a direct link is information about what and how to do in order to achieve the goal. Feedback is information obtained in the course of training control by comparing the achieved indicators and the conditions for their implementation with the parameters of direct connection and model characteristics. Based on the comparison of indicators of direct and feedback, decisions are made in the form of correction of training programs that regulate the further content and direction of the competitive and training processes in various training cycles.

Fig.1. An example of measuring the registration of special speed-strength indicators of the extensor muscles of the knee joint

Fig. 2. A sample of the registration of special speed-strength indicators of the extensor muscles of the ankle joint

RESULTS

The transformation of digital IT-technologies into the management of the system of training athletes affects the effectiveness of the training process as a whole, and is the potential for effective performance of athletes in the process: competitive activity.

The training management system for athletes of various qualifications, but especially high-class athletes, requires constant strict and clear monitoring of the organization and control of the information received, according to all characteristics of each level, taking into account the relationship between them in order to identify weak links in the elements of the system and select comprehensive means to correct shortcomings or strengthen the leading ones.

Thus, the transformation of digital technologies in the system of training highly qualified athletes is carried out with constant monitoring and comparison of the characteristics of the current state with the predicted (model) one, and

as a result of the use of targeted training tools, feedback is provided with a constant correction of the training process at a new round of the three-level control system.

For a visual comparison of the effectiveness of the transformation of digital technologies using the proposed methodology, we present the results of control tests between the control and experimental groups at the end of experimental studies (Tables 1 and 2).

In the initial results of the two study groups, control and experimental group (CG and EG), no significant statistical differences were found. This allows us to judge that wrestlers with approximately the same level of development of speed-strength qualities were selected for the study. Comparing the studied indicators in the experimental groups at the beginning of the experiment, there were no significant statistical differences in all the studied indicators ($p > 0.05$), at the end of the experiment (Tables 1 and 2), we observe an absolutely opposite phenomenon, we have identified for all standard indicators in wrestlers experimental group higher results, as evidenced by the arithmetic mean of these values, as well as the significance of the difference (table 1 and 2).

Table 1. Comparative analysis of statistical data of special speed-strength indicators between groups of highly skilled wrestlers

Speed-strength indicators of individual muscle groups		Control group (CG)		Experimental group (EG)		t	p
		$\overline{X}$ ±σ	V%	$\overline{X}$ ±σ	V%		
The extensor muscles of the knee joint of the left leg	F_{max}	210,1±19,7	9,4	228,8±17,8	7,8	2,15	<0,05
	t_{max}	1436,7±136,2	8,9	1391,4±128,6	7,2	2,14	<0,05
	J	0,146	-	0,164	-	-	-
	Q	298,1±31,2	10,5	346,2±27,6	8,0	2,93	<0,01
	G	152,6±14,3	9,4	172,4±12,4	7,2	2,24	<0,05
The extensor muscles of the knee joint of the right leg	F_{max}	218,4±21,6	9,9	245,6±18,7	7,6	2,94	<0,01
	t_{max}	1394,8±132,1	9,5	1212,4±126,8	10,5	2,13	<0,05
	J	0,156	-	0,202	-	-	-
	Q	396,2±29,6	7,5	438,9±19,8	4,5	2,15	<0,05
	G	171,5±16,24	9,5	192,8±11,6	6,1	2,41	<0,05

Table 2. Comparative analysis of statistical data of special speed-strength indicators between groups of highly skilled wrestlers

Strength indicators of individual muscle groups		Control group (CG)		Experimental group (EG)		t	p
		$\overline{X}$ ±σ	V%	$\overline{X}$ ±σ	V%		
The extensor muscles of the ankle joint of the left foot	F_{max}	108,2±6,9	6,4	120,4±9,8	8,1	2,40	<0,05
	t_{max}	1918,3±127,4	6,7	1898,4±112,1	5,9	2,23	<0,05
	J	0,056	-	0,063	-	-	-
	Q	197,4±12,3	6,2	203,5±10,2	5,0	2,30	<0,05
	G	51,6±4,7	9,1	57,2±5,3	9,3	2,12	<0,05
The extensor muscles of the ankle joint of the right foot	F_{max}	139,2±12,8	9,2	151,6±13,1	8,6	2,14	<0,05
	t_{max}	1889,7±130,2	6,9	1764,6±106,8	6,1	2,14	<0,05
	J	0,074	-	0,085	-	-	-
	Q	198,5±13,8	6,9	211,3±11,3	5,3	2,93	<0,01
	G	54,6±6,1	11,2	65,1±7,2	11,0	3,25	<0,01

The results of the comparative experiment prove that the ratio of results in the experimental and control groups at the end was significantly different, so in the experimental group in all special speed-strength indicators there were significant statistical differences ($P<0.05$), while in the control group there were significant statistical differences has not been identified.

Thus, it is important to emphasize that one of the fundamental tasks of transforming digital technologies into a system of long-term training of athletes in the course of the training process and competitive activity is complex monitoring, including the measurement and evaluation of various indicators in micro, meso and macrocycles of training in order to determine the multifaceted level the preparedness of an athlete at each stage, covering: pedagogical, psychological, biomedical, physiological, sociological and other areas of examination, taking into account the provision of feedback. It is quite obvious that this problem is very complex, voluminous and multifaceted. Consequently, we associate the prospects for future research with the transformation of digital technologies in the system of training highly qualified athletes in various sports.

CONCLUSIONS

Thus, the transformation of digital technologies into a system of long-term training of wrestlers has contributed to a significant increase in sports results and purposeful provision of a training system for athletes based on fundamentally new technical solutions, including modern digital technologies, which in turn contributes to the development of scientific and technological progress in sports.

The transformation of digital technologies in the training process of highly qualified wrestlers is a new promising methodological approach of the modern system of sports training. The use of quantitative instrumental methods of objective registration of individual muscle groups of various body segments in sports training determines the dynamics of the athlete's condition.

This information can help the coach to make timely adjustments to the athlete's individual card, necessary to improve the motor potential of wrestlers and their performance, which in turn will have a positive impact on the ability of athletes to effectively demonstrate special strength qualities in specific technical and tactical actions, both in the training process and in the competitive period.

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USE OF HEART RATE VARIABILITY IN THE TRAINING OF ELITE WRESTLERS

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INTRODUCTION

One of the methods of training support for elite wrestlers is the assessment of the objective state of the body. Training and competition are interconnected by psycho-emotional factors that can affect the effectiveness of sports activities (Périard et al, 2015; Pryimakov et al, 2016).

Considering that psychophysiological functions constitute the most important link in the formation of psycho-emotional response in situations of extreme states, it is logical to expect a connection between stress resistance and indicators of perception and information in elite wrestlers (Radchenko 2012; Korobeynikov et al, 2021).

As is known, the physiological reaction to the extreme conditions of the competition is characterized by the psycho-emotional stress of athletes (Chernozub et al., 2019).

A number of works indicate that stress resistance affects the ability to endure training loads and the ability to train elite athletes (Freitas et al, 2013). The cause of stress is a multifactorial stimuli that affects the decrease in the performance of athletes (Gustafsson et al, 2017). The leading cause the decline in performance is the imbalance between stress and recovery after training (Hartmann et al, 2000).

One of the main links in the stress response during emotional stress is the autonomic nervous system (Laborde et al, 2018). In previous studies, the results of the relationship of adaptive response to intense physical and emotional stress were obtained (Korobeinikov et al., 2021). The mechanism of stress resistance and coping in the psycho-emotional state of competitive activity has been studied (Barbas et al., 2011).

Traditionally, one of the indicators of stress in the psycho-emotional state is heart rate variability. In response to a competitive stressful situation, a functional system is formed that provides muscular activity in highly qualified wrestlers (Theophilos et al., 2011). Modern Olympic wrestling is spectacular with a high intensity of competitive fight. This is a situation related to changes in United World Wrestling competition rules over the past ten years (Dokmanac et al., 2018). In this regard, the need to revise the systemic preparedness of elite wrestlers is very urgent. In addition, an increase in the intensity of competitive activity leads to a tension in the physiological regulation of the body in athletes (Kerimov et al., 2019).

Therefore, studying the physiological mechanisms of the stress response of heart rate variability in competitions among elite wrestlers is of great importance. In addition, the development of a method of objectively monitoring the actual condition of elite wrestlers is a key direction in optimizing the training process.

Therefore, the study of the stress response mechanisms of heart rate variability is of great importance for the training of elite wrestlers.

MATERIALS AND METHODS

Our study includes two stages. The first stage included the study of stress response to competitions among elite wrestlers. At the second stage, the autonomic regulation of the heart rate was studied in athletes with different speeds of sensory-motor reaction.

Participants. 24 elite Greco-Roman wrestlers (age 20-25 years), members of the National team of Ukraine, were examined. All athletes individuals gave consent to use the results of the study for scientific work in accordance with the recommendations of biomedical research ethics committees. The study was conducted before and during the competitions.

Procedure

Heart rate variability (HRV) was assessed using a computerized electrocardiograph "Fazagraf" (Ukraine). The approach to HRV analysis in accordance with the recommendations of the European Association of Cardiology was used. The characteristics of statistical, frequency-domain and entropy analysis of heart rhythm were used.

The sensory-motor response was determined using the computer complex "Multipsychometer-05". The functional asymmetry of brain hemispheres was studied using the «Color & Word Test» (Stroop, 1935).

Statistical analysis

The program "Statistica 12" was used to analyze the data of our study. The study of statistically significant differences between the obtained results was carried out using the Wilcoxon rank sum test. Interquartile range was used to represent the distribution of data, indicating the lower (25% percentile) and upper quartile (75%).

RESULTS

Stress response to competitions among elite wrestlers

Table 1 presents the characteristics of heart rate variability in elite wrestlers before and during competition. The obtained results indicate a significantly lower standard deviation of NN intervals (SDNN) in the competitive period compared to the pre-competition period. This fact indicates an increase in the level of tension of HRV regulation in wrestlers in the process of competitive activity.

The values of HRV frequency analysis indicate the decrease of LF and HF in competitive conditions. This competitive activity provokes inhibition of the activity of sympathetic and parasympathetic links. However, the balance between LF and HF does not change during competition.

Analysis of the scatter plot of NN intervals shows a decrease in SD1 and SD2 in athletes during competition. The obtained fact is accompanied by a change in SDNN and indicates an increase in the tension of regulation due to periodic and aperiodic fluctuations of cardio-intervals. In addition, the decrease in SD2 is associated with the activation of sympathetic tone of the autonomic nervous system.

Table 1. Characteristics of heart rate variability in elite wrestlers before and during competition (Median, Lower and Upper Quartile, n=24)

Variables	Before competition			During competition		
	Median	Lower Quartile	Upper Quartile	Median	Lower Quartile	Upper Quartile
NN, ms	922,41	836,72	1238,59	937,72	883,52	1736,52
SDNN, ms	142,36	75,36	253,38	78,74*	43,63	96,27
LF, ms^2	5238,37	2743,26	12693,26	832,73*	483,37	1947,58
HF, ms^2	4627,46	1743,37	13759,43	793,53*	327,37	18432,65
LF/HF	1,31	1,12	2,36	1,12	0,69	1,85
SD1, ms	86,36	67,32	194,23	42,34*	37,32	89,43
SD2, ms	183,45	118,68	284,43	82,54*	63,89	104,54
Sample entropy	1,36	0,74	1,93	1,74*	1,16	2,25

Legend: * p =.01, compared to before competitive state

According to modern ideas, a more informative entropic variable is the sample entropy of NN intervals, which is related to non-stationary processes under psycho-emotional stress (Richman et al, 2000). The resulting analysis revealed an increase in the sampling entropy of competitive performance (Table 1). This is evidenced by the stochastic increase in systemic regulation of heart rate during competition.

Thus, the stress-response to competition in elite wrestlers is characterized by an increase in the level of tension of HRV regulation with deterioration of sympathetic and parasympathetic tone activity.

Different speed of sensory-motor response

As is known, a wrestling match is distinguished by a rigid coordination structure and intensity. In this regard, the main physiological adaptation to sports activities the requirements for psychophysiological functions and the autonomic nervous system (Lucini et al, 2004; Korobeynikov et al, 2016). Despite various methods for assessing the characteristics of the response of cardio-intervals to external loads, the relationship between the autonomic regulation of the heart rate and the level of sensory-motor response in wrestling remains poorly understood.

All athletes were divided into two groups according to the level of sensory-motor reaction:
- athletes of the first group with a fast sensory-motor reaction, with a latent period from 120 ms to 240 ms (10 people);
- the second group - athletes with a slowdown in the sensory-motor reaction of 240 ms or more (14 people).

Data from the study of heart rate variability in elite wrestlers with different speeds of sensory-motor reactions are presented in Table 2.

Table 2. Statistical characteristics of heart rate variability in wrestlers with different speed of sensory-motor response (Median, Lower and Upper Quartile, n=24)

Parameters	Fast response			Slow response		
	Median	lower quartile	upper quartile	Median	lower quartile	upper quartile
NN, ms	967,45	917,20	1083,05	1159,50*	1008,70	1221,40
SDNN, ms	96,45	61,95	138,35	110,10	99,40	123,40
NN triangular index, standard unit	17,61	12,88	24,37	20,57	16,16	23,55
SD1, ms	72,45	38,35	100,20	64,40	55,00	66,30
SD2, ms	130,85	82,500	180,65	167,40*	141,10	168,90

Legend:*- $p<0.01$

Table 2 shows that between both groups of athletes there is a statistically significant difference between the NN value and the SD2 indicator, which characterizes the periodic frequency of cardio intervals. Thus, the speed of the sensory-motor reaction in wrestlers is indirectly related to the duration and frequency of heart rate fluctuations.

As seen from Table 2, there is a tendency to an increase in the aperiodic frequency of cardio intervals (according to SD2 parameters) in wrestlers with a fast sensory-motor response. This result is consistent with the idea of more pronounced changes in the pre-launch state in experienced athletes. The revealed fact reflects an increase in the level of psychomotor regulation in athletes with a fast sensory-motor reaction. The data of the spectral characteristics of the heart rate in wrestlers with different rates of sensory-motor reaction are presented in Table 3.

Table 3. Spectral characteristics of heart rate variability in athletes with different speed of sensory-motor response (Median, Lower and Upper Quartile, n=24)

Parameters	Fast response			Slow response		
	Median	lower quartile	upper quartile	Median	lower quartile	upper quartile
VLF, ms^2	5275,00	1267,50	10095,00	7088,00	4802,00	10398,00
LF, ms^2	2444,50	1674,00	3704,50	2428,00	2395,00	2767,00
HF, ms^2	1092,50	600,00	3512,50	2373,00*	1959,00	2586,00
Total	9668,00	3541,50	17312,00	12979,50*	11575,00	16710,00
LF/HF	1,91	1,308	2,65	1,41*	1,01	1,51

Legend:*- $p<0,01$, for concerning of athletes with fast response

Analysis of Table 3 indicates a significant difference between the two groups of athletes in terms of the parameters of the spectral analysis of the heart rate: HF, Total power of the spectrum and LF/HF. The presence of significantly higher values of HF in wrestlers with a slow of sensory-motor response indicates the activation of the parasympathetic tone of the autonomic regulation of the heart rate. This fact is also indicated by the ratio of the Total power of the oscillation spectrum of cardio intervals. An increase of HF/HF in wrestlers with a fast response indicates an increase in the intensity of the autonomic regulation of the heart rate due to the activation of the parasympathetic tone.

Thus, the speed of the sensory-motor reaction has an indirect relationship with the regulation of the heart rate tension due to the parasympathetic tone. This is result consistent with a decrease in the duration and frequency of cardio oscillations in wrestlers with a fast sensory-motor activity. To study the features of the formation of a functional system responsible for the regulation of heart rate, we used an approach to assessing the information-entropy characteristics (Table 4).

Analysis of the Table 4 showed the presence of significant differences in the approximated entropy, which is significantly higher in athletes with a fast of sensory-motor reaction. The obtained fact indicates the presence of a stochastic functional organization of the heart rhythm regulation system in athletes with a fast of speed of sensory-motor reactions. This result is consistent with our previous studies, which showed that an increase in the entropy of the system of autonomic regulation of the heart rate reflects the ability of an athlete to adapt to intense muscle activity (Korobeynikov et al, 2017).

Table 4. Characteristics of information-entropy analysis of heart rate variability in athletes with different speed of sensory-motor response

(Median, Lower and Upper Quartile, n=24)

Parameters	Fast response			Slow response		
	Median	lower quartile	upper quartile	Median	lower quartile	upper quartile
Determinism, %	98,820	97,920	99,04	98,98	97,28	99,46
Shannon Entropy, standard unit	3,124	2,918	3,31	3,29	2,87	3,46
Approximate entropy	1,13	0,981	1,15	1,00*	0,87	1,10
Sample entropy, standard unit	1,504	1,44	1,64	1,53	1,19	1,66

Legend:*- p<0,01, for concerning of athletes with fast response

Autonomic regulation and brain dominance in elite wrestlers. One of the genetically determined characteristics of a person is the functional asymmetry of the brain. Our previous studies show that among elite wrestlers, one third has a functional brain asymmetry with a predominance of the right hemisphere (Korobeynikov et al, 2016).
But, the relationship between dominance of brain hemisphere and autonomic regulation of heart rhythm in elite wrestlers insufficiently studied.

According to the results of the study of functional asymmetry of the brain, all athletes were divided into two typological groups: with left hemisphere dominance (13 athletes) and right hemisphere dominance (10 athletes).
The analysis of heart rate variability indices in wrestlers with different dominance of brain hemispheres showed that in case of right hemisphere dominance there are increased values of NN, SDNN and triangular index NN (Table 5).

The changes of SDNN and NN triangular index revealed an increase of tension of autonomic regulation of heart rate in wrestlers with left-hemispheric dominance compared to the group of wrestlers with right-hemispheric dominance. This fact indicates an increase in the total influence of sympathetic and parasympathetic tone on the sinus node of the heart in athletes with left-hemispheric dominance.

Table 5. Characteristic of heart rate variability in elite wrestlers with different dominance of brain hemisphere (Median, Lower and Upper Quartile, n=24)

Values	Right hemispheric dominance (n=10)			Left hemispheric dominance (n=13)		
	Mediana	Lower quartile	Upper quartile	Mediana	Lower quartile	Upper quartile
NN, ms	1046,00	722,30	1312,90	980,16*	722,30	1281,90
SDNN, ms	115,51	887,80	146,60	87,32*	67,800	109,10
NN triangular index, standard unit	59,40	46,10	83,20	14,02*	8,52	23,33

Legend:*- p<0,01, for concerning of athletes with right hemispheric dominance

The results of spectral analysis of heart rate in elite wrestlers with different dominance of cerebral hemispheres are presented in Table 6. The analysis showed that in wrestlers with left-hemispheric dominance the value of VLF is significantly higher than in wrestlers with right-hemispheric dominance. However, an inverse relationship is observed for the LF. This is due to the fact that in wrestlers with left-hemispheric dominance there is an activation of central cerebral mechanisms of heart rhythm regulation, and in wrestlers with right-hemispheric dominance - sympathetic tone of the autonomic nervous system.

The conducted studies have shown that wrestlers with right hemispheric dominance have significantly higher values of HF. This fact indicates the activation of the parasympathetic tone of the autonomic nervous system. The analysis of the vegetative balance index (LF/HF) indicates a more intense character of vegetative regulation in wrestlers with left-hemispheric dominance.

Table 6. Spectral characteristic of heart rate variability in elite wrestlers with different dominance of brain hemisphere (Median, Lower and Upper Quartile, n=24)

Values	Right hemispheric dominance (n=10)			Left hemispheric dominance (n=13)		
	Mediana	Lower quartile	Upper quartile	Mediana	Lower quartile	Upper quartile
VLF, ms^2	149,57	87,50	242,60	4666,37*	3332,00	7081,00
LF, ms^2	11528,58	312,00	61346,00	2259,12*	275,00	6243,00
HF, ms^2	2620,42	875,00	3919,00	1545,37*	1006,00	1720,00
LF/HF	1,59	0,87	2,27	2,19*	1,83	4,92

Legend:*- p<0,01, for concerning of athletes with right hemispheric dominance

DISCUSSION

The obtained dynamics of HRV indicates the inhibition of activity of sympathetic and parasympathetic links of autonomic regulation of heart rhythm in elite wrestlers in competitive activity. Thus, the predominance of cerebral autonomic centers of neurohumoral regulation was activated in elite wrestlers under conditions of psychoemotional stress. At the same time, the dynamics of scatter plot parameters is accompanied by SDNN changes and indicates an increase in stress regulation of heart rhythm due to periodic and aperiodic fluctuations of cardio-intervals. The revealed fact of balance between the activity of sympathetic and parasympathetic tone indicates the activation of autonomic regulation mechanisms in elite wrestlers.

It has been established that in competitive conditions there is an increase in the stochastic organization of the heart rate regulation system. The presence of a stochastic organization of heart rate regulation during psychoemotional stress indicates one of the ways to activate compensatory mechanisms for stress prevention. The result of this process, probably, is the optimization of competitive activity indicators.

Functional asymmetry of the human brain is a property that determines the personal characteristics of a athlete. The functional asymmetry of the brain is largely associated with the manifestation of psychosomatic and autonomic reactions of the athlete's organism (Korobeynikov, et al, 2020). Therefore, for the objective assessment of the functional state of the athlete and the construction of the training process it is of great importance to determine the dominance of the cerebral hemispheres. One of the objective indicators of the adaptation process of an athlete is the analysis of heart rate variability. The efficiency of activation of the regulatory mechanisms of the circulatory system also depends on the personal properties of athletes.

In our study it was found that for wrestlers with left-hemispheric dominance is characterized by a slowing of heart rate due to activation of parasympathetic tone and a decrease in the level of tension of the autonomic regulation system. Wrestlers with right-hemispheric dominance are characterized by a higher level of tension of autonomic regulation due to activation of cerebral and sympathetic mechanisms.

Thus, an increase in the speed of the sensory-motor reaction in elite wrestlers is accompanied by psychomotor tension, which leads to the stability of motor performance. The speed of the sensory-motor reaction is associated with the tension in the regulation of autonomy nervous system due to the parasympathetic tone. This result is consistent with a decrease in the duration and frequency of cardio interval fluctuations in athletes with a fast sensory-motor reaction. The presence of a stochastic organization of the heart rhythm regulation system in wrestlers reflects the ability to adapt to intense muscular activity.

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Keynote Lecture

DEVELOPING THE NEW GENERATION OF EXERCISE MONITORS TO IMPROVE ATHLETIC PERFORMANCE

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Current sports monitoring devices predominantly rely on heart rate monitoring to offer real-time assessments of cardiovascular performance and response to exercise intensity. However, heart rate measures can be significantly influenced by various physiological and environmental factors, rendering them less precise and effective, particularly for elite athletes with lower resting heart rates. Moreover, monitoring heart rate cannot provide information about the metabolic activity and function of exercising muscles.

To address these limitations, our team at the University of British Columbia is pioneering the development of a state-of-the-art multi-modal wearable sensor system. This innovative approach aims to deliver comprehensive, real-time data on the metabolic activity of active muscles and the broader cardiovascular response to exercise. Analyzing this multi-modal physiological data helps elite athletes gain valuable insights into their metabolic reactions at varying exercise intensities and predict the lactate threshold of exercising muscles. This groundbreaking information equips athletes with the knowledge needed to optimize their exercise regimens, thereby enhancing their athletic performance while minimizing the risks of overtraining and overuse injury.

Exercise Monitoring

Exercise Monitoring – Basic Methods

- Body Dynamics
- Muscle force

➢ Distance, Elevation, Speed, Torque
➢ Muscle contraction force, power

Exercise Monitoring – Current Methods

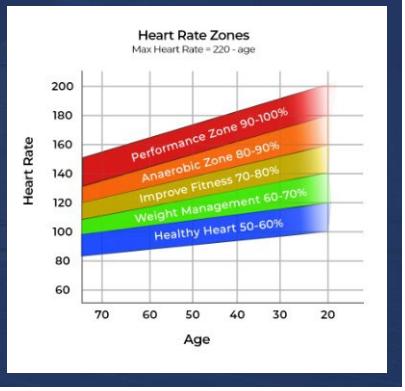
- Cardio-respiratory Function

Exercise Monitoring – Current Methods

- Cardio-respiratory Function

Heart Rate (HR)

➢ To design exercise programs to target specific percentages of the maximum heart rate.

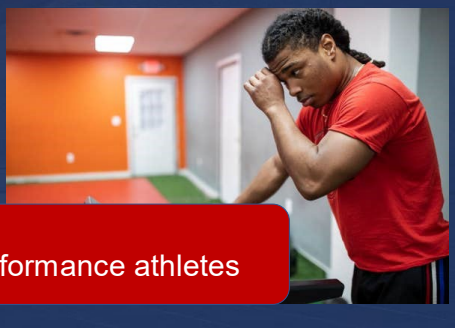


Exercise Monitoring – Current Methods

- Cardio-respiratory Function

Heart Rate (HR)

- Training intensity zone
- Inexpensive
- Easy to use



- Affected by other factors
- Less informative in high-performance athletes

Monitoring heart rate during exercise is a common and inexpensive way to monitor cardio-respiratory function during exercise. Athletes can then design their exercise program to target specific percentages of their maximum heart rate.

However, monitoring heart rate has several limitations:

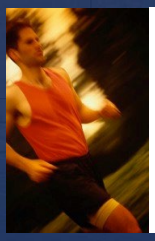
➢ Heart rate can be affected by physiological factors such as hydration and caffeine intake as well as environmental factors such as temperature and altitude

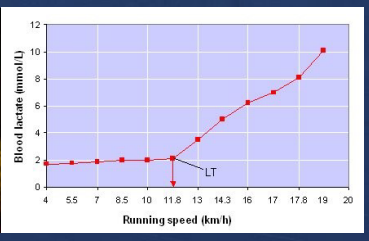
➢ Furthermore, heart rate monitoring is less effective in highly trained endurance athletes as they typically have lower heart rates that may not be reflective of muscular fatigue during exercise.

Exercise Monitoring – Current Methods

- Core Body Metabolic Fitness

Blood Lactic Acid



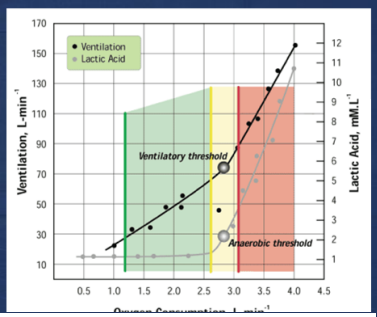


The lactate threshold can also be determined directly by measuring the lactate concentration in the blood. Blood lactate concentration is typically measured with a blood test at the finger or earlobe. During an incremental exercise test, blood samples will be taken approximately every 5 minutes. At a certain point, the blood lactate concentration will increase significantly (>4 mM/L), indicating that the lactate threshold has been reached. However, this method is invasive, costly and time-consuming, making it unsuitable for a large-scale study or for measurement in the field.

Exercise Monitoring – Current Methods

- Core Body Metabolic Fitness

VO2



Ventilatory gas analysis using a metabolic cart is the most accurate way of monitoring body oxygen consumption or VO2 during exercise.

During an incremental exercise protocol, the VO2 test can define the ventilatory threshold that is equal to lactate threshold as well as the VO2 max, which is a body aerobic fitness parameter.

Exercise Monitoring – Current Methods

General Limitations:

- Provides general fitness metrics.
- Do not monitor specific muscle groups.
- The most accurate methods are lab-based.

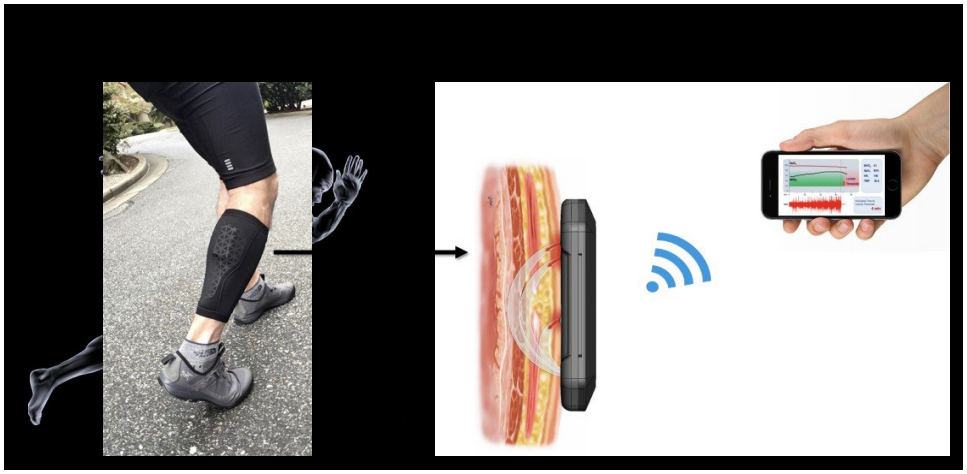
It is a non-invasive method for real-time monitoring of body VO2 during exercise that can be used to identify the lactate threshold point. However, it is a laboratory-based testing method that requires trained staff to run and analyze the data. Also, it is an expensive method which is not easily accessible to athletes. And this method measures and monitors the whole body's aerobic fitness.

Exercise Monitoring – Ideal Methods

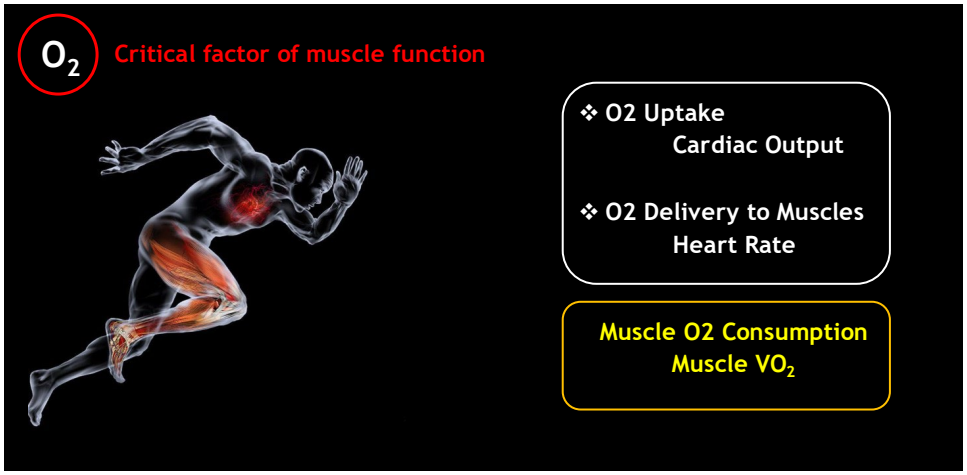
- Non-invasive, Inexpensive
- Wearable, User-friendly
- Continuous & Real-time
- Multi-modal evaluation of:
  - Body dynamics
  - Cardio-respiratory
  - Core Metabolism
  - Muscle Metabolism
  - Muscle Activation

3D Exercise Monitoring

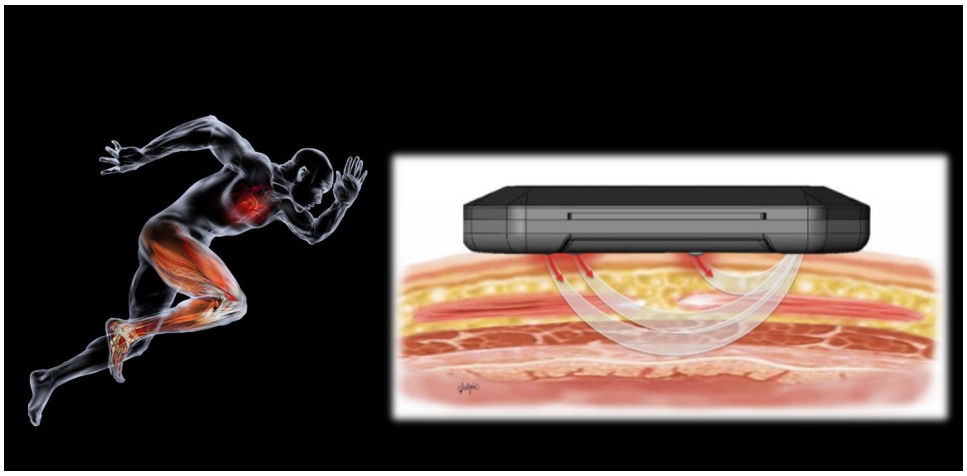
OTP Sports Monitor



OTP Sports Monitor

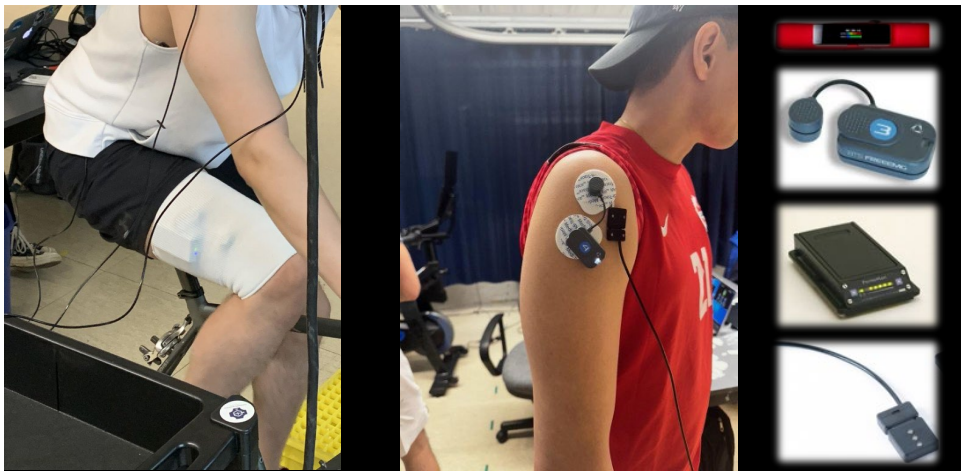


OTP Sports Monitor



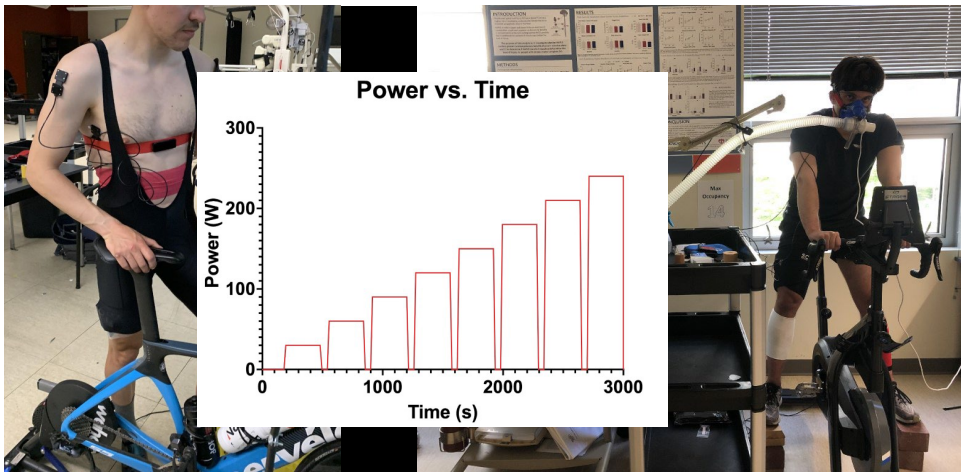
Muscle Near-Infrared Spectroscopy (NIRS)

Muscle NIRS

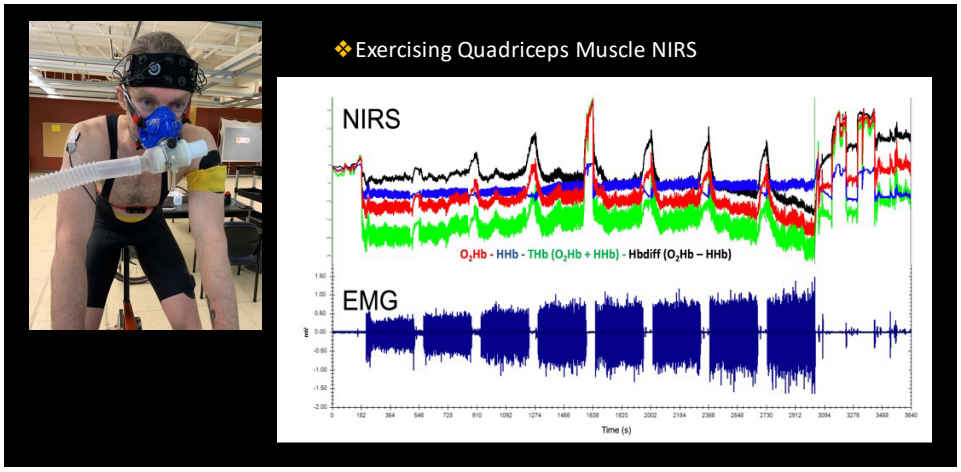


Muscle VO_2

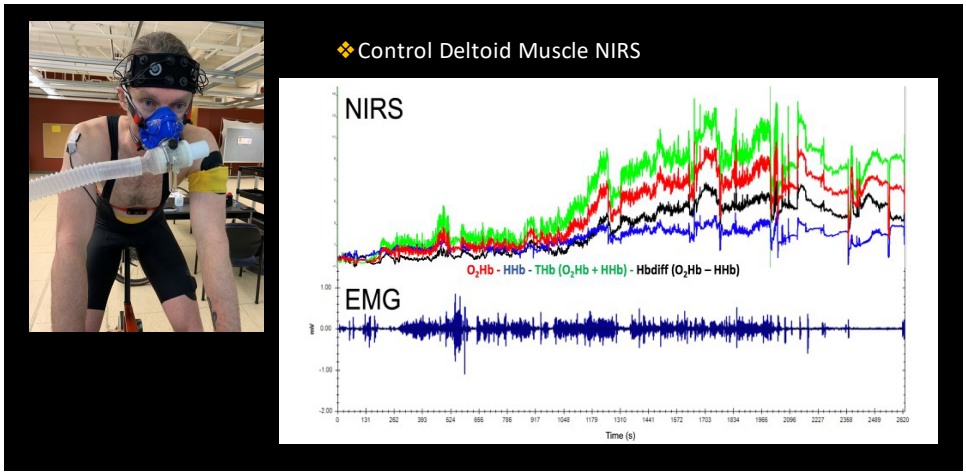
Ventilatory VO_2



Muscle VO_2

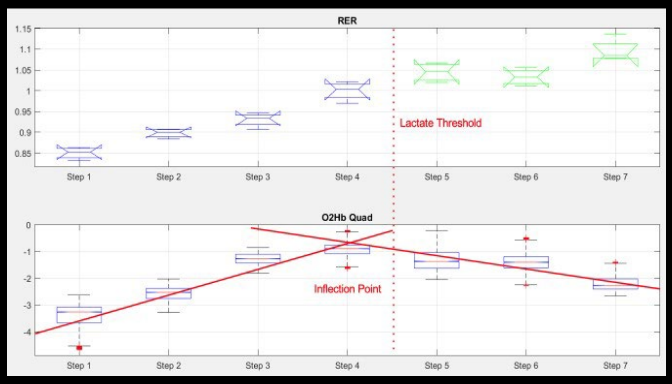


Muscle VO_2



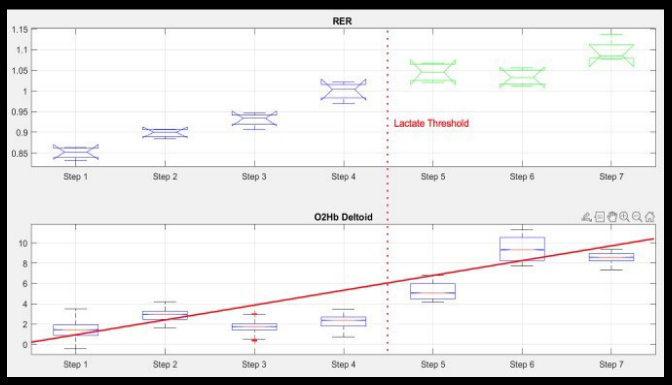
Muscle VO_2

❖Exercising Quadriceps Muscle VO2– Inflection point pre LT



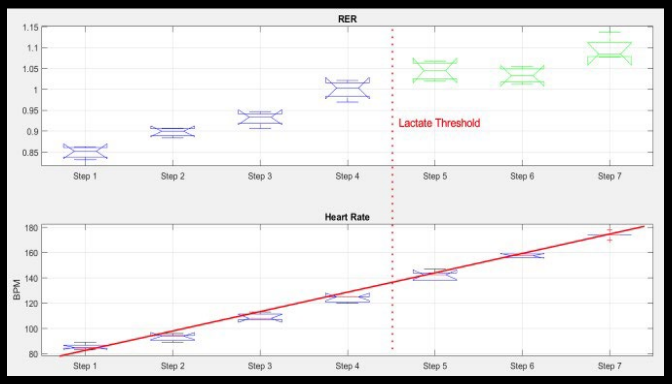
Muscle VO_2

❖Control Deltoid Muscle VO2– No significant change at LT



Muscle VO_2

❖Heart Rate- No Significant change at the Lactate Threshold

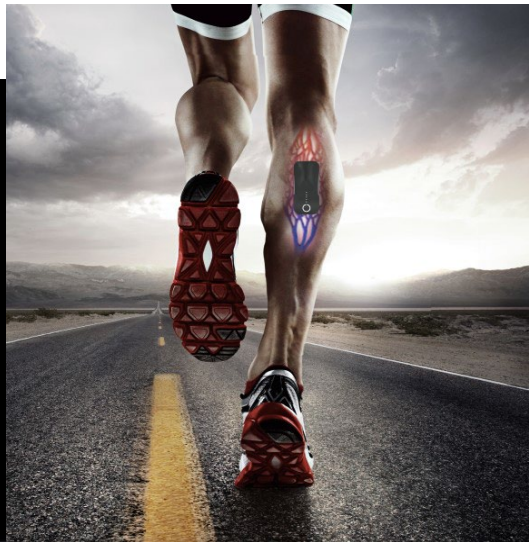


Muscle VO2

- Exercise Optimization
- Exercise Intensity Adjustment
- Recovery Adjustment

Exercise Safety- Prevention

- Muscle Overuse Injury
- Overtraining Syndrome
- Return to Sports



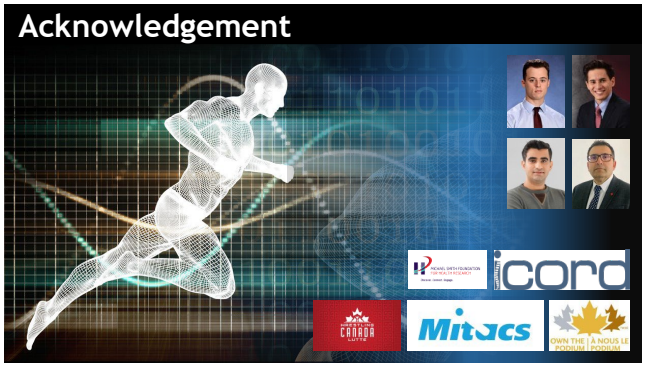
Multimodal Sports Monitor

Potential Applications

1. Design individualized training protocols
2. Monitor physiological feedback and athletic performance
3. Adjust recovery periods
4. Early diagnosis of the over-reaching condition
5. Facilitating functional rehabilitation after sports injuries
6. Define the return-to-sport time following an injury

The long-term objective of this research project is to develop a novel, reliable, and noninvasive multimodal sports sensor. Potential applications of this sensor include: Designing individualized training programs to optimize performance. Monitor physiological feedback and performance from the athlete Early diagnosis of the over-reaching condition from over training. Define suitable recovery periods following intense exercise. Aid in the rehabilitation process following sport injuries and better define the timeline for returning to sport following an injury.

Acknowledgement



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TECHNICAL – TACTICAL ANALYSIS OF XXXII SUMMER OLYMPIC GAMES AND 2022 WORLD CHAMPIONSHIP FREESTYLE WRESTLING COMPETITIONS

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Underg. Student Emre Açıkgoz[1], [2]

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ABSTRACT
PURPOSE: The aim of present study was to compare notational technical – tactical analysis of XXXII Summer Olympic Games (OG) and 2022 World Championship (WC) freestyle wrestling competitions. METHODS: A total of 293 (103 OG and 190 WC) videos of bouts were watched and analyzed by Dartfish Connect Plus 8.0 match analysis program. Bouts analyzes were performed according to 1) bout analysis preparation, 2) searching and tagging, 3) creating a database, 4) data usage procedures. Wrestling techniques were grouped into take downs and throws (wrestling in standing position), flips and throws (wrestling in parterre position). Diversity, effect and efficiency of techniques are determined in matches. Points according to time and periods, standing and parterre position, winning types, passivity and cautions were determined. There is significant difference between attack and counter-attacks in WC and OG ($p<0.05$; $x^2 = 31.689$). Type of victories in WC and OG are %63.7 and %73.8 by point, respectively. In first and second period are determined Mean Technical points according wrestling actions (WA_{mean}) 1.74 and 1.76 (t=0.488, Cohen's d = .031), 1.66 and 1.69 (t=0.567, Cohen's d = .048) in WC and OG, respectively. The most wrestling techniques are performed in standing position (WC 58.8% and OG 68.2%). Leg Attack is the most commonly used technique in standing position (WC 17.9% and OG 21.8%).
CONCLUSIONS: In conclusion, techniques which earning two points, attack movements, performed at standing position such as leg attack, take down and push to out are important in elite wrestling matches.
Key words: wrestling, performance, match analyses, elite athlete

Introduction

- In previous studies, wrestling matches have been examined (Arabaci et al., 2018, Atan & Imamoğlu, 2005; Kajmovic et al., 2014; López-González, 2013; López-González, 2014; Miarka, 2016; Shakhmuradov, 2011; Tünnemann, 2016).
- However, the frequent changes of wrestling rules require these studies to be done again.
- Moreover many techniques, training methods change over time.
- In our knowledge, after last rule changes of wrestling, there aren't study comparing the technical-tactical matches of the Olympic games and World Wrestling Championship.

Performance Analysis

- PA often takes the form of video analysis using both handheld and computerized systems. PA is evaluated from a technical-tactical or movement analysis perspective during and after match/training (James, 2009).
- Basically, PA establish a valid and reliable record of performance through systematic observations and is done to facilitate feedback.
- Well-chosen performance indicators show good and bad techniques or team performances (Hughes & Franks, 2007, McGarry et al., 2013).

Aim

- Development of appropriate and optimal training methods is key requirement to become a successful wrestler (Chaabene et al., 2017; Yoon, 2002).
- A wrestler's success in bout is determined by level of technique and tactic skills (Tropin, 2013).
- In order to develop training methods in wrestling and innovations in terms of techniques and tactics, it is necessary to analyze the elite level wrestling matches.

The main aim of present study was to compare notational technical – tactical analysis of XXXII Summer Olympic Games and the 2022 World Championship freestyle wrestling competitions.

Material and Methods

Sample

- Wrestling matches in two tournament were analyzed using the Dartfish Connect Plus 8.0 match analysis program.
- Nominal technical-tactical parameters of bouts are analyzed by researchers (first and second authors) who are wrestling coaches and wrestled for at least ten years.
- Matches in 6 weight categories (57 kg, 65 kg, 74 kg, 86 kg, 97 kg, and 125 kg) included in the competition program of both tournaments were analyzed.
- Bouts in 4 weights categories (61 kg, 70 kg, 79 kg and 92 kg) in WC were not analyzed because these categories were not in the Olympic Games programme.
- This research was supported by Bursa Uludag University Scientific Research Projects unit (Project Number: SGA-2021-356, Date: 14.04.2021).

Procedures

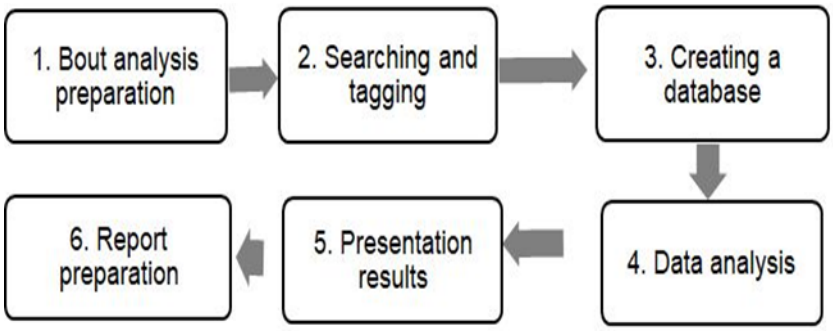
Bouts analyzes were performed according to the following procedure:

1) Bout analysis preparation: Determining the type of analysis to be performed. An example was made for Technical Tactical Performance Analysis.

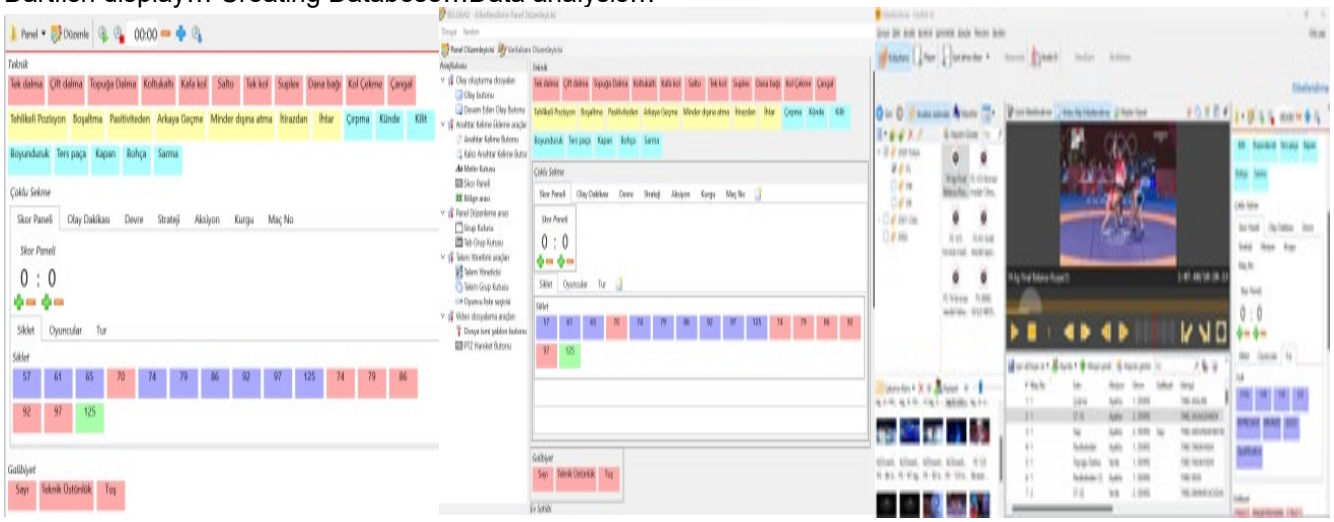
2) Searching and tagging: searching for sequences, actions or behaviors to be analyzed, labeling the behavior, limiting the order.

3) Creating a database: Characterizing each index and producing summary tables.

4) Data usage: Data analysis, presentation results and report preparation (Figure 1).



Dartfish display… Creating Databese…Data analysis…



Technical-tactical combinations

Classification: Two nominal categories were created as attack and counter-attack movements. Attack coefficient (A/C Coefficient) was found by dividing the number of attacks by the number of counter-attacks.

Techniques: Wrestling techniques were grouped into take downs and throws (wrestling in standing position), flips and throws (wrestling in parterre position).

Quantitative indicators of the technical-tactical performance of wrestlers
Diversity: It was determined by dividing the techniques by the number of matches (technique/match).
Effect: It was determined by dividing the frequency of the applied technical-tactical combinations by the total number of matches (TTC/match).
Efficiency: Determination of total points earned in a match based on total wrestling time (points/minute).

Technical-tactical indicators
Standing/parterre coefficient: The number of standing position techniques divided in the number of parterre position techniques.
Type of struggle: Movements were expressed in three different groups as pushing, pulling and actions.
Parameters to be analyzed: Points according to time and periods, points earned in standing and parterre wrestling, techniques, winning types, passivity and cautions were determined.

Statistical Analysis
- Quantitative and qualitative data of the variables determined in Dartfish Connect Plus 8.0 program were analyzed by transferring them to SPSS for Windows 27 (IMB SPSS, Inc., Chicago, IL) program.
- Independent Samples T test, Chi-Square test, One Way Anova test and Univariate Analysis of Variance will be used to compare the obtained data. Bonferroni test was used for pairwise comparisons (Post hoc test) after One-Way Anova Test.
- Measures of the effect size for Independent Samples T test were assessed with Cohen's d (ES) - 0.20 small, 0.50 medium and 0.80 large; One-Way ANOVA Test and Univariate Analysis of Variance were assessed with Partial Eta Squared (ηp2) – 0.10 small, 0.25 medium and 0.8 large.
- An alpha $p < 0.05$ was considered statistically significant for all tests.

Results
Table 1. Technical points scored of WC (n=192) and OG (n=102) and comparisons.

Technical Point	**WC**			**OG**			**F / η_p^2**
	TP	**%**	**TP/bt**	**TP**	**%**	**TP/bt**	
1	328	18.6	1.7	182	22.7	1.8	*7.054 / .16*
2	1276	72.5	6.7	584	72.8	5.7	
4	152	8.6	0.8	36	4.5	0.3	
5	5	0.3	0.03	0	0		
Total	1761	100	9.2	802	100	7.8	

Table 2. Technical points scored according wrestling position and comparisons.

Wrestling Position	**WC**				**OG**			
	TP / f	**Mean**	**SD**	**t / d**	**f**	**Mean**	**SD**	**t / d**
Standing	1115 / 656	1.66	0.8	*7.389**	691/422	1.62	0.6	*5.742**
Parterre	644 / 325	1.98	0.2	*.633*	240/124	1.94	0.3	*.545*
Total	1759 / 981	1.75	0.6		931/566	1.68	0.5	
S/P Coefficient	*1.73*				*2.9*			

Table 3. Frequencies of actions gained point and mean technical points scored according bout and comparisons.

Time (min)	**WC**				**OG**				**$F_{timexcompet}$**
	f	M	SD	Pairwise	f	M	SD	Pairwise	
1	128	2.1	0.8	*1-2,3,5,6**	44	1.9	0.6	*1-3**	
2	182	1.8	0.6	*2-3**	78	1.7	0.7		
3	212	1.5	0.6		116	1.5	0.5	*3-5**	
4	145	1.9	0.5		65	1.7	0.6		*0.516*
5	185	1.8	0.6		86	1.8	0.5		
6	151	1.7	0.7		93	1.6	0.6		
F_{time} / η_p^2	*13.137 / .06*				*4.875 / .04*				

Table 4. Mean of technical points/match according weight categories and actions.

Weight Categories (kg)	WC			OG		
	TP_{mean}	WA_{mean}	SD	TP_{mean}	WA_{mean}	SD
57	9.8	1.75	0.64	9.9	1.68	0.59
65	10.2	1.73	0.68	9.4	1.60	0.49
74	9.5	1.77	0.64	10.2	1.72	0.51
86	9.5	1.77	0.59	9	1.40	0.46
97	9	1.77	0.77	7.4	1.70	0.79
125	7.5	1.75	0.59	9.4	1.67	0.53
TOTAL	*9.3*	*1.75*	*0.65*	*9*	*1.68*	*0.56*

Table 5. Frequency and Distribution of Technical Movements.

Wrestling Techniques	WC			OG		
	f	%	f/match	f	%	f/match
Standing	***592***	***58.8***	***3.11***	***382***	***68.2***	***3.70***
Take Down	164	16.3	0.86	90	16.1	0.87
Push to out	152	15.1	0.80	110	19.6	1.06
Leg Attack	180	17.9	0.95	122	21.8	1.18
Throws	30	3	0.16	11	2	0.11
Heel Tackle	55	5.5	0.29	32	5.7	0.31
Miscellaneous	11	1.1	0.06	17	3	0.16
Parterre	***241***	***24***	***1.27***	***85***	***15.2***	***0.82***
Gut Wrench	88	8.7	0.45	39	7	0.37
Bring to danger position	85	8.5	0.46	28	5	0.27
Ankle Lace	54	5.4	0.28	9	1.6	0.09
Crotch Lift	14	1.4	0.07	9	***1.6***	***0.09***
Other	***173***	***17.2***	***9.1***	***93***	***16.6***	***0.90***
Passive	125	12.4	0.66	63	11.3	0.61
Caution	23	2.3	0.12	17	3	0.17
Challenge	25	2.5	0.13	13	2.3	0.13
TOTAL	**1006**	**100**	**5.29**	**560**	**100**	**5.43**

TP_{mean}: Mean technical points /match according weight categories
WA_{mean}: Mean of technical points according wrestling actions.

Study Limitations:

- We are aware that present study has several limitations, which might have influenced the results. Firstly, number of wrestlers and matches of two competitions is different. Secondly, wrestlers competed in two tournaments which were not the same level. In order to get better results, the number of matches and tours must be equal and the same wrestlers participate in comparable competitions. Lastly, referee factors and mistakes should be considered in match analysis.

Future Studies

- In future studies, need to address to notational video analysis for women, Greco-Roman and youth wrestling. Also, can be examined sections body movements of wrestlers, biomechanical parameters, speed and reaction times during performed techniques

Conclusions

- In conclusion, techniques which earning two points, attack movements, techniques at standing position such as leg attack, take down and push to out are important in elite wrestling matches.
- There are many chances in first period to improve attack efficiencies, especially in the first minute of the match.
- Wrestlers must be in high physical and physiological condition throughout the all bout duration.
- Therefore, wrestling education starting from young years to elite level can be target well-rounded development of wrestlers.

THE INFLUENCE OF CLUB COACHES AND PEERS ON THE MOTIVATION OF 11-TO-13-YEAR-OLD BOY WRESTLERS

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ABSTRACT
INTRODUCTION: Although wrestling training is done in a group (club) and there are team competitions, wrestling in its essence belongs to individual sports. Since the drop in the number of children in the clubs was observed, the aim of this research was to determine the involvement of coaches and peers from the club in motivating and supporting children to practice wrestling. METHODS: The sample consisted of 79 young wrestlers between the ages of 11 and 13 from most Croatian wrestling clubs, who, according to the Regulations of the Croatian Wrestling Federation, belong to the age group "younger boy wrestlers" (U13). A questionnaire was used that measures the social orientation of athletes towards coaches and peers. RESULTS: The results show that the most important thing for younger boy wrestlers is the coach's praise, followed by the friendship of their peers with whom they train in the wrestling club, and in third place is the sense of belonging and acceptance of the peer group. In the obtained results, the particles of the questionnaire related to common experiences outside of training such as birthdays and going to the cinema, as well as particles of trust in peers and particles related to the importance of the coach's praise, were separated. CONCLUSION: From the results of this research, we can conclude that the social environment significantly affects the motivation to engage in wrestling. Although wrestling in its essence is an individual sport, friendship and acceptance of peers, socializing outside the club as well as the positive attitude of the coach and his praise of the individual athlete form a very important link in the motivation of young athletes for wrestling training. Under the positive influence of the social environment (coaches and friends from the club), young wrestlers will perceive wrestling as a sporting activity that gives them pleasure and will be happy to continue wrestling. This paper is part of the doctoral thesis "Social environment and youth participation in wrestling" by Ivica Biletić (2022).
Keywords: greco-roman style, social environment, social orientation, wrestling training, individual sport.

AIM
The aim of the research was to determine club coach and peer (kids from the club) involvement in motivating children to practice wrestling and in providing them relevant support.

SAMPLE
- The representative sample consisted of 79 male wrestlers aged 11 to 13 years who belong to the age group of younger wrestlers (U 13), in accordance with the Rules of the Croatian Wrestling Federation.
- The sample covered about 60% of male wrestlers of that age group from 22 out of 28 wrestling clubs, which accounts for more than 90% of all Croatian wrestling clubs as not all of them have wrestlers of that age group.

PREVIOUS RESEARCH
- A good relationship in the team, support from peers and friends from the club, and friendship are important sources of sports enjoyment and motivation for further participation in sports. (Stuntz & Weiss, 2003)
- Coach support is related to satisfaction in sport, and young athletes with a high level of social orientation towards peers are more dedicated to and satisfied with their sport and they have a higher level of intrinsic motivation (Crnjac, 2017)
- Peers create either a positive or negative atmosphere (motivational climate) for training (Biletić, 2022)

INSTRUMENT
- **Social Goal Orientations Questionnaire** (Author: Crnjac, 2017 according to Stuntz & Weiss, 2003)

– 18 items → 2 dimensions/
2 forms of Social Goal Orientations:
1st dimension – **Coach Compliments** → 6 items
2nd dimension – **Peers** → 2 subdimensions
– Peer Friendship → 6 items
– Peer Acceptance → 6 items

Procedures

• The young wrestlers filled out the questionnaire anonimously in groups of 5 - 10, in the absence (without presence) of their coach.
• It took them less than 10 minutes to complete the questionnaire in a quiet area on the club's premises, either before or after the training.
• It was explained to them how to fill out the questionnaire, and the person in charge was available to them at all times for any potential questions.

Table: Descriptive statistical parameters and the reliability coefficient of the Social Goal Orientations Questionnaire

Dim./Subdimensions	A.M.	Min.	Max.	S.D.	α
Coach praise	4.34	3.00	5.00	0.52	**0.80**
Peer Friendship	4.16	2.00	5.00	0.76	**0.86**
Peer Acceptance	3.61	1.17	5.00	0.88	**0.85**

Legend: A.M. – arithmetic mean;
Min. – the minimum response value in a subdimension;
Max. – the maximum response value in a subdimension;
S.D. – standard deviation;
α – Crombah's Alpha

RESULTS
The most important thing for younger boy wrestler:
1. Coach's Compliments
2. Frendship of their peers from the club
3. Sense of belonging and acceptance of the peer group

CONCLUSIONS
Social environment (Coachs and kids from the club) significantly affects motivation for engaging in wrestling.
Although wrestling in its essence is an individual sport, friendship and acceptance among peers, socialization outside the club, as well as the coach's compliments and positive attitude towards an individual athlete form a very important link in the motivation of young athletes for training wrestling.

Under the positive influence of social environment (coaches and friends from the club), young wrestlers will perceive wrestling as a sporting activity that gives them pleasure and will be happy to continue wrestling.

Considering the strong positive effect of wrestling on a large number of various anthropological characteristics, which are directly correlated with the health of children and youth, the results of this research have considerable significance as they demonstrate the forms and scope of support from the coaches and friends from the club contributing to the motivation of younger male wrestlers to continue engaging in wrestling.

INVITED LECTURE -
DEVELOPMENT OF WRESTLING-SPECIFIC ENDURANCE

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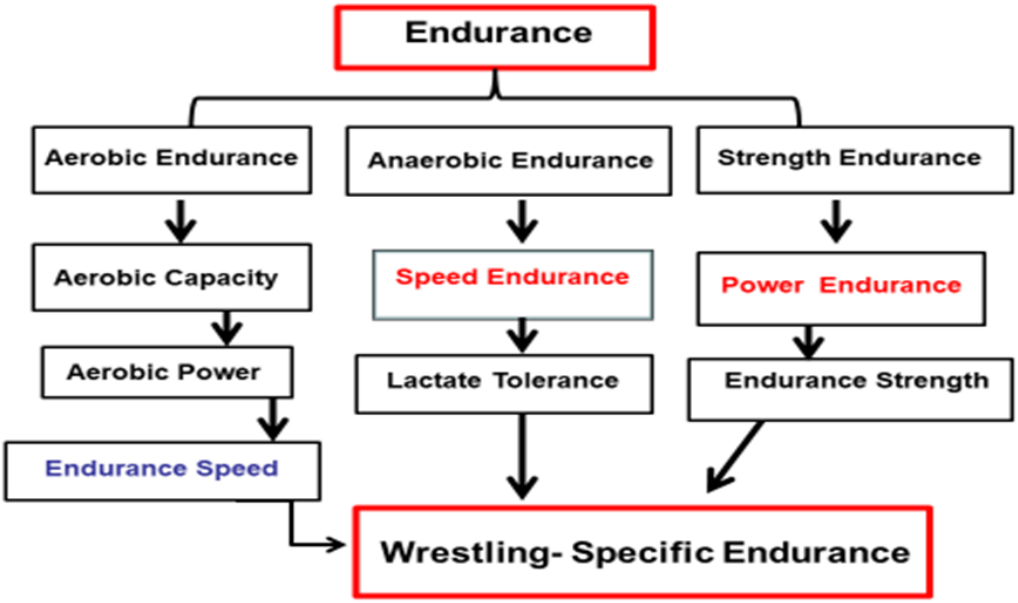
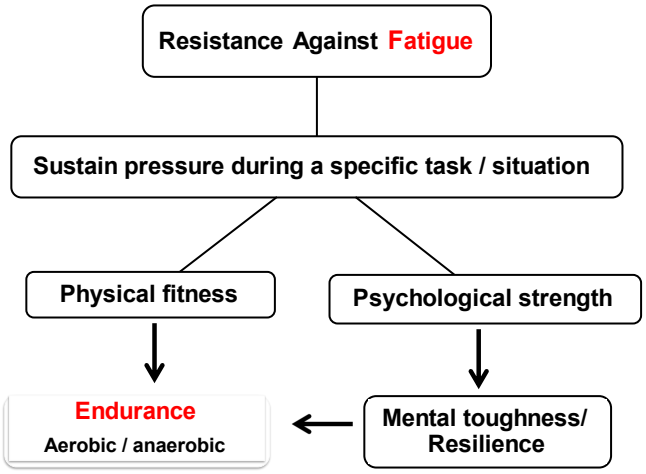
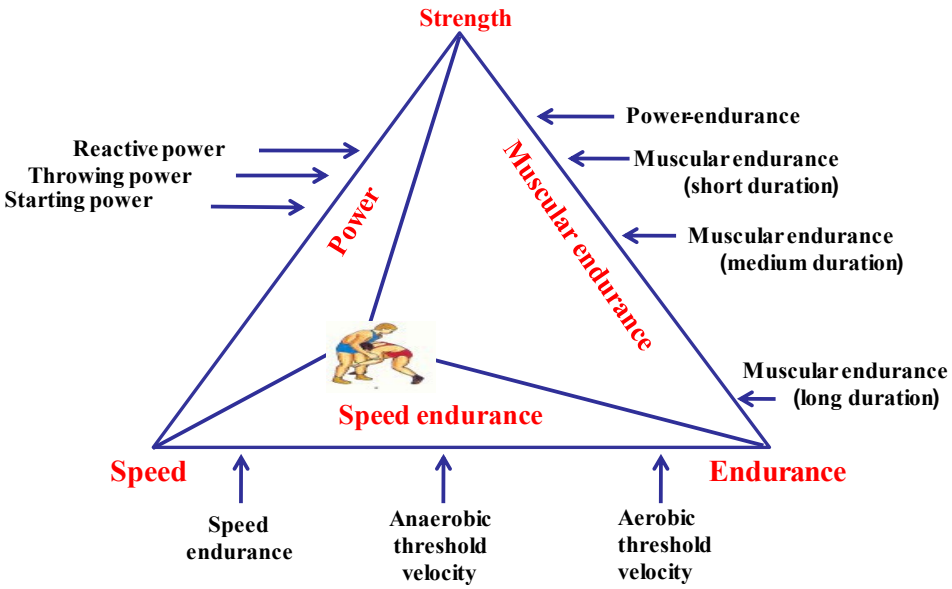
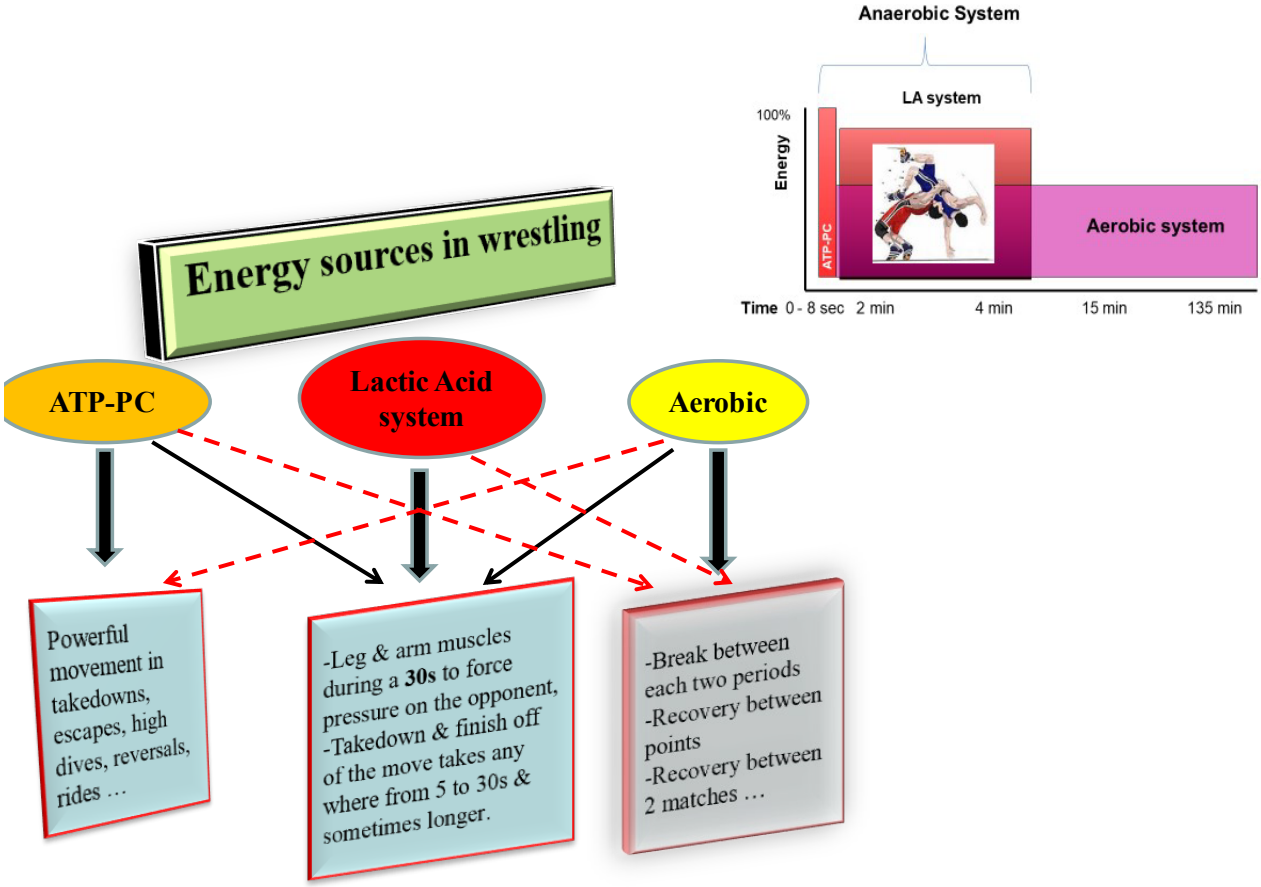
Endurance is a key factor affecting wrestlers' performance and defined as the ability to continue to endure a stress, hardship or level of suffering. In the sport of wrestling, as one of the hardest individual combative sports, athletes need to develop a specific type of endurance that is called "*anaerobic endurance*". Anaerobic endurance training focuses on the physiological improvements in the muscles' ability to endure force output through both neural and metabolic mechanisms (efficiency of energy systems, aerobic capacity/VO2max, lactate threshold (LT), muscle strength, power and muscular endurance) . A wrestling match is an alternative physical activity of variable intensity. It is characterized by sudden, explosive attacks and counterattacks that are repeatedly executed. So, endurance training in wrestling should involve developing all above-mentioned activities in a specific time period and situation.



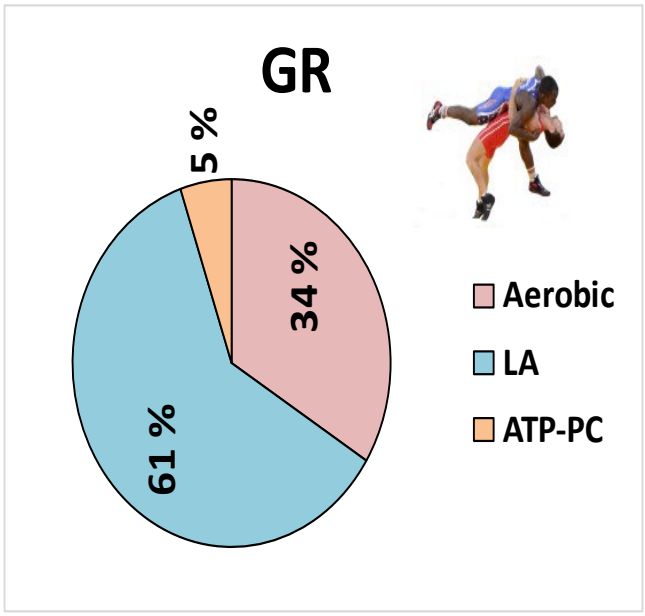

Resistance Against Fatigue
Sustain pressure during a specific task / situation
Physical fitness
Psychological strength
Endurance
Aerobic / anaerobic
Mental toughness/
Resilience

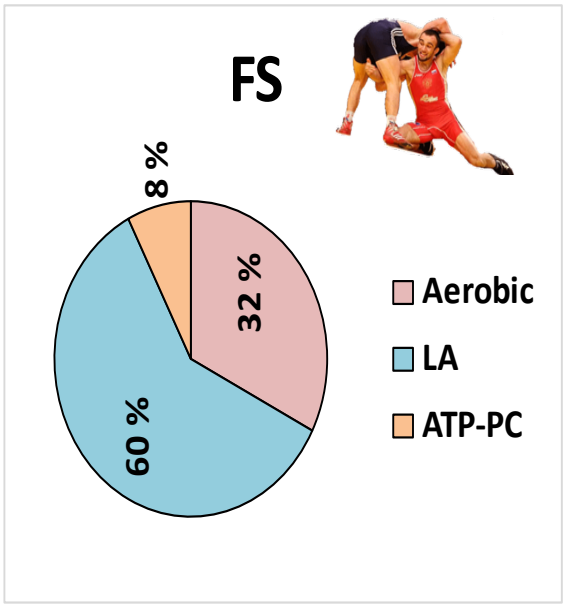

Strength
Power-endurance
Reactive power
Throwing power
Starting power
Muscular endurance
(short duration)
Power
Muscular endurance
Muscular endurance
(medium duration)
Muscular endurance
(long duration)
Speed endurance
Speed
Endurance
Speed
endurance
Anaerobic
threshold
velocity
Aerobic
threshold
velocity

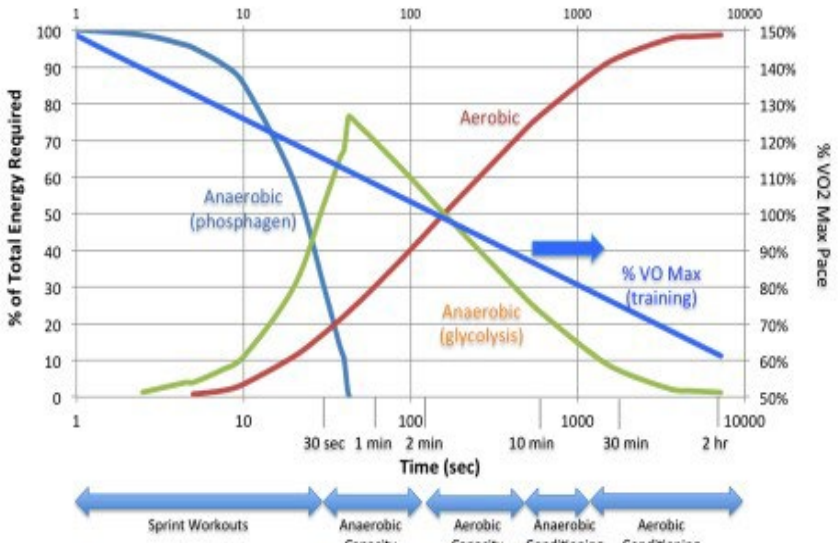

Anaerobic System
LA system
100%
Energy
ATP-PC
Aerobic system
Time 0 - 8 sec 2 min 4 min 15 min 135 min
Energy sources in wrestling
ATP-PC
Lactic Acid system
Aerobic
Powerful movement in takedowns, escapes, high dives, reversals, rides …
-Leg & arm muscles during a 30s to force pressure on the opponent, -Takedown & finish off of the move takes any where from 5 to 30s & sometimes longer.
-Break between each two periods -Recovery between points -Recovery between 2 matches …

Comparison of Energy Systems in GR & FS

Video-based time motion analysis (**TMA**) of all **679 matches** in both Styles (Men)







5 KEY Points

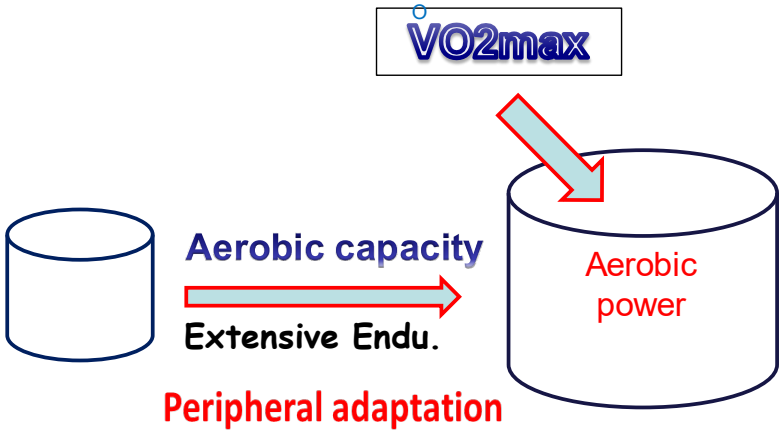
1. Endurance training is not equal to Aerobic training!!

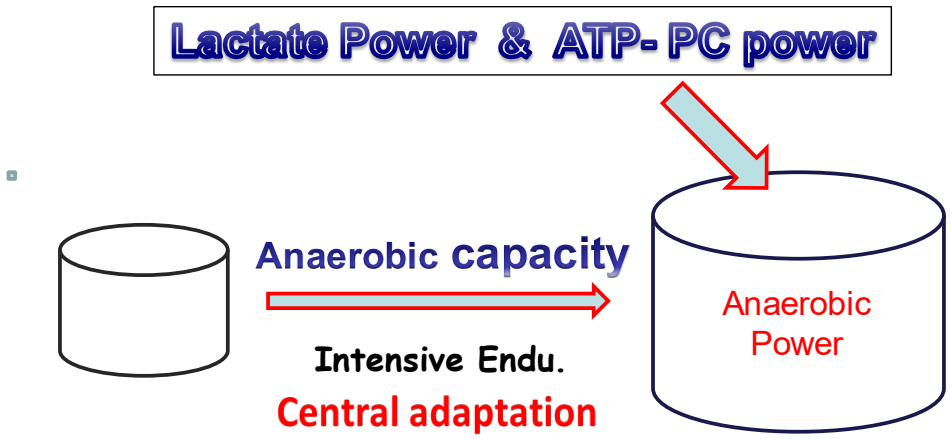
2. Endurance is massively influenced by physiological factors such as:
   - Efficiency of energy systems
   - Exercise economy
   - Aerobic and anaerobic capacity
   - VO2max
   - Lactate threshold
   - Muscle strength, power and
   - Muscular endurance

3. Endurance is also influenced by our psychological strengths.

4. The primary factor that limits endurance exercise is FATIGUE

5. Fatigue tolerance it is highly trainable





Periodized macro-cycle program for combat sports

Preparatory phase

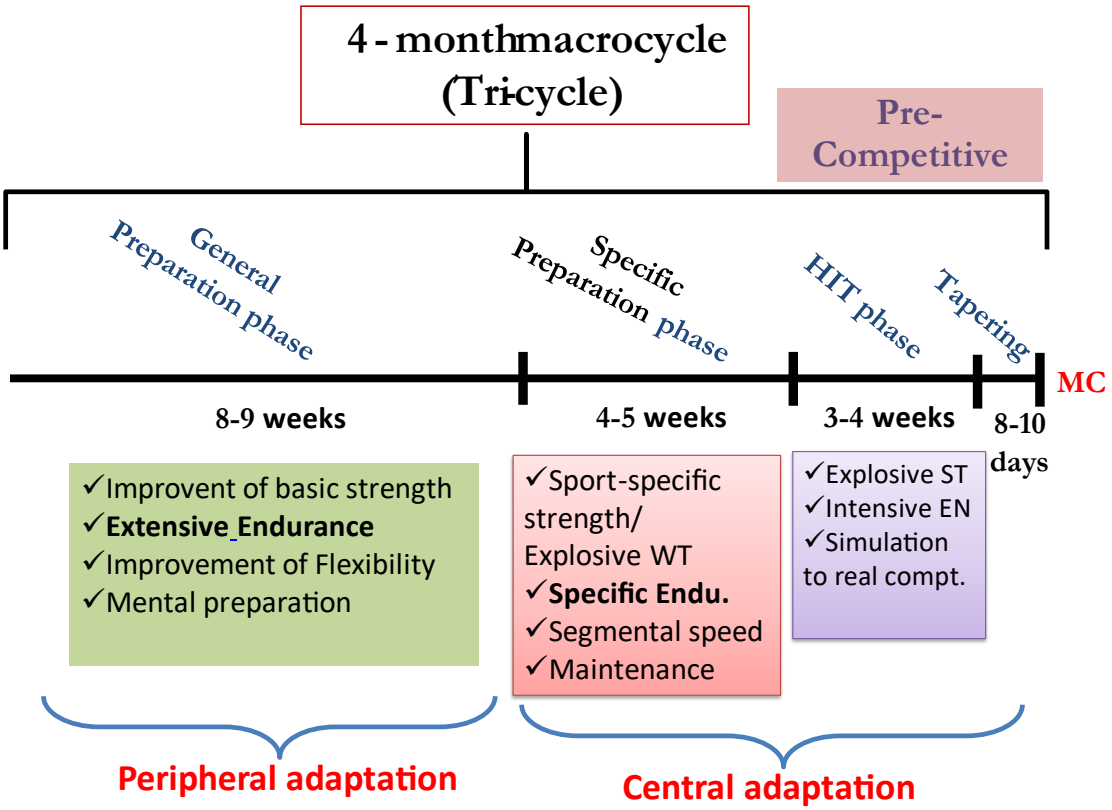
G.P.P	S.P.P
- Maximal strength	- Conversion to power / muscle-endurance
Aerobic Capacity	- Reduce volume of training
- Increase Volume of training	- Increase intensity of training
- Moderate intensity	Aerobic power
- Foundation of physical fitness	

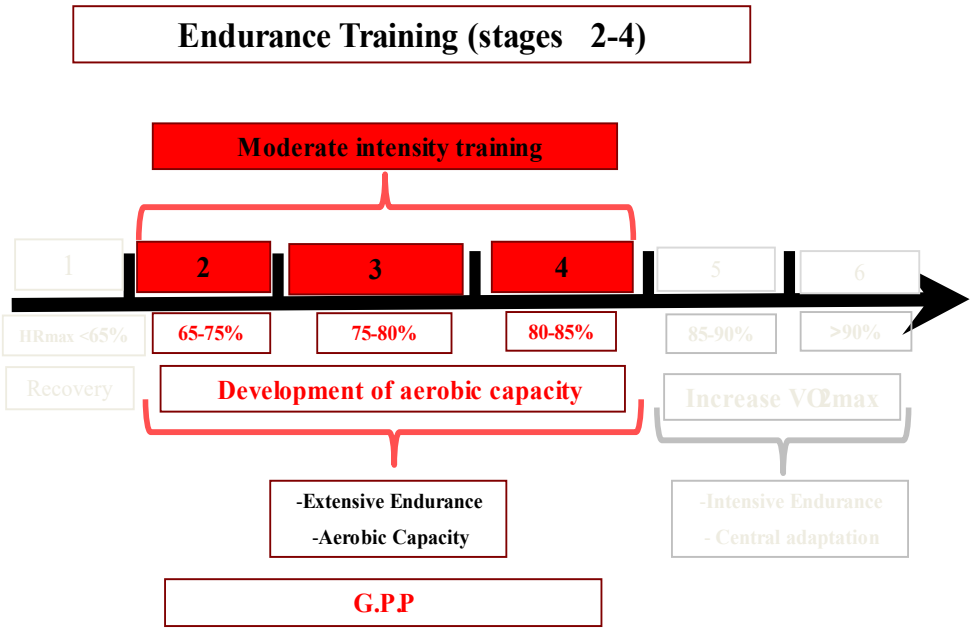
Competitive phase

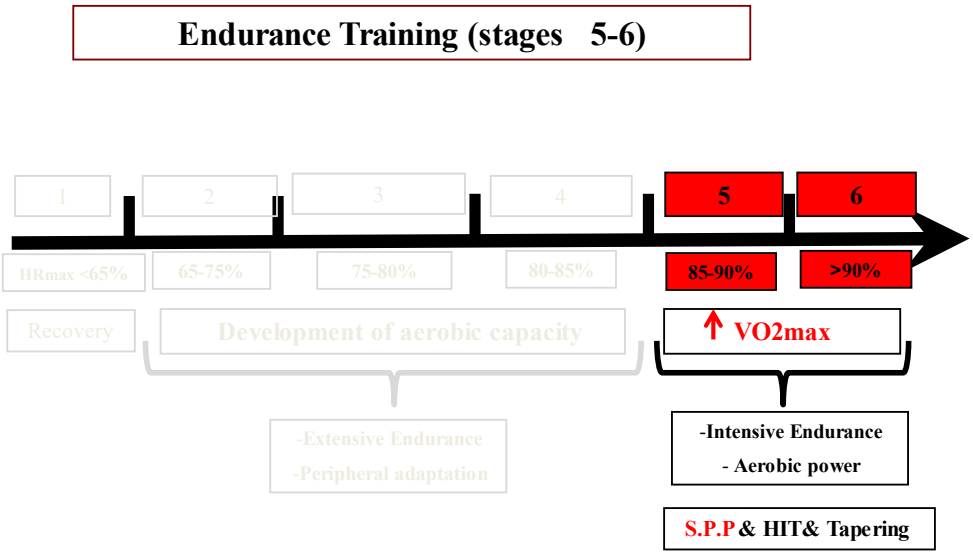
Pre-competitive	Competition
Maintenance of power/muscle endurance	- Tapering (Overcompensation)

Transition

Regeneration/ Recovery training

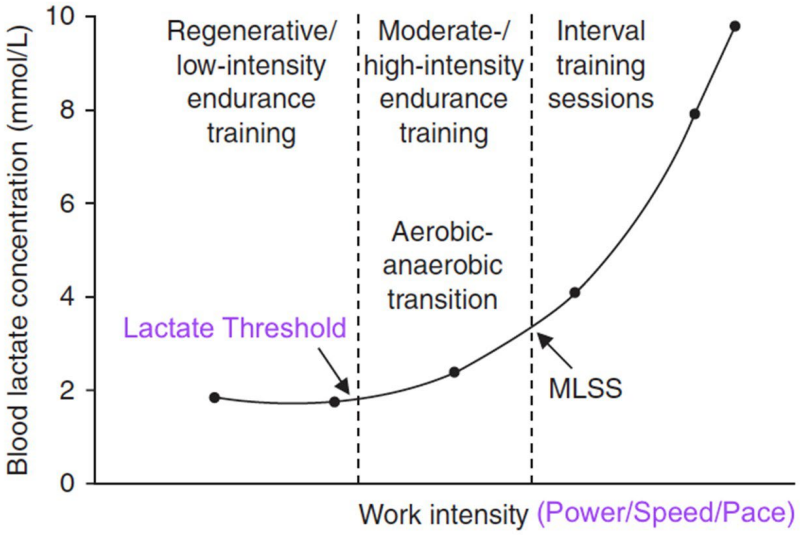



Endurance Training (stages 2-4)
Moderate intensity training
1
2
3
4
5
6
HRmax <65%
65-75%
75-80%
80-85%
85-90%
>90%
Recovery
Development of aerobic capacity
Increase VO2max
-Extensive Endurance
-Aerobic Capacity
-Intensive Endurance
- Central adaptation
G.P.P


Endurance Training (stages 5-6)
1
2
3
4
5
6
HRmax <65%
65-75%
75-80%
80-85%
85-90%
>90%
Recovery
Development of aerobic capacity
VO2max
-Extensive Endurance
-Peripheral adaptation
-Intensive Endurance
- Aerobic power
S.P.P & HIT& Tapering

Examples of ways to develop anaerobic endurance in wrestling:

- *Intervals completed* ***above VO 2max intensity****, using either short or longer recoveries.*
- *Short intervals at above VO 2max intensity with short active recoveries.*
- *Longer VO 2max intervals with longer recoveries*
- *Speed endurance intervals*
- *Short repeats of around 30 seconds duration.*



CANNABIS IN SPORTS & HOW ATHLETES TRY TO CHEAT DRUG TESTS FOR IT

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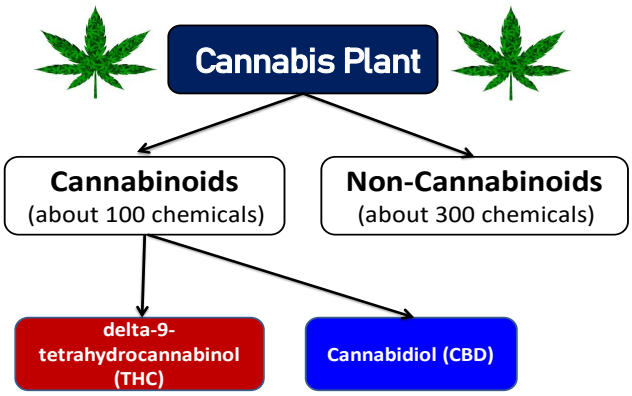
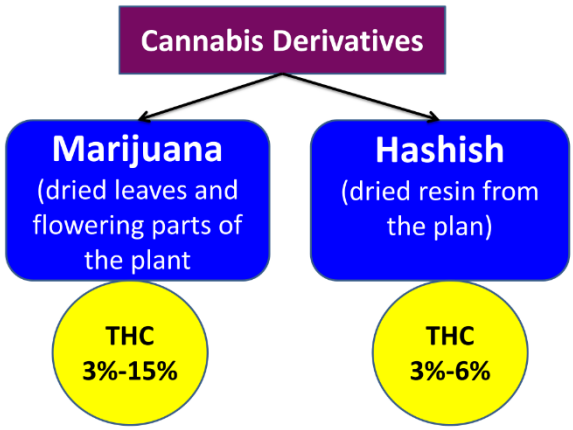




S8 CANNABINOIDS

- As per section S8 of the prohibited list published by the WADA:

1) Cannabinoids are prohibited *in-competition*.

2) All natural cannabinoids are prohibited, except Cannabidiol (CBD).

3) All synthetic tetrahydrocannabinols (THCs) are prohibited.

4) Synthetic cannabinoids that mimic the effects of THC are prohibited.

Synthetic cannabinoids ("synthetic marijuana," "Spice", "K2") that mimic the effects of THC:

- **HU-210** (a synthetic analogue of THC, first synthesised in 1988 and considered to have a potency of at least 100 times that of THC)
- **UR-144**
- **JWH** (created in 1994 by Dr John W. Huffman for studies of the cannabinoid receptors)
- **AM-694, AM-2201**
- **RCS-4, RCS-8**
- **5F-ADB**
- **CUMYL-PEGACLONE**

How Athletes Are Tested for Detection of THC

- **THC, the major psychoactive chemical in cannabis, is rapidly metabolized to the inactive metabolite THC-COOH and excreted in urine.**
- ***THC-COOH = 11-Nor-9-carboxy-Δ^9-tetrahydrocannabinol = THC carboxylic acid***
- **Urine is the best sample to look for THC metabolite.**
- **However, it can be detected in blood, hair and saliva as well.**

The 8 Factors That Affect the Detection of THC in the Body:

- **1) Dose of THC consumed**
- **2) Frequency of use**
- **3) Route of consumption**
- **4) Body fat**
- **5) Genetics and metabolism**
- **6) Types of drug tests**
- **7) Hydration**
- **8) Exercise**

Detection Windows for THC:

Specimen	Time to detect THC
Urine	Up to 20–30 days - Single dose.....3 days - Moderate use (4X/wk).....5-7 days - Daily use.....10-14 days - Chronic heavy use.....30 days
Blood	Up to 12 hours
Hair	Up to 90 days
Saliva	Up to 24 hours

Cut-Off Level for THC:

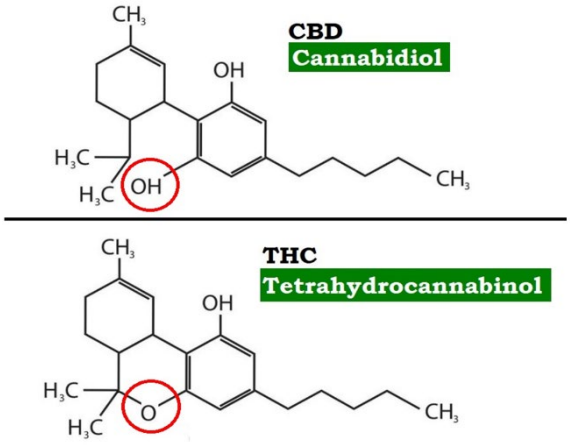
- Cut-off level is a level above which the concentration of THC is deemed a positive test.
- The World Anti-Doping Agency (WADA) has not published the cut-off level for THC.
- In the past, the cut-off level for THC was 15 ng/mL in sports.
- In medical references, it is 50 (20-100) ng/mL.

Can you have false-positives for THC?

YES!

1 CBD (Cannabidiol):

- CBD is not prohibited in sports.
- Most CBD products contain THC.
- CBD and THC have very similar chemical structures.



2 Hemp-Containing Foods:

Hemp-containing foods can cause false-positives for THC in urine tests:

- Hulled hemp seeds ("Hemp hearts")
- Hemp seed oil
- Hemp seed milk
- Hemp flour ("seed cake")
- Hemp protein powder

3 Proton-Pump Inhibitors:

- **A group of medications that are prescribed for stomach acidity, peptic ulcer, acid reflux, etc.**
- **Examples:**
  - **Esomeprazole (Nexium)**
  - **Lansoprazole**
  - **Omeprazole**
  - **Pantoprazole**

1 Urine Substitution:

Submitting a urine sample that isn't theirs:

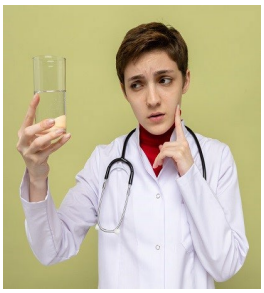
- **Synthetic urine**
- **Someone else's urine**

4 Other Medications:

- **Dronabinol (Marinol):**
  - To treat nausea and vomiting during chemotherapy
  - To stimulate appetite in patients with HIV/AIDS and cancer
- **Efavirenz (Sustiva):**
  - To treat the human immunodeficiency virus (HIV)
- **NSAIDs (Painkillers):**
  - Ibuprofen (Advil)
  - Naproxen
  - Diclofenac

2 Urine Dilution:

- **Pre-collection dilution:**
  - consuming large quantities of fluids before collecting the sample
- **Post-collection dilution:**
  - adding fluids to the sample after collecting it



Doping Control Station:

- **You will be asked to provide a urine sample of at least 90 ml.**
- **You will be asked to roll up your sleeves up to the elbows.**
- **A DCO or witnessing chaperone of the same gender will directly observe the urine collection process.**

How are diluted urine samples diagnosed?

Two validity tests are:

- **1) Measuring urine creatinine level:** a urine with a creatinine level of less than **20 mg/dL** is considered "dilute".
- **2) Measuring urine specific gravity**, aka ***urine density***: shows the concentration of all chemical particles in the urine. The normal range for urine specific gravity is **1.005 to 1.030**.

3 Urine Adulteration:

Manipulating a urine sample by adding exogenous chemicals (adulterants) or masking agents:

A) attempts to change urine pH by adding:

- Ammonia
- Baking soda
- Bleach
- Citric acid
- Laundry detergents
- Table salt

B) attempts to destroy drug metabolites in urine or confuse GC-MS by adding:

- Soap
- Iodized table salt
- Toilet bowl cleaners
- Glutaraldehyde
- Pyridinium chlorochromate (PCC)
- Potassium nitrite & sodium nitrite
- Pineapple or papaya juices
- Proteolytic enzymes (e.g. Bromelian, Nattokinase & Pepsin)

4 Blood Tampering:

- **A) Drinking vinegar or cranberry juice**
- **B) Consuming large doses of niacin (vitamin B3)**
- **C) Taking creatine supplements to increase creatinine levels in urine**
- **D) ZOC combo (Z= zinc, O=oral contraceptive pills, C=creatine)**

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DIFFERENCES IN SELECTED VARIABLES FOR ASSESSMENT OF SITUATIONAL EFFICIENCY IN BEGINNER WRESTLERS DEPENDING ON THE METHOD OF LEARNING AND IMPROVING TECHNIQUES

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INTRODUCTION: Wrestling is a very complex and energy-demanding kinesiology activity and quite often the improvement of techniques takes place only in the dominant side, which is criticized by wrestling experts and scientists. The goal of this manuscript is to compare the situational efficiency of beginner wrestlers who trained symmetrically to the left and right side with the situational efficiency variables of beginner wrestlers who trained asymmetrically only to the dominant side. METHODS: The sample consisted of 115 beginner wrestlers who were divided into two groups. The experimental group performed training symmetrically in both sides (n=61), while the control group performed training asymmetrically only in the dominant side (n=54). During the training process included in this research, 48 hours of training were conducted. The competition was held according to the Scandinavian competition system with 5 wrestlers in each group. Six variables were observed to assess the situational efficiency of wrestlers (General efficiency, Point efficiency, Pure efficiency, Activity, Success, Superiority). Marić (1985) proposes the variables for assessing situational efficiency in a wrestling match that were used in this research.

General efficiency - number of actions divided by the number of fights
Point efficiency – number of points divided by the number of actions
Pure efficiency – number of pins divided by the number of actions
Activity – (the sum of the number of attempts and the number of actions) divided by the duration of the fight
Success - number of attempts divided by the number of actions
Superiority - the number of actions performed by one wrestler divided by the number of actions of the opponent

Differences between the control and experimental groups were determined using univariate analysis of variance. RESULTS: Univariate analysis of variance for each variable separately determined a statistically significant difference between the arithmetic means in four of the six variables for assessing situational efficiency in wrestling - General efficiency, Point efficiency, Activity, Superiority.

Full test name	mark	SS	df	MS	SSe	dfe	MSe	F	P
General efficiency	OE	10,89	1	10,89	207,68	113	1,84	5,93	0,02
Point efficiency	BE	3,36	1	3,36	73,84	113	0,65	5,14	0,03
Pure efficiency	CE	0,05	1	0,05	1,91	113	0,02	3,11	0,08
Activity	AKT	64,80	1	64,80	315,24	113	2,79	23,23	0,00
Success	USP	1,08	1	1,08	61,83	113	0,55	1,96	0,16
Superiority	SUP	21,45	1	21,45	551,03	113	4,88	4,40	0,04

CONCLUSIONS

It is evident from the results that beginner wrestlers who practiced symmetrical learning and improving techniques in training are better in all variables for assessing situational efficiency. Because of this, we can conclude that in order to improve competitive efficiency in a wrestling match, wrestling elements must be learned and improved in both sides symmetrically.

Key words: symmetric learning and improvement, asymmetric learning and improvement, dominant side

PHYSICAL FITNESS PREPARATION OF TOP-LEVEL WRESTLERS

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[1] University of Zagreb, Faculty of Kinesiology, Croatia

mario.baic@kif.unizg.hr

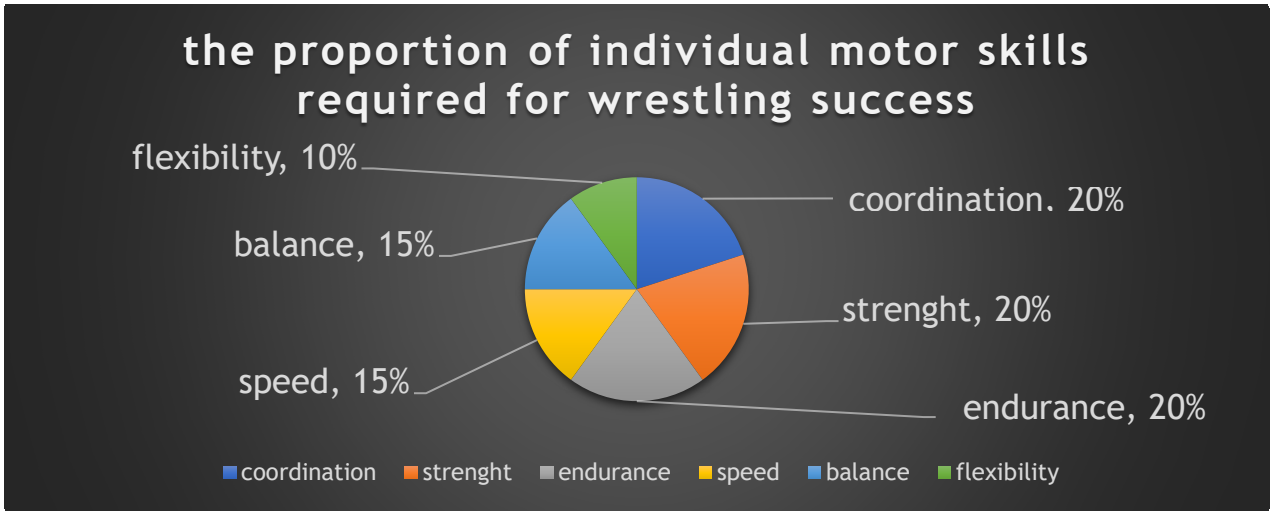
ABSTRACT
INTRODUCTION: Today, about 400 elements of technique and combinations in standing and ground position have been registered in classical wrestling and in freestyle wrestling, that number is over 1000. Physical fitness training is a very important part of a wrestler's preparation for top results. A particularly sensitive area in wrestling is how to balance physical fitness preparation and technical-tactical preparation so that wrestlers are fit for technical-tactical requirements, all to achieve top- level sports achievements.
DISCUSSION: Loads during a competitive fight vary from small to maximum, depending on the quality of the opponent and in the wrestling specification strength endurance is hypothetically placed first, along with coordination followed by speed, balance, and flexibility.
The importance (share) of each of these abilities in the specification equation is difficult to calculate precisely, because the share of these abilities differs in wrestlers of different weight categories, age groups, gender and wrestling style.
Some wrestling experts emphasize that coordination is crucial for success in the younger age categories, but as wrestlers move towards the older age categories, strong endurance and strength play an increasingly important role. In heavier weight categories wrestlers have higher absolute strength while wrestlers in lower weight categories have higher relative strength. We must not lose sight of the difference in physical fitness between female and male wrestlers. In situational physical fitness preparation, simplified situational training fights and training technical-tactical complexes are used, which are focused on independent and integral improvement of specific motor abilities, skills and habits. That kind of tasks are used mainly to develop specific strength endurance, coordination speed, balance and flexibility, and to improve tactical thinking.
CONCLUSION: This lecture aims to draw attention to the fact that physical fitness is different for wrestlers of different weight category, age group, genders and wrestling style. Even within the same category, the individual characteristics of each wrestler should be taken into account. Neglecting physical fitness training at one stage of sports development can lead to stagnation of sports achievements in the following stages and increase the risk of injury.
Keywords: Greco-Roman style, free style, woman's wrestling, fitness training of wrestlers, technical-tactical training, individualisation in sport.

INTRODUCTION

A particularly sensitive area in wrestling is how to balance physical fitness and technical-tactical preparation, so that wrestlers are ready for technical-tactical requirements, all in order to achieve top- level sports achievements.

According to the criterion of structural complexity, wrestling is a polystructural acyclic activity in which the motion of one wrestler and the motion of the biomechanical system of two wrestlers can be observed. Under the new rules, a wrestling fight lasts 2 x 3 minutes with 30 seconds of rest between two parts to win on points or a pin. Loads during a competitive fight vary from small to maximum, depending on the quality of the opponent.
In the wrestling specification strength endurance is hypothetically placed first, along with coordination and followed by speed, balance, and flexibility. Due to the reduction in the duration of the fight, an increasingly important place in the specification equation has a specific (speed-strength) endurance, and the importance of this ability is greater the more a wrestler is in a higher quality class.

HYPOTHETICAL STRUCTURE OF LEADING SKILLS OF WRESTLERS



The importance (share) of each of these abilities in the specification equation is difficult to calculate precisely, because the share of these abilities differs in wrestlers of different weight categories, and age groups. The importance (share) of each of these abilities in the specification equation is difficult to calculate precisely, because the share of these abilities differs in wrestlers of different weight categories, and age groups.

DIAGNOSIS AND ANALYSIS OF TRAINING CONDITIONS

In order to control the transformation effects, three measurements are performed every year, the aim of which is to determine the global and partial effects of the training process. Measurements are made at the beginning of the preparation period, immediately before the first competition period and immediately before the second competition period.

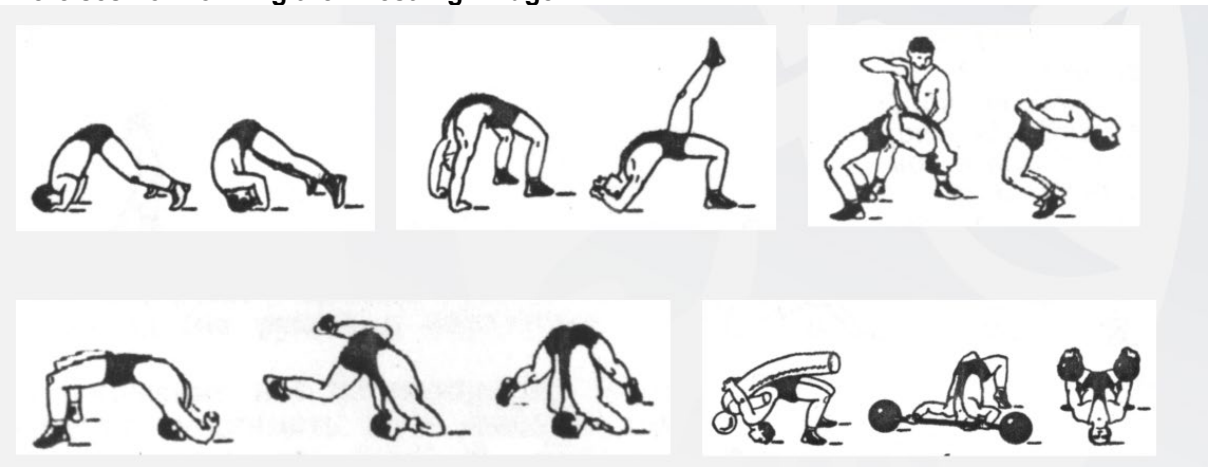
METHODOLOGICAL ASPECTS OF BASIC, SPECIFIC AND SITUATIONAL CONDITIONING PREPARATION

Basic Conditioning Preparation It is characteristic for the basic preparation that it uses those exercises that belong, according to the dynamics of neuro-muscular stresses and the structure of movement, to the basic movements performed by wrestlers during the fight. Their main purpose is to raise the level of basic motor skills of wrestlers, and to strengthen the health of wrestlers (natural corset, empowerment). Gymnastics (parterre, hoops), athletics, weightlifting and modified sports games (rugby basketball, knee handball, etc.) are used for basic fitness training.

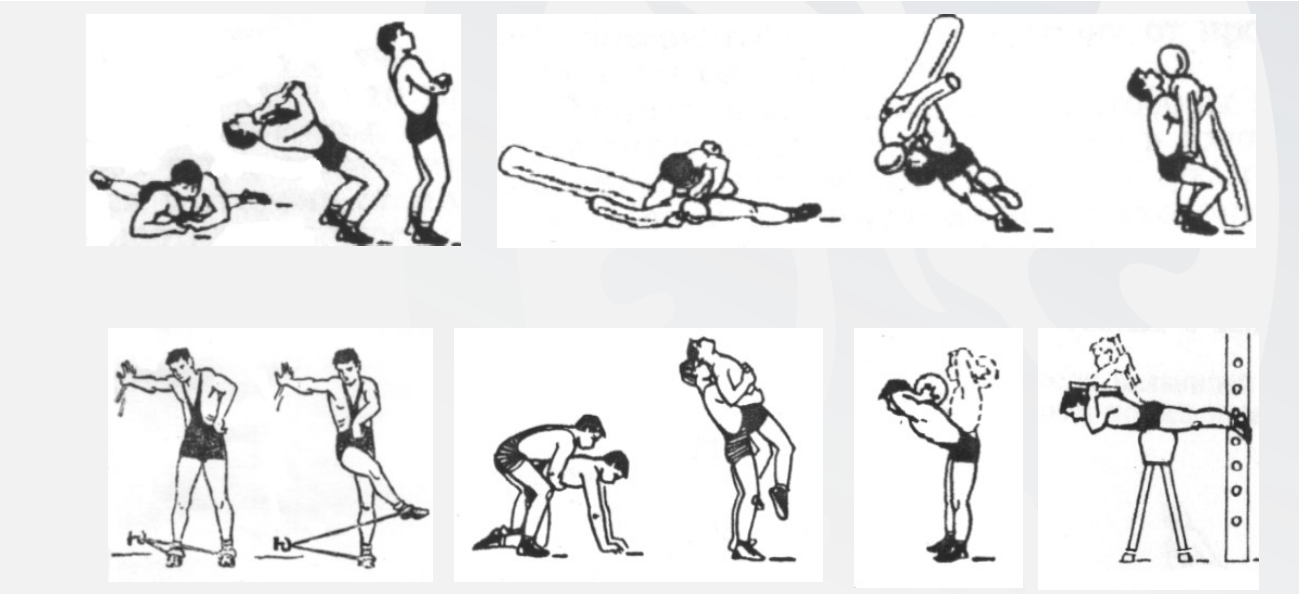
SPECIFIC CONDITIONING PREPARATION

In specific (special) fitness preparation, specific exercises are used, which are aimed to independent and integral improvement of specific motor abilities, skills and habits important for the successful realization of technical knowledge. Indirectly, these exercises also have a positive effect on some psychological factors. Conditionally, they can be divided into three qualification groups:

Exercises For Forming the Wrestling Bridge

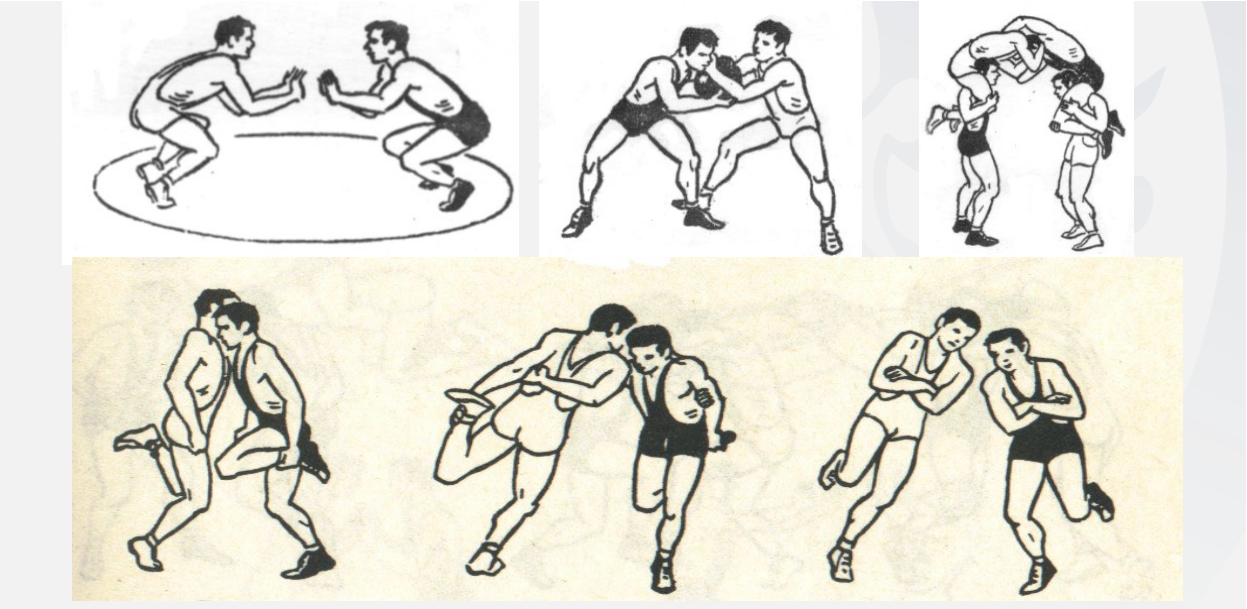


Imitation Exercises



SIMPLE FORMS OF

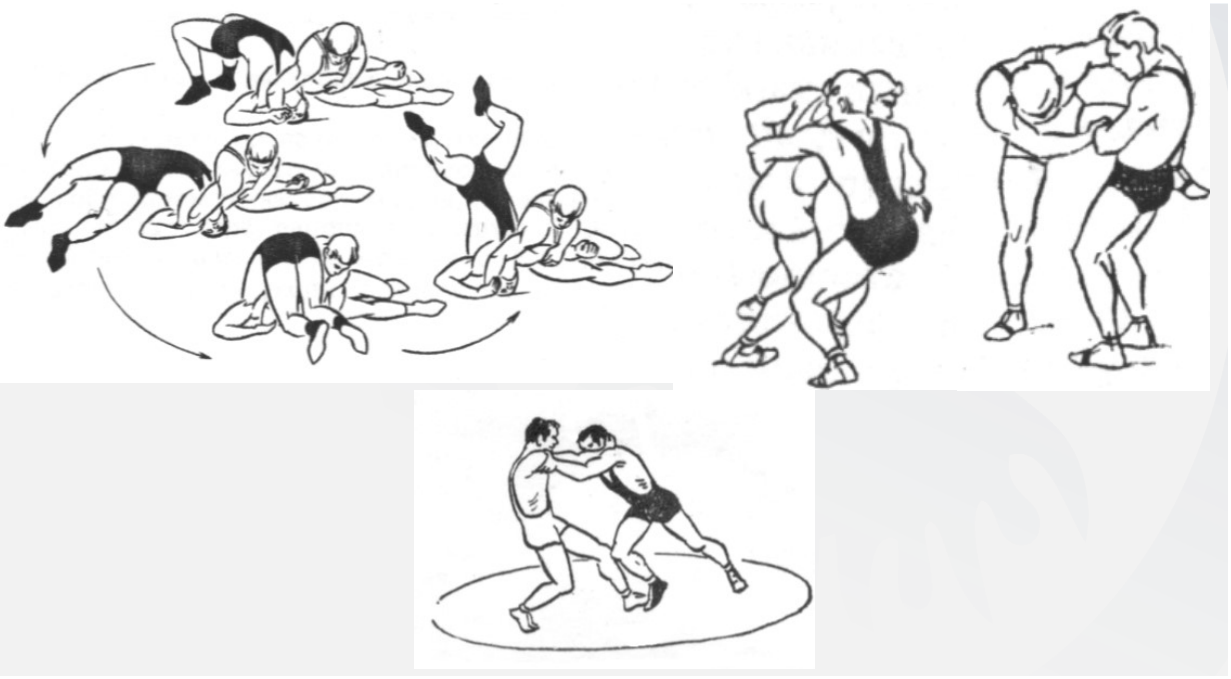
WRESTLING



SITUATIONAL CONDITIONING PREPARATION OF WRESTLERS

In situational conditioning preparation, simplified situational training fights and training technical-tactical complexes are used, which are focused on independent and integral improvement of specific motor abilities, skills and habits. That kind of tasks are used mainly to develop specific strength endurance, coordination, speed, balance, flexibility and to improve tactical thinking.

No less important is the influence of situation conditioning preparation on the psychological preparation of wrestlers. for that purpose, selected sparring partners are model of the expected behavior of the opponent according to the way of fighting, or according to the performance of the technical - tactical task.



PLANNING AND PROGRAMMING OF CONDITIONING TRAINING IN THE ANNUAL CYCLE

Conditioning preparation of wrestlers is carried out throughout the annual cycle, and the means and methods are selected according to the periods and phases of the annual training cycle. The tools of basic physical preparation prevail in the first part of the preparation and transition period, while the tools of specific and situational fitness preparation take over the main role in the competition period. The concept of modern training and previous experience suggest that the weekly training microcycle includes 2-3 fitness trainings which, in addition to developing certain motor and functional abilities, are also used as excellent tools for relieving the nervous system and active rest.

An example of a circuit training scheme to increase the endurance of wrestlers in the preparation period

R.B.	EXERCISE	REPS
1.	Push-ups on parallel bars	15
2.	Snatch (70- 80% max.)	5
3.	Push-ups	20
4.	Clean (70- 80 % max)	5
5.	movements in combat	20
6.	Barbell Twists - imitation of the initial movement of the throw by twisting (70- 80 % max)	20
7.	jump with dumbbells	10

An example of a circuit training scheme to increase the endurance of wrestlers in the competition period

R.B.	EXERCISE	REPS
1.	Backward throw	10
2.	Push-ups	25
3.	Pull-ups	15
4.	Strive - Circling in the wrestling bridge	5x each side
5.	Bench press from wrestling bridge position	20
6.	Partner twist "rebur"	5x each side
7.	Barbell Twists - imitation of the initial movement of the	10x each side
	throw by twisting (70- 80 % max)	
8.	Circling with weights (kettlebell) in wrestling bridge position	10x each side
9.	pull-up standing position	40 sec
10.	Clean (80-90% max)	5

The entire complex is run on time, and the number of repetitions of the complex corresponds to the functional status of the athlete. In the final stage of preparation, the circuit training will include mainly strength exercises with a partner.

Mesocycle model of immediate preparation for competition

DAY	SUN	MON	TUE	WEN	THU	FRI	SAT	SUN	MON	TUE	WEN	THU	FRI	SAT
DATE	27	28	29	30	31	1	2	3	4	5	6	7	8	9
LOAD	a	M	H	M	MX	MX	M	L	MX	MX	M	H	H	M
CONDITIONAL UNIT	r	397	500	318	749	744	309	260	696	633	323	522	514	336
DURATION (MIN)	r	83	106	68	160	161	70	80	132	137	69	98	107	90
GENERAL PHYSICAL PREPARATION (MIN)	i	3	25	45	50	50	50	60	42	24	50	15	33	80
SPECIFIC PHYSICAL PREPARATION (MIN)	v	49	81	23	110	111	20	20	90	113	19	83	74	10
INTENSITY IN ZONE	a													
5-8 POINTS (MIN)	l	32	58	38	59	76	20	0	99	66	29	58	64	18
NUM. TRAININGS	0	1	2	2	3	3	2	2	3	3	2	2	3	2

DAY	SUN	MON	TUE	WEN	THU	FRI	SAT	SUN	MON	TUE	WEN	TOTAL
DATE	10	11	12	13	14	15	16	17	18	19	20	24 DANA
LOAD	M	MX	MX	L	MX	MX	L	L	H	H	L	
CONDITIONAL UNIT	220	638	657	240	696	739	160	183	607	504	133	11178 C.U.
DURATION (MIN)	80	121	170	40	136	152	40	38	131	107	39	2415 MIN (100%)
GENERAL PHYSICAL PREPARATION (MIN)	60	30	55	20	25	30	40	25	50	35	25	953 (39,4%)
SPECIFIC PHYSICAL PREPARATION (MIN)	20	91	115	20	111	122	0	13	81	72	14	1462 (60,6%)
INTENSITY IN ZONE												
5-8 POINTS (MIN)	0	71	40	40	73	73	0	8	61	34	9	1026 MIN(42,5%)
NUM. TRAININGS	2	3	3	1	3	3	1	2	3	3	1	55 TRAININGS

CONCLUSIONS

The share of individual abilities in the equation of specification varies depending on the stage of sports development (age), and on weight categories.

Neglecting fitness training at one stage of sports development can lead to stagnation of sports achievements in the following stages and increase the risk of injury.

In this paper, it is confirmed that certain groups of advanced Croatian wrestlers have unnecessarily high and overdeveloped individual motor skills (explosive power), while some other skills, which should be more developed, at the same time are not appropriately developed (specific coordination).It can be concluded that the individualization and rationalization of conditional training programs for top level wrestlers is still not respected enough, and especially their:

- - wrestling style,
- - wrestling age,
- - wrestling weight category,
- - connection with their technical-tactical (coordination) preparation and individual anthropological characteristics.

INVITED LECTURE

TO FIGHT ANOTHER DAY, THE IMPORTANCE OF PROPER RECOVERY AND REGENERATION

NIKOS C. APOSTOLOPOULOS, PhD
Founder of Stretch Therapy & microStretching

microstretching@gmail.com

ABSTRACT:
The main function of skeletal muscle is the generation of force to provide movement and stability - two actions critical to the sport of wrestling. Training and competing exert significant stress on muscle as different parts of the body are subjected to diverse patterns of recruitment and activity. Proper training for wrestling relies on the development of muscle strength and power, as well as honing learned patterns of response, relying on muscle's adaptive and plastic properties. However, both training and competition can result in muscle injury. Approximately 50% of sports injuries involve damage at the myofiber level – sometimes the result of acute, unexpected over stress of the muscle, sometimes the result of chronic overload of muscle without adequate recovery and regeneration to allow adaptation. What determines the influence of force on muscle concerns the variables - the intensity, duration, and frequency of the applied stress, the mechanical properties of the tissue, and the provision of proper recovery time to allow the adaptive (or healing) response to occur. Clearly, a suitable balance between stress (training and competition load) and recovery is essential for the wrestler's ability to achieve continuous high performance. However, one perspective that needs to be critiqued concerns the "no pain, no gain" philosophy often adopted by athletes and coaches. To examine this issue in terms of developing muscle through the use of proper levels of stress, balanced by suitable amounts of rest to promote positive adaptation during recovery and regeneration, we can look at what is happening within the autonomic nervous system – in particular, the interplay between the parasympathetic and sympathetic nervous systems and their relationship to pain, inflammation, and the inflammatory response. In this presentation, the stress – response relationship will be explored in terms of negative adaptation (maladaptation), and the role that low intensity stretching (termed microStretching) can play in promoting positive adaptation. It is hoped that by the end of this presentation, the audience will gain an appreciation of a new approach – "greatest pain is achieved without pain" when wrestlers and their coaches consider their approach to training, recovery and regeneration.

To Fight Another Day:

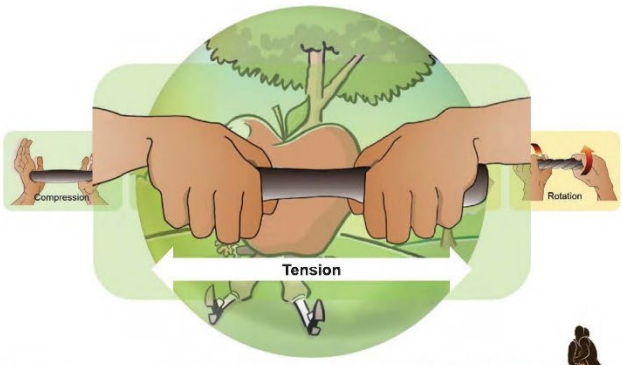
microStretching®, the Importance of Proper Recovery & Regeneration

Dr Nikos C. Apostolopoulos PhD, MPhil, BPHE (Sports Medicine)
Founder of Stretch Therapy™ & microStretching®

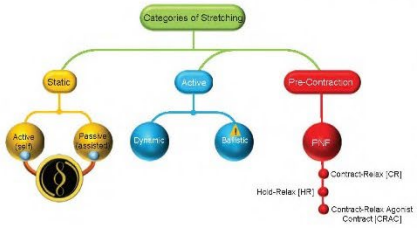
UWW Science Symposium
Belgrade, Serbia
Sept. 20th, 2023

STATEMENT:

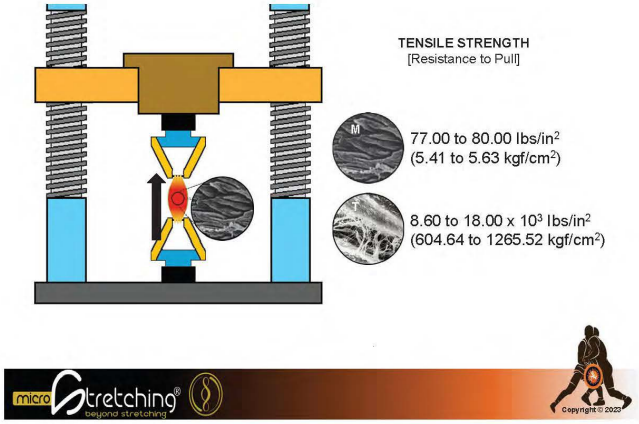
Wrestlers undergo a training plan which includes various training sessions characterized by assorted activities consisting of diverse mixture of **intensities, durations, frequencies** and **volumes** with the aim of developing specific physiological adaptations to promote improved performance. Recovery and regeneration are a **critical aspect** of training that focuses on re-establishing the physiological homeostasis disrupted through training. Creating the **right conditions** for optimal performance is crucially dependent on following the **appropriate** recovery and regeneration plan to facilitate adaptation and avoid over-training and/or injury. Of the four training variables - **intensity, durations, frequency,** and **volume**, **INTENSITY** is of greatest importance.



What Is microStretching®?



A SYSTEM of evidenced based **static** Low *Intensity Stretching* (LIS), both active and passive. microStretching® consists of **Attributes** and **Principles** focused on facilitating the body's natural healing process for proper recovery and regeneration by decreasing inflammation and by engaging the parasympathetic nervous system (PsNS), thereby activating the relaxation response


TENSILE STRENGTH
[Resistance to Pull]
77.00 to 80.00 lbs/in2
(5.41 to 5.63 kgf/cm2)
8.60 to 18.00 x 10³ lbs/in2
(604.64 to 1265.52 kgf/cm2)
microStretching
beyond stretching
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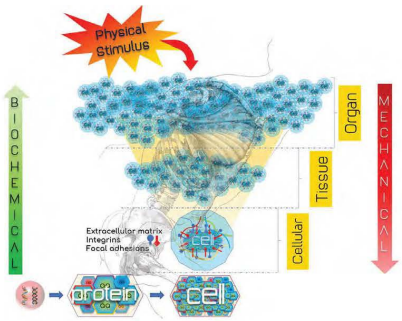
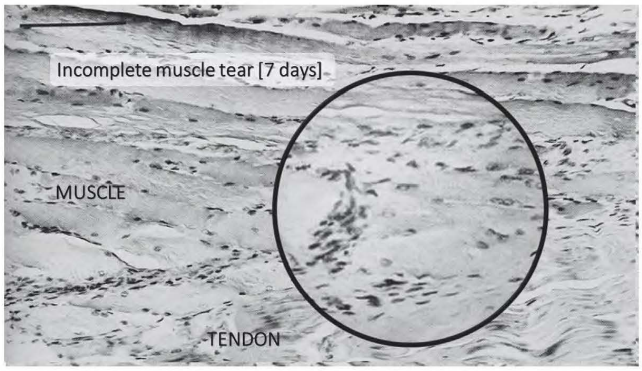
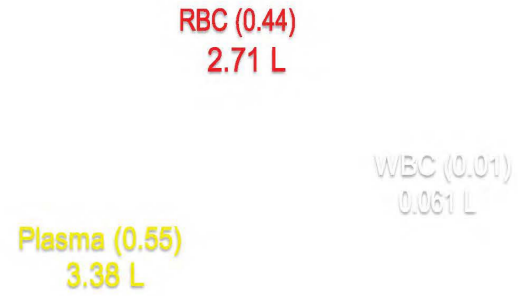
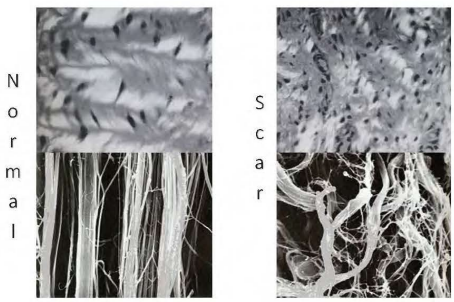

Physical Stimulus
BIOCHEMICAL
MECHANICAL
Organ
Tissue
Cellular
Extracellular matrix
Integrins
Focal adhesions
cell
protein
cell


Incomplete muscle tear [7 days]
MUSCLE
TENDON


RBC (0.44)
2.71 L
WBC (0.01)
0.061 L
Plasma (0.55)
3.38 L


Normal
Scar
microStretching
beyond stretching
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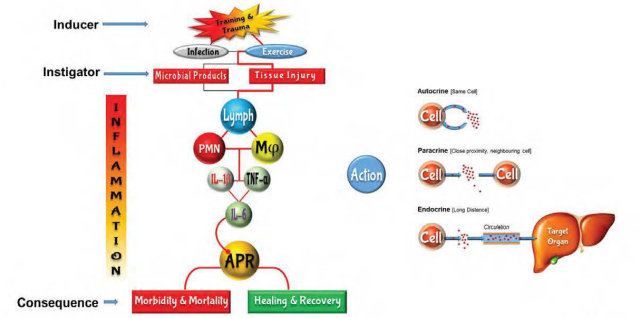
Inducer
Training & Trauma
Infection
Exercise
Instigator
Microbial Products
Tissue Injury
INFLAMMATION
Lymph
PMN
Mφ
IL-1
TNF-α
IL-6
APR
Consequence
Morbidity & Mortality
Healing & Recovery
Action
Autocrine
Cell
Paracrine
Cell
Cell
Endocrine
Cell
Target Organ
microStretching
beyond stretching
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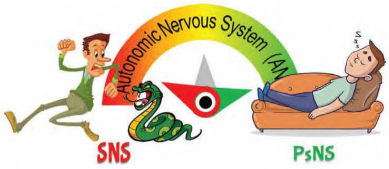
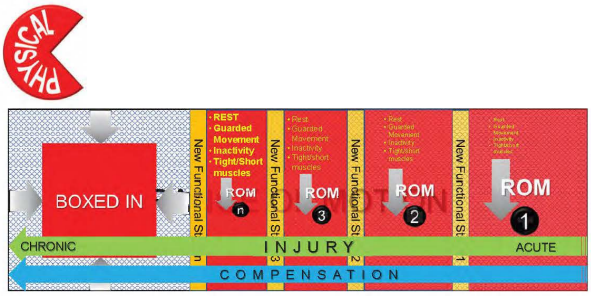
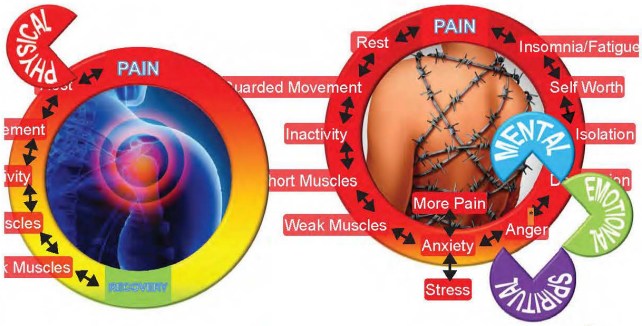
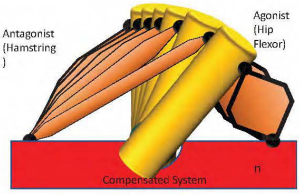

Autonomic Nervous System (ANS)
SNS
PsNS

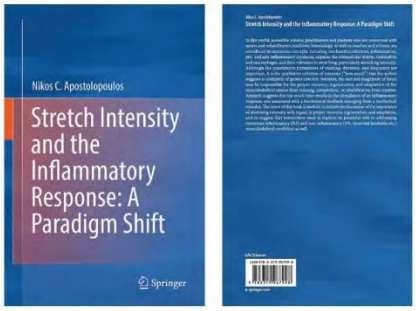
MENTAL
PHYSICAL
EMOTIONAL
SPIRITUAL

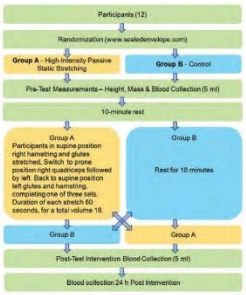

PHYSICAL
BOXED IN
REST
Guarded Movement
Inactivity
Tight/Short muscles
New Functional St.
ROM
n
3
2
1
CHRONIC
INJURY
ACUTE
COMPENSATION


PHYSICAL
PAIN
Guarded Movement
Inactivity
Weak Muscles
Rest
Insomnia/Fatigue
Self Worth
Isolation
MENTAL
More Pain
Anger
Anxiety
Stress
EMOTIONAL
SPIRITUAL


Antagonist (Hamstring)
Agonist (Hip Flexor)
Compensated System

PAIN
An unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage*
Pain in the form of too much force during a stretch can injure tissue, resulting in inflammation**
Formation of scar tissue in response to tissue damage
SNS response
*International Association for the Study of Pain
TRAUMA***
INFLAMMATION
Innate and adaptive response
A local and systemic response after physical, chemical, thermal insults. It functions as a repair/host defense mechanism process heavily involved in restoration of normal tissue function
Acute Inflammation = necessary for repair
Chronic Inflammation = SNS response, impedes healing
Avoid causing additional pain and inflammation





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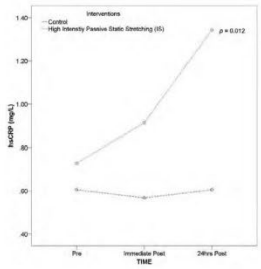
- Acute Inflammation Response to Stretching (p. 131 – 43)



CONCLUSION:

In summary and within the study's limitations (i.e., timing of blood collection), the present data demonstrated that high-intensity passive static stretching [HIS] is associated with an increase in systemic hsCRP attributed to inflammation and the inflammatory response. Further research into the probable causes of inflammation regarding intense stretching will elucidate if this form of activity is detrimental to the health of the muscle tissue and its proper function

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NUMERICAL RATING SCALE – maximum perceived stretch intensity

- Stretch Intensity vs. Inflammation: Is There A Dose Dependent Association (p. 145 – 57)

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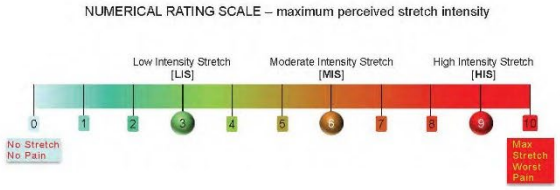

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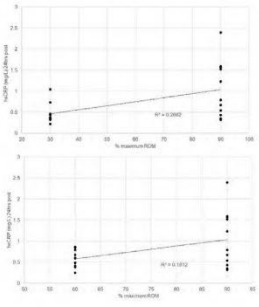
hsCRP (mg/L) 24-hour post comparing 30 to 90% and 60 to 90% maximum ROM



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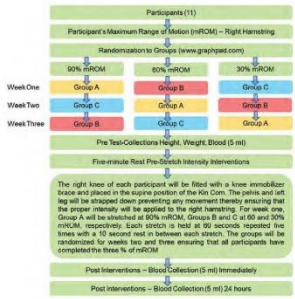

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CONCLUSION:
The data revealed that increases in percentage maximum ROM were associated with a progressive increase in hsCRP. Since the production of hsCRP has been linked to inflammation, intensities between 30 & 60% maximum ROM were less likely to cause inflammation.

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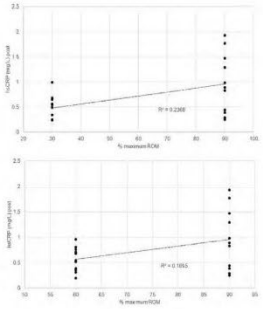
hsCRP (mg/L) immediately post comparing 30 to 90% & 60 to 90% maximum ROM



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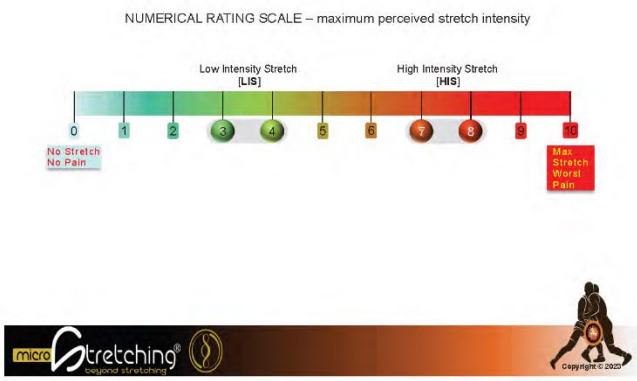
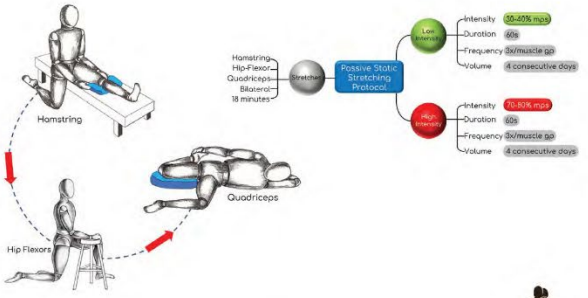
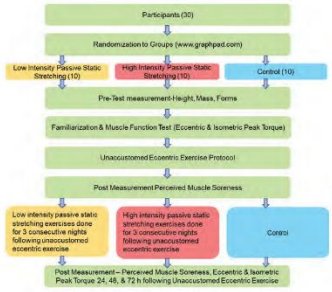
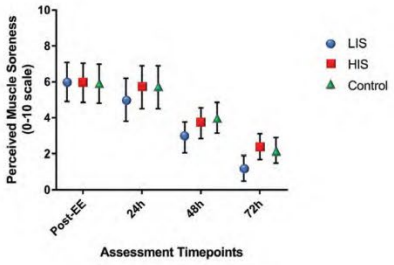
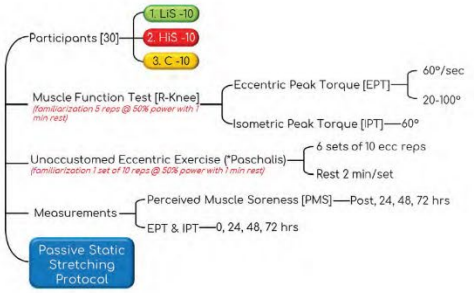
- The Effects of Different Passive Static Stretching Intensities on Perceived Muscle Soreness and Muscle Function Recovery Following Unaccustomed Eccentric Exercise: A Randomised Controlled Trial (p. 159 – 81)

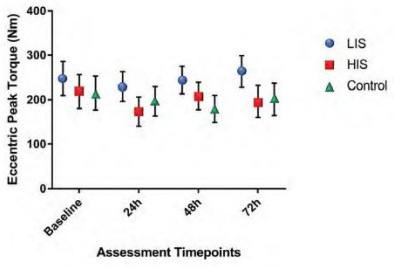

NUMERICAL RATING SCALE – maximum perceived stretch intensity
Low Intensity Stretch
[LIS]
High Intensity Stretch
[HIS]
0
1
2
3
4
5
6
7
8
9
10
No Stretch
No Pain
Max Stretch
Worst Pain

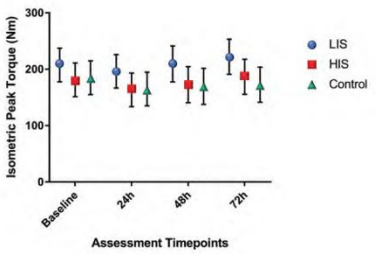

Hamstring
Quadriceps
Hip Flexors
Hamstring
Hip-Flexor
Quadriceps
Bilateral
18 minutes
Stretches
Passive Static Stretching Protocol
Intensity 30-40% mpa
Duration 60s
Frequency 3x/muscle gp
Volume 4 consecutive days
Intensity 70-80% mpa
Duration 60s
Frequency 3x/muscle gp
Volume 4 consecutive days


Participants (30)
Randomization to Groups (www.graphpad.com)
Low Intensity Passive Static Stretching (10)
High Intensity Passive Static Stretching (10)
Control (10)
Pre-Test measurement-Height, Mass, Forms
Familiarization & Muscle Function Test (Eccentric & Isometric Peak Torque)
Unaccustomed Eccentric Exercise Protocol
Post Measurement Perceived Muscle Soreness
Low intensity passive static stretching exercises done for 3 consecutive nights following unaccustomed eccentric exercise
High intensity passive static stretching exercises done for 3 consecutive nights following unaccustomed eccentric exercise
Control
Post Measurement – Perceived Muscle Soreness, Eccentric & Isometric Peak Torque 24, 48, & 72 h following Unaccustomed Eccentric Exercise


Perceived Muscle Soreness (0-10 scale)
10
8
6
4
2
0
Post-EE
24h
48h
72h
Assessment Timepoints
LIS
HIS
Control


Participants [30]
1. LiS -10
2. HiS -10
3. C -10
Muscle Function Test [R-Knee]
(familiarization 5 reps @ 50% power with 1 min rest)
Eccentric Peak Torque [EPT]
60°/sec
20-100°
Isometric Peak Torque [IPT]—60°
Unaccustomed Eccentric Exercise (*Paschalis)
(familiarization 1 set of 10 reps @ 50% power with 1 min rest)
6 sets of 10 ecc reps
Rest 2 min/set
Measurements
Perceived Muscle Soreness [PMS]—Post, 24, 48, 72 hrs
EPT & IPT—0, 24, 48, 72 hrs
Passive Static Stretching Protocol

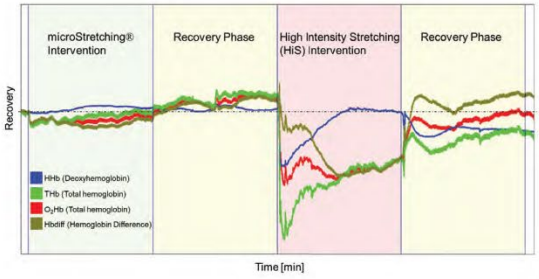

Eccentric Peak Torque (Nm)
400
300
200
100
0
Baseline
24h
48h
72h
Assessment Timepoints
LIS
HIS
Control

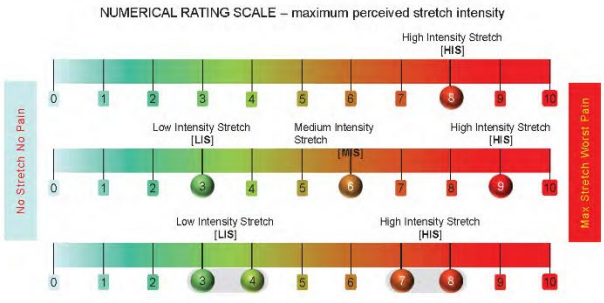


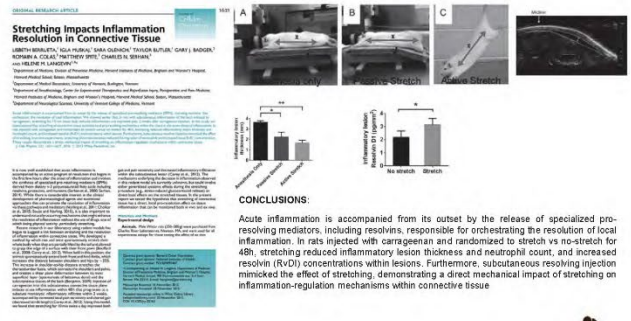
- Quantifying Stretching Intensity - microStretching® vs Aggressive (high-intensity) Stretching With Use of NIRS

CONCLUSION:

Compared with high-intensity passive static stretching and no stretching, low-intensity passive static stretching results in beneficial effects on perceived muscle soreness and recovery of muscle function post-unaccustomed eccentric exercise. Since soreness associated with DOMS affects athletic performance, a decrease in perceived muscle soreness may aid in the restoration of maximal muscle function, and an increased adherence to regular exercise with nonathletes.







CONCLUSIONS:

Acute inflammation is accompanied from its outset by the release of specialized pro-resolving mediators, including resolvins, responsible for orchestrating the resolution of local inflammation. In rats injected with carrageenan and randomized to stretch vs no-stretch for 48h, stretching reduced inflammatory lesion thickness and neutrophil count, and increased resolvin (RvDI) concentrations within lesions. Furthermore, subcutaneous resolving injection mimicked the effect of stretching, demonstrating a direct mechanical impact of stretching on inflammation-regulation mechanisms within connective tissue

SCIENTIFIC REPORTS
OPEN
Stretching Reduces Tumor Growth in a Mouse Breast Cancer Model
There is growing interest in developing non-pharmacological treatments that could boost natural defences against cancer and contribute to primary and secondary cancer prevention. Recent studies have shown that gentle daily stretching for 10 minutes can reduce local connective tissue inflammation and fibrosis. Because mechanical factors within the stroma can influence the tumor microenvironment, we hypothesized that stretching would reduce the growth of tumours implanted within locally stretched tissues and tested this hypothesis in a mouse orthotopic breast cancer model. Female FVB mice (N=66) underwent bilateral injection of p53^{R172H};ERN double-null primary mouse mammary tumor cells into the third mammary fat pad. Mice were randomized to stretch vs. no stretch, and treated for 10 minutes once a day, for four weeks. Tumor volume at end-point was 52% smaller in the stretch group, compared to the no stretch group (p < 0.001) in the absence of any other treatment. Cytotoxic immune responses were activated, and levels of Specialized Pro-Resolving Mediators were elevated in the stretch group. These results suggest a link between immune exhaustion, inflammation resolution and tumor growth. Stretching is a gentle, non-pharmacological intervention that could become an important component of cancer treatment and prevention.

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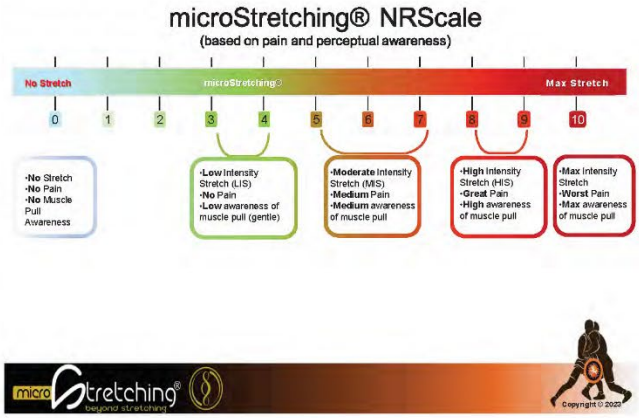
microStretching® NRScale
(based on pain and perceptual awareness)
No Stretch
microStretching©
Max Stretch
0
1
2
3
4
5
6
7
8
9
10
•No Stretch
•No Pain
•No Muscle Pull Awareness
•Low Intensity Stretch (LIS)
•No Pain
•Low awareness of muscle pull (gentle)
•Moderate Intensity Stretch (MS)
•Medium Pain
•Medium awareness of muscle pull
•High Intensity Stretch (HIS)
•Great Pain
•High awareness of muscle pull
•Max Intensity Stretch
•Worst Pain
•Max awareness of muscle pull
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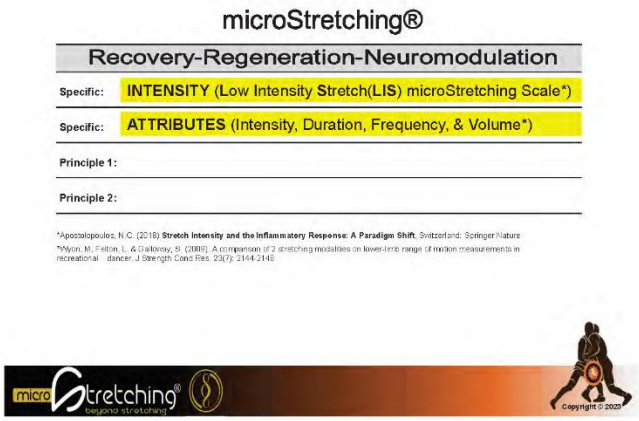
• Paradigm Shift


microStretching®
Recovery-Regeneration-Neuromodulation
Specific: INTENSITY (Low Intensity Stretch(LIS) microStretching Scale*)
Specific: ATTRIBUTES (Intensity, Duration, Frequency, & Volume*)
Principle 1:
Principle 2:
*Apostolopoulos, N.C. (2018) Stretch Intensity and the Inflammatory Response: A Paradigm Shift, Switzerland: Springer Nature
*Wyon, M; Felton, L. & Galloway, S. (2008). A comparison of 2 stretching modalities on lower-limb range of motion measurements in recreational dancer. J Strength Cond Res. 23(7): 2144-2148
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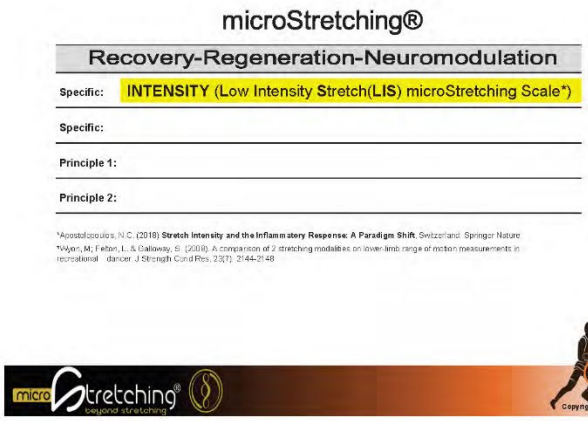
microStretching®
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*Wyon, M; Felton, L. & Galloway, S. (2008). A comparison of 2 stretching modalities on lower-limb range of motion measurements in recreational dancer. J Strength Cond Res. 23(7): 2144-2148
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microStretching®
Subjectiv
Intensity (how hard)
30-40% of maximum perceived stretch
Objective
Duration (how much)
60 seconds
Frequency (how often)
Once per day 3 times per muscle group- preferably before sleep or 2 hours post activity
Volume (how many)
Total number of Stretch sessions per week
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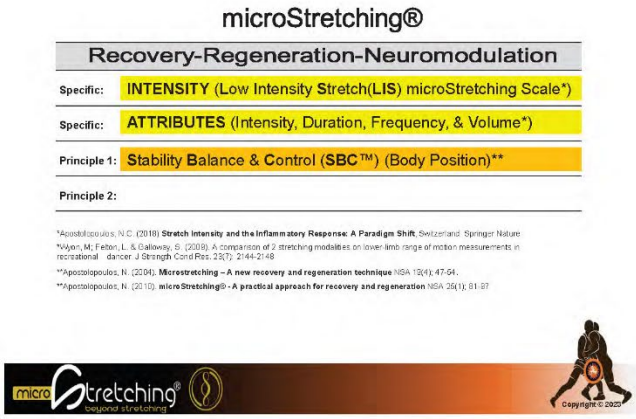
microStretching®
Recovery-Regeneration-Neuromodulation
Specific: INTENSITY (Low Intensity Stretch(LIS) microStretching Scale*)
Specific: ATTRIBUTES (Intensity, Duration, Frequency, & Volume*)
Principle 1: Stability Balance & Control (SBC™) (Body Position)**
Principle 2:
*Apostolopoulos, N.C. (2018) Stretch Intensity and the Inflammatory Response: A Paradigm Shift. Switzerland: Springer Nature
*Wyon, M; Felton, L. & Galloway, S. (2009). A comparison of 2 stretching modalities on lower limb range of motion measurements in recreational dancer. J Strength Cond Res. 23(7): 2144-2148
**Apostolopoulos, N. (2004). Microstretching – A new recovery and regeneration technique NSA 19(4): 47-54.
**Apostolopoulos, N. (2010). microStretching® - A practical approach for recovery and regeneration NSA 25(1): 81-97
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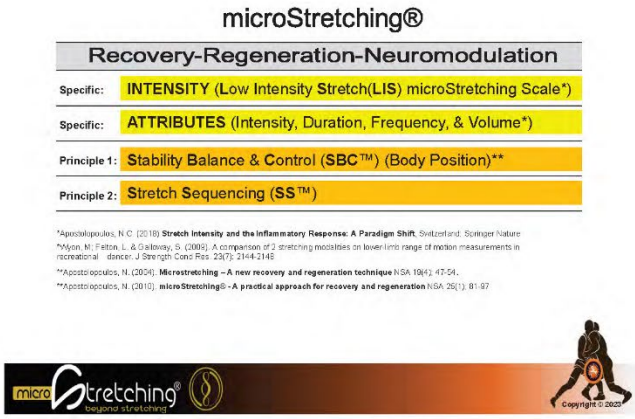
microStretching®
Recovery-Regeneration-Neuromodulation
Specific: INTENSITY (Low Intensity Stretch(LIS) microStretching Scale*)
Specific: ATTRIBUTES (Intensity, Duration, Frequency, & Volume*)
Principle 1: Stability Balance & Control (SBC™) (Body Position)**
Principle 2: Stretch Sequencing (SS™)
*Apostolopoulos, N.C. (2018) Stretch Intensity and the Inflammatory Response: A Paradigm Shift. Switzerland: Springer Nature
*Wyon, M; Felton, L. & Galloway, S. (2009). A comparison of 2 stretching modalities on lower limb range of motion measurements in recreational dancer. J Strength Cond Res. 23(7): 2144-2148
**Apostolopoulos, N. (2004). Microstretching – A new recovery and regeneration technique NSA 19(4): 47-54.
**Apostolopoulos, N. (2010). microStretching® - A practical approach for recovery and regeneration NSA 25(1): 81-97
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Balance
Stability
Control
Eliminate the Potential of muscle contraction during a stretch*
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Kinetic Chain
Stretch Sequencing™
microStretching® Chain
Focuses on the origin and insertion of the muscle groups, their overlap*, as well as addressing the generation of tension in the body
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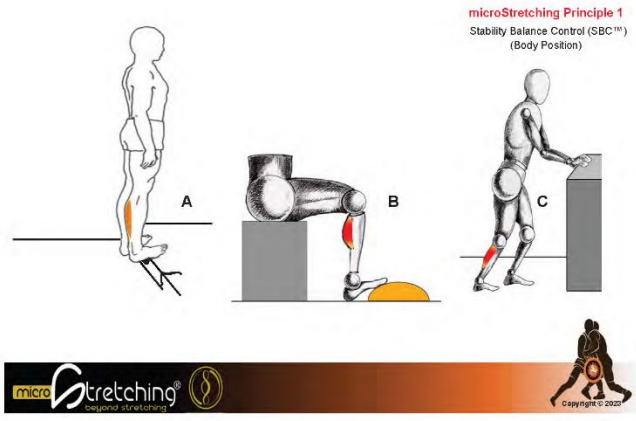
microStretching Principle 1
Stability Balance Control (SBC™)
(Body Position)
A
B
C
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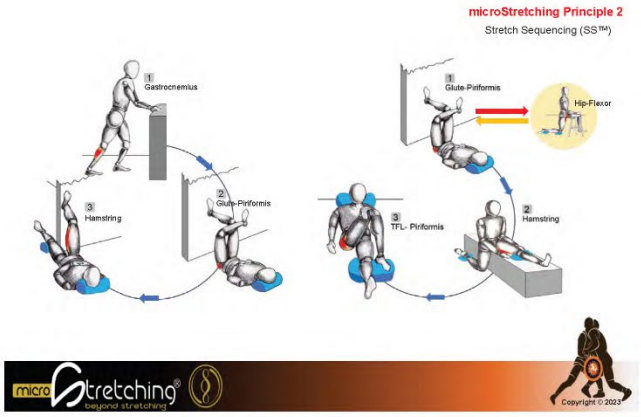

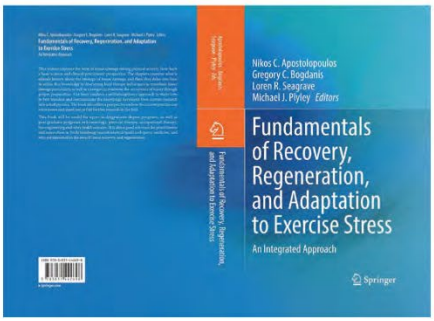

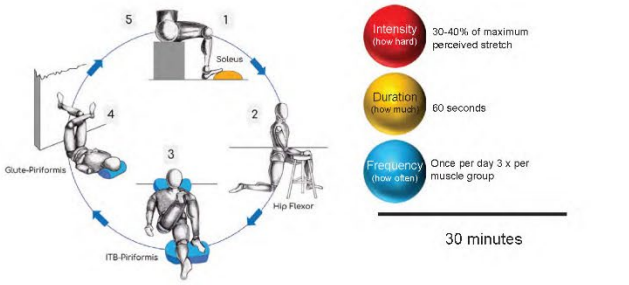

CONTACT INFORMATION

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Email: Info@microstretching.com
microstretching@gmail.com

@microstretching

@microstretching

@microstretching

IT TAKES A TEAM

There is an art and science to all things when we look at the training of wrestlers. To maximize performance, we need to recognize that this is a team effort of which I presented just one piece of the puzzle. As professionals we need to see and account for any aspect of the whole picture. Rowing in the same direction we can look through multiple lenses creating a more complete picture of their needs to perform. This collaborative path is an *Integrative Approach* to firstly their health and then their performance.

Working as a team, we learn and discover **more angles** about various issues that confront them. This enables **CRITICAL THINKING** resulting in deeper questions about seemingly unrelated events that could have a significant impact on training outcomes, and any appropriate treatment approaches.

TECHNICAL – TACTICAL MOVEMENTS USED IN 2021 AND 2022 WORLD SENIOR FREESTYLE WRESTLING CHAMPIONSHIPS

[1,3]Ramiz Arabaci, [2,3]Ali Kamil Gungor
[1]Bursa Uludag University, Faculty of Sport Sciences, Nilufer, Bursa / Turkey, ramizar@uludag.edu.tr [2] Bursa Uludag University, Faculty of Sport Sciences, Department of Coaching Education [3]Elite Performance in Sport Research Group

Abstract
PURPOSE: The present study aimed to conduct notational analysis on technical and tactical aspects of super elite men's wrestling, comparing the winning and losing markers of the 2021 and 2022 Senior World Wrestling Championships. METHODS: A total of 598 bout videos were observed and analysed by Dartfish Connect Plus 8.0 match analysis program. Analyses were performed according to bout analysis preparation, searching and tagging, creating a database, data usage procedures. Wrestling techniques were grouped into take downs and throws (standing position), flips and throws (parterre position). There is significant difference between attack and counter-attacks in 2021WC and 2022WC ($p < 0.05$; $\chi 2=8.318$). The mean technical points (TP_{mean}) are determined in first and second period 5.2 and 4.4 ($p>0.05$, $d=.071$) and according wrestling actions (WA_{mean}) 1.78 and 1.73 ($p>0.05$, $d=.068$) in 2021WC, and TP_{mean} 5.1 and 4.4 ($p>0.05$, $d=.061$) and WA_{mean} 1.77 and 1.76 ($p>0.05$ $d=.001$) in 2022WC, respectively. The most wrestling techniques are performed in standing position (WC2021 61.4% and WC2022 58.6%). CONCLUSIONS: The findings of present study demonstrated attractive and active combat of wrestle in 2021 and 2022 WC. Leg attack, take down, push to out and gut wrench are most valuable techniques in elite freestyle wrestling.
Key words: wrestling, notational analyses, technic-tactic, elite athlete

Body-Mind-Community: Using Wrestling to Build Safer and Stronger Communities and Members

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This programme description will present a proposed interdisciplinary research project conducted by Coach Saeid Esmaeli and colleagues at Bournemouth University and the University of the West of England, which aims to investigate the positive and transformative impact of wrestling participation on the lives of marginalised young people living in Bristol, U.K. This programme description proposes an ethnographic methodology of interviews and observations and aims to build upon the British Home Office project: RAYS (Berry, 2023), which used music and art to divert at-risk Albanian youth towards pro-social life trajectories. Research indicates the tremendous value of wrestling in building participants' physical health, psychological resilience and career success (Gould, et al 2017). By applying the concept of body-mind-community, this project aims to investigate how wrestling can also assist in promoting community safety concerning young people at risk of gang membership and criminal offending, besides promoting community engagement for refugees, participants with visible/non-visible disabilities, mental health and substance misuse issues. Esmaeli's non-profit organisation: Wrestling for Humanity, recently received a Points of Light award from the British Prime Minister, Rishi Sunak for his outstanding community work, which this proposed research seeks to systematically evaluate.

STRESS RESPONSE MECHANISMS IN WRESTLING COMPETITIONS

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ABSTRACT
PURPOSE: To study the peculiarities of stress response to competition in elite wrestlers.
METHODS: The 24 elite Greco-Roman wrestlers (age 22-26) were examined. Heart rate variability (HRV) was used as an indicator of stress response. We used the approach to analyze HRV according to the European Association

of Cardiology by a computer electrocardiograph "Fazagraf" (Ukraine). All of these persons agree to the use of research results for scientific work, according recommendation of Ethics Committees for Biomedical Research.
RESULTS: The obtained result indicates an increase in the level of tension of HRV regulation in wrestlers in the process of competitive activity. Competitive activity provokes inhibition of activity of sympathetic and parasympathetic links. However, the balance between LF and HF does not change during competition.
Scatterplot analysis of NN intervals shows a decrease in SD1 and SD2 in athletes during competition. The obtained fact indicates an increase in the tension of regulation due to periodic and aperiodic fluctuations of cardiointervals. In addition, the decrease in SD2 is associated with the activation of sympathetic tone of the autonomic nervous system. Thus, the stress reaction to competitions in elite wrestlers is characterized by an increase in the level of HRV regulation stress with deterioration of sympathetic and parasympathetic tone activity.
CONCLUSION: Competitions lead to an increase in the stress response due to the tension of the autonomic regulation of the heart rate in elite wrestlers. The adaptive mechanism for the prevention of stress response during competitive activity in elite wrestlers is associated with changes in the organization of the autonomic regulation of the heart rhythm.

INDIVIDUAL WINNING CONSISTENCY METRICS PREDICT MATCH OUTCOME AND PODIUM PERFORMANCE IN FREESTYLE SENIOR WORLD WRESTLING

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Purpose. This study introduces the concept of Individual Winning Consistency (IWC) as an Opponent Quality metric in Freestyle Wrestling. The research aims to address two primary questions: a) Can a higher IWC for a contender, calculated prior to a match-up, reliably predict the match result? b) Can the IWC effectively predict Medal Performance? **Methods**. Athlete Place and Match results of the Wrestling Senior World Championships 2022 were collected, with 176 Women's (WW) and 258 Men's Freestyle (FS) participants. Final athlete rankings were compiled for those participating in at least one international tournament between September 10th, 2020, and September 9th, 2022. The quantification of IWC involved recording victories for each individual and subsequently calculating the median victories per tournament. For instance, an undefeated wrestler winning 10 tournaments, each with 4 victories, would hold an IWC of 4.0. Match pairings were meticulously chosen based on varying IWC values, enabling computation of the associated metric "Winning Consistency Advantage" (WCA) by subtracting the lower IWC from the higher. For instance, in a match-up between athletes with IWC values of 3.5 and 1.0, the athlete with higher IWC would have a WCA of 2.5. A total of 151 WW and 236 FS matches formed corresponding datasets, each split into training (70% of the data) and testing (30%) subsets, for CHAID classification tree analysis to evaluate outcome prediction. The wrestler's outcome ("won" or "lost") when in advantage was the target, with three WCA value ranges categorized as "Big" (WCA >=2.5), "Moderate" (WCA of 1.5 to 2.0), and "Small" (WCA of 0.5 to 1.0) as predicting variables. Medal Performance prediction utilized IWC of all the participants with international participation in the 2 years prior time span as predicting variable and final place as target variable, ranging from 1 (1st place) to 24 and 34 (24th place in WW and 34th place in FS respectively), treated by regression CHAID. Accuracy %, p-value, and Root Mean Square Error (RMSE) were calculated for model evaluation. **Results.** The accuracy of Match Outcome prediction achieved by WCA was 82% for the WW testing dataset and 72% for the FS testing dataset ($p < 0.05$). The calculated probability of winning a match was greater than 75% with a "Moderate" advantage, and greater than 85% with a "Big" advantage. Medal performance prediction reached RMSE lower than 0.4, indicating IWC >= 3.5 as predictor of 1st to 3rd place in WW ($p < 0.05$) and 1st to 8th place in FS ($p = 0.00$). **Conclusion**. Evaluation of classification and regression models demonstrates that IWC and WCA, computed from international performance data spanning two years prior, predict podium performance and match outcomes within the context of Senior World results. These indicators hold promise for high-performance Olympic Wrestling programs, contributing to performance prediction, athlete selection, resource allocation, and opponent scouting.
Keywords: wrestling, performance analysis, outcome prediction, opponent quality, machine learning.

DYNAMICS OF THE NUMBER OF WEIGHT CATEGORIES IN WOMEN'S WRESTLING

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ABSTRACT
PURPOSE: to analyze the dynamics of the number of weight categories in women's wrestling. METHODS: theoretical analysis and generalization of literature data, Internet sources, system-historical analysis, methods of mathematical statistics. RESULTS: the article presents the results of empirical studies of the dynamics of the number of weight categories of women wrestling athletes since 1987. It was found that since 1997, there has been a clear trend of increasing the number of weight categories of women wrestlers. It has been established that since 1997 women have competed in only six categories; since 2002 – at seven; from 2014 – in eight, and from 2018 – in ten weight categories. In 2004, women's wrestling received general recognition with the inclusion in the program of the Olympics in Athens as an independent discipline. Since then, there has been a division of weight categories into "Olympic" and "non-Olympic". In total, women's wrestling was included in the programs of the Olympic Games 4 times and during this period 18 sets of awards were drawn. CONCLUSIONS: It is established that to promote, entertain and promote wrestling as a sport in the world, UWW makes changes and additions to the rules of competition, including changes in the number of weight categories. It was found that with the beginning of the popularization of women's wrestling, there is a clear trend of increasing the number of weight categories of wrestling. The number of participating countries and athletes has also increased significantly, which indicates the growing popularity of women's wrestling in the world. All this objectively confirms the leading role of women's wrestling and contributes to the preservation of a worthy status of wrestling in the structure of modern world sports. **Key words:** weight categories, women's wrestling, dynamics, women wrestlers, world championships, Olympic Games, system-historical analysis, regulations.

DESIGNING A MODEL FOR MEASURING THE EMPOWERMENT OF WRESTLING COACHES

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ABSTRACT
PURPOSE: This study was to design a model for measuring the empowerment of wrestling coaches. The present study was a mixed method (qualitative-quantitative). The qualitative part included the directors of wrestling (former and current), the president of the federation and the deputies, the secretary of the federation, and the wrestling coaches and veterans, and the quantitative part included the coaches and wrestlers of the 2nd grade and above Iran. The sample of the qualitative section was ten people. The quantitative section consisted of 300 coaches of wrestlers of 2nd grade and above, who were selected by the available sample method. The research tool was a researcher-made questionnaire. Data were analyzed using SPSS and AMOS software**.**
CONCLUSIONS: The results showed that the model of empowering ship coaches consists of 4 main components, including individual, environmental, organizational, and managerial factors, and nine sub-factors of the feeling of efficiency, self-efficacy, economic status, perceived support, organizational structure, organizational perspective, training quality, information growth, and Management style was identified and extracted. The obtained model based on the approved fit indices can be useful to achieve more empowerment of trainers**.**

COMPARATIVE ANALYSIS OF PHYSICAL PREPAREDNESS INDICATORS AMONG WRESTLERS OF DIFFERENT QUALIFICATIONS

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ABSTRACT

PURPOSE: This study aims to conduct physical fitness testing among wrestlers of different qualifications to identify differences in physical preparedness indicators. METHODS: The study involved 32 Greco-Roman style wrestlers in the middleweight classes (72 kg, 77 kg, 82 kg). The participants were divided into two groups: elite athletes (n=16) with an average weight of 77.07±6.11 kg and sub-elite athletes (n=16) with an average weight of 76.98±5.99 kg. Various physical fitness tests were conducted on the wrestlers, including the 30-meter sprint (s), vertical jump (cm), legless rope climb (s), pull-ups for 10 s (n), push-ups for 10 s (n), maximum number of squats with a partner (n), maximum number of pull-ups (n), maximum number of push-ups (n), and three sets of 15 hip turning throws with a one-minute rest interval (s). The differences between groups were assessed using the Student's T-Test. RESULTS: The results of the tests indicated that elite wrestlers significantly outperformed sub-elite wrestlers in almost all assessments: 30-meter sprint ($t=5.07$; $p<0.001$), vertical jump ($t=3.5$; $p<0.01$), legless rope climb ($t=3.5$; $p<0.01$), pull-ups for 10 s ($t=5.25$; $p<0.001$), maximum number of squats with a partner ($t=4.81$; $p<0.001$), maximum number of pull-ups ($t=7.44$; $p<0.001$), and three sets of 15 hip turning throws ($t=5.27$; $p<0.001$). Statistically insignificant differences were observed in the tests of push-ups for 10 s ($t=1.91$; $p>0.05$) and the maximum number of push-ups ($t=0.46$; $p>0.05$). This discrepancy can be attributed to the fact that the strength demands in these exercises are not specific to wrestling, as wrestlers predominantly engage in movements involving pressing their opponents towards themselves rather than pushing them away. CONCLUSIONS: The study revealed that elite wrestlers exhibit superior physical preparedness indicators compared to sub-elite wrestlers across all tests. The findings validate this claim, with the most substantial disparities observed in the tests of three sets of 15 hip turning throws (25%), maximum number of pull-ups bar (23%), maximum number of squats with a partner (20%), and legless rope climb (19%). Other exercises also displayed higher performance in elite wrestlers: pull-ups for 10 s (15%), vertical jump (11%), 30-meter sprint (11%), push-ups for 10 s (10%), and the maximum number of push-ups (2%).
Keywords: physical preparedness, Greco-Roman wrestling, elite and sub-elite athletes.

SYMMETRY OF LEG MUSCLES IN WRESTLERS

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ABSTRACT
PURPOSE: The purpose of this research is to determine the relationship between the contractile characteristics of the right and left leg, as well as the flexors (F) and extensors (E) of the knee joint muscles, during voluntary and involuntary contractions. METHODS: Voluntary muscle contractions were measured using the isokinetic dynamometry method (KinCom) in concentric mode of operation at the speeds of 60 and 180 ˚/s (peak torque/moment – T^{max}). Involuntary muscle contractions were measured by tensiomyography (TMG) on the rectus femoris (RF) and biceps femoris (BF) muscles (parameters of contraction time - Tc, delay time - Td, relaxation time - Tr, maximal displacement - Dm, sustain time – Ts). The sample consists of 8 wrestlers aged 22.5±3.1 years, body height 176.8±8.7 cm, body mass 79.3±9.4 kg, body mass index 25.4±1.3 kg/m2, body fat percentage 10.9±3.3 % and body muscle percentage 51.2±2.1 %. Among the statistical procedures, the method of descriptive statistics and analysis of differences (T test) was applied in the study. RESULTS: Initially, the absence of differences in the lean body mass of the left and right legs was determined, whereas the main results of the research further showed that there was a statistically highly-significant difference ($p=0.000$) in the isokinetic strength between the muscles of the front and the back of the thigh, regardless of the angular velocity of movement (60/180 ˚/s) and regardless of the leg (R/L). There was no difference between the right and the left leg, both in terms of the function of flexors and in the function of extensors. From the aspect of mechanical and contractile properties, TMG results also showed the absence of a cut between the right and the left leg, while significant differences were observed between RF and BF in Tr of the right leg ($p = 0.034$) and in Dm of the left leg ($p = 0.040$), and Ts at the limit of significance for both legs, while no differences were observed in the other parameters. CONCLUSION: Data on the differences in isokinetic strength and the defined degree of asymmetry – BF is 65.8% of the RF of the left and 63.8% of the right – represents a physiological normal, or perhaps a specific characteristic of the leg muscles in wrestlers, which can be used to design the training load, but also in the process of physical therapy and rehabilitation.

PSYCHO-PHYSIOLOGICAL CONTROL FOR OPTIMIZING THE TRAINING AND COMPETITIVE ACTIVITIES OF YOUNG WRESTLERS IN THE CONDITIONS OF MARTIAL LAW

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ABSTRACT PURPOSE: this investigation is dedicated to identifying the role of the athlete's psychophysiological functions in the effectiveness of the competitive activity of young wrestlers, namely the properties of the higher departments of the central nervous system, in the martial law conditions. METHODS We examined the psychophysiological functions of 12 wrestlers aged 10-11 years (anxiety level, indicators of simple and complex sensorimotor reaction to positive and negative stimuli, sensorimotor reaction to a moving object), which trained and competed under the conditions of martial law. The obtained results were compared with the similar indicators of wrestlers of the same age recorded in the pre-war period. RESULTS: a comparison of indicators of a complex sensorimotor reaction and sensorimotor reactivity to a moving object established a clear tendency to the worsen of psychophysiological functions in wrestlers which trained and competed under the martial law, compared to the data of wrestlers obtained in pre-war times. Indicators of anxiety in wrestlers, who trained in the martial law conditions, were highly variable and indicated a significant risk of the stress. CONCLUSIONS It is shown that martial law acts as a catalyst for negative changes of the mental and sensorimotor levels of athletes, and neurodynamic analysis is a sensitive method of assessing the psychophysiological status of young wrestlers. This information can be used by the coach to prevent the occurrence of stress, exhaustion of the nervous system, the development of overtraining, and a decrease of the technical and tactical capabilities of young wrestlers.

STUDY OF THE CARDIOVASCULAR SYSTEM'S REACTION TO THE TRAINING LOAD OF HIGHLY QUALIFIED WRESTLERS

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Abstract
This study examined the reaction of the cardiovascular system of highly qualified freestyle wrestlers to a competitive load in the pre-competitive period of training, where such internal changes such as the maximum heart rate, heart rate variability before and after the load, the level of stress before and after the load, and the recovery time of athletes after exercise in the submaximal and maximum intensity zones. The heart rate and stress index were measured before the load at rest, during the competitive load and after the completion of the training process, the effect of the physical load on the wrestlers' body was studied. It was found that the stress index was exceeded in most wrestlers before the start of the training process, which subsequently had a negative impact on the entire training process. In this connection, it was decided to identify the causes causing an increase in the stress of athletes. The results of the study discussed in this article may be useful to coaches and specialists in the preparation of athletes in martial arts. **Purpose of the research.** To reveal the maximum heart rate for the competitive load in highly qualified wrestlers in the pre-competitive period of preparation. **Subjects:** 4 highly qualified wrestlers participated in the study (2 wrestlers participated in the Olympic Games in Tokyo, 1 wrestler was a bronze medalist of the Olympic Games in Buenos Aires and 1 wrestler was a bronze medalist of the Olympic Games in Rio de Janeiro). **Methods:** The study of the reaction of the cardiovascular system with an instrumental method, the identification of heart rate variability and stress index before exercise, during exercise and after it, as well as the recovery time with a special measuring device Veda Pulse and Polar h10 with CardrioMood software. The study lasted 4 microcycles, where each microcycle was 7 days. The training process was as follows: the athletes came to the gym, where, before the warm-up, we took measurements and determination of heart rate variability and stress index, then determined the maximum heart rate at submaximal and maximum load, as well as the performance of wrestlers. After the competitive load, the second measurement was carried out, where the heart rate variability and the stress index for the load were determined. **Results of the study**: as a result of the study, the following indicators were obtained. At the beginning of the training process, the average heart rate of highly skilled wrestlers was 74.8±6.7 beats per minute; during the submaximal training load, this indicator increased to 165.3±13.6 beats per

minute. The submaximal load lasted 3 minutes. And in the maximum training load, the maximum heart rate reached 187.3±9.4 beats per minute. But to date, heart rate indicators in highly qualified athletes are uninformative, but heart rate variability and body stress index at high or low heart rate are more informative for coaches and specialists. **Conclusions:** In the course of the study of the cardiovascular system of the body of highly qualified freestyle wrestlers, it was revealed that at this stage the level of preparedness is not high enough to compete in the submaximal and maximum intensity zones to show high results in international competitions, and therefore it is necessary to further develop proposals and recommendations for increasing the special working capacity and the level of the functional state of athletes.

IN MEMORIUM

Robert A Oppliger, PhD, FACSM

June 10, 1945 – December 21, 2023

The world of wrestling science has lost a prolific researcher. Robert Oppliger made huge contributions to the health and safety of wrestlers with his work at the University of Iowa. These included work in the body composition of wrestlers, weight loss, minimal wrestling weight programs and hydration status.

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INSTRUCTIONS FOR AUTHORS

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