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PROGRESO PARA NUESTRO DEPORTE MEDIANTE CONOCIMIENTO

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Cover Photo Credit: UWW photo showing GR130 kg, Sergey SEMENOV (RUS) throwing Osman YILDIRIM (TUR) at the Belgrade Individual World Cup, December, 2020.

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Volume 10, Number 2 2020

TABLE OF CONTENTS

PERFORMANCE DATA ANALYSIS OF GRECO-ROMAN WRESTLING MATCHES OF THE 2019 EUROPEAN CHAMPIONSHIPS

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ABSTRACT
Wrestling is recognized as a vigorous, intermittent and weight categorized combat sport. For the purpose of revealing essential information for development of sport- specific preparation of wrestlers, technical-tactical and physiological demands analyses of wrestling matches are critical for elite level athletes. The aim of this study was to present analyzed technical-tactical scoring actions in Greco-Roman wrestling in the 2019 Senior European Championship via a novel *Performance Data Analysis.* Results of this study indicated the prevalence of points scored from standing position compared to parterre actions. Additionally, higher percentage of total points scored were achieved due to technical points in comparison with other points scored, 71.37% vs 28.63%, respectively. Implementing *Performance Data Analysis* could facilitate the understanding and following of a wrestling match. Furthermore, it could help coaching staff to obtain the relevant wrestling-specific data, and that way, to help athletes getting prepared for upcoming competitions.
Keywords: elite athletes; performance analysis;

INTRODUCTION

Wrestling is widely recognized as one of the oldest sports in human history, and as such it was performed within the original events in the ancient Olympic Games (Nilsson et al., 2002). Although the form of wrestling changed over time, it is still one of the most prominent combat sports in modern Olympic Games. Currently, two styles of wrestling are included in the Olympics. Greco-Roman style, which allows strictly upper body techniques, meaning holds below the waist are forbidden, and is practiced only by men. The second is freestyle wrestling where athletes are allowed to use lower extremity techniques and trips which is practiced by both men and women across the world (Horswill, 1992; García-Pallarés et al., 2011). Wrestling is an individual combat sport where athletes are divided in weight-categories with an aim to equalize the physical characteristics during competition, thus trying to highlight their technical and psychological skills as a crucial component of performance (García-Pallarés et al., 2011).

In many sports, activity patterns are intermittent by its nature (Glaister, 2005). Wrestling is characterized as a high-intensity intermittent combat sport (Barbas et al., 2011), containing myriad of various actions and techniques which were examined in earlier studies (Cipriano, 1993; Atan & İmamoğlu, 2005; López-González & Miarka, 2013; González, 2014; Tünnemann, 2016; Tünnemann & Curby, 2016). Due to the nature of wrestling, physical demands include explosive strength, aerobic endurance, and anaerobic capabilities in terms of achieving competitive success (Demirkan et al., 2015).

Building an elite wrestler is a complex and long-lasting process (Baić et al., 2014). Since wrestling is characterized as vigorous physical activity and sport, meticulous physical, psychological and emotional preparation of wrestlers is required (Yoon, 2002). To compete in the finals of the biggest competitions, elite wrestlers usually have to go through 5–6 qualifying matches (Gierczuk et al., 2018), which makes such activity very demanding from a physiological standpoint. Therefore, the ability of an athlete to fully recover between two matches might be crucial not only for performance but injury prevention as well (Barbas et al., 2011). Physical dominance and physical control over the opponent are considered to be the main objective among wrestlers in a competitive setting (Chaabene et al., 2017). Furthermore, quick and explosive maneuvers are related to wrestlers' power and ability to gain control of the opponent (Lansky, 1999).

Due to the frequent modification of rules proposed by UWW (United World Wrestling), technical and tactical adjustment of coaches and athletes are of great importance in terms of competitive success (Lopez-Gonzales, 2014). For the purpose of revealing essential information for development of sport-specific preparation of

wrestlers, technical-tactical and physiological demands analyses of wrestling matches are critical for elite level athletes (Miarka, 2016).

Most sports have taken advantage of modern technology to obtain important information about the sport specifics. Basketball (Suárez-Cadenas et al., 2016), soccer (Palucci et al., 2019), American football and tennis (Tiwisina & Külpmann, 2019) made the greatest success in the IT monitoring of sporting event.

At this moment, wrestling significantly falls behind in the information tracking of wrestling competitions. Therefore, the purpose of this study is to introduce an innovative approach to obtain wrestling-related data during a match. We analyzed technical-tactical scoring actions in Greco-Roman wrestling in the 2019 Senior European Championship via the novel *Performance Data Analysis*.

METHODS

Participants

European wrestling championships for senior-age competitors was held in Bucharest, Romania (08-14.04.2019.) both for Greco-Roman and freestyle wrestling. A two-day competition of Greco-Roman style wrestling included a total of 292 wrestlers from 34 different countries that competed in the championship. Since the entire sample represented national teams, all participants were considered elite athletes. Accordingly, athletes competing in all of the ten weight classes were observed and analyzed (55 kg, 60 kg, 63 kg, 67 kg ,72 kg, 77 kg, 82 kg, 87 kg, 97 kg and 130 kg). Consequently, each wrestling match starting from qualifying matches to the finals was included in Performance Data Analysis *observation.*

Performance Data Analysis

Data was analyzed on several levels in which we explored: weight categories data, total number of matches, medal matches (1st and 3rd place), scoring data, executed techniques data, technical and other points scored, standing position and parterre scored points. During the championship, the Technical Commission UWW and the Scientific Commission of UWW had to standardize the variables with the exact name of the wrestling techniques that were analyzed in the software system. It was necessary for UWW to prepare the instruction (written and video) through its expertise that clarified how and in what way these qualitative statistics of big wrestling competitions are going to be performed.

Overview of mode application qualitative statistics in wrestling competitions

For the needs of the new monitoring system of the wrestling match, it was essential to provide wrestling experts (coaches) who entered relevant data into computer in real time. All computers had to be networked and they used all data from the Arena system. In a case of a large number of points in a single match and in a case of a dilemma involving the wrestling technique, the supervisor in the secretariat has examined the video and made corrections in case an expert near to the mat has made a mistake.

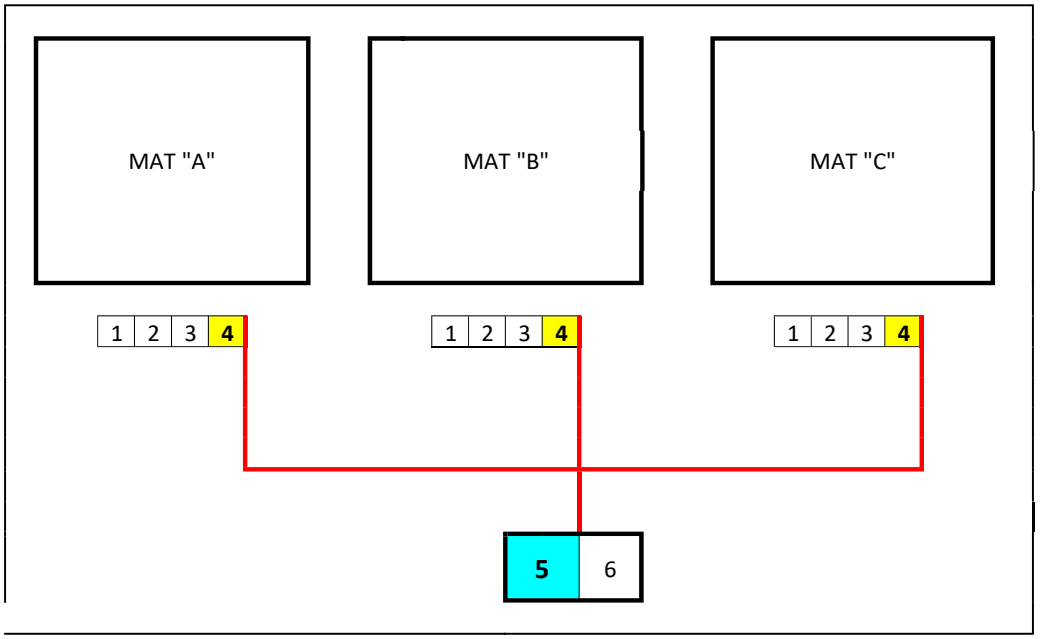

Figure 1. Application of qualitative analysis on wrestling competitions
1 = Video operator; 2 = Mat chairman; 3 = Scoreboard operator; 4 = Experts for technical analysis of matches; 5 = Supervisor - experts for technical analysis of matches; 6 = Arena - system for generating and processing the data.

For the purpose of implementing this monitoring system in wrestling competitions, UWW prepared a software, based on all given data that was automatically generated. Based on all given information, after completing the wrestling competition in this wrestling style, within 5 minutes we have prepared qualitative statistical analysis. This analysis was carried out without any connection to the Arena system, in such a way that, after the competition, videos were examined and recorded all performed wrestling techniques and duration of the match. However, in this case, errors in manual input and processing of data may occur, especially in the analysis of all segments of the matches.

RESULTS

Analysis of all matches Table 1 demonstrates the overall number of points and percentage scored in standing and parterre position. It can be observed that more points were scored in standing compared to parterre position, 62.08% vs 37.92 %, respectively. In terms of standing position actions, the most of the points have been scored due to passivity, take-downs and hip turning throws, 18.82%, 14.11% and 7.40%, respectively. On the other hand, the most commonly used technique in parterre position was gut wrench, following lifts and counter attacks, 20.08%, 9.47% and 3.96% respectively.

Table 1. Percentage and total number of points scored in all matches

	Wrestling techniques	Points	%
Standing position			
1	S-passivity	328	18.82
2	S-take down	246	14.11
3	S-hip turning throw	129	7.40
4	S-forward bending throw	95	5.45
5	S-throw suplex	89	5.11
6	S-push out	76	4.36
7	S-counter	59	3.38
8	S-challenge	24	1.38
9	S-caution	20	1.15
10	S-negative Wrestling	16	0.92
	Total =	1082	62.08
Parterre position			
1	P-gut wrench	350	20.08
2	P-lifts	165	9.47
3	P-counter	69	3.96
4	P-turn over	42	2.41
5	P-caution	22	1.26
6	P-challenge	13	0.75
	Total =	661	37.92
	All total =	1.743	100.00

Table 2 shows the percentage of points being scored as technical points (points achieved out of an action - execution of wrestling technique) and other points - which are not related to performance of wrestling technique. Results demonstrate the prevalence of technical points scored related to other points, 71.37% vs 28.63%, respectively.

Table 2. Percentage of points scored - divided by technical and other points

	Wrestling techniques	%
Technical points		
1	P-gut wrench	20.08
2	S-take down	14.11
3	P-lifts	9.47
4	S-hip turning throw	7.40
5	S-forward bending throw	5.45
6	S-throw suplex	5.11
7	P-counter	3.96
8	S-counter	3.38
9	P-turn over	*2.41*
	Total technical points =	*71.37%*
Other points		
1	S-passivity	18.82
2	S-push out	4.36
3	S-challenge	1.38
4	P-caution	1.26
5	S-caution	1.15
6	S-negative Wrestling	0.92
7	P-challenge	0.75
	Total other points=	28.63%
	All total =	100.00

S – standing position, P – parterre position

Data regarding total points scored and percentages across each of ten categories is visible in table 3. This table provides details of most frequently executed techniques both in standing and parterre position in all Greco-Roman style matches observed.

Table 3. Total scored points per weight category according to standing and parterre position

	WRESTLING TECHNIQUES	55 kg		60 kg		63 kg		67 kg		72 kg		77 kg		82 kg		87 kg		97 kg Pts		130 kg	
		Pts	%	Pts	%	Pts	%	Pts	%	Pts	%	Pts	%	Pts	%	Pts	%	Pts	%	Pts	%
Standing position																					
1	S-take down	24	18.60	40	21.86	24	15.89	40	17.47	4	2.29	52	21.31	29	18.35	38	19.10	45	28.30	36	31.03
2	S-passivity	15	11.63	23	12.57	21	13.91	28	12.23	20	11.43	34	13.93	18	11.39	36	18.09	22	13.84	12	10.34
3	S-hip turning throw	10	7.75	16	8.74	12	7.95	26	11.35	21	12.00	19	7.79	14	8.86	21	10.55	6	3.77	4	3.45
4	S-forward bending throw	8	6.20	10	5.46	10	6.62	16	6.99	28	16.00	13	5.33	10	6.33	16	8.04	6	3.77	4	3.45
5	S-throw suplex	6	4.65	9	4.92	8	5.30	16	6.99	2	1.14	12	4.92	10	6.33	13	6.53	5	3.14	3	2.59
6	S-push out	5	3.88	6	3.28	4	2.65	6	2.62	2	1.14	10	4.10	7	4.43	10	5.03	4	2.52	2	1.72
7	S-counter	2	1.55	4	2.19	4	2.65	4	1.75	31	17.71	7	2.87	2	1.27	8	4.02	4	2.52	2	1.72
8	S-negative Wrestling	2	1.55	1	0.55	2	1.32	4	1.75	1	0.57	6	2.46	2	1.27	2	1.01	0	0.00	1	0.86
9	S-caution	2	1.55	0	0.00	2	1.32	2	0.87	9	5.14	5	2.05	1	0.63	0	0.00	0	0.00	0	0.00
10	S-challenge	1	0.78	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total standing position =		75	58.14	109	59.56	87	57.62	142	62.01	118	67.43	158	64.75	93	58.86	144	72.36	92	57.86	64	55.17
Parterre position																					
1	P-gut wrench	34	26.36	38	20.77	42	27.81	50	21.83	26	14.86	32	13.11	26	16.46	32	16.08	32	20.13	44	37.93
2	P-lifts	14	10.85	20	10.93	12	7.95	13	5.68	18	10.29	32	13.11	24	15.19	10	5.03	26	16.35	4	3.45
3	P-counter	6	4.65	10	5.46	6	3.97	9	3.93	6	3.43	11	4.51	8	5.06	7	3.52	6	3.77	2	1.72
4	P-turn over	0	0.00	2	1.09	4	2.65	8	3.49	4	2.29	5	2.05	4	2.53	4	2.01	2	1.26	2	1.72
5	P-challenge	0	0.00	2	1.09	0	0.00	6	2.62	1	0.57	4	1.64	2	1.27	2	1.01	1	0.63	0	0.00
6	P-caution	0	0.00	2	1.09	0	0.00	1	0.44	2	1.14	2	0.82	1	0.63	0	0.00	0	0.00	0	0.00
Total parterre position =		54	41.86	74	40.44	64	42.38	87	37.99	57	32.57	86	35.25	65	41.14	55	27.64	67	42.14	52	44.83
All total =		129	100.00	183	100.00	151	100.00	229	100.00	175	100.00	244	100.00	158	100.00	199	100.00	159	100.00	116	100.00
Time(s) =		57.58		105.00		79.79		147.36		101.96		179.46		112.85		146.91		152.78		121.01	
WQ/min =		2.24		1.74		1.89		1.55		1.72		1.36		1.40		1.35		1.04		0.96	

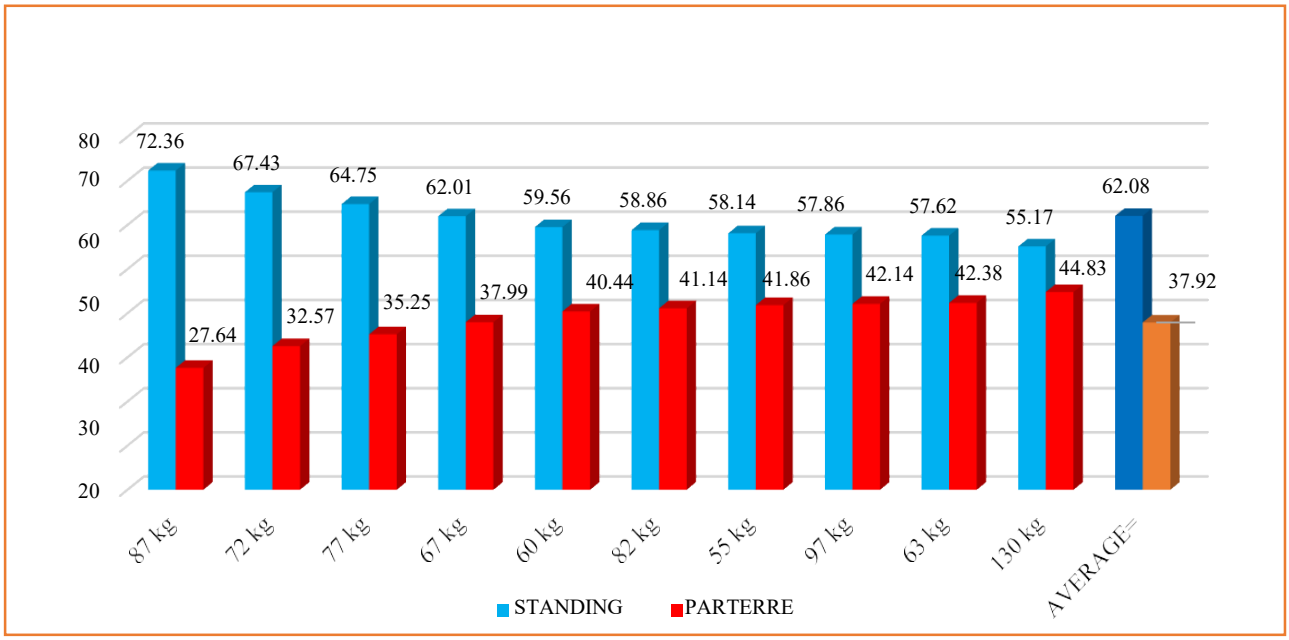

Figure 2. Percentage of total points scored based on standing and parterre actions according to weight category

Relation of standing and parterre techniques during entire championship is depicted in Figure 2. The highest percentage of standing position points was scored by the 87 kg weight category while the least percentage was demonstrated by the heavyweight (130 kg) category wrestlers, although compared to other weight categories, they have scored the highest percent of points performing parterre techniques.

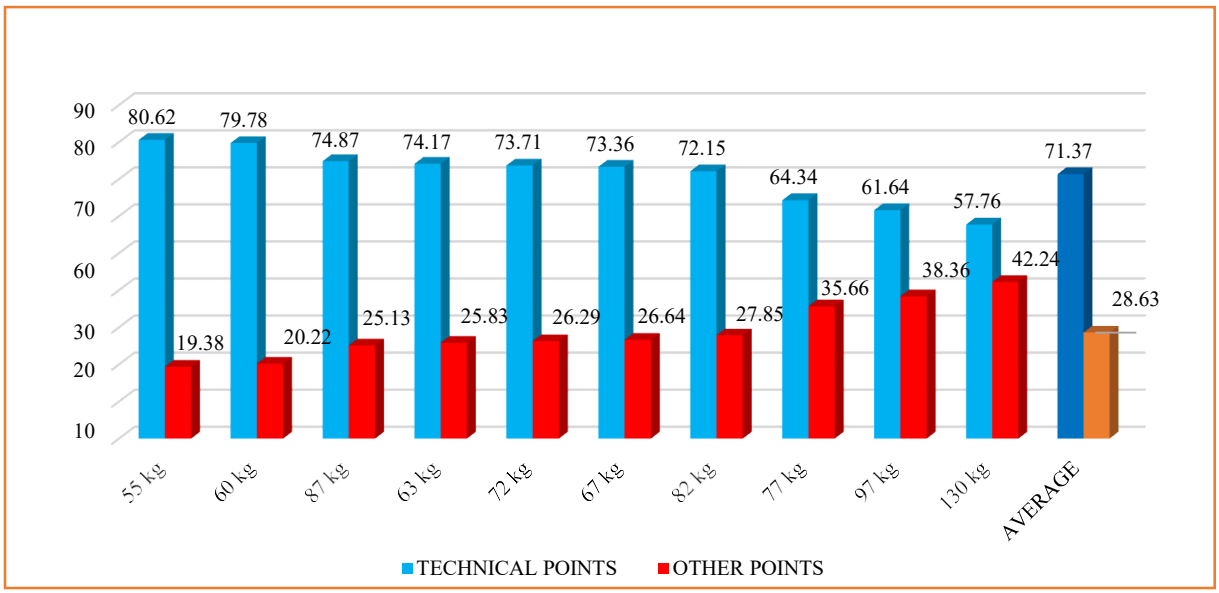

Figure 3. Percentage of total points scored based on technical and other points according to weight category

Relation of technical and other points scored during entire championship is depicted in figure 3. The least percentage of technical points was scored by heavyweight (130kg) wrestlers, whereas, at the same time these category athletes won the highest percentage of other points. On the other hand, the lightest weight category (55kg) scored the highest percentage of technical points with the least other points scored compared to other categories.

Figure 4 presents the mean number of points scored per minute for all categories. Apparently, the lightest category wrestlers seem to be the most active in terms of scoring points during the match. Generally, it can be noted that as the weight category increases the number of points scored per minute drops (with an exception of 72 kg weight class). Mean value of points scored per minute for the entire championship was 1.45.

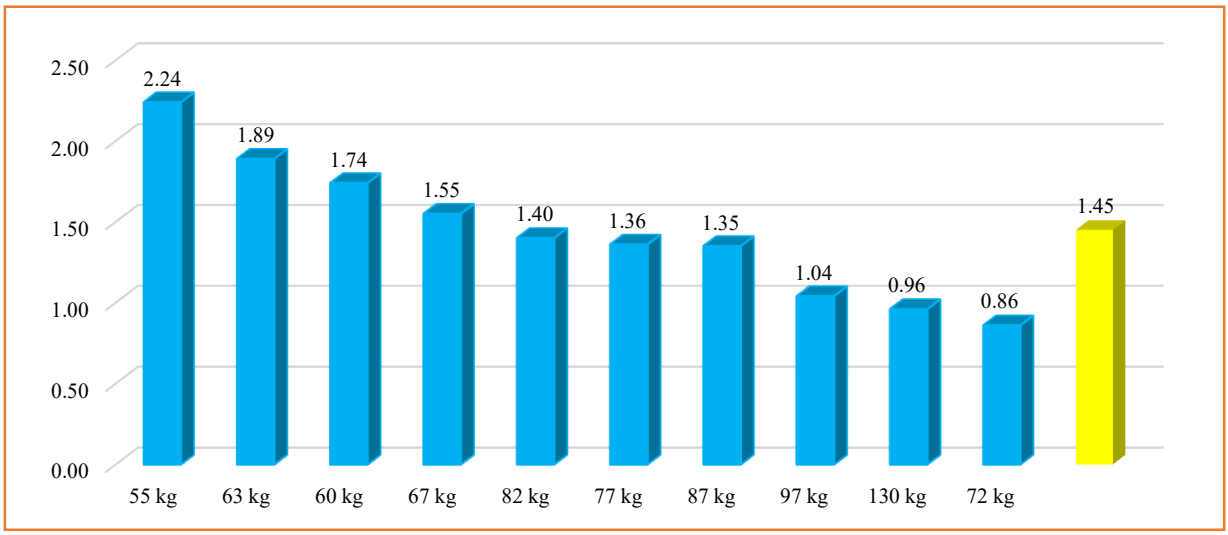

Figure 4. Mean value of total points scored per minute according to weight category (WQ/min)

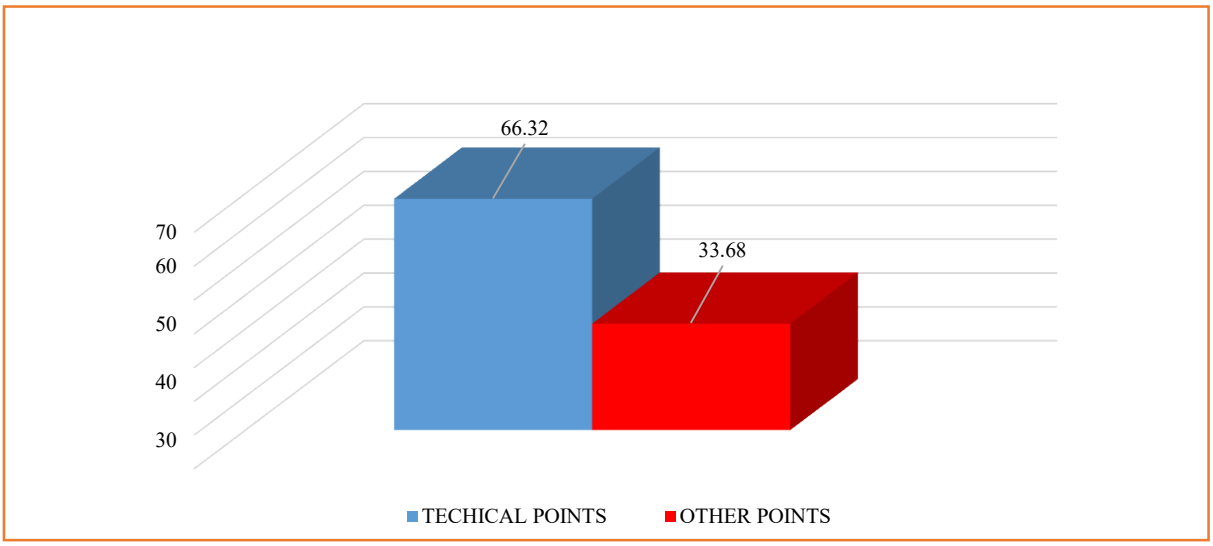

Figure 5. Relation of technical points and other points scored during the final matches. Values are expressed as percentages (%)

Analyses of medal matches (1st and 3rd place matches)

This subsection presents analysis of final matches and thus provide useful data regarding techniques performed in finals.

Table 4. Percentage and total number of points scored in medal matches

	Wrestling Techniques	No. Points	% Final Match.
Standing position			
1	S-passivity	46	24.60
2	S-take down	28	14.97
3	S-throw suplex	16	8.56
4	S-forward bending throw	12	6.42
5	S-push out	10	5.35
6	S-hip turning throw	6	3.21
7	S-counter	5	2.67
8	S-challenge	3	1.60
9	S-negative Wrestling	2	1.07
10	S-caution	0	0.00
Total standing =		128	68.45
Parterre position			
1	P-gut wrench	36	19.25
2	P-counter	9	4.81
3	P-lifts	6	3.21
4	P-turn over	6	3.21
5	P-caution	2	1.07
6	P-challenge	0	0.00
Total parterre =		59	31.55
All total =		187	100.00

S – standing position, P – parterre position

It was evident that the number of points scored in a standing position is more than twice as high compared to scored points in parterre position. When those values are converted to a percentage, values are 68.45% vs 31.55% in favor of standing position points scored (Table 4). It was notable that there is a prevalence of technical points over other points achieved during the finals (1st and 3rd place matches), 66.32% vs 33,68%, respectively (Figure 5). The mean value of total points scored per minute in medal matches was 1.14.

DISCUSSION

The current official Bulletin from wrestling competitions contains only numerical data of the winning points, classification points and the duration of the fight. Based on these data it is not possible to make any quality statistical analysis of the important information regarding wrestling competition. For the reasons mentioned above, a unified monitoring system for important wrestling competitions is proposed with an aim to make a performance data analysis of various parameters after the completion of the wrestling competition. A special emphasis was placed on the analysis of points achieved on the basis of the performed wrestling techniques (Technical Points - TP), in relation to the number of points achieved which are not the result of performing wrestling techniques (Other Points - OP). Another important analysis is the number of points in the standing position in relation to the number of points in the parterre position. Significant data are also the number of points made in one minute of the match (WQ / min).

The goal of this study was to provide sport-specific parameters observing the European Greco-Roman wrestling championship with an emphasis to demonstrate data drawn from final matches and total number of matches. Despite the presence of large variety of throws in Greco-Roman wrestling, the most points achieved in standing position seems to occur due to one athletes' passivity. The results from the final matches (1st and 3rd place) are in line with total matches regarding the most points scored from standing position. Most likely, this appeared along with Greco-Roman wrestling regulation changes. This type of wrestling, caused by modification of rules, is often more suitable for wrestlers that are physically better prepared and are capable of performing a super high intensity during the battle. Take downs were the second most common way to score points from standing position. In terms of parterre actions, the gut wrench technique dominated in comparison to other ones, simultaneously presenting the technique by which the largest number of points was scored during entire tournament. It is notable that percentage of technical points scored exceeded the number of other points, meaning that wrestlers most commonly performed a technique in order to score. The most frequently used standing and parterre position wrestling techniques refer to all ten weight categories.

In order to be able to apply the new performance data analysis, it is necessary to develop software based on which data will be automatically generated. This software will enable us to conduct quality analysis on bases (analysis of all matches, analysis of weight categories, analysis by nation, analysis of medal matches and analysis the best wrestlers on the championship). Data obtained with our study could be of great help to sport scientists, coaches and athletes.

The scientific communities are concerned about the understanding the scoring actions in Greco-Roman wrestling. With an aim to improve the monitoring of prestigious championships (Olympics Games, Continental Games, World Championships, Continental Championships, qualifying tournaments for the Olympic Games and tournaments from the Ranking Series), wrestling associations around the world should consider implementing *Performance Data Analysis* in competitions. Consequently, it could facilitate the understanding and following of a wrestling match. By employing *Performance Data Analysis* more extensive range of data can be provided. However, this study presented only small portion of those which are considered to be of interest for coaches and sport scientists.

CONCLUSIONS

It is of the greatest value to have quality statistical monitoring of wrestling competitions. This method is important for coaches because after each big competition, they can have a clearer overview of all wrestling techniques. Thereby, the coaching staff will be able to work on technical and tactical improvement of wrestlers for the upcoming important competitions. Engagement of this explorative approach of statistical monitoring could have a broader application. By adopting *Performance Data Analysis* in prestigious championships, easier analysis by Technical Commission of the United World Wrestling (UWW) is enabled. Furthermore, this favors of preparation of quality proposals for amendments to the wrestling rules. All analyzed data prepared this way will significantly help by rapidly obtaining comprehensive sport-specific information.

Disclosure statement

No potential conflict of interest was reported by the authors.

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COMPREHENSIVE DIAGNOSTICS OF TRAINING OF YOUNG FIGHTERS AT THE INITIAL STAGE OF PREPARATION

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ABSTRACT
The concept of the training system for highly qualified athletes, and the methodology for constructing model characteristics of the strongest athletes in the main groups of sports, was created by A.A. Novikov and his numerous students (Novikov, 2008; Podlivaev & Shakhmuradov, 2013), which was based on the concept of "model characteristics of the strongest athletes", and presently forms the basis of complex control in elite sports and is still extremely relevant. A comprehensive assessment of the state of various sides of fitness: technical, physical and functional gives complete information about the state of fitness of young combatants, contributes to the timely correction of training based on identifying the strengths and weaknesses of training and significantly increases the effectiveness of the training process. Evaluation of only individual sides of readiness and, in particular, physical qualities, significantly reduces the effectiveness of management of the training of young athletes (Graevskaya & Dolmatova, 2004; Kiselev, 2006; Korzhenevsky, 2011; Podlivaev, 2018; Podlivaev, 2016; Shakhmuradov, 2011)
Keywords: complex assessment, young wrestlers and boxers, technical, physical, functional readiness, physical performance, aerobic performance

INTRODUCTION
This work determined the effectiveness of the developed standards and model characteristics of technical, physical and functional readiness for young wrestlers and boxers 12-13 years old. Revealing the strengths and weaknesses of preparedness made it possible to develop an optimal structure of training for young athletes, which, in contrast to the generally accepted one, is characterized by an increase in the intensity of the exercises performed and an increase in the volume of loads of a special orientation. In the practice of sports to assess the fitness of athletes, pedagogical testing is mainly used (Godik, 1980; Karpman, Belotserkovsky & Gudkov, 1974; Kiselev, 2006).

In the currently existing program materials for assessing the fitness of young athletes standards were developed for physical fitness (Kuznetsov & Podlivaev, 2016; Podlivaev, Shakhmuradov & Kuznetsov, 2016). At the same time, only pedagogical testing does not always allow to adequately assess the level of preparedness. In the generally accepted pedagogical testing, only a part of the information is used, which often reflects the data on the fitness of athletes one-sidedly (Podlivaev, 2018). To assess the various sides of readiness, complex control is used when registering indicators of the physical, functional and psychological state, the level of technical and tactical skill, the characteristics of competitive activity (Korzhenevsky, 2011; Ozolin, 1970; Platonov, 2005). In combat sports, technical and tactical training takes the leading place in the content of the training process. In fact, the tasks of physical, mental and functional training are to create a base for the formation of high efficiency of technical and tactical actions, created or arising in the course of a duel in single combat with an opponent (Novikov, 2003; Korzhenevsky, Dakhnovsky & Podlivaev, 2004). The aim of the research was to determine the criteria of fitness of young wrestlers and boxers on the basis of complex testing of various aspects of fitness at the stage of initial training.

METHODS
In the process of 3-year studies of young wrestlers and boxers at the stage of initial training, 25 athletes of 10-13 years old took part in each year of training. When examining athletes, complex testing was used with the definition of indicators, technical, physical and functional fitness. The technical readiness of young wrestlers was assessed according to the results of the following tests: -5-fold execution of the arching to the bridgefrom standing, leaving the bridge by circling in any direction and returning to standing, (s); - alternate circling in the bridge to the left - to the right (5, 10, 15 times, depending on the weight category) (s); - flips from the bridge (5, 10, 15 times, depending on the weight category) (s); - 10 throws of a mannequin with a turn of the hips (s); - 10 dummy throws over the chest (s). The technical readiness of young boxers was assessed according to the results of the following tests: - 15-second test - maximum number of blows on a special bag; - 8-second test; -

3 minute test, - the density of the battle (number of strikes); - interval of attacks in a duel, (s) To determine the physical fitness of young wrestlers and boxers, pedagogical testing was used, which assessed the development of basic physical qualities. To assess the functional readiness of young combatants, the PWC170 test was carried out with the calculated determination of the VO2 max (Karpman, Belotserkovsky & Gudkov, 1974), the hypoxic tests of Stange and Genchi were performed with holding the breath during inhalation and exhalation (Graevskaya & Dolmatova, 2004; Karpman, Belotserkovsky & Gudkov, 1974; Korzhenevsky, 2004). The level of performance in the PWC170 test characterizes the aerobic capabilities of athletes. Breath-holding samples characterize anaerobic potential. When analyzing the data, a comprehensive assessment of a group of indicators was used:

1. Indicators of physical fitness of athletes;
2. Indicators of athletes' functional readiness;
3. Indicators of technical readiness of athletes;
4. Ergometric indicators of physical performance (PWC170);
5. Reserve capacity of aerobic performance (IPC);
6. Reserve capabilities of anaerobic performance (breath holding samples).

When analyzing the indicators of physical, functional and technical readiness among young combatants, 3 variants of assessment were used. First possibility: Uniform increase in the indicators of physical, functional and technical readiness of young athletes from year to year during the 3-year training. Second possibility: The lack of a uniform increase in indicators of physical, functional and technical readiness from year to year with a positive dynamics of their changes from 1 year of study to the end of 3 years. Third possibility: The absence of positive dynamics of changes in the indices of physical, functional and technical readiness of young athletes during the 3-year training period from the initial stage of training.

RESULTS

The results of a comprehensive study of changes in the technical, physical and functional readiness of young wrestlers in the process of long-term examinations are presented in tables 1, 2, 3. Table 1 presents the data of changes in the indicators of technical readiness of young wrestlers in the process of a 3-year study. To determine the technical readiness of young wrestlers, 6 sets of exercises were used, including special exercises. The analysis of the results obtained indicates the absence of a reliable increase in indicators from 1 year of training to 2 years and from 2 years of training to 3 years of training ($p < 0.05$). But at the same time, a positive dynamics of changes in the indicators of technical readiness of young wrestlers was revealed from 1 to 3 years of training. ($p < 0.05$).

Table 1 - Dynamics of indicators of technical readiness of young wrestlers at the stage of initial training.

Indicators of technical readiness	Year 1	Year 2	Year 3	Significance of differences, p		
				p (1)-(2)	p (2)-(3)	p (1)-(3)
1) set of exercises 5-fold execution Standing to back arch and bridge and circle to standing (s)	16.5±0.1	16.4±0.06	15.5±0.04	p< 0.05	p< 0.05	p< 0.05
2) complex of exercises circles in bridge: 5-left, 5-right (s)	19±0.06	18.8±0.1	18.7±0.05	p< 0.05	p< 0.05	p< 0.05
3) complex of circles in bridge 10-left, 10-right (s), 15-left, 15-right (s)	52±0.55	51.0±0.5	47±0.41	p< 0.05	p< 0.05	p< 0.05
4) complex of exercises Coups on the bridge: 10 times (s)	36±0.55	35±0.45	33±0.4	p< 0.05	p< 0.05	p< 0.05
5) complex of exercises 10 dummy throws with turn and over the hip (s)	33±0.45	32±0.55	30±0.4	p< 0.05	p< 0.05	p< 0.05
6) complex of exercises. 10 dummy throws with back arch (s)	42±0.5	39±0.46	36±0.57	p< 0.05	p< 0.05	p< 0.05

A significant increase in technical readiness indicators from 1 to 2 years of study and from 2 to 3 years of study is noted in the 3rd set of exercises (running on the bridge 10 – to the left, 10 to the right, 15 – to the left, 15 – to the right) and in the 6th a set of exercises (10 throws of the dummy with a back arch) ($p < 0.05$). Table 2 presents

the results of 3-year dynamics of physical fitness indicators of young wrestlers. Positive dynamics of changes in physical readiness indices from year to year was revealed in the following tests: running at 400 m., 800 m., 1500 m., Flexion and extension of the arms in a lying position, pull-up on the bar, long jump from a standing position, high jump from places, triple jump from a standing position, throwing medicine ball forward from behind the head, throwing medicine ball backward, lifting legs to a hang grip on a gymnastic wall ($p < 0.05$). The absence of a significant increase in physical qualities from 1 to 2 years of training and from 2 to 3 years of training was determined in the following tests: running 30 m, 60, shuttle running, pulling up on the bar for 20 s, flexion and extension of the arms in the lying position for 20 s. , flexion and extension of the arms in the lying position for 20 s., lifting the trunk while lying on the back for 20 s. ($p > 0.05$). The indices of physical readiness, characterized by the absence of physical qualities growth in young wrestlers from year to year (from 1 to 2 years and from 2 to 3 years of training), significantly increase in a longer period of time by the end of 3 years of training.

Table 2 - Dynamics of indicators of physical readiness of young wrestlers at the stage of initial training

Physical readiness indices	Year 1	Year 2	Year 3	Significance of differences, p		
				p(1)-(2)	p(2)-(3)	p(1)-(3)
30 m run	6.4±0.04	6.25±0.07	6.15±0.05	p> 0.05	p> 0.05	p< 0.05
60 m run	10.3±0.07	10.2±0.06	9.9±0.05	p> 0.05	p> 0.05	p< 0.05
Shuttle run 3x10 m	8.2±0.056	8.1±0.074	7.95±0.07	p> 0.05	p> 0.05	p< 0.05
400 m run	1.43±0.05	1.40±0.06	1.37±0.04	p< 0.05	p< 0.05	p< 0.05
800 m run	3.37±0.04	3.31±0.05	3.25±0.04	p< 0.05	p< 0.05	p< 0.05
1500 m run	8.3±0.053	8.1±0.048	7.9±0.006	p< 0.05	p< 0.05	p< 0.05
Pushups	13.0±0.65	15.0±0.54	17.0±0.41	p< 0.05	p< 0.05	p< 0.05
Pullups	1.0±0.31	1.5±0.28	2.5±0.5	p< 0.05	p< 0.05	p< 0.05
Throwing a medicine ball (3 kg) forward from behind the head	2.0±0.15	2.5±0.18	3.5.0±0.2	p< 0.05	p< 0.05	p< 0.05
Medicine ball throw (3 kg) backward	1.0±0.12	2.0±0.14	3.0±0.12	p< 0.05	p> 0.05	p< 0.05
Raising the legs to the hands while hanging on bar of gymnastic wall	1.0±0.12	1.5±0.14	2.5±0.16	p< 0.05	p< 0.05	p< 0.05
Long Jump from a spot	140.0±0.9	155.0±1.2	165.0±1.1	p< 0.05	p< 0.05	p< 0.05
Vertical Jump from a spot	25.0±1.3	30.0±1.4	35.0±1.5	p< 0.05	p< 0.05	p< 0.05
Triple Jump from a spot	2.5±0.23	3.5±0.3	4.5±0.37	p< 0.05	p< 0.05	p< 0.05
Pullups in 20 seconds.	1.0±0.15	1.5±0.6	2.0±0.16	p> 0.05	p> 0.05	p< 0.05
Pushups in 20 seconds	5.0±1.1	6.0±1.2	7.0±0.9	p>0.05	p>0.05	p< 0.05
Situps in 20 seconds	2.0±0.45	2.5±0.35	3.0±0.57	p> 0.05	p> 0.05	p< 0.05

Table 3 presents the data of changes in the indicators of the functional readiness of young wrestlers in the process of 3-year research.

Table 3 - Dynamics of indicators of functional readiness of young wrestlers at the stage of initial training

Indicators of functional readiness	Year 1	Year 2	Year 3	Significance of differences, p		
				p (1)-(2)	p (2)-(3)	p (1)-(3)
Weight (kg)	41±0..6	44±0.4	48±0.4.3	p < 0.05	p < 0.05	p < 0.05
Stange test (s)	22±0.37	25±0.46	27±0.52	p < 0.05	p < 0.05	p < 0.05
Genchi test (s)	12±0.42	15±0.37	17±0.45	p < 0.05	p < 0.05	p < 0.05
PWC170 ml / min	410±44	540±34	650±38	p < 0.05	p < 0.05	p < 0.05
PWC170 kgm / kg	10±0..38	12±0.5	13.5±0.41	p < 0.05	p < 0.05	p < 0.05
Maximal Oxygen Capacity ml per minute	1940±55	2160±47	2600±53	p < 0.05	p < 0.05	p < 0.05
Maximal Oxygen Capacity Ml/kg/min	47±0.54	49.0±0.43	52.5±0.38	p < 0.05	p < 0.05	p < 0.05

In the first year of training, young wrestlers showed a minimum level of development of the functional systems of the body. This refers to the indicators of body weight, reserve capacity of anaerobic functions (breath holding time in hypoxic tests), the level of physical performance (PWC170), aerobic performance (IPC). In the second year of training, the indicators of functional readiness: body weight, breath holding time in the Shtange and Genchi tests, the level of PWC170, the VO2 max in young athletes significantly increases ($p < 0.05$). The same is observed as the athletes' fitness level increases by the third year of training. Indicators of functional readiness: body weight, breath holding time in the Stange and Genchi tests, level (PWC170), VO2 max in young athletes significantly increases ($p < 0.05$), compared to the 2nd year of training. Table 4 presents the data of changes in the indicators of technical readiness of young boxers in the process of 3-year research. It was revealed that when performing short-term exercises lasting 8 and 15 seconds, young boxers did not show a significant improvement in the results from 1 to 2 years of training and from 2 to 3 years of training ($p > 0.05$). An increase in results in these tests is achieved only by the 3rd year of training ($p < 0.05$).

Table 4 - Dynamics of indicators of technical readiness of young boxers at the stage of initial training

Load duration, m., S.	Year 1	Year 2	Year 3	Reliability of differences, p		
	Technical actions, num blows			p (1)-(2)	p (2)-(3)	p (1)-(3)
15-second test	49±0.87	52±0.95	54±0.75	p > 0.05	p> 0.05	p >0.05
8-second test	26±0.54	27±0.61	28±0.55	p > 0.05	p> 0.05	p > 0.05
3-minute test	235±2.1	253±2.5	273±1.9	p < 0.05	p < 0.05	p < 0.05
Density of battle (number of strikes)	50±1.1	58±0.95	68±1.3	p < 0.05	p < 0.05	p < 0.05
Interval of attacks in a duel, (s)	3.5±0.12	3.0±0.14	2.6±0.1	p < 0.05	p < 0.05	p < 0.05

Changes in the results in the 3-minute test have a positive trend. A significant increase in the number of strikes in this test was revealed from 1 to 2 years of training and from 2 to 3 years of training ($p < 0.05$). The same

dynamics of changes in technical characteristics was revealed when performing technical actions (the density of the battle and the interval of attacks in a duel) in the conditions of a competitive battle. Reliably, from year to year, young wrestlers showed an increase in their characteristics: the density of the fight and the interval of attacks in the duel ($p < 0.05$). Table 5 presents the data of changes in the indicators of physical fitness of young boxers in the process of 3-year research. Positive dynamics of changes in physical readiness indices from year to year was revealed in the following tests: running on 3000m, ($p < 0.05$). The absence of an increase in physical qualities from 1 year to 2 years of training was determined in the test of flexion and extension of the arms in an emphasis lying on the floor, long jump from the spot ($p > 0.05$).

Table 5 - Dynamics of indicators of physical fitness of young boxers at the stage of initial training.

Physical readiness indices	Year 1	Year 2	Year 3	Significance of differences, p		
				p (1)-(2)	p (2)-(3)	p (1)-(3)
30m running (no more than 5.4 (s)	5.9±0.056	5.7±0.072	5.5±0.045	p > 0.05	p > 0.05	p < 0.05
Running 3000 m (no more than 15 min)	16.0±0.06	15.7±0.05	15.2±0.04	p < 0.05	p < 0.05	p < 0.05
Hanging pull-ups on the bar (at least 6 times)	2.0±0.42	4.0±0.84	5.0±0.52	p > 0.05	p > 0.05	p < 0.05
Flexion and extension of the arms in an emphasis lying on the floor (at least 35 times)	25.0±0.81	28.0±0.6	35.0±0.74	p < 0.05	p > 0.05	p < 0.05
Standing long jump (not less than 180 cm)	170.0±1.2	173.0±1.4	180.0±0.9	p > 0.05	p < 0.05	p < 0.05
Push of a medicine ball 4 kg, with the strongest hand at least 6 m	3.0±0.42	3.5±0.61	5.0±0.57	p > 0.05	p > 0.05	p < 0.05
Push of a medicine ball 4 kg, with the weakest hand not less than 4 m.	2.0±0.57	3.0±0.64	4.0±0.39	p > 0.05	p > 0.05	p < 0.05

The absence of a reliable increase in physical qualities from 1 to 2 years of training and from 2 to 3 years of training was determined in the following tests: running 30 m, pulling up from a hang on the bar, pushing a medicine ball (medicine ball) 4 kg, with the strongest hand, the weakest hand ($p > 0.05$). Table 6 presents the data of changes in the indicators of the functional readiness of young boxers in the process of 3-year research. During many years of research, young boxers showed a significant increase in body weight, physical performance PWC170, absolute values of aerobic performance (VO2 max ml / min).

Table 6 - Dynamics of indicators of functional readiness of young boxers at the stage of initial training

Indicators of functional readiness	Year 1	Year 2	Year 3	Significance of differences, p		
				p (1)-(2)	p (2)-(3)	p (1)-(3)
Body Weight (kg)	39±0..5	43±0..44	48±0..54	p < 0.05	p < 0.05	p < 0.05
Stange test (s)	19±0.48	21±0..43	24±0..51	p > 0.05	p > 0.05	p > 0.05
Genchi test (s)	10±0.57	11.3±0.62	12.4±0.42	p > 0.05	p > 0.05	p > 0.05
PWC170 kgm / min	380±35	500±31	710±38	p < 0.05	p < 0.05	p < 0.05
PWC170 kgm / kg	9.5±0..32	11.3±0..41	14.8±0..44	p < 0.05	p < 0.05	p < 0.05
Oxygen Uptake ml / min	1880±51	2100±45	2450±53	p < 0.05	p < 0.05	p> 0.05
Maximal Oxygen Uptake ml / min / kg	48.0±0.67	49±0.58	51.0±0.61	p > 0.05	p > 0.05	p> 0.05

The relative values of oxygen uptake during the 3-year training period stabilized at the same level and did not change significantly (p> 0.05). Although the values of indicators in the Stange and Genchi tests from 1 to 2 years of training and from 2 to 3 stages of training increase, no significant differences were found (p> 0.05). Only over a long period of time, athletes from 1 to 3 years of training showed a significant increase in the time of holding their breath in hypoxic tests (p> 0.05).

CONCLUSIONS

Complex testing of technical, physical and functional readiness of young wrestlers and boxers at the stage of initial training made it possible to reveal the orientation of the training process, positive and negative dynamics of changes in various sides of readiness, factors limiting the growth of athletes' fitness. In the process of 3-year research in young wrestlers, it was revealed that with a high level of basic and speed endurance, aerobic and anaerobic performance, the development of strength and speed-strength qualities, as well as coordination abilities is insufficient, which reduces the effectiveness of technical and tactical actions and the growth of special readiness. An increase in the normative requirements for the lagging qualities of athletes, an increase in the loads of speed and coordination orientation will contribute to an increase in the fitness level of young wrestlers. In young boxers in the process of training at the initial stage of sports specialization, a significant increase in overall endurance and aerobic capabilities was revealed during the 3-year training period. At the same time, a pronounced lag in the development of speed, power and speed-power qualities and insufficient development of anaerobic capabilities, deteriorates the technical characteristics in speed tests.

To increase the training level of young boxers, it is advisable to use an increased volume of loads of general and technical orientation, the energy supply of which is carried out due to the predominance of alactate and glycolytic anaerobic reactions to increase speed, speed-strength and strength capabilities throughout the entire period of initial training of young athletes. At the initial stage of sports training, it is especially important to take into account the peculiarities of the age development of young combatants at each stage of preparation when drawing up plans and programs of sports training. All specialists working with children should determine the structure and content of training programs, taking into account age characteristics. Knowledge about the gender, age, individual characteristics of athletes will allow coaches to successfully solve problems of forming elements of technique and tactics of single combat, improving motor qualities, psychological qualities and competitive reliability, in general.

An important role in this process should be played by systematic control of both the dynamics of changes in the indicators of physical and mental development of children and their sportsmanship. The introduction of sportsmen testing classes into the training process, on the one hand, contributes to the harmonious physical and mental development of children; forms motivation to practice the chosen sport; increases the body's resistance to physical activity. On the other hand, the analysis of testing results allows you to control the training process, make corrections to the content and structure of training programs.

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ASYMMETRICAL HANDGRIP STRENGTH AND BODY COMPOSITION OF CADET WRESTLERS: A PILOT STUDY

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ABSTRACT.
Purpose: to compare the body composition and the maximum of handgrip strength of Venezuelan cadet wrestlers. The sample was of ten wrestlers of Greco-Roman (GR=5; M±SD, age: 16.81±0.34 yrs.-old; weight: 58.76±4.43 kg; height: 167.2±0.31 cm) and Freestyle (FS=5; M±SD, age: 16.35±0.59 yrs.-old; weight: 60.92±3.34 kg; height: 166.7±0.39 cm). **Methods:** the procedure used to estimate the body composition (BC) followed the established standards by the International Society for the Advancement of Kinanthropometry. The handgrip strength (HGS) was measured using the manual dynamometer (Takei), recording the best value of three (3) attempts for both right and left hand. The "t Student" was used to compare GR vs. FS wrestlers and to verify statistical differences between the strength of handgrip (left and right), p ≤0.05 value. **Results:** No effects were observed between GR and FS; the reported values of BC were 12.98±3.08 % for the % body fat and 52.07±3.73 kg for the fat-free mass. The handgrip strength was registered in absolute and relative terms to body weight having as a result for the right hand: (HGS: 49,70±3,53kg.s; 0,83±0,41Kg·kg.s^{-1}) and the left hand (HGS: 43,90±4,07kg.s; 0,74±0,05Kg·kg.s^{-1}). Significant differences were found between the (HGS) of the right hand compared with the left hand (absolute, p ≤0.05; relative, p ≤0.05). **Conclusion:** The differences obtained in the (HGS –asymmetrical) could be due to the predominance of the right hand in relationship with the left hand, or to the actions performed with greater emphasis of the right handed side in this group of wrestlers.
***Key words*:** handgrip strength, body composition, wrestlers.

INTRODUCTION

The early specialization of youth wrestlers and the developing availability of high–level events to younger competitors have led to increased focus on specific adaptations to physical training (Fukuda et al., 2013). Wrestling is one of the sports in which a great level of physical aptitude and an optimal body composition is shown (Demirkan et al., 2015). Specific focus has been given to participants during periods of development in which growth and maturation may demonstrate both threats and opportunities to physical implementation (Capranica & Millard-Stafford, 2011). Since youth, the international competition system with emphasis in competitiveness by weight divisions implies that the body mass of wrestlers must be evaluated during a full training period of wrestling and a few hours before the beginning of an official competition (Alderman et al., 2004).

Therefore, finding the optimal body composition of wrestlers, especially the distribution of the lean and fat component, has been one of the biggest concerns of the technical and scientists related to this sport during the last decades (López-Gullón, 2010). However, the methods used by young athletes to modify body composition can potentially lead to significant health risks including compromised nutritional status, diminished physical performance and impaired growth and development (Berkovich et al., 2016).

Worried about this circumstance, the importance of the body composition in wrestlers has been studied extensively in research, with the usage of several methodological procedures. Among these methodologies, it is important to highlight the study of skin folds (Horswill et al., 1988; Park et al., 1990; Callan et al., 2000; Kramer

et al., 2001; Mirzaei et al., 2009; 2011). As a consequence, it has been demonstrated that the measurements of subcutaneous adipose tissue are very important since previous research has reported a reduction on the physical performance or health due to a high or low percentage of body fat, respectively (Amani et al., 2010; Potteiger et al., 2010).

During a wrestling match, efforts of high intensity are perceived and they are characterized by demanding strength levels and muscular potency both in the upper body and lower body, prevailing a predominance of the production system of the anaerobic energy, and also the isometric component for the technical performance (Horswill, 1992; McGuigan et al., 2006; Vardar et al., 2007; García-Pallarés et al., 2010).

Under these remarks, the isometric strength level is an important agent for the practice of defensive maneuvers in wrestling, both standing and the *f*loor (*par-terre)* position, for that reason, it has been stated that the isometric muscular tensions of handgrip are committed in a combat and during the development of a wrestling tournament (Kraemer et al., 2001; 2004; Barbas et al., 2011). In the same way, this aspect is considered an indicator of the general strength quality, which can determinate the performance of athletes who depend on an appropriate level of lateral symmetrical gripping strength to raise their performance and control and reduce possible injuries (Blackwell et al., 1999).

On the other hand, it is of great importance to emphasize that the term "Cadet" is an official designation of the age group for international competition by the international governing body of wrestling (United World Wresting). Thus, cadet continental championships are held annually for these wrestlers who are between 16 and 17 years old (with the participation in some cases of wrestlers of 15 years old).

Demirkan et al. (2012) made a comparison on the physical and physiological characteristics of Freestyle and Greco-Roman young wrestlers of elite; as a result, they did not find statistically significant differences on the percentage of fat body, with 9.6±5.2% versus 10.7±4.7%, and on isometric hand grip strength, with 54±8.0Kg.s and 49±8.0kg.s for right hand versus 53±7.8kg.s and 48±7.9kg.s for left hand, respectively.

Additionally, Gerodimos and Karatrantou (2013) carried out a study about the reliability of the maximum grip strength test in pre-pubertal and pubertal wrestlers from Trikala, Greek. The individuals were grouped in concordance with their biological age, according to the sexual maturation stages of Tanner, puberty stage: pre-pubertal: (stages 1-2) and pubertal (stages 3-4). As part of the results, they showed statistically significant differences in all of the basic variables recorded (age, body mass, and years of training), pubescent versus pre-pubescent. Furthermore, according to the procedure of the executed tests and the reliability for the maximum grip strength described as an attempt, the best or the average of two and three tries, absolutely all of the trials made for both right and left hand showed a high reliability, with a rank of interclass correlation coefficient of 0.869–0.993 and a rank of technical measurement error (TME) within acceptable limits. So that the manual dynamometry is a reliable method to evaluate the grip strength in young wrestlers.

More recent investigation, made by Arslanoğlu (2015) about Greco-Romans physical profiles of young wrestlers from Turkey, age: 18.61±1.01years old, height: 173.0±8.79cm, body mass: 77.88±18.84kg and sports experience: 8.09±2.7years. In their results, revealed a %BM: 11.04±3.42% and inside the physical parameters, a grip strength: 52.62±9.87kg.s (for the right hand) and 50.89±10.17kg.s (for the left hand). Nevertheless, this study only describes the values of the variables researched, without making comparisons and to determine differences from the results obtained (differences in the values of handgrip strength of the right hand in regard to the left hand).

Based on these statements, a well-established quantitative approach to investigate body composition and manual dynamometry in young wrestlers aged 15-17, values of body fat, handgrip strength in absolute terms and relative to body weight in these subjects. These pratical applications could allow establishing comparisons with other wrestlers of the same age and making adjustments in training programs, avoiding effects of early specialization, as this last component is considered an important aspect to reduce injuries and to develop the domain of actions that require a level of handgrip strength and control during a wrestling match.
Therefore, the purpose of this study was to compare the body composition and the maximum expression of handgrip strength of Venezuelan cadet wrestlers. The results of the investigation will allow adjustments to be made in the preparation of these wrestlers.

METHODS

Subjects

The sample was composed by ten male wrestlers, Greco-Roman (GR=5; M±SD, age: 16.81±0.34 yrs.-old; weight: 58.76±4.43 kg; height: 167.2±0.31 cm) and Freestyle (FS=5; M±SD, age: 16.35±0.59 yrs.-old; weight: 60.92±3.34 kg; height: 166.7±0.39 cm), belonging to the selection of a province of Venezuela (Barinas) in the cadets category, located in the intermediate weight divisions (≤54, 54≤58 and 58≤63kg).

Inclusion criteria: these subjects had at least five (5) years of experience in the sport and performed a daily workout between about 120-150 minutes, at five (5) times per week, being evaluated during a special stage of the annual cycle preparation.
Exclusion criteria: Athletes who could not perform all evaluations, with injuries, chronic problems or who were training with a weekly frequency less than 4 times a week or with experience in the modality less than 5 years.
Testing procedure
The Observatory of Research in Physical Activity and Sport Sciences Review Board, of the Experimental National University of the Western Plains Ezequiel Zamora, approved all procedures conducted during this study. Also, before doing the evaluations, all the subjects and their parents were summoned to explain them the purpose of the study, the potential benefits and risks that could be presented during the development of the investigation, so that was how informed written consent was obtained from both the participants and their parents or guardians.

The tests were carried out at a single moment in agreement with the study design; all measurements took place at the stage of specific preparation of an annual plan of wrestling. It is important to declare, that all subjects were in good physical health and were free of injury or difficulties in the upper extremities, also demonstrating a domain of the right hand (right–hand side) in participants.

Estimation of the Body Composition (BC)
The body mass and height were registered as basic variables. Body weight was measured with a digital scale (Electronic XACTA-150, USA); the height was measured using a wall-mounted scale (Holtain Limited, Ukraine), and followed the technique described by Stewart et al. (2011).

The subcutaneous body fat was estimated using the anthropometric technique, taking into consideration the measurement of the thickness of subcutaneous adipose tissue on the right side of the body (triceps skin fold and calf fold), with the clamp type Holtain adipometer. The percentage of fat (%BF) was calculated using the formula developed by Slaughter et al. (1988) and the fat-free mass (FFM) was obtained from the derivation of total weight less fat weight in kilograms (Demirkan et al., 2014; Demirkan, 2015).

It must be stated that all variables were recorded using the protocol which follows the standards set by *The International Society for the Advancement of Kinantropometry* [*I.S.A.K.]* (Stewart et al., 2011). In addition, measurements were made by an anthropometrist of experience with accreditation level II ISAK.

Measurement of the isometric handgrip strength (HGS)
Before starting the test, the wrestlers were informed about the purpose of it, and they were instructed according to the indications of España-Romero et al. (2010) and Gerodimos and Karatrantou (2013): how they should hold the hand dynamometer to avoid possible bias in the reading of the values obtained, make three (3) tries for each hand (right and left), with one (1) minute rest between trials. The exercised contraction should be gradually and continuously for 2-5 seconds and were encouraged to do their best at the time of testing.

In addition, as standardization of the application of the test, the Alkurdi and Dweiri (2010) protocol was considered, in which the individual in a standing position, with separation of the legs to the same broad shoulders and with the dynamometer trigger adjustment according to the size of the person´s hand evaluated, taking the device and leaving visible hand out the screen, raises his arm, flexing the shoulder and elbow at 90 degrees to the front, begins apprehension of the dynamometer while descending the arm to be extended to one side of the body .Then, he delivers the dynamometer against the evaluator face up to read the value obtained by providing blind measurements to the teenager. The instrument used for measuring this component was an analog manual adjustable grip dynamometer (TKK –*Takei Kiki Kogyo*– model 5101, Japan), with measured values in kilograms.

STATISTICAL ANALYSIS
The Kolmogorov–Smirnov statistical test was used to determine the normal distribution of strength of handgrip variable. Descriptive data are presented as measures of central tendency (average), dispersion measures (standard deviation), range (minimum and maximum) values; Likewise, To verify statistical differences in the strength of hand grip (left and right), the "t Student" test was applied for related samples in order to determine differences in the results of the gripping force of the right hand respecting to his left hand and effect size (ES) was calculated by Cohen's *d*, taking as criterion for all analysis a significance level of $p \leq 0.05$. Statistical analysis was conducted in the Statistical Package for the Social Sciences (SPSS) version 21.0 for Windows. The graphical representation was performed using Prism Graph v4.4.2 program.

RESULTS

Kolmogorov–Smirnov statistical test was applied as exploration to verify the data normality. It became clear in the process that the values obtained from the maximum expression of isometric grip force from both the right hand and the left come from a normal distribution. Similarly, descriptive statistical values were determined for body composition, the fatty component and fat-free mass, and for the ultimate expression of isometric hand grip force obtained with the dynamometer, exerted by both the right hand and the left, data expressed in absolute terms, kilogram–strength (kg.s) and relative divided by the body weight ($kg.s*kg^{-1}$).

Taking into consideration the published results, statistically significant difference was found in the gripping force exerted by the right hand compared to the force exerted by the left hand. From the results, you can say analytically that there is a predominance of isometric strength of his right hand compared to his left hand in this sample of wrestlers. The values can be seen in Table 1.

Table 1. Values of body composition and the ultimate expression of isometric hand grip force in a sample of ten (10) fighters.

	M±SD	**Mínimum**	**Máximum**	**t**
BF (%)	12.98±3.08	9.82	17.91	-----
FFM(Kg)	52.07±3.73	47.46	56.79	
ISRH(Kg.s)	49.70±3.53	45	55	6.794
ISLH(Kg.s)	43.90±4.07*	38	50	
ISRH ($Kg.s{\cdot}kg^{-1}$)	0.83±0.41	0.78	0.90	6.639
ISLH ($Kg.s{\cdot}kg^{-1}$)	0.74±0.05*	0.66	0.81	

M= *mean*; **SD**= *typical standard deviation*; **BF**= *body fat*; **FFM**= *fat free mass*; **ISRH**= *isometric strength right hand*; **ISLH**= *isometric strength left hand*; **a.-** Absolute grip strength (Kg.s), **b.-** Relative grip strength to body weight ($Kg.s{\cdot}kg^{-1}$), *= significance at 0.001.

In a more obvious way, the results obtained are graphically presented from the measuring of the maximum expression of the absolute strength of hand grip and significant differences found in the right hand against the left in this group of wrestlers (ES=1.91), in Figure 1.

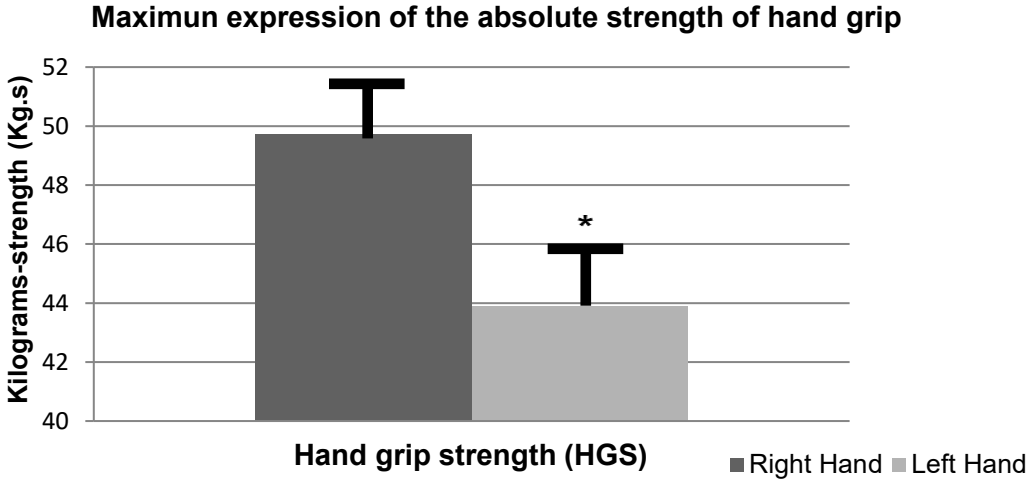

Figure 1. Differences between the values of grip strength of the right hand in connection with the left hand in the sample of wrestlers
*= significance between right and left hand at 0.001

DISCUSSION

As previously mentioned, the purpose of this study was to describe the body composition and a comparison of the maximum expression of isometric handgrip strength of Venzuelan cadet wrestlers. In contrast to the results, lower values of BF%, higher values of FFM, handgrip strength (HGS) and sports experience (SE),were reported by Demirkan et al. (2014), In Free Style (FS) and Greco-Roman (GR) 15-17 year old style. The results ([FS] % BF: 9.0±4.9; FFM in Kg: 61.3±9.6; HSG in kg.s: 43.9±9.1 for the right hand; 43.4±8.8 for the left hand; SE: 5.7±1.6; [LG] % GC: 8.7±6.4; FFM in Kg: 60.5±11.2; HSG in kg.s: 45.7±9.31 for the right hand; 44.6±9.0 for the left hand; SE in years: 5.7±1.6) not showing statistically significant differences between the wrestlers of both

styles. However, the current study shows manifest statistically significant difference between left and right hands, with a large effect size.

Demirkan et al. (2015) revealed data for fat % lower than found in the present study ([Group A: 15years; B: 16years; C: 17years]% GC A: 6.5±3.6; B: 8.6±5.6; C: 9.5±5.8 vs. 12.98±3.08), a FFM kg (A: 51.9±11.8; B: 60.0±10.3; C: 63.2±9.1 versus 52.07±3.73), one consistent with those published in this research (in years SE SD: 4.5±1.3; B: 5.4±1.5; C: 5.8±1.6, respect 5.6±1.3 compared to) and isometric strength values similar handgrip ([HGS in kg.s] A: 36.4±10.7; B: 43.9±8.4; C: 46.6±8.7 to 49.70±3.53, for the right hand and A: 34.9±10; B: 42.5±7.8; C: 46.4±8.3 vs. 43.90± 4.07 for the left hand). However, they established statistically significant differences between groups regarding the FFM: A ≠ B; A ≠ C, muscle contraction exerted his right hand (A ≠ B, A ≠ C) and left hand (A ≠ B, A ≠ C, B ≠ C). In the current study, subjects were grouped globally for under age range 15-17 as participatory research sample.

As part of the analysis of the result, a functional motor asymmetry is evidenced for the hand grip strength on the right side with respect to the left side (ie failure to demonstrate symmetrical manual grip strength) observed in this group of wrestlers. On average, subjects showed asymmetry for grip strength, exhibiting slightly higher values of right hand grip strength, which are only statistically significant with respect to the left hand. Further, based on the trend, all subjects reported that the right hand was their dominant side.

Kapoor (2011) documented handgrip strength values in 60 young wrestlers matched for age, group 1 (G1: 11-15 years), group 2 (G2: 16-20 years) and Group 3 (G3: 21-26 years). From the results he revealed statistically significant differences between groups regarding grip strength obtained both right hand and left ([HGS in kg.s] right hand G1: 27.64±6.72; G2: 36.68±5.23; G3: 41.63±3.22; for the left hand G1: 25.68±6.51; G2: 35.27±7.15; G3: 39.50 ±4.38. The findings published in this investigation are higher than those obtained by Kapoor in each age group. On the other hand, a study accomplished by Terbizan and Seljevold (1996) showed an increase in the grip strength in a group of older fighters due to the increase in muscle mass compared to the younger fighter group (G1 <G2, G3).

In accordance with the above, similar values in grip strength were published by Bayraktar et al. (2012) in a sample of wrestlers FW and GR cadet category, determining statistically significant differences between groups ([HGS in kg.s] right hand FW: 41.19±9.39; GR: 44.68±9.90; these results show a balance of grip strength manifestation in this sample of wrestlers FS and GR. In this research, statistical differences were found in the force exerted by the right hand (dominant) with respect to the left hand; this could be due to the predominance of right or performing actions with greater emphasis on the right-hand side in this group of wrestlers.

To let people know, this is the first study which reports grip strength values in relative terms to body mass, so the discussion is based on the result of the absolute strength. Taking into account previous studies in which the discussion of this research was generated, it is noted that the synergistic action of the flexor and extensor muscles and the interaction of the muscle groups that exert maximum manual isometric tension, is an important factor for the manifestation of force resulting grip.

Therefore, the findings of this study show that handgrip strength is an important component to make various grips in wrestling and define control over an opponent so, in training programs specific actions should be included to improve isometric grip strength; its evaluation over a whole macrocycle preparation will allow to observe the changes as performance characteristics of this muscular action and also confirm the predominance or balance of the level of strength of the upper extremities, which allow to make adjustments in the training process.

It is important to note, that differences presented in the discussion regarding the results of previous studies could be due to the protocol and the type of instrument used, the dominant hand, the time of evaluation, physical condition of the subject, among others. On the other hand, a thorough review allows us to demonstrate that variables such as age, body mass, muscle mass, the level of biological maturation and training experience can influence the ultimate expression of isometric hand grip force exerted in healthy subjects and athletes(Terbizan & Seljevold, 1996; Kapoor, 2011; Bayraktar et al., 2012; Gerodimos and Karatrantou, 2013; Arslanoğlu, 2015).

CONCLUSIONS

The group of Cadets wrestlers evaluated for body composition, showed higher values of % fat and a lower FFM than those reported in the literature, in samples of similar studies in chronological age, and training experience, indifferent to the training stage in which these subjects were evaluated.

Regarding the ultimate expression of isometric handgrip strength, similar values were reported in other studies in the same age wrestlers and sporting experience. However, statistically significant differences obtained in this study on the values of handgrip strength, could be due to the predominance of the right hand compared with

the left hand or carrying out actions in training where they usually rely more emphasis on the right-hand side of this group of wrestlers.

PRACTICAL APPLICATIONS

Anthropometric characteristics can easily describe the physical subjects, so, some anthropometric variables can be used to estimate body composition in wrestlers. This aspect is very useful to provide necessary information about the lean and fat component of the wrestlers, and it also provides information regarding the specific weight division in which a wrestler must compete without affecting its performance.

Reliable measurement of maximal isometric handgrip strength, in wrestling, can be used as an indicator to confirm the predominance or balance of strength of the upper limb or right side against the left, as a means to estimate the level of grip strength and raise their performance in training monitoring, as well as for prevention and rehabilitation of injuries in wrestling.

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CONFLICT OF INTERESTS

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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THE IMPACT OF INDOOR TRAINING PROGRAM DUE TO COVID-19 QUARANTINE, ON SOME PHYSIOLOGICAL, PHYSICAL, AND TECHNICAL VARIABLES IN ELITE WRESTLERS

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ABSTRACT
Egypt's COVID-19 co-existence plan insisted on social distancing and the closure of physical and sport entities. WHO illustrated the importance of training at home with at least 150 minutes of moderate load exercises or 75 minutes of high load exercises in order to reduce the indoor related health problems such as; anxiety, stress, and immunity deficiency. This study aimed to investigate the Impact of Indoor Training Program Due to COVID-19 quarantine, on some Physiological, Physical, and Technical Variables in Elite Wrestlers. 8 professional wrestlers with an average age of 19.3 years, agreed to participate in a 12 week of indoor training regimen. Long period change in training regime with short bouts of resistive physical and technical exercises affected the back flexibility and physiological variables with a reduction in maximal oxygen consumption "VO_2max", breathing frequency "BF", ratio between carbon dioxide and oxygen "RER", and little change in caloric expenditure. Performance efficiency decreased especially in performance endurance measured in time and score, in correlation with the physiological variables.
Keywords: indoor training, wrestling, efficiency, COVID-19.

INTRODUCTION

The COVID-19 pandemic changed the face of the world. Since the corona virus had spread nearly all over the world, restricted instruction came out of health ministries and agencies in order to stop the spread of the virus. All aspects of human life was affected with restrictions including; social activities, physical activities and sports, these restrictions resulted closure of sport facilities like sporting clubs, gyms, fitness centers and rehab centers (Daniela et al., 2020). Egypt's COVID-19 co-existence plan also insisted on social distancing and keeping closure of physical and sport entities (State information service, 2020). Stay home was the first goal of all governorates all over the world so, WHO and health monitors began to advocate plans for mitigation of detraining effects on human health and immunity which was badly needed for reducing the probability of infection.

WHO illustrated the importance of training at home with at least 150 minutes of moderate load exercises or 75 minutes of high load exercises in order to reduce the indoor related health problems such as; anxiety, stress, immunity deficiency and even fear of loss of family and beloved ones (Daniela et al., 2020). Amateurs and professional athletes were the highly affected by stay home restriction, so tele-training, self-training and online personal trainers were and still are in action.

Detraining was the main concern for trainers where interrupting training has a passive effect on athletes' physiological and physical adaptation that can also lead to abnormality in eating, sleeping and psychological status (Mujika, and Padilla, 2000; Chen, et al., 2020; Joo, 2018). This was the opportunity for the researchers to carry out this study to identify the capability of tele-training based on interactive training program on elite wrestlers' physiological and physical parameters.

METHODS

In this experimental study pretests were taken during a period of preparation for the Egyptian universities' championship in March just before university shuts down and closure of all sport facilities. Researchers took the opportunity to test the capability of tele-interactive indoor training program in maintaining the athletes' physiological and physical parameters.

Participants: 8 healthy, professional wrestlers with average age 19.3 years, agreed to participate "with written consent" in this study, wrestlers are members of the Egyptian wrestling federation. Table 1, describes the variables of the study sample.

Table 1, Statistical norms of the study sample in all the study variables

Main variables	unit	Mean	Median	SD	skew
Growth variables					
Age	year	19.375	19.500	1.408	-0.564
Height	cm	170.250	170.500	3.615	-1.255
Weight	kg	75.500	76.000	3.381	-0.796
Training experience	year	8.250	8.000	1.282	-1.546
Physiological variables					
Vo2max	h	47.194	42.415	1.403	2.234
BF	L/min	53.000	54.000	3.703	-0.722
RER	L/min	1.659	1.815	0.366	-1.309
Calories	kcal	94.973	96.730	5.450	0.036
Physical variables					
Handgrip "right"	kg	35.250	35.000	2.053	0.142
Handgrip "left"	kg	29.125	29.000	1.808	-0.930
Back muscle strength	kg	79.625	79.500	3.292	0.700
Back muscle flexibility "bridge"	cm	26.000	26.000	3.071	-0.804
Technical variables					
Performance efficiency "score"	score	20.500	20.000	1.069	-0.831
Performance efficiency "speed"	sec	6.875	7.000	0.641	0.741

Table 1, represents the mean, median, standard deviation "SD"

Procedure

Study tests were based on pretest before closure; tests were physiological parameters with ergospirometry. VO_2max (maximum oxygen uptake) recorded in ml/kg/min, BF (breathing frequency) in number, RER (ratio between exhaled carbon dioxide and inhaled oxygen) in ratio, and calories expended in the overall test. Physical tests were handgrip strength (hand dynamometry), back muscles strength (dynamometry) and back flexibility (with bridge test) in centimeters. Efficiency of performance (score- time) was the technical tests where athletes perform 3 times bridge and throw where the shorter time scored, the more efficiency in performing as a performing speed. The other performance test utilized multiple suplexes achieved during a specified time, the more suplexses recorded the more efficiency in performance. These performance tests were carried out to investigate the influence of indoor training on the technical capability of the wrestlers.

Wrestlers experienced tele-interactive training program, consisted of 3 sessions/ week and lasted up to 12 week of indoor training tell the gradual reopening of sport facilities in June. Training program was alike the traditional training program of the wrestlers, but the challenge for this study were the equipment, adequate wrestling mats, open area for full range of motion during performance, face to face wrestling mates and proper recovery. Training program carried out by coaching over zoom cloud meeting app, as its easy and common in use between youth, Table 2, represents the training program.

Table 2, the indoor training program

Week	Session content	Unite Duration	Exercise, (wrestling drills)	Intensity	Rept.	Group	Tools
1 - 4	Warm up	5min.	March in place Muscle stretching	40-50%	1	1	
	Main part (wrestling drills)	15min.	arm control "left-right" (cling)	60-75%	15	3	Elastic band-pull rally rope-dumbbell-sand bags
			palm, wrist Grip				
			Snatch drill upright position (obstacle resistance)				
			Snatch drill upright position (light resistance)				
	Closure part	5min.	Cool down-Stretch	30%	1	1	
5 - 8	Warm up	5min.	Jogging Muscle stretching	40-50%	1	1	
	Main part (wrestling drills)	15min.	arm control (cling)	60-75%	15	3	dumbbells 10k-pull rally rope-kettlebells
			Balance, palm Grip				
			Snatch drill upright position				
			Snatch drill upright position (heavy resistance)				
			Snatch drill upright position (heavy resistance)				
			Snatch drill down position (heavy resistance)				
			Snatch drill down position (heavy resistance)				
			Snatch drill down position (heavy resistance)				
			down position (wrenching against obstacle)				
	Closure part	5min.	Jogging	30%	1	1	
9 - 12	Warm up	5min.	Jogging Muscle stretching	40-50%	1	1	
	Main part (wrestling drills)	15min.	Rope fixed in shoulder level upper hence "right, left" rope fixed in waist level (back bent "bridge") rope fixed in feet level lower hence "right, left" squat raise then back through "right, left"	75-85%	15	3	dumbbells 10k-pull rally rope-kettlebells
	Closure part	5min.	Jogging	30%	1	1	

Statistical analysis: Statistical analyses were performed using SPSS software, M "means", SD "standard deviation", T-test and Changing percentage were used for treating the collected data of study tests.

RESULTS

Analytic treatment of the study data resulted the following results, tables 3, 4, represent the study results.

Table 3, t-test and changing percentage of the physiological variables of the study

Physiological variables	Pre-test		Post-test		Mean def.	error	t-test	Changing percentage
	M	±SD	M	±SD				
Vo2max	47.194	1.403	43.489	1.637	3.705	0.841	4.404	8.781
BF	53.000	3.703	49.750	3.412	3.250	1.032	3.149	6.132
RER	1.659	0.366	1.714	0.378	0.055	0.120	0.459	3.316
Calories	94.973	5.450	96.347	5.884	1.374	2.978	0.461	1.446

T value at significance of 0.05=1.895

Table 3, represents significant differences between pre and post-test in vo2max and BF variables, but no significant differences found between pre and post-tests of RER and calorie expended in overall test, were calculated t value was between (0.461:4.404).

Table 4, t-test and changing percentage of the physical and technical variables of the study

Physical and Technical variables	Pre-test		Post-test		Mean def.	error	t-test M	Changing percentage ±SD
	M	±SD	M	±SD				
Physical variables								
Handgrip "right"	35.250	2.053	35.975	2.031	0.725	0.310	2.339	2.057
Handgrip "left"	29.125	1.808	30.125	1.959	1.000	0.378	2.646	3.433
Back muscle strength	79.625	3.292	81.450	3.855	1.825	0.263	6.938	2.292
Back muscle flexibility "bridge"	26.000	3.071	31.375	3.420	5.375	0.460	11.672	20.673
Technical variables								
Performance efficiency"score"	20.500	1.069	13.375	0.916	7.125	0.998	7.139	34.756
Performance efficiency"speed"	6.875	0.641	8.000	0.756	1.125	0.125	9.000	16.364

T value at significance of 0.05=1.895

Table 4, represents significant differences between pre and post-test in all physical and technical test, were calculated t value was between (2.339:13.840).

DISCUSSION

Indoor training was a challenging experience for keeping athletes in action. Lack of space, partnership cooperation and sport equipment were the first challenges to both athletes and trainers. To investigate the impact of indoor training on athletes' status the researcher chose physiological, physical and technical variables, as representors of athletes' overall well-being. Wrestling is a high intensity sport with short interval of performance where wrestlers always attempt to maximize their muscle size and power (Yoon, 2002), although wrestling is characterized with anaerobic system, many studies used VO_2max as a detector of wrestlers status (Arslanoğlu, 2015; Ramirez-Velez, et al., 2014). VO_2max is considered one of the common indicators of evaluating aerobic capacity and body energy system. VO_2max reflects a player's overall fitness level, it is also known as aerobic and oxidative capacity, where it represents the maximum oxygen consumption used during building ATP (Hadžović-Džuvo, et al., 2014). VO_2max is characterized by the limits of ones oxygen transport system, and because its value does not vary from moment to moment, it gives a true indication of the athletes aerobic capacity (Scribbans, et al., 2016; Dlugosz, et al., 2013).

Physiological variables taken by through an ergometer cardiopulmonary testing showed significant difference in VO_2max reading, The recent study recorded mean of 47.194 mL/kg/min in the pre-test showing moderate status of the study sample. Reported values of international level wrestlers' are 45.9 ± 6.6 mL/kg/min for Colombian wrestlers, (Ramirez-Velez, et al., 2014), 49 mL/kg/min for Turkish wrestlers (Arslanoğlu, 2015), and 59.8 mL/kg/min for Polish wrestlers (Hübner-Woźniak, et al., 2009). Post-test of VO_2max recorded decreased mean with 43.489 mL/kg/min in wrestlers reading after indoor training showing the decrease of aerobic capacity with 2.057%, that can be attributed to less of working area, lack of performance endurance where there is no colleague or opponent to challenge, the attitude of the training program which depended on small resistance with short time endurance, but as a physiological detector, the post reading is still in the frame of high trained athletes reading according to the relative studies (Heywood, 2006).

BF (breathing frequency) is the number of breaths per minutes. Adaptive breathing frequency is decreased in trained athletes at rest with 7-8 breaths/minute, where it ranges about 12-20 breaths/minute in untrained individual. This reduction in breathing frequency represents greater respiration efficiency which attributed to adequate training or physical exercises (Gulam, 2016), unlike the measured BF during exercise where breathing frequency rises related to the high efficiency of athletes' respiration (Nicolò, et al., 2017). Recent reading of BF showed a little reduction with 6.132%, related to VO_2max reduction showing minor retreat of respiration efficiency caused by the less endurance enclosed in the indoor training program.

RER is the ratio between the amount of exerted carbon dioxide (CO2) exhaled and the inhaled oxygen (O2) showing the energy expenditure during the performance (Ramos-Jiménez, et al., 2008). RER is related to the high training intensity that could determine the anaerobic threshold of the athletes (Bellar, and Judge, 2012), matching the wrestling energy regime. RER value is considered a proper indicator of overall physical fitness (Bearden, et al., 2004). Recent RER reading recorded insignificant increase with 3.316% for the post-test where related studies emphasized unchanging values of RER in case of changing the training intensity (Houmard, et al., 1992), RER reduction signaling a drop in aerobic metabolism in of carbohydrate consumption matching the results of related studies (Bellar, and Judge, 2012; Rietjens, 2001), recent reading also related to decrease in

VO_2max and BF collected from post-test of the sample wrestlers showing the physiological changes in anaerobic capacity and fatigue threshold.

Insignificant increase in calories expended in the post-test with 1.446%, reflecting the change in energy expenditure and fast fatigue threshold of the wrestlers after the reduction of the training bout "indoor training" matching the results of related studies (Madsen, 1993; Mujika, and Padilla, 2001).

The training program in this study cared avoiding the detraining condition that may result out of "stay home" restriction, although the detraining influence the athletes after a long period of cutting the training off (Mujika, and Padilla, 2001), but studies pointed that a less amount of training may help in reducing the impact of detraining effect (MacDougall, and Sale, n.d.), that was the priority of this study. The researcher tried to preserve the physical and technical capabilities as well, so the training program depended on short bouts of specific physical exercises, the physical pre/post-tests of the wrestlers were significantly changed as little increase with 2.057% and 3.433%, in muscular strength represented in hand grip test for right and left handgrip respectively, where hand grip strength is considered a detector of overall body strength and successful wrestling performance (García-Pallarés, et al., 2011; Iermakov, et al., 2016), the recorded increased in right and left hand grip test is due to the focus of the training program on single joint action strength exercises as it's a successful method of increasing the overall body strength (Gentil, et al., 2015), and because of the ease of its performance and the less equipment needed, that was convenient with home training. Back muscle strength test as well is considered a successful method of testing wrestlers strength capability (Guilhem, et al., 2014), where relative studies emphasized on its crucial impact in wrestling performance (García-Pallarés, et al., 2011; Kraemer, et al., 2001), recent study resulted significant increase in back muscle reading in post-test with 2.292%, which also directs the influence of single joint muscle strengthening in wrestlers as performed in the study program matching the related study which showed the slow effect of reducing the exercising bouts on isometric strength of back muscles (de França, et al., 2015; Tucci, et al., 1992). On the contrary, back mobility test recorded significant reduction with 20.673% as the single joint resistance exercise resulted in a strong but stiff body in contrast with resistive wide range of motion resulted in technical performance with actual opponent weight, then the applied exercises of single joint increased the muscles strength but lowered the mobility of back muscle which in compatible with related studies (Basar, et al., 2014; Chaabene, et al., 2017) unlike the findings of other related studies which demonstrated a little increase in back flexibility out of muscle strengthening only (Leite, et al., 2017; Saraiva, et al., 2014). Technical variables recorded significant reduction with 34.756% for performance efficiency in score, and 16.364% for performance efficiency in time, which represent the performance endurance. This reduction was related to previous decrease in physiological and physical variables indicating the integrating adaptation of athlete's body (Swärd, 1990).

CONCLUSIONS

Wrestling performance was influenced by the change in training regime due to "stay home" COVID-19 restrictions. Although athletes maintained their muscular strength, but the long period of change in training regime, with short bouts of resistive physical and technical exercises affected the back flexibility and physiological variables with reduction in VO_2max, BF, RER, and little change in calorie expenditure. Performance efficiency decreased, especially in performance endurance measured in time and score, in correlation with the physiological variables. Indoor training succeeded in ceasing the influence of detraining, but wasn't sufficient enough to simulate real performing with opponent resistance.

Conflict of interest: the authors declare that this study is self-funded, and there is no conflict of interest.

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ENDOCRINE BIOMARKER RESPONSES DURING AN INTERCOLLEGIATE WRESTLING SEASON

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ABSTRACT
The aim of the current investigation was to quantify the endocrine biochemical markers including testosterone (T), cortisol (C), secretory immunoglobin A (sIgA) and testosterone: cortisol ratio (T:C) as indicators of the balance between anabolic and catabolic processes quantifying the homeostatic response to late competitive phase of the college wrestling season using a longitudinal repeated measures design. A volunteer sample of ten collegiate wrestlers (age = 22.11 ± 1.1yrs, height = 177.8 ± 3.1cm; weight = 77.6 ± 20.9kg) gave saliva samples via unstimulated passive drool (@0.75 mL) at 24 hours before and 24-48 hours post competition. All biomarker concentrations were determined using indirect enzyme-linked immunosorbent assay (ELISA) kits. Time since awake for each sample, whether the team traveled, number of competitions, day of the study, and trial (pre vs. post) was recorded to test for effect and interactions on biomarker concentrations. Conceptualizing the change in T, C, T:C ratio and sIgA over the competitive season, a series of hierarchical linear models were utilized. Our analyses revealed that cortisol and testosterone concentrations were predicted by day of study, time since awake, and number of competitions; however, T:C ratio was only predicted by day of the study and trial, indicating that as the season progressed, T:C ratio decreased over time after competitions. Secretory IgA was predicted by number of competitions indicating a decrease in sIgA as bouts increased, sIgA decreased. The exploration of salivary biomarkers could be conceptualized as an objective method to understand demands of competitive exposures on several physiological systems.
Key Words: athletics, combative sports, hormones, physiology, physical fitness, salivary

INTRODUCTION

Wrestling is a vigorous and physically demanding sport activity requiring tremendous physical preparation as well as the ability to tolerate significant psychological and emotional load. Training for wrestling traditionally incorporates high exercise volumes with limited recovery periods in an annual training program. Wrestlers at the elite level are required to sustain physical efforts of intermittent power and endurance at high speed with repeated high intensity bouts in a single match. For the one-day tournament competition, evidence of muscle damage and inflammation response is heightened (Barbas et al., 2011; Kafkas et al., 2016). Over two days of competition, significant reductions in lower and upper body strength and power occurs as the tournament progresses (Kraemer et al., 2001). From these investigations, data suggest neuroendocrine responses are linked to success (Fry et al., 2011). Wrestling has a profound effect on endocrine and cardiovascular function during a competitive season (Schmidt et al., 2005; Strauss et al., 1985). A college wrestling season is a stressor reducing an individual's lean body mass and peak power in competing athletes (Roemmich & Sinning, 1997). High intensity exercise over an extended period of a wrestling season has also been associated with immunosuppression, including a reduction in circulatory lymphocyte concentration and secretory immunoglobin A (sIgA) (Nieman, 2000; Pedersen et al., 1996; Ratamess et al., 2013).

Empirical evidence on physiological and performance changes in competitive intercollegiate athletes during a season, specifically with participants in team sports, is limited (Hoffman et al., 2005). Physical exercise stress as a result of high level training and competition induces significant hormonal, biochemical and immunological changes to an athlete's physiology. Multiple investigations on soccer players, road cyclist and runners demonstrated hormonal changes during a season of competition and major tournaments (Filaire et al., 2001; Hough et al., 2011; Moreira et al., 2009; Ohkuwa et al., 1995). Subsequently, monitoring the immune status of athletes has received greater attention at the elite level with most of the research focusing primarily on post-exercise salivary immune response (Owen et al, 2016).

Testosterone (T), cortisol (C), testosterone-to-cortisol ratio (T:C) and sIgA have been proposed as indicators of the ratio between anabolic and catabolic processes (Viru & Viru, 2004). These biomarkers have been proposed

as indicators of the balance between anabolic and catabolic processes amongst athletes across an annual conference season and tournament campaign (Jack et al., 2013). Testosterone is a male sex hormone that is important for sexual and reproductive development. Cortisol is a hormone that is released from the adrenal gland in response to stress or other chemical signals. Cortisol as a stress marker has been extensively studied in professional, collegiate and recreation athletes due to its catabolic and immunosuppressive effect on protein synthesis (Papa et al., 2015). However, regular exercise-induced training will decrease this effect, causing the body to have a better response to stress and require less C release. Empirical evidence for fatigue-related mechanisms in exercise-induced training is unequivocal, but the function of the hormonal regulation of metabolism and cellular homeostasis is well documented. Repeated exercise-induced training bouts and competition without a sufficient period of recovery can cause a persistent disturbance in this metabolic homeostasis (Morgans et al., 2015). Secretory IgA is an important protein that plays a major role in protecting us from respiratory infections found throughout the body such as the intestines, the lungs and importantly in saliva. Investigations have shown that when the level of sIgA is high, the risk of upper respiratory tract infections (URTIs) is low, and people with low sIgA suffer from URTIs at a higher rate than the general population (Adlercreutz et al., 1986). The causes of immune depression after prolonged exercise are thought to be related to increases in circulating stress hormones (e.g., adrenaline and C).

The primary aim of the current investigation was to describe the changes in salivary biochemical markers including T, C, T:C and sIgA during the latter stages of the competitive season of collegiate-level wrestlers. A secondary aim is to identify the variables that relate to changes in these markers. We hypothesize that due to the demands on wrestlers during this phase of the competitive season, there will be changes in these biochemical markers. Although changes in T and C may reflect the physiological stress associated with weight reduction ("cutting weight") in wrestling, it is expected that changes might appear to amplify the endocrine response to a season of training and competition. This is primarily related to the ability of biomarkers to provide a quantitative view of the homeostatic response in a subject's training as a point of exercise periodization and potential adaptive processes to training (Poste, 2011).

METHODS

Experimental Approach to the Problem

Investigators collected salivary samples simultaneously from a cohort of athletes in a non-laboratory setting, which would cause minimal interference in the athletes' training regimen. In general, the investigators collected samples from each subject approximately 24 hours before competition and 24-48 hours post competition, allowing a competition monitoring program across an entire collegiate conference competitive season. Prior to any data collection, all participants signed an informed consent form. This study was approved by and carried out in accordance to the Declaration of Helsinki.

Participants

To be eligible, each participant was considered elite as a member of a top-10 ranked NCAA Division I wrestling team (5 obtained NCAA All American designation) between the ages of 19 and 24 years of age. Participants were free from any current or ongoing musculoskeletal injuries or neuromuscular disorders via pre-season physical exam by a licensed physician. Subjects who met inclusion criteria were contacted by the investigator. All wrestlers were fully familiarized with the experimental procedures within this investigation. All mandatory health and safety procedures have been complied with in the course of conducting any experimental work. Ten male elite wrestlers (mean ± SD; age =22.11 ± 1.1yrs; height=177.8 ± 3.1cm; weight=77.6 ± 20.9 kg) were analyzed and reported in this manuscript.

Procedures

During the study, subjects were instructed to maintain normal daily food and water intake, with no individual dietary or recovery modality changes made throughout the annual assessment period as determined by a state licensed, registered dietician providing a clearer picture of well-being with respect to immune function, physical state and performance. Wrestlers provided pre-workout saliva sample approximately 15 to 30 minutes before training session commenced. Additionally, before saliva sampling, to regulate saliva secretion, wrestlers were asked to maintain hydration (consumed 500 ml of water) because dehydration has been associated with reduced resting saliva flow rates (Phillips et al., 2012). Samples were collected 24-hour period before and 24-to-48 hour period after 10 different competition weeks beginning in the pre-conference season (early January) and ending one week after the end of season conference competition (early March). On the weeks (n = 3) in which the team did not compete (bye weeks), samples were taken in the same time intervals (48 hours apart).

Saliva Collection

All saliva samples were collected via unstimulated passive drool (0.75 mL) over a time period of 3 to 5 minutes, a procedure all the subjects were familiar with procedure and informed of all testing procedures. Participants were instructed on the following: 1) refrain from brushing their teeth 30 minutes prior to collections, 2) avoid dairy and foods high in sugar or caffeine content for 20 minutes prior to sample collection, and 3) wait at least

10 minutes after food or drink intake before providing sample to avoid sample dilution. Participants were asked to sit quietly, lean slightly forward, and accumulate saliva in the floor of the mouth. All saliva in the subject's mouth was subsequently swallowed prior to providing a whole saliva sample as a standardized saliva collection procedure. During collection, saliva dribbled through a 5 cm plastic straw into a 2 mL polypropylene cryovial (SalivaBio, Carlsbad, CA). Samples were transported in a cooler to a -20°C freezer as soon as possible, typically within 20 minutes of collection.

Instruments-Tests for Hormonal Assays

On the day of analyses, saliva samples were thawed and centrifuged at 3500 rpm for 15 minutes to remove mucins (Sorvall ST40R Multispeed Centrifuge; Thermo Scientific, Waltham, MA) and the resulting supernatant was stored at -80°C until further assay analysis. Samples were assayed in duplicate for T, C and sIgA. All biomarker concentrations were determined using commercially available indirect enzyme-linked immunosorbent assay (ELISA) kits (Salimetrics, Carlsbad, CA) as measured by an absorbance microplate reader (BioTek x808; BioTek Instruments, Inc., Winooski, VT) in accordance with the manufacturer's instructions without modification (Salimetrics). A separate assay was used for each player with 10 assays per hormone, for 20 assays in total, with samples, standards, and controls run in duplicate for all standards, controls, and samples. The minimal concentration that can be distinguished from 0 with this assay is less than 0.03 nmol/L and 0.2 nmol/L for T and C, respectively. Intra-assay coefficients were 4.33%, 4.20%, and 4.47%, and inter-assay coefficients were 2.15%, 6.47%, and 11.26% for C, T, and sIgA, respectively. Cortisol, T, and sIgA are measured in nmol/L, pmol/L, and ug/mL, respectively.

Research Design

In order to investigate the various contributing factors to changes in biomarkers over a competitive season, in each case, a nested model with two levels of predictor variables were included in the model of fixed effects. Level 1 represents within-person change, and level-2 variables vary between wrestlers. These variables include Level-1 variables of Day (outlined above), Pre-Post, and Travel, and two interaction terms (Day X Pre-post, and Day X Travel). In addition, Time since Wake-Up and Bouts were entered into the model as Level-2 variables, and one cross-level interaction term was examined (i.e., Day X Bouts). Level-1 variables were consistent across individuals, indicating changes within the individual: Day represents the day since the start of the season to correct for uneven intervals between samples, Pre-Post is a categorical variable representing pre-competition sample or post-competition samples, and Travel is a categorical variable representing home (no travel) or away (some travel). The time awake for each salivary sample day and whether pre-competition or post competition was recorded. In addition, whether the competition was at home (no travel) or away (travel) was noted. Finally, the day in the study period (Day) and competition number (Bout) were recorded as to test the influence of wrestling season duration on hormonal and immune functions. At Level 2, Time since Wake-Up approximates diurnal rhythm given the varied times each individual woke up the day of practice, and Bouts (i.e. number of competitions between pre-competition and post-competition samples) varied among the wrestlers. Interaction terms were also included in the models, predicting T, C, T:C ratio, and sIgA as anabolic, catabolic, anabolic:catabolic ratio, and immune function outcomes, respectively.

Statistical Analysis

A comparison alpha level of $p \leq 0.05$ was used to determine statistical significance, and "marginally significant" results constitute p-values of < 0.15. Although the tests do not meet the strict $p \leq 0.05$ cutoff values, given the small number of participants in the current study, we interpret them as potentially statistically significant in magnitude-based research design (Hopkins et al., 2009). In order to conceptualize the change in T, C, T:C ratio, and sIgA over the competitive conference season, a series of hierarchical linear models were utilized. Due to the nested nature of the data (i.e., observations were not independent), the model was partitioned into within-person variance, and between-person variance by wrestler, time (Day) at Level 1, and other variables were analyzed at Level 2 and 3. Given the diurnal nature of both T, C and sIgA, variables related to the time of day the sample was taken, and a time since individuals woke up variable was included in the model. Data were analyzed using SAS 9.4 (SAS Institute Inc., Cary, NC) PROC MIXED models. Time since Wake-Up was included in all models as a better metric of diurnal rhythm (vs. absolute time of day) given the individual variability relation to wake-up time for each individual. All data are reported as mean $\pm$ SD in Table 1.

Table 1: Salivary Biomarker Concentration Data by Week of Competition

Competition	Sample	Sample number	n	Testosterone (pmol/L)	Cortisol (nmol/L)	T:C ratio	Secretory IgA (ug/mL)
Week 1	Pre	1	10	863.29 ± 529.15	11.75 ± 5.97	0.073 ± 0.025	
	Post	2	9	540.90 ± 214.37	6.07 ± 2.47	0.096 ± 0.037	156.26 ± 85.58
Week 2	Pre	3	10	621.42 ± 314.54	10.23 ± 6.50	0.072 ± 0.024	
	Post	4	10	480+39± 127.94	5.13 ± 2.66	0.118 ± 0.072	164.02 ± 101.14
Week 3	Pre	5	10	739.98 ± 434.28	10.53 ± 9.17	0.082 ± 0.025	
	Post	6	8	420.92 ± 152.27	4.61 ± 2.40	0.100 ± 0.034	264.49 ± 242.63
Week 4 (Bye)	Pre	7	10	724.88 ± 353.26	8.19 ± 3.21	0.091 ± 0.028	
	Post	8	10	900.18 ± 386.58	8.57 ± 3.12	0.111 ± 0.047	260.79 ± 169.04
Week 5	Pre	9	7	627.08 ± 254.49	7.86 ± 4.24	0.097 ± 0.045	
	Post	10	10	456.43 ± 159.76	5.51 ± 3.84	0.098 ± 0.033	126.94 ± 131.33
Week 6	Pre	11	10	541.23 ± 248.74	5.75 ± 3.75	0.114 ± 0.059	
	Post	12	10	831.69 ± 326.04	13.54 ± 9.04	0.124 ± 0.144	192.41 ± 121.69
Week 7 (Bye)	Pre	13	9	610.01 ± 280.26	7.29 ± 3.58	0.091 ± 0.038	
	Post	14	10	771.34 ± 245.27	11.51 ± 6.46	0.094 ± 0.067	334.51 ± 333.97
Week 8 (Bye)	Pre	15	10	467.86 ± 209.86	4.46 ± 2.56	0.123 ± 0.051	
	Post	16	10	623.10 ± 299.47	6.92 ± 3.63	0.103 ± 0.051	213.56 ± 109.39
Week 9	Pre	17	9	699.27 ± 320.90	8.26 ± 4.02	0.093 ± 0.036	
	Post	18	9	573.12 ± 139.83	4.81 ± 1.98	0.139 ± 0.062	207.96 ± 132.72
Week 10 (Bye)	Pre	19	10	628.77 ± 279.07	6.16 ± 2.73	0.108 ± 0.035	
	Post	20	9	443.32 ± 255.04	5.88 ± 3.67	0.090 ± 0.044	176.24 ± 99.24
Note: Salivary biomarker numbers represent mean values ± standard deviation							

RESULTS

Throughout the conference season and post-season tournaments, not all subjects' performance contributed equally as to the outcome of the match. Some parameters such as individual and team scoring efficiency or competition against national ranking per weight class could influence hormonal and perceptional performance changes. Only team results and average salivary values are reported within this investigation (Table 1).

Testosterone and Cortisol Concentrations

In order to assess the patterns of T and C separately over the conference competitive and tournament season, two hierarchical linear models were conducted. The T model showed evidence of nesting (i.e., lack of independence of observations in T concentrations), $ICC = 0.43$, $p = 0.02$. Table 2 shows the values of the estimates for fixed effects estimates on T levels. In both models, T values were significantly different between wrestlers (see Table 2), $p < .0001$. A full model with eight predictor variables (five individual variables and three interaction terms) were entered into the model. At Level 1, Pre-Post was a significant positive predictor, indicating that on average, the post-competition levels were higher than the pre-competition levels. However, in contrast to the positive Pre-Post effect, Day X Pre-Post indicated that on average, as the season went on, average T levels decreased in post-match samples. There were marginally significant changes over time (Day), but no significant changes between home and away matches (Travel), nor the interaction between the two variables (Day X Travel). As expected, Level-2 variables of time since wake-up and number of bouts were significant negative predictors of T concentrations, indicating that the further from wake-up and as the number of bouts increased, respectively, the T concentrations decreased; for example, for each week where bouts increase by n = 1, testosterone concentrations decreased by 293.57 units (on average), as indicated by the parameter estimates in Table 2. Interestingly, the Day X Bout interaction was a significant positive predictor of T levels, indicating that on average, as the season went on (increase in days), an increase in bouts resulted in an average increase in T over time.

Table 2. Effects on Salivary Testosterone Concentrations

	Empty Model		*Full Model*	
	PE (SE)	*p*	PE (SE)	*p*
Intercept (Wrestler)	641.70 (67.88)	< .0001*	818.92 (78.36)	< .0001*
Fixed Effects	--	--		
Level-1 (Within-Subjects)	--	--		
Day			- 1.62 (1.08)	.13†
Pre-Post	--	--	317.88 (103.25)	.002*
Travel	--	--	168.40 (140.34)	.23
Day X Pre-Post	--	--	-5.40 (2.22)	.02*
Day X Travel	--	--	-7.19 (6.19)	.25
Level-2 (Between-Subjects)	--	--		
Wake-Up	--	--	-0.37 (0.09)	< .0001*
Bouts	--	--	-293.57 (67.31)	< .0001*
Day X Bouts (Cross-Level Interaction)	--	--	5.74 (1.68)	.0008*
Fit Statistics				
-2 Log Likelihood	2635.20	--	2575.70	--
AIC	2641.20	--	2597.70	--
BIC	2642.20	--	2601.00	--

Note: *Statistically significant at p < .05; † Marginally significant at p < .15; PE = parameter estimate; SE = standard error

Cortisol concentrations showed similar nesting, *ICC* = 0.14, *p* = 0.05. Therefore, a full model was also run on C concentrations. There were significant differences in C concentrations between wrestlers (*p* < .0001). At Level 1, unlike T, Day was a significant negative predictors of C concentrations, indicating as the season went on, C decreased. Pre-Post and its interaction with time (Day X Pre-Post) were non-significant. Travel was a marginally significant positive predictor (*p* = 0.11), i.e., cortisol concentrations increased by an average of 4.61 units after travel compared to pre-travel levels (see Table 3 for parameter estimates). However, Day X Travel indicated that as the season progressed, C significantly decreased on average on travel days (see Figure 1 and Table 3). At Level 2, as expected, and in line with T concentrations, time since wake-up and number of bouts were negative predictors of C concentrations. This indicates that as time since wake-up and number of bouts increased, respectively, the C concentrations decreased. Day X Bout showed that as the season progressed, on average, an increase in bouts resulted in an average increase in C over time.

Table 3. Effects of on Salivary Cortisol Concentrations

	Empty Model		*Full Model*	
	PE (SE)	*p*	PE (SE)	*p*
Intercept (Wrestler)	7.89 (0.71)	< .0001*	12.26 (1.12)	< .0001*
Fixed Effects	--	--		
Level-1 (Within-Subjects)	--	--		
Day	--	--	-0.04 (0.02)	.05*
Pre-Post	--	--	1.19 (2.11)	.57
Travel	--	--	4.61 (2.87)	.11†
Day X Pre-Post	--	--	-0.008 (0.05)	.86
Day X Travel	--	--	-0.26 (0.13)	.04*
Level-2 (Between-Subjects)	--	--		
Wake-Up	--	--	-0.009 (0.002)	< .0001*
Bouts	--	--	-3.24 (1.37)	.02*
Day X Bouts (Cross-Level Interaction)	--	--	0.08 (0.03)	.01*
Fit Statistics				
-2 Log Likelihood	1151.60	--	1100.70	--
AIC	1157.60	--	1122.70	--
BIC	1158.50	--	1126.10	--

Note: *Statistically significant at p < .05; † Marginally significant at p < .15; PE = parameter estimate; SE = standard error

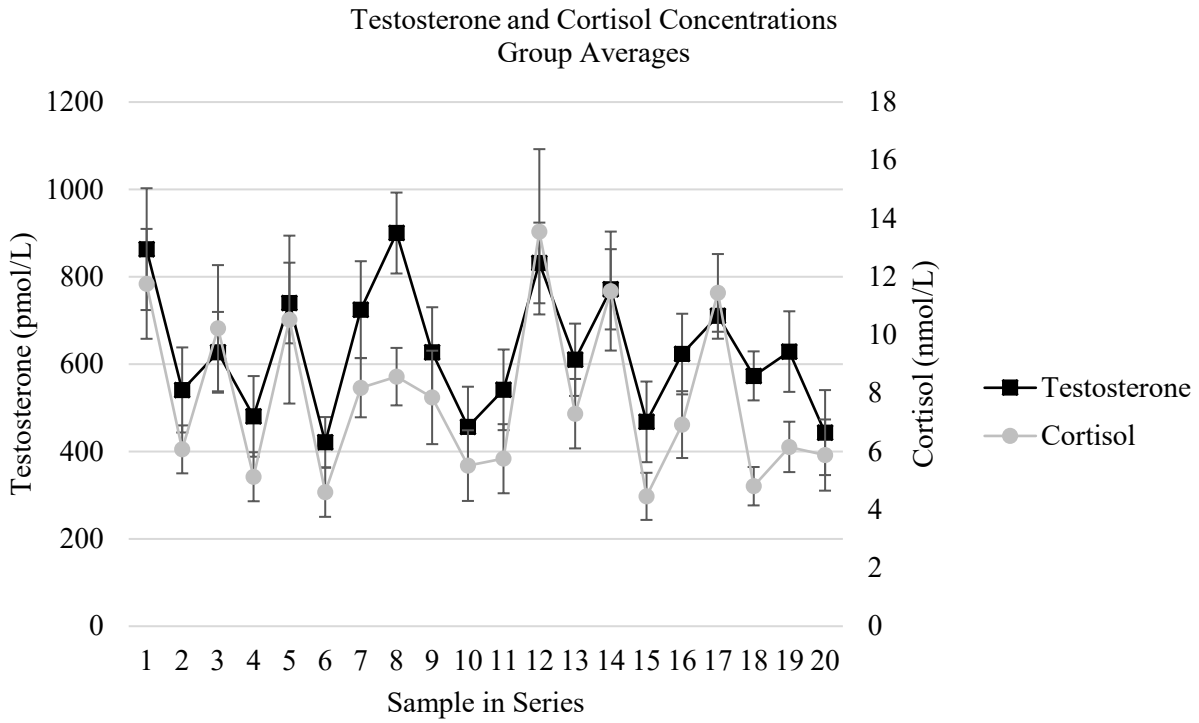

Figure 1: Testosterone and Cortisol Concentrations by Sample

Note: Error bars represent standard error values; sample numbers are shown in Table 1.

Testosterone:Cortisol Ratio

Given some similar and some disparate findings in predictors of T and C concentrations separately, T:C ratio was subsequently analyzed. The initial empty model showed the presence of nesting of T:C ratio values, *ICC* = 0.19, $p = 0.03$, and indicated that Day was a marginally significant predictor of T:C ratio. (Figure 2 for T:C ratios) (Hopkins et al., 2009). The full model with five predictors and three interaction terms showed only two marginally significant predictors and one interaction term, Day X Pre-Post. Interestingly, although Day ($p = 0.07$) and Pre-Post ($p = 0.03$) indicated marginally significantly increased T:C ratios, the interaction term indicated that as days increased, T:C ratios were lowered by an average of 0.0009 units after competitions as compared to pre-competition levels. This is perhaps not surprising given the evidence that only four of the eight predictors overlapped in significantly predicting both T and C concentrations individually (see Table 4 for detailed model results).

Table 4. Effects on Testosterone-to-Cortisol Ratio

	Empty Model		*Full Model*	
	PE (SE)	*p*	PE (SE)	*p*
Intercept (Wrestler)	0.10 (0.008)	< .0001	0.07 (0.01)	< .0001*
Fixed Effects				
Level-1 (Within-Subjects)				
Day	--	--	0.0004 (0.0002)	.07†
Pre-Post	--	--	0.04 (0.02)	.07†
Travel	--	--	0.03 (0.03)	.37
Day X Pre-Post	--	--	-0.0009 (0.0005)	.09†
Day X Travel	--	--	-0.0009 (0.001)	.53
Level-2 (Between-Subjects)				
Wake-Up	--	--	0.00002 (0.00002)	.37
Bouts	--	--	-0.02 (0.02)	.27
Day X Bouts (Cross-Level Interaction)	--	--	0.0005 (0.0004)	.20
Fit Statistics				
-2 Log Likelihood	-581.00		-592.70	--
AIC	-575.00	--	-570.70	--
BIC	-574.10	--	-567.40	--

Note: *Statistically significant at p < .05; † Marginally significant at p < .15; PE = parameter estimate; SE = standard error

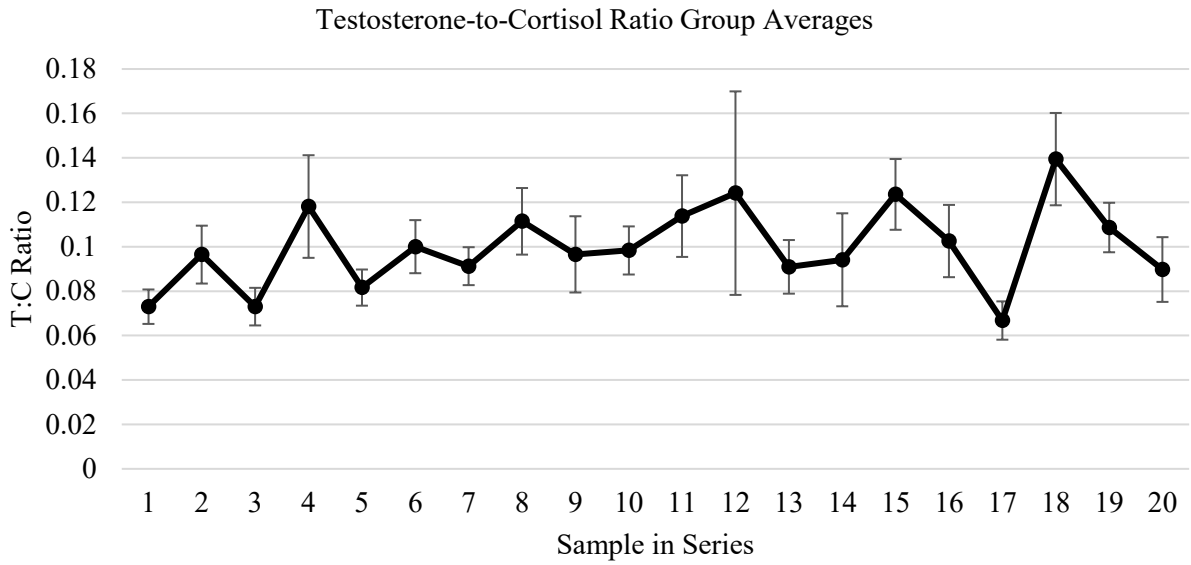

Figure 2: Testosterone:Cortisol Ratio by Sample
Note: Error bars represent standard error values; sample numbers are shown in Table 1.

Secretory IgA

The initial empty model showed the presence of nesting of sIgA values (ug/mL), *ICC* = 0.19, *p* = 0.059. A nested model with all predictors except Pre-Post and its interaction with Day were included because sIgA samples were collected one time per week (all post-match). Sectory IgA concentration levels were significantly different between wrestlers ($p < .0001$). At Level 1 and Level 2, Day, Wake-Up, Travel, and the Day X Travel predictors were non-significant predictors of sIgA levels. The number of bouts in a given week was a significant negative predictor of sIgA concentrations; however, its interaction with time (Day X Bouts) showed a marginally significant positive prediction, indicating that over time as bouts increased, sIgA concentrations increased on average by 1.86 units (Figure 3 for sIgA concentrations and Table 5 for model results).

To summarize the conclusions of this investigation, analyses revealed that Day predicted T, C, and T:C; however, where T and C concentrations decreased over time, T:C ratio increased on average. Pre-Post positively predicted T and T:C ratio, indicating the post-competition levels were higher than the pre-competition levels. In both T and T:C ratio, however, Day X Pre-Post was a significant negative predictor, and C concentrations did not change significantly pre-post, nor over time (Day X Pre-Post).. Bouts negatively predicted T, C, and sIgA concentrations; however, it did not predict T:C ratio, and interestingly, these values increased as the season went on (Day X Bouts). Travel only affected C concentrations, showing increased levels on days traveled; however, C concentrations decreased as the season went on for travel weeks (Day X Travel). The exploration of these salivary biomarkers could prove as objective non-invasive method to understand demands of intense competitive exposures.

Table 5. Effects on Salivary Secretory IgA Levels

	Empty Model		*Full Model*	
Intercept (Wrestler)	210.84 (28.43)	< .0001*	315.76 (75.02)	.002*
Fixed Effects				
Level-1 (Within-Subjects)				
Day	--	--	-1.28 (1.25)	.31
Travel	--	--	86.37 (89.63)	.34
Day X Travel	--	--	-3.33 (4.02)	.41
Level-2 (Between-Subjects)				
Wake-Up	--	--	-0.09 (0.08)	.26
Bouts	--	--	-88.78 (42.84)	.04*
Day X Bouts (Cross-Level Interaction)	--	--	1.86 (1.08)	.09†
Fit Statistics				
-2 Log Likelihood	1291.10	--	1232.50	--
AIC	1297.10	--	1250.50	--
BIC	1298.00	--	1253.20	--

Note: *Statistically significant at p < .05; † Marginally significant at p < .15; PE = parameter estimate; SE = standard error

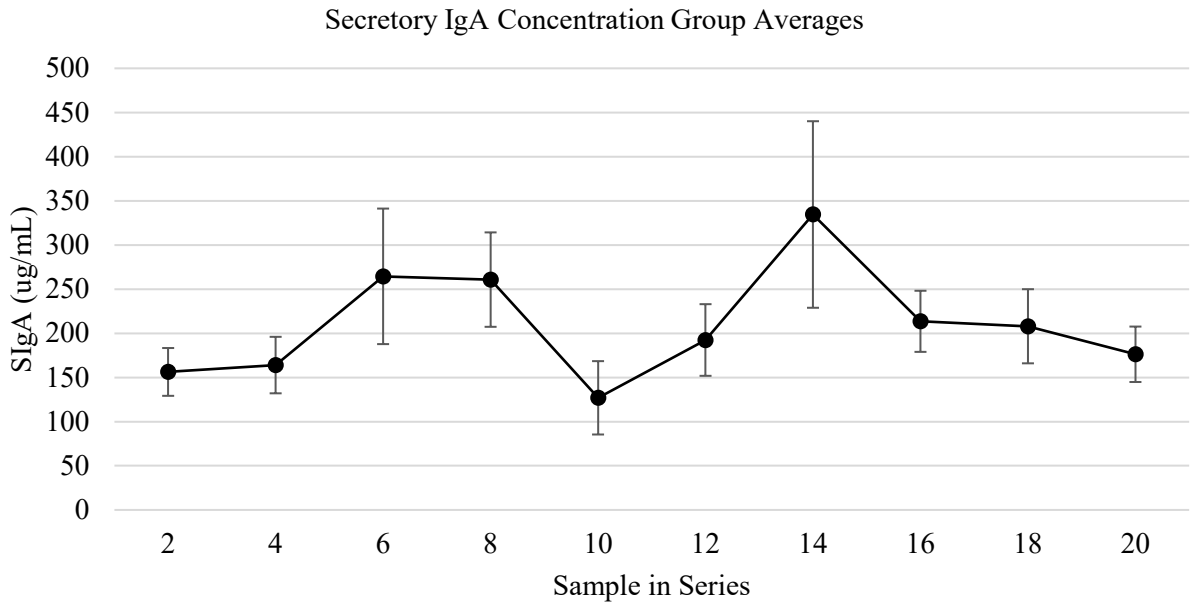

Figure 3: Secretory IgA by Sample
Note: Error bars represent standard error values; sample numbers are shown in Table 1.

DISCUSSION

Salivary analyses have evolved into a sophisticated science and recognized in a variety of biomedical basic and clinical sciences. Saliva is an easily available specimen containing a large array of hormones and enzymes used in screening and diagnostic assessment (Brownlee et al., 2005). Salivary collection is a minimal invasive process compared to current methods of blood collection. The procedures to collect and analyze blood samples can often be expensive, painful and invasive. Yet, investigations on the reliability and validity of salivary analysis to blood-based biomarkers in response to stress remains unclear. Implementing a system of exercise training and periodization that incorporates the use of non-invasive methods allowing for an accurate evaluation of exercise-induced physiological and psychological stress is important. This was the first study to examine and quantify the relationships between hormonal and enzyme variables that surround a typical competitive wrestling season and objective markers of training (T, C, T:C ratio, and sIgA) applied to predict exercise intensity in elite athletes with variable outcomes (Gatti & De Palo, 2011).

Wrestling conference season involves weekly home or away dual meets against high quality teams. While the rigors of each match are less than a single day tournament, the preparation for the competition (i.e. daily training, weight reduction, travel) are similar and can challenge the athlete's ability to cope with stress. During the ten weeks of sample collection, there was evidence of increases in T and decreases in C although the T:C ratio was not significantly different. An increase in T would suggest an anabolic condition while the C decrease would indicate a lowering of "catabolic state" associated with the competitive season. Unfortunately, the changes in these individual hormones did not coincide with the T:C ratio which might suggest independence in these biomarkers. An optimal change over time would be to have a rise in the T:C ratio, which would suggest an adaptation favoring the athlete's ability to recover each week from competition. The competitive portion of the wrestling season is designed to test the skills and conditioning of the athlete and prepare them for competition at the national level. While the rigors of daily training are replaced with competition (which includes travel and weigh-in), the mental and physical challenges (particularly in the Big 10 Wrestling Conference), can strain the body and therefore create problems which could result in overtraining. A taper period is introduced at the end of the dual meeting schedule ("bye week") which is designed to rest the athlete as to prevent overtraining. It should be noted, however, that the schedule of competition for this season included a "bye week" after the three weeks of competition (representing approximately five cumulative bouts per person) against three of the top five placed teams in the 2016 NCAA National Championship. This "bye week" did include training but not having to "make weight" should have affected a summative change in T or C. The pre-salivary C concentration for this week was lower than the three-previous week's pre-salivary C levels suggesting less stress. This could be due solely to the lack of weigh-in, which creates a catabolic state due to restriction of food intake. In addition, the post-salivary T concentration during this week produces the highest mean value across the study period. This response might be due to numerous reasons but does provide some indication of an anabolic condition.

Exercise-induced stress provides a similar avenue for the use of salivary biomarkers in prediction and evaluation. These biomarkers offer potential in both an acute assessment of physiological and psychological stress (Nieman & Henson, 1994). Cortisol was elevated by the stressful in-season training camp while T and T:C did

not change suggesting that a 28-day training camp may not cause significant disturbances in hormonal or biochemical stress markers in elite athletes (Hoffman et al., 1999). Although, findings from the present investigation is consistent with previous investigation on professional basketball subjects, increases in tested T did not occur after a taper. The weeks coinciding with recovery or taper during the season did not alter the sIgA group values suggesting immune resistance is not as reactive to brief periods returned training or changes in dietary restrictions.

The exploration of salivary biomarkers could prove as objective non-invasive method to understand demands of intense competitive exposures. Investigations assessing salivary inflammatory and stress responses may identify and help illuminate some validity issues regarding the assessment of salivary stress, inflammatory and immune system biomarkers. In multiple cases, the immune system exhibits adverse change after prolonged and intense exercise exertion lasting more than 90 minutes (Hoffman et al., 1999). Research data on the resting immunity status of athletes and non-athletes is limited and presents a confusing picture at present (Hofman, 2001). For example, the few studies available suggest that the immune system responds differentially to the chronic stress of intensive exercise, which is dependent on fitness, nutritional, and pathological status (Vining & McGinley, 1987).

In conclusion, investigative analyses revealed a significant Pre-Post T and T:C ratio as a significant predictor, indicating the post-competition levels were higher than the pre-competition levels. In this investigation, Pre-Post C and interaction with time (Day X Pre-Post) were not significant. Although, a marginally significant sIgA concentration (Day X Bouts) showed a positive prediction, indicating that over time as bouts increased, sIgA concentration levels increased. In future investigations, the degree to which salivary biomarkers correspond to blood-based markers is unclear in both a resting state and in response to stress. Monitoring salivary biomarkers is recommended to identify excessive stress caused by the natural demands to meet season demands of training and competition. Supporting a need for additional research on salivary indices validating inflammation and stress measures to systemic and pathological mechanisms. Where this is not possible, any extrapolation of findings from endurance athletes to wrestling demands should be made with caution, since the physiological demands of combative training is not necessarily the same as those of endurance training and competition.

This study provided some evidence that factors such as time of day and time awake might play a role in the levels of biochemical markers of stress and immune function. Based on current findings in conjunction with results from the previous studies, a practical approach in assessing the state of recovery, stress and consistency in these factors would be beneficial testing day to day variance. The demands on athletes can be subjective to other factors than practice or competition. For this study, the time awake varied; in future studies, researchers and practitioners should note if naps are taken or there is disruptive sleep in the previous night. While the researcher can ask for recall on each of these variables, some adjustment might need to be made to control for changes in sleep patterns or awake time between days.

Another implication for future research is to evaluate the interdependence of testosterone and cortisol. While a ratio of these two hormones are reported in the literature, our findings do not support this interdependence. If higher cortisol is catabolic to certain tissue, the rationale for lower levels to promote better recovery is under question. If the lower hormonal levels of testosterone are viewed as detrimental to recovery, then how does variance in levels of testosterone across athletes justify this implication? In many cases heavy exercise training promotes an elevation of testosterone while also elevating the levels of cortisol. In effect, this might result in both anabolic condition concurrently with a catabolic state which supports the Fitness-Fatigue Theory (Chiu & Barnes, 2003) for adaptation to the stress imposed and suggesting the use of a T:C ratio needs farther investigation. The goal for in-season surveillance of biochemical markers is to identify potential signs of overtraining which might lead to injury or illness.

Practical Applications

A complete endocrine profile combined with optimal exercise training is an important factor for any athletic performance. This study has provided a description of elite athletes experience with a seasonal surveillance system using salivary-based medians to determine hormonal levels associated with anabolic and catabolic metabolic processes. In addition, a measure of an antibody, such as sIgA, which has been linked to upper respiratory infection during a period of time in which immunosuppression might be present (Neville et al., 2008). During periods of intensive training and high expectations for athletic performance, many individuals are prone to overtraining and therefore should be monitored for signs associated with this condition. Our data suggest that the performance and health care professional can benefit from this investigation that employed a non-invasive procedure for analyses of easy to obtain bodily fluid which carries biological indicators of stress, recovery state, and immune defense.

While the results of this study provides evidence that will impact decisions on the field, a performance and health care professional should adopt a holistic approach for monitoring exercise training and develop questions

towards the use of salivary sampling in our professions and practice. Future investigations in this area will promote a better understanding of the demands the athletes endures during exercise training and competition. Additionally, provide an application for accurate detection of signs of overreaching and overtraining which need to be dealt with before the athlete reaches a point of decay in health.

Disclosure Statement
The authors report no potential conflict of interest.

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WRESTLING TRADITIONS OF INDO-EUROPEANS - FROM WARRIOR EXERCISES TO FOLK GAMES AND CIRCUS PERFORMANCES

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ABSTRACT
Background. All warrior cultures have respected or still cultivate wrestling as a male display of strength and fitness.
Problem. On the basis of the preserved wrestling traditions of the descendants of the Aryans, can we claim that the ancient Lechites practiced similar exercises (before the historical Poland came into being)?
Method. On the basis of a series of premises, the regression method was applied, which is used in historical research and in social sciences more generally.
Results. We find a series of premises and possible deductions with probable origins - from the present state to the possible earlier one. Today, Poles and other Slavic nations are doing well in sports wrestling and related jujitsu. We can only infer the ancient forms of wrestling indirectly, by analogy to other preserved traditions.
Conclusions. Since peoples growing out of the same genetic (biological and culturally) stem and neighboring peoples retained the original forms of wrestling, it is likely that the ancient Lechites (i.e. Western Slavs) had similar forms of exercise and competition.
Key words: history, combat sports, wrestling, warrior traditions, Poland

INTRODUCTION

Wrestling have been cultivated in all or the great majority of civilizations and cultures from the earliest times. It can be assumed that also in the direct ancestors of the Slavs and Poles. All cultures of warriors respected, or still cultivate, this type of masculine display of strength and fitness. The analysis of the conditions for the emergence and development of wrestling in Poland requires taking into account various aspects and many factors. This is how it is realized in the systemic anthropology of martial arts and in research conducted in this perspective (Zeng, Cynarski, Xie, 2013). It is worth starting from almost legendary, ancient times. Most likely at that time the ancestors of today's Slavs and Poles practiced similar exercises. It concerns mainly Poles and their immediate ancestors.

Pre-Slavs were neighbors with other Ario-Slavic, Indo-European peoples, also with Turkish, Mongolian and Finno-Ugric peoples. There were probably mutual contacts other than war ones, and the resulting borrowings in the field of technique and customs, including para-sports forms. These could be, inter alia, wrestling grown for ritual, ludic or utilitarian purposes. This kind of "sport" was known and cultivated in all known civilizations as a game or a fighting technique of warriors. On the basis of the preserved wrestling traditions of the descendants of the Aryans, can we claim that the ancient Lechites practiced similar exercises (before the historical Poland came into being)?

Folk wrestling cultivated in many countries in Asia and Europe (cf. Swiss *Schwingen* and Breton *Gouren*) are perhaps a legacy of something that was common centuries ago. Particularly when warriors became farmers, at least in some tribes, the tradition of similar exercise and competition could be preserved. Kazimierz Toporowicz points out that, based on the paintings from the Beni Hassan tomb in Egypt, dating from around 2000 BC, we can assume that wrestling fights were popularized much earlier. Since about 70 wrestling moves are shown there, it is evidence of the advanced development of this form of hand-to-hand combat. Thus, the regressive method allows us to assume a much earlier beginning of growing wrestling in that region (Toporowicz, 1996: 133). The same regressive method was used in this study.

Finally, when the institution of a circus appeared in Europe, the circus arena became a place of displays of male strength and fitness, including wrestling fights (Chełmecki, 2012; Czarnecka, 2019). It was popular entertainment at a time when the circus was later taken over by television. Interestingly, at the beginning of the 20th century, the descendants of Ario-Slavic warriors played a significant role in the international competition of strongmen.

RESULTS

1. Old times

Did the ancient Slavs, living in the territories of today's eastern Germany and Poland from around 2000 BC (Haarmann, 2016), grow wrestling? The Ario-Slavic peoples originally functioned on the principles of military democracy. Each man was also a warrior. Regressive inference, from later states to possible earlier states, gives an affirmative answer. Since wrestling exercises were preserved in Iran and in India, the countries of the Aryan conquest, probably the Slavs coming out of the same trunk did similar things.

According to the results of genetic research, the Aryans migrated from the so-called Lechitic lands (from the Lechitic, West Slavic languages) to the east and south (Underhill et al., 2015). It is a people with a dominant R1a1 Y-DNA haplogroup. Their descendants are the Medes, Parthians and Persians, Afghans and Hindus from the northern part of India (the Brahmin and Kshatriya caste), as well as the Kurds, living today between Turkey and Iraq and Syria. The rest of the people with the indicated dominant haplogroup remained in the basins of the Odra and Vistula. These were the times before the creation of the Scythian state. Then the Scythians and Sarmatians, peoples originating from the Aryans and related peoples (genetically and culturally) influenced the Slovinian tribes through their close neighborhood (Makuch, 2013; Cynarski, 2018; cf. Trybała-Zawiślak, 2020). We know little about the times of the legendary Lechia (before the name *Polonia* / Poland appeared and became popular); even more so about men's games and training of warriors. The chronicles speak of horse racing. Predatory birds were probably used for hunting (they could have been eagles, falcons and hawks) (cf. Moszyński, 1957: 131). However, only later history is revealed better thanks to archaeological research and historical sources.

We know that in Poland in the 10th century CE the men practiced horse riding, archery, sword fencing and the use of other weapons. They probably also played or specially dealt with wrestling as a simple form of competition. Legendary strongmen such as Waligura and Wyrwidąb were sung in songs. Especially the mercenary team of the prince had to maintain high combat efficiency. The form of training was hunting for "big game" - aurochs or a bear. The warriors probably used baths in order to regenerate their strength. According to Ibrahim ibn Jakub, in the country of Mieszko I there were "… a great number of wooden bathhouses with walls sealed with moss. In the corner of the room there was a stove on which water was poured to produce hot steam. (...) Whipping with rods in clouds of steam was considered one of the mildest physical punishments" (Koper, 2013: 39). Also during the reign of Bolesław I the Brave, there were numerous steam baths, similar to the Russian "bania" (Jasienica, 1978: 98).

2. Neighboring Turkish and Mongolian peoples

The Ario-Slavic peoples were neighbors with the Finno-Ugric and Turkish peoples, and temporarily also with the Mongol peoples (Huns and Mongol invasions). Especially among the Turkish peoples, wrestling has been popular for centuries. In Turkey, oil wrestling called *güreş* are still cultivated (Podolak, 2013). Other Turkish peoples cultivate their traditional wrestling with very similar names - Uzbek *kurash*, Buryat and Tatar *kuresh*, Kazakh *kures* / *kuresi*, Turkmen *Goresh*, Tajik *gushtingiri* and the like [cf. Vorontsov, Korobeynikov, 2020). In particular - in the descendants of the nomads of the great steppe - it is Horse Wrestling, as in Kyrgyzstan and Tajikistan. In this form of wrestling, the wrestlers fight hand-to-hand but on horseback and try to throw the opponent off the horse.

Traditional Mongolian wrestling, on the other hand, have been cultivated since the times of the Hun empire. Currently, as part of the Naadam festival, they are part of powerlifting, next to traditional archery and horse racing. Naadam is both a celebration and a traditional sport (Napierała, 2006). The former exercises of warriors are today a show of physical fitness and bravery, quasi-religious and quasisport.

Throughout history, influences may have been multidirectional over the past three thousand years. We don't know who borrowed more from whom in terms of technical skills and fighting arts training. In addition to the Turkic and Mongolian peoples, this also applies to the Finno-Ugric peoples neighboring the Ario-Slavic peoples.

3. India and Iran

The Aryans conquered the lands of what is now Iran and India, establishing new kingdoms and spreading their knowledge (Veda, Avesta). They appeared in Hindustan in the second millennium BC (Klyosov & Rozhanskii, 2012). Ancient Indian reliefs depict fighting wrestlers. It can be assumed that the wrestling went to India along with the brave Aryan warriors, although they could have been cultivated in these areas earlier. The Aryans started the *brahmin* and *kshatriya* castes. The *kshatria* (warrior) class typically practiced archery, wrestling, boxing, and swordsmanship as part of their education (Auboyer, 1965: 580).

"Everything is here from ages past. The compacted red ground of the arena. Oiled, scarred bodies of warrior athletes. Their focus and seriousness. Honor and prestige of coaches. Rule instead of regulations. (...) In the

Pakistani Punjab, on the border with India, there are also the last akharas (training places) where ancient Indian wrestling are grown." (Kobiela, 2018). *Kushti* or *kuśti* is the name of traditional Hindu wrestling. *Mukna* and *pehlwani* wrestling are also cultivated today, with *pehlwani* and *malla-yuddha* being ancient forms. What Alter calls specific nationalism is simply patriotism associated with the cultivation of a centuries-old tradition (cf. Alter, 2002). Traditional sports contribute to national identification by integrating the society. *Vajramushti* (diamond fist) was a martial art of the descendants of the Aryans practiced from the 10th c. BC, originally in northern India, by professional brahmin wrestlers. Lind suggests the influence of this martial art on *kalaripayattu* (South India) and Chinese *Shaolin quanfa* (Lind, 1996: 912; cf. Alter, 1992). The mentioned *kalaripayattu*, also known simply as *Kalari*, is an Indian martial art with its origin in the martial arts timeline dating back to at least the 3rd century BCE. It is related to Ayurveda, Indian traditional medicine. Both *vayramushti* and *kalaripayattu* are more than just supplies. They take into account a wider range of hand-to-hand combat, and in the case of the latter - also the use of numerous types of traditional weapons.

Iran has developed various martial arts, influencing traditions in this regard in other countries. To this day, styles such as *selembam* (or *silembam* - wielding the stick and other weapons) and *varma kalai* ("the art of vital points", similar to original karate) are still practiced there. But wrestling is still very popular here. The contemporary outstanding Iranian wrestler was, among others, Gholam Reza Takhti (1930-1968), a three-time Olympic medalist and two-time world champion.

Iran's martial arts are akin to Indian to some extent, derived from the Aryans. Traditional Persian fencing is similar [cf. Kurochkin, Khorasani 2015]. However, wrestling have their own specificity here. The training room is called *zurkhaneh*. This is where Iranians practice the traditional system of exercises called *varzesh-e pahlavani* or *varzesh-e bastany*. It was developed centuries ago by the Persians to train elite warriors. It combines martial arts, gymnastics, strength exercises and music, and the main emphasis is on the development of strength, endurance and flexibility (cf. Khorasani 2010, 2014).

4. 20th century

Graham Noble (2003) looks at the traditions of Indian wrestling in the distant past. It describes six prominent figures in the history of wrestling operating in the 20th century. These are: Gulam (India), The Great Gama (born as Mian Ghulam Muhammad), Imam Bux, brather of Gama (India), Banjamin F. Roller (USA), Stanislaus "Zbyszko" Cyganiewicz (Poland, coach of the American wrestler), and Kalloo Pahelwan (India). The beginning of the 20th century was a time of competition between athletes from different wrestling traditions, which usually took place in circus arenas. The years 1890–1914 are called the Golden Age in the history of wrestling. Four out of the six champions mentioned above represented Indian wrestling. For example, Gama came from a family that had cultivated wrestling for at least several generations, and had trained himself from the age of five. Gama defeated Roller in the direct confrontation, but drew with "Zbyszko" Cyganiewicz.

Jan Stanisław Cyganiewicz (1.04.1881-23.09.1967) was the professional world wrestling heavyweight champion 1921-1925. Earlier, he competed with Ivan Poddubny (Ukrainian, Russian champion), which, however, did not bring a decision. He gained great worldwide fame (more, Pease, 2017]. However, he was not the first Pole in this discipline. Well, Władysław Pytlasiński, better known as Ladislaus Pytlasinski (July 26, 1863 - November 10, 1933), is rightly called "the father of Polish wrestling". He practiced mainly the classical, Greco-Roman style, then called the French fight. In 1898 he won a golden belt in Paris; later he won several times. In 1901 his student and assistant was the famous Stanisław "Zbyszko" Cyganiewicz, with whom they made a tour of circuses in Polish cities that were then under Russian rule. Pytlasiński founded an athletics school in Odessa, which he then transferred to Łódź. He founded a second school in Warsaw. He was a trainer and promoter of wrestling (cf. Pytlasiński, 1929; Godlewski 1994), the initiator of the establishment of the Polish Athletic Society. In the USA, the super champion of professional *catch-as-catch-can* wrestling was Frank Gotch (1878-1917), the world champion in 1906-1911. The Olympic Freestyle later developed from this fighting style. The classical, Greco-Roman style was practiced at the same time. The beginning of the 20th century was full of circus shows of strength and wrestling fights. Strong men lifted weights and fighters challenged each other and the audience. For example, in Europe, the Austrian baron Hubert Kinger von Kingerstorff and the German *jujutsu* teacher from Berlin - Erich Rahn, both of whom were honored with the highest degree of 10 dan in *jujutsu*, fought in Europe. *Jujutsu* representatives from Japan, boxers and wrestlers fought. So a bit similar to ancient fights to the delight of the audience, a bit like today's fights in rings and cages (MMA). Mitsuyo Maeda, a *judo* and *jujutsu* competitor, before becoming a teacher of Brazilian *jujutsu* creators, also competed successfully in Olympic wrestling. In conditions of difficult competition, the descendants of the former Ario-Slavic warriors - wrestlers from India, Iran and Slavic countries also compete. First, there were fights in circus arenas, then - on the mats of sports competitions, including the Olympic ones. It can be said that from the circus arena wrestlers went on the one hand to the sport of great feat, and on the other - to a show called professional wrestling, popular especially in the USA. There are still shows with wrestling matches, but in a specific convention, with a manifestation of male strength and aggression (Czarnecka, 2019).

Sports wrestling is still popular - both in India and in Slavic countries (cf. Korobeynikov et al. 2020; Singh Suhag, 2020), although in Poland now as if less. Once the winner was a two-time classic Olympic champion in the up to 100 kg class, Andrzej Wroński (Soeul 1988, Atlanta 1996), who was also the World Champion (Tampere 1994) and a three-time European Champion. In the plus 100 kg freestyle category, Adam Sadurski was the bronze medalist of the Olympic Games and the World Championships. Poland still had gold medalists of the Olympic Games: Kazimierz Lipień and Włodzimierz Zawadzki (both -62 kg), and Ryszard Wolny (-68 kg), all of them in the classic style. However, in the medals in the modern history of wrestling, Ukraine ranks higher, and Bulgaria, Russia and the Soviet Union even higher.

DISCUSSION

Even though traditional wrestling from ancient times in their original form have not been preserved in Poland (cf. Bronikowska, 2013; Bronikowska & Laurent, 2018), but this does not mean that they were not cultivated. Rather, it is a folk form of physical culture of a ludic or sometimes ritualistic nature (like the original Japanese sumo), but in the early Slavic community of the so-called war democracy, every man was also a warrior. It can be expected that similar tests of strength and relatively safe competition were often carried out at that time. Currently, the old Polish word "*kulać*" (literally: to roll) is used to mean "fight lying down" and to describe "ground fighting" in sports *jujitsu* and mixed martial arts (MMA). *Kulać* is a clue about language research. If its origin is Old Slavic, it may mean old wrestling preferences of the Lechite Slavs.

Jujutsu, which has been cultivated in Poland since the beginning of the 20th century (Grzegorz & Walendowicz, 2008; Cynarsk,i 2012), is an Old Japanese art of self-defense related to wrestling. Namely, it is based mainly on wrestling type techniques. It is also the name used to describe many related hand-to-hand combat techniques derived from the original Old Japanese wrestling, *sumo* preforms. *Judo* and modern sports *jujitsu* allude to traditional *jujutsu*.

Sports *jujitsu* is a discipline in which Poles win the highest laurels in international competition (more: Cynarski & Siekanski, 2019). Co significant, structure of personality of person training *jujitsu* and wrestling is similar, too (Litwiniuk et al., 2009). These circumstantial evidence allows only a regression inference, that is, from today's effects to probable causes. It is about drawing conclusions about giftedness and relatively high interest in this type of sport.

While in ancient Russia the rural people practiced fist fights, in today's Poland it has not been confirmed so far. Poles mainly practiced fencing, hence pole fights were very popular, but mainly among the young nobility (Sawicki, 2020). Hand-to-hand combat was actually just an accessory to fencing. First of all, the young Pole had to wield a saber well, ride horses, shoot a bow and firearms.

The successes of competitors from Slavic countries in combat sports, such as *judo*, contact *karate*, boxing, MMA, but also fencing, may indicate the ethos of old warriors and fighting spirit preserved here (Cynarski & Obodyński, 2005). As long as only Western martial arts and *judo* could be practiced in Poland, there was no shortage of young people interested in boxing and wrestling. From the breakthrough of 1989/1990 and the systemic changes that took place at that time (democratization and the opening of the country to the West), martial arts and combat sports of Asian origin gained great popularity here. Of course, individual sports associations are still operating successfully and successive successes are noted, including wrestling, *judo*, fencing and boxing (Godlewski, 1994; Sikorski, 2009; Chełmecki, 2012; Szajna & Cynarski, 2018; Kolodziej et al., 2020; Rutkowska & Gierczuk, 2020]. The commercialization process is currently accompanied by the professionalization of wrestling and boxing.

Perhaps the category of "national character" introduced by Erich Fromm would be helpful here? More hypotheses are born that will not be easy to test. Is the national character (and to what extent) decisive for the sports interests of youth (Cynarski, 2004)? Perhaps the sports successes of Belarusians and Ukrainians, Poles and Russians in combat sports are related to this. But it is also possible that the causes are much more complicated.

After the stage of folk traditions and circus performances, wrestling for sports dominates. This sport, like boxing and *judo*, was supported in Poland until 1989 by the army and the security service (the so-called guard division) (Kolodziej et al., 2020; Kulpinski, 2020). Currently, there is not enough support from state institutions or trade unions. Young Poles, or their parents, more often choose *karate*, football or other sports.

CONCLUSIONS

The analysis of the circumstantial evidence gives us a series of premises and the possibility of deduction with probable origins - from the present state to the possible earlier. Today, Poles and other Slavic nations are doing well in sports wrestling and related sports jujitsu. We can only infer the ancient forms of wrestling indirectly, by analogy to other traditions preserved to this day. Since the peoples growing out of the same genetic (biologically

and culturally) stem and the neighboring peoples retained the original forms of wrestling, probably also in the ancient Lechites (i.e. Western Slavs) similar forms of exercise and competition were practiced.

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IMMEDIATE EFFECT OF MULLIGAN TAPING ON JOINT POSITION SENSE AND MUSCLE STRENGTH IN AMATEUR WRESTLERS

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ABSTRACT
The knee is one of the most frequent sites of injuries in wrestling. Taping techniques are commonly used in other to reduce the pain and incidence of knee injuries in physical activities. This study aimed to investigate the immediate effect of mulligan taping on joint position sense and muscle strength in amateur wrestlers. Twelve Amateur freestyle wrestlers (Mean age 23±3 years old, weight 68±12 kg and height 176±12 cm) volunteered to participate as subjects in this study. The reproduce angle and dynamometer speed test was considered 60° and 5 Θ/sec respectively and peak torque of concentric and eccentric of quadriceps muscle groups tested at 90 Θ/sec by using an isokinetic dynamometer (Biodex Model, System 3, Made in USA) Before and after Mulligan taping. Data were analyzed by using Origin Pro (2019) and SPSS software (version 25). The Shapiro-Wilk test was used to check the normality distribution of the data, and a paired t-test was adopted to compare the results before and after taping at a significant level (P≤0.05). The statistics showed significant differences between active (p=0.001) and passive (p=0.002) Repositioning errors before and after taping. Also, there were significant differences between the Maximum concentric (p=0.003) and eccentric (p=0.002) torque of the quadriceps muscle group before and after taping. It seems that Mulligan taping could improve the knee proprioception and increase maximum concentric and eccentric extensor torques. It is highly recommended that to provide more comprehensive information by conducting more sample research size about the use of taping (Mulligan method) during the treatment of knee injuries in wrestling.
Keywords: Mulligan taping, Proprioception, Muscle Strength

INTRODUCTION

The lower extremities are one of the most frequent sites for injuries in wrestling (Pasque and Hewett 2000). The knee injuries involved approximately 37 percent of all wrestling injuries (Agarwal and Mann 2016). Many factors contributed to knee incidence injuries such as lack of proper proprioception, muscle fatigue, imbalance of strength in agonist and antagonist muscle (Khaleghi Tazji et al. 2020). Proprioception is defined as the ability to detect the movement and position of a limb in space which is an essential factor for joint coordination inappropriate sports performances. The proper joint position sense reduces the risk of injuries and improves performance (Naserpour and Sadeghi 2017). joint position sense is the interaction of muscle and joint receptors with the efferent output of the muscles that control the joint which is likely to provide stability and stiffness to the joint (Edin 2001). The change in the afferent input during sports activities compromised the neuromuscular control of the lower extremities, may lead to an inability to dynamically stabilize the knee (Hiemstra, Lo, and Fowler 2001). The injuries or local fatigue altered knee joint proprioception due to damage of joint sense receptors (Wilson and Lee 1986). Proprioceptive deficits are found in anterior cruciate deficient knees (Ghaderi et al. 2020), patellofemoral pain syndrome (Ahmadi et al. 2020), and in the osteoarthritic knee (Al-Dadah, Shepstone, and Donell 2020).

From another point of view, a good muscle strength ratio between agonist and antagonist muscles which are working on the joint is one of the crucial factors of stability and prevention of knee joint injuries in athletes (Khaleghi Tazji et al. 2020). There is an increased risk of knee injury in athletes due to an imbalance in quadriceps and hamstring ratio (C.-G. Kim and Jeoung 2016). Weak quadriceps strength was associated with knee pain and poor balance ability (D. Kim et al. 2018).

During wrestling or competition and following the collision or performs various actions, uncontrolled pressure may apply to the lower extremities of the wrestlers, which in some cases require medical treatment. One of common treatment techniques is the taping method (Naserpour, Habibi, and Sadeghi, 2017). Taping technique contributes to minimizing pain, increasing muscle strength, modifying the unwanted movements, and enhancing functional outcomes in athletes with sports injuries (Fu et al., 2008; Hadadnezhad, Zarea, & Amro, 2020).

Previous studies have shown that mulligan taping could affect joint position sense and muscle strength, but so far there is no comprehensive research to show the simultaneous effect of Mulligan taping on the strength and knee joint sense in wrestlers, Therefore, the purpose of the present study was to determine the immediate effect of Mulligan taping on joint position sense and muscle strength in amateur wrestlers.

METHODS

A) Participants

Twelve amateur freestyle wrestlers (Mean age 23±3 years old, weight 68±12 kg and height 176±12 cm) volunteered to participate as subjects in this study. They were checked in terms of posture and lower extremities abnormalities by an expert physician and excluded if they have any lower extremities abnormality or injury history for at the latest 6 months. The information and purpose of the study were explained by the researcher to all subjects before data collection. Informed consent got from all the participants and procedures conducted corresponding to the declaration of Helsinki.

B) Instruments- Test

The joint proprioception and muscle strength of knee joints were evaluated by using the isokinetic dynamometer (Isokinetic Dynamometer, Biodex Model, System 3, Made in USA).

C) Procedures and Research Design

First, the subjects were instructed to do their best to struggle during the test. In other to prevent injuries before performing each test, the subjects warm up themselves on a stationary bike for five minutes, then the subject sat on a dynamometer seat and his torso and thigh were stabled with tightened bands to control the other joint muscle interference. The attachment assembled on the shaft of the dynamometer, so that center of the shaft was exactly placed in front of the lateral epicondyle of the subject's knee. The subject performed the test with five repetitions of maximum concentric and eccentric contraction. At the end of the testing process, if the output coefficient variability of the test was less than 15%, the test was approved (Khaleghi Tazji et al. 2020). The tests were performed at 90 Ɵ/sec speeds, and Verbal encouragement was used to perform the maximum effort of the subject during the test.

Second, for proprioception assessment, reproduction angle and dynamometer speed test was considered at 60° and 5°/sec respectively, and the dominant limb was used for the same conditions. Initially, each subject was asked to move his knee to the target angle with open eyes three times and remain for five seconds in that situation and maintain this position in his short-term memory. Then, to eliminate visual interference during measurement of the test, the eyes were closed by a blindfold and he was asked to hold his knee with a stop button at 60° in active and passive form (Naserpour, Habibi, and Sadeghi 2017; Naserpour and Sadeghi 2017). Error angle defines as the difference between the target angle and the angle created by the participants reproduced, regardless of whether the error was positive or negative. Each movement was repeated three times, and then the average error angles for each movement were taken as the main record.

Following that, the rigid tape applied to the dominant knee of each subjects by a physical therapist experienced in the application of the Mulligan knee taping procedure. The tape was applied while participants stood with the dominant leg in full tibiofemoral internal rotation and 20 of knee flexion (Mackay et al., 2020). The tape began at the neck of the fibula and was applied spirally in an anteromedial direction inferior to the tibial tuberosity and medial knee joint line, across the popliteal fossa to the anterolateral thigh, then all tests were repeated.

D) Statistical Analyses

Data were analyzed by using Origin Pro (2019) and SPSS software (version 25). The Shapiro-Wilk-test was used to check the normality distribution of the data, and a paired t-test was adopted to compare the results before and after intervention at a significant level (P≤0.05).

Results:

The result of repositioning error on knee flexion in active and passive form are presented in table 1. The statistics showed that the significant differences between active (p=0.001) and passive (p=0.002) Repositioning error before and after applying taping.

Table 1. The effect of Mulligan taping on joint position sense in amateur wrestlers

Variable name	Pre-test	Post-test	t (11)	P-value	Variation(%)
Repositioning error of active knee Flexion (Ɵ)	6.25±1.6	5.38±1.56	4.75	0.001*	13.92▼
Repositioning error of Passive knee Flexion (Ɵ)	5.66±1.6	5.16±1.49	4.18	0.002*	8.83▼

* Differences are significant at the 0.05 level.

Furthermore, the result of maximum eccentric and concentric torque of quadriceps muscle group are available in table 2. The statistics showed the significant differences between maximum concentric (p=0.003) and eccentric (p=0.002) torque of quadriceps muscle group before and after applying taping.

Table 2. The effect of Mulligan taping on muscle strength in amateur wrestlers

Variable Name	Pre-test	Post-test	t (11)	P-value	Variation (%)
Maximum Concentric Torque of Quadriceps Muscle group (N.M)	165.58±38.83	174.58±36.57	-3.78	0.003*	5.4▲
Maximum Eccentric Torque of Quadriceps Muscle Group (N.M)	162.16±36.09	174.25±35.66	-4.16	0.002*	7.4▲

* Differences are significant at the 0.05 level.

DISCUSSION:

The current study aimed to investigate the immediate effect of Mulligan taping on joint position sense and muscle strength in amateur wrestlers. The results indicated that the Repositioning error of the knee at 60° flexion were decreased significantly the following taping in both active (13.9%) and passive forms (8.83%). Taping may increase the knee joint proprioception through the stimulation of cutaneous mechanoreceptors and enhance the feedback from the muscle spindles, soft tissue, and skin in the skin (Edin, 2001). The finding corresponded to the Heit et al. (1996), and Spanos et al. (2008) findings, which reported a significant decrease in repositioning error of knee after taping (Heit, Lephart, & Rozzi 1996; Spanos, Brunswic, & Billis, 2008); and was in contrast to Wong et al. (2012), Keenan et al. (2017) that report no significant differences on repositioning error after taping (Keenan et al., 2017; Wong et al., 2012). These conflicting statements may have derived from utilizing various joint or taping methods.

Lastly, taping increases the concentric (5.4%) and eccentric (7.4%) torque of the quadriceps muscle group. There are several assumptions that supported why the taping increase the torque, such as stimulation of cutaneous mechanoreceptors in the skin (Edin, 2001), Biomechanical modification of muscle fascia direction (Hadadnezhad, Zarea, & Amro, 2020; Vithoulka et al., 2010), increase muscle tone, stiffness and improve the overlap of actin and myosin fibers (de Jesus et al., 2016). Our finding corresponded to the Elif et al. (2021), Kim et al. (2020), and Tomruk et al. (2020) which reported significant improvements after the interference (Altaş, Uçurum & Kaya, 2021; Kim & Kim, 2020; Tomruk et al., 2020). On the other side, our finding was in contrast to Thiago et al. (2018) and Chang et al. (2010) that reported no significant increase in muscle strength (Chang et al., 2010; Lemos et al., 2018). This diversification in results of taping effects on muscle strength is due to the various forms of taping, such as inhibitory and facilitatory or different subject and joint that the investigator used in their surveys.

The authors declare that there is a limitation in our study which the isokinetic dynamometers does not assess the muscle group power in actual situation and contraction with stable pace is not functional.

CONCLUSIONS

According to the results of present study, it implies that Mulligan taping could improve the knee proprioception and enhance maximum concentric and eccentric extensor torques. It is highly recommended that to provide more comprehensive information by conducting more research about the use of taping (Mulligan method) during the treatment of knee injuries in wrestling activities.

PRACTICAL IMPLICATIONS/ADVICE FOR ATHLETES AND COACHES

Athletes or coaches can use positive aspects of taping in other to reduce their pain, injury incidence and proprioception deficit under supervision of an expert physician.

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Declaration of Interest Statement

The authors declare that there is no conflict of interest in this research

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Commentary

PREVENTION OF HEAT EXHAUSTION: FOCUS ON WRESTLING

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INTRODUCTION

Of the several sports in which competitors are grouped according to body weight (wrestling, judo, weightlifting, boxing) wrestling is the most popular. Not only is the number of participants greater in wrestling, but the number and frequency of matches is far greater during each season for wrestlers. Wrestlers often adopt dangerous weight loss practices at a young age (Gibbs, 2009). It has been estimated that outstanding wrestlers will "make weight" 20 to 30 times each season and will likely repeat this process 200 times during their careers. Medical researchers, sports medicine physicians, athletic trainers, coaches and parents have raised concerns about not only the immediate and short-term effects of repeated occurrences of making weight, but the possible long-term effects of repeated episodes of food and water deprivation.

THE SCOPE OF THE PROBLEM

Of particular concern are the immediate and short-term consequences of food and water deprivation in wrestlers during the off-season summer matches. Whereas scholastic and collegiate wrestling is a fall-winter sport with environmental conditions of temperature and humidity less hostile, the environmental conditions during off-season tournaments are often difficult if not dangerous. Ambient temperatures not infrequently approach or exceed normal body temperatures and relative humidities in the gym are often 50 to 90%. Since dehydration is the quickest and by far the most frequent method used by wrestlers to "make weight", thermal regulation and control in a dehydrated, glycogen depleted wrestler in unfriendly environmental conditions is often compromised and should be of concern.

To better understand the problem of temperature regulation, a brief review the normal physiology and the pathophysiology of heat related injury is necessary. The human body has a magnificent thermal regulatory system capable of maintaining thermal balance throughout a wide range of conditions. The system can compensate for an extremely wide range of external temperature (skiers at less than 0 degrees Celsius and runners at greater than 37 degrees Celsius) but the system can fail to maintain the core temperature within a normal range when the body's ability to either conserve or dissipate heat has been compromised.

Heat Production

At rest, the average heat production resulting from normal body function is approximately 72 Kcal per hour. During strenuous exercise (since even the best athletes work at only 30% efficiency) heat production can reach 600 Kcal per hour.

Heat Loss

The heat production must be balanced by an equal amount of heat loss. Four mechanisms are available for dissipating heat – radiation, conduction, convection, and evaporation (Armstrong 2007). Loss through radiation in the form of infra-red rays accounts for 60 percent of total heat loss at rest. Conduction, the transfer of heat directly to an object (such as a chair or wrestling mat) accounts for 3 percent at rest. Convection, the transfer of heat to air or water is responsible for 12 percent at rest and is improved with the movement of air. Evaporation (sweating) accounts for 25 percent of heat loss at rest.

During exercise, however, evaporation becomes the major mechanism for heat loss. Sweating can be effective only if the sweat evaporates on the skin. Dripping drenching sweat serves only to increase water loss and does little to dissipate heat. To evaporate, the ambient temperature must be lower than the body temperature and the humidity must be lower than the humidity at the skin surface. Finally, the movement of air across the surface of the skin will aid evaporation.

Training and acclimation will improve the efficiency if sweating is a mechanism for heat loss.

Thermal Regulation

The temperature regulatory center is located in the hypothalamus. The responses to heat are controlled primarily by heat sensitive neurons in the anterior hypothalamus, while responses to cold are controlled by the posterior thalamus. Overheating of the anterior hypothalamus will stimulate the heat loss mechanisms primarily by increasing the production of sweat resulting in increased evaporative heat loss. Additionally, the vasomotor

center is inhibited, removing the normal constriction of the skin vessels allowing an increase in heat loss through the skin.

The hypothalamus functions as the body hemostat and initiates heat production or heat loss whenever the core temperature goes above or below the “set point”. Peripheral sensors play a minor role in the problems of heat loss and a more important role in heat conservation.

Environmental Factors
The effective heat dissipation process depends not only on internal regulation but, as mentioned earlier, on ambient temperature, humidity, air movement, and radiation. Measurement of ambient dry bulb temperature alone is inadequate to fully evaluate the effect of environment.

The measurement of wet bulb temperature has been accepted as the standard for estimating the environmental effect on thermal regulation (Budd, 2008). A system of color-coded flags used to indicate the risk of thermal stress has been adopted by the American College of Sports Medicine (Armstrong 2007). The W.B.G.T. index is calculated by ensuring the ambient temperature with a dry bulb thermometer, a wet bulb temperature with a water saturated thermometer and a black globe temperature with a thermometer encased within a black painted globe.

W.B.G.T. = 0.7 wet bulb temperature + 0.2 black globe temperature + 0.1 dry bulb temperature.
The importance of the wet bulb temperature (indicating the effect of humidity) can be appreciated since it accounts for 70 percent of the index.

Table 1. W.B.G.T. Index for Physical Activities

W.B.G.T. above 76 degrees F.	Utilize discretion (**Yellow** signal flag)
W.B.G.T. above 82 degrees F.	Avoid strenuous activity (**Red** signal flag)
W.B.G.T. above 86 degrees F.	Cease physical activity (**Black** signal flag)

* Adapted from American College of Sports Medicine

FOCUS ON WRESTLING
The importance of hydration can be implied from the understanding that the major mechanism for heat dissipation during exercise is the production of sweat with a resulting loss of body fluid. Adequate hydration thus, is critical to effective thermal regulation. In wrestling, however, adequate hydration is problematical. Unfortunately, many wrestlers do not understand body composition, lean body mass and body fat and in their attempts to lose weight opt for the “quick fix” (Walker, 2020). Rather than utilize the caloric reduction/ exercise approach, they utilize the dehydration approach – a combination of fluid restriction and sweat loss accelerated by exercise in a hot environment. Most weight is loss the day before competition and several studies have shown the average loss to be approximately 7 pounds. Clearly weight loss of this amount in a short period of time is strictly fluid loss. But, completely replenishing body fluids may take 24 to 48 hours (Case, 2016).

It has been shown that the body fat of wrestlers did not change during the week that they lost five percent of body weight. So, wrestlers who need to make weight usually do so through dehydration (Walker, 2020). At the time of weigh-in they are dehydrated. Can adequate replenishment of body fluids be accomplished between the weigh-in and competition? Every study published indicates that the answer to this question is NO (Convertino, 1996).

Klinzing and Karpowicz (1986) at Cleveland State University studied the effect of a 50-hour 5 percent weight loss on performance as measured by a test requiring many of the same performance factors as wrestling. Seven subjects were administered the test four times including: after no weight loss, immediately, one hour and four hours after making the 5 percent weight loss. The subjects regained 22 and 44 percent of their lost weight in one and in five hours respectively. Performance was significantly less when the test was taken immediately after making weight, somewhat improved at one hour but still significantly less than at the five-hour performance test. Performance scores retuned to baseline levels after adlib fluid and food consumption.

RECOMMENDATIONS
The question of long- term effects of repeated episodes of acute and chronic dehydration aside, since the data are not clear on this subject, we have legitimate concerns about the acute effects in wrestlers particularly during the off-season summer tournaments. Are there any recommendations that could be adopted to decrease the potential of thermal stress and injury?

A. Clearly the adoption of the W.B.G.T. index is a readily available recommendations with precautions taken in the event of yellow (76-82 degrees F.), red (82-85.9 degrees F.), and black (86 degrees F. or higher). For example, when the W.B.G.T. index is greater than 86 degrees F. all physical activity should be stopped.

B. Should the time of weigh-ins be changed? Presently, weigh-in 2 hours prior to competition may not be long enough to allow rehydration – perhaps 5 hours should be allowed.
C. Should wrestlers be required to make weight for the second consecutive day of wrestling or should an initial single weigh-in be adequate?

Our primary goal is the prevention of injury through education (Hudson 2003). There is no legitimate reason for our young men to risk heat exhaustion or heat stroke and our own efforts in education and regulation should be directed to their welfare. All administrative policies should be directed to their welfare. All administrative policies should be directed toward decreasing the risk of injury to our athletes, e.g. postponement or delay of tournaments, scheduling of matches in compliance with environmental conditions and flexibility in weigh-in regulations.

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In Memoriam

Alexander Alexandrovich Novikov (January 27, 1925 - January 2021)

On January 7, 2021, at the age of 96, Academician, Doctor of Pedagogical Sciences, Professor, Alexander Alexandrovich Novikov died. All his life, Alexander Alexandrovich was devoted to the development of the science of wrestling and is one of the founders of domestic sports science. For more than 60 years he worked at the All-Russian Scientific Research Institute of Physical Culture and Sports, where he was the deputy director.

Alexander Novikov is a laureate of many orders and medals. He received his first award as a young man - the medal "For Valiant Labor in the Great Patriotic War." In the 1970-1990s, he headed the USSR Wrestling Federation. For a quarter of a century from 1970 to 1995 he was vice-president of the international federation of unified wrestling styles (FILA).

One of the main areas of A.A. Novikov's scientific research was the study of the possibility of using wrestling as a model for studying the problem of managing complex movements (Greco-Roman wrestling, freestyle, judo, sambo, etc.) in variable conditions of sports activity. The importance of this direction has been confirmed by many theoretical and experimental studies (D.D. Donskoy, Yu.S. Eremin, A.D. Novikov, L.P. Matveev, N.G. Ozolin, V.M. Dyachkov, I.P. Ratov, V.K. Balsevich, R. Petrov and others). From the standpoint of the systemic-structural approach, this side of an athlete's skill is considered as a specific, specialized system of complex movements aimed at an expedient and effective solution of a motor problem while achieving the highest possible sports results.

Technical and tactical skill in sports, especially in combat sports, is a decisive factor in the success of an athlete. In wrestling, the most effective technique is considered to be a technique that is more reliable and highly appreciated by the judges. The technical skill of wrestlers, as a focus, results from concentrated physical, tactical and psychological training, as well as the degree of fitness. The main aspects of an athlete's skill must align with the individual characteristics of the wrestler's technical arsenal as a realizing factor. Therefore, the study of the peculiarities of the process of improving sports technique in the light of the theory of complex dynamic systems and the search for new opportunities for this improvement remains relevant today for the theory and practice of sports.

In wrestling Alexander Novikov during the war. Then he worked as a mechanic at a small plant at the Research Institute of Aircraft Equipment. Trained in the section of the sports club "Wings of the Soviets" and in the technical school of physical culture, became a prize-winner of the USSR Championships, for which he was awarded the title "Master of Sports of the USSR", was a member of the USSR national team. In the process of training, A.A. Novikov showed an early desire for scientific research and the decision to go to work in sports science matured. The All-Russian Research Institute of Physical Culture and Sports (VNIIFK), in which he worked almost all his life, became his scientific home. In the post-war years, famous scientists worked at VNIIFK, who laid the foundations of sports science for many years. N.A. Bernstein was a prominent representative of this cohort. His ideas served as the basis for the creation of biological cybernetics and the theory of control of complex movements, in particular, the improvement of the technical skill of athletes. His work "On the Construction of Movements" in 1948 was awarded the State Prize. In the post-war years, the scientific problems of sports training were greatly developed (general methodological foundations of sports training, physiology and fitness clinics, biodynamic research in sports. A significant contribution to the development of these areas of scientific research was made by I.A. Kryachko, G.V. Vasiliev, N. G. Ozolin, D. D. Donskoy, R. E. Motylyanskaya.

This group also includes A.A. Novikov, who took an active part in the development of the concept of the training system for highly qualified athletes, which was based on the concept of "model characteristics of the strongest athletes", which now form the basis of comprehensive control in high-performance sports. The methodology for constructing model characteristics of the strongest athletes in the main groups of sports, created by A.A. Novikov and his numerous students, is still relevant today. the activity has always been aimed at strengthening the prestige of national sports and science. Alexander Alexandrovich has published over 350 scientific papers. More than 130 candidates of pedagogical sciences and doctors of sciences have been trained under his leadership. Academician of sports and applied martial arts, awarded five orders, sixteen medals of the USSR and the Russian Federation, the Golden Order and the Knight's Cross of the International Federation of United Wrestling Styles (FILA), he has always remained an amazingly pure, honest, open person for people and thus earned himself gratitude and respect their colleagues. The kind and bright memory of him will forever remain in our hearts.

Professor Doctor Boris Podlivaev

Александр Александрович Новиков (27 января 1925 г. - января 2021 г.)

7 января 2021 года на 96 году жизни скончался академик, доктор педагогических наук, профессор, Александр Александрович Новиков. Всю свою жизнь Александр Александрович посвятил развитию науки о спортивной борьбе и является одним из основателей отечественной спортивной науки. Более 60 лет он проработал во Всероссийском научно-исследовательском институте физической культуры и спорта, был заместителем директора. Александр Новиков лауреат орденов и медалей. А первую награду он получил ещё юношей - медаль "За доблестный труд в Великой отечественной войне".

В 1970-1990-ых он возглавлял Федерацию борьбы СССР. Четверть века с 1970 по 1995 год был вице-президентом международной федерации объединенных стилей борьбы FILA. Одной из главных проблем научных изысканий А.А.Новикова было исследование целесообразности применения спортивной борьбы в качестве модели для изучения проблемы управления сложными движениями (борьба греко-римская, вольная, дзюдо, самбо и др.) в вариативных условиях спортивной деятельности. Важность этого направления подтвердилась многими теоретическими и экспериментальными исследованиями (Д.Д.Донской, Ю.С.Еремин, А.Д.Новиков, Л.П.Матвеев, Н.Г.Озолин, В.М.Дъячков, И.П.Ратов, В.К.Бальсевич, Р.Петров и др.).

Эта сторона мастерства спортсмена с позиций системно-структурного подхода рассматривается как определенная, специализированная система сложных движений, направленных на целесообразное и эффективное решение двигательной задачи при достижении возможно более высоких спортивных результатов.

Технико-тактическое мастерство в спорте, особенно в видах единоборств, является решающим фактором успешной деятельности спортсмена. В борьбе наиболее эффективной считается такая техника выполнения приема, которая более надежно и высоко оценивается судьями.
В техническом мастерстве борцов, как в фокусе, концентрируются результаты физической, тактической и психологической подготовки, а также степень тренированности.

Основные стороны мастерства спортсмена приводятся в соответствие с индивидуальными особенностями технического арсенала борца как реализующего фактора. Поэтому изучение особенностей процесса совершенствования спортивной техники в свете теории сложных динамических систем и поиск новых возможностей этого совершенствования остается и сегодня актуальным для теории и практики спорта.

В спортивную борьбу Александр Новиков в годы войны. Тогда он работал слесарем на небольшом заводе при научно-исследовательском институте самолетного оборудования. Тренировался в секции спортивного клуба «Крылья Советов» и в техникуме физической культуры, становился призером Чемпионатов СССР, за что ему было присвоено звание «Мастер спорта СССР», входил в состав сборной команды СССР. В процессе тренировок у А.А.Новикова рано проявилась тяга к научным исследованиям и созрело решение идти работать в спортивную науку. Его научным домом стал Всероссийский НИИ физической культуры спорта (ВНИИФК), в котором он проработал практически всю жизнь.

В послевоенные годы во ВНИИФКе работали известные ученые, заложившие основы спортивной науки на долгие годы. Ярким представителем этой когорты был Н.А.Бернштейн. Его идеи послужили основой для создания биологической кибернетики и теории управления сложными движениями, в частности,

совершенствование технического мастерства спортсменов. Его труд «О построении движений» в1948 году был удостоен Государственной премии.
В послевоенные годы большое развитие получили научные проблемы спортивной тренировки (общие методические основы спортивной тренировки, физиологии и клиники тренированности, биодинамические исследования по видам спорта. Значительный вклад в развитие данных направлений научных исследований внесли И.А. Крячко, Г.В. Васильев, Н.Г. Озолин, Д.Д. Донской, Р.Е. Мотылянская. В эту группу вошел и А.А.Новиков, который принял активное участие в разработке концепция системы подготовки спортсменов высокой квалификации, в основу которой было введено понятие «модельные характеристики сильнейших спортсменов», которые в настоящее время составляют основу комплексного контроля в спорте высших достижений.

Созданная А.А.Новиковым и его многочисленными учениками методология построения модельных характеристик сильнейших спортсменов в основных группах видов спорта актуальна до сих пор.
деятельность всегда была направлена на укрепление престижа отечественного спорта и науки. Александром Александровичем опубликовано более 350 научных работ. Под его руководством подготовлено более 130 кандидатов педагогических наук и докторов наук.

Академик спортивных и прикладных единоборств, награжденный пятью орденами, шестнадцатью медалями СССР и Российской Федерации, Золотым орденом и Рыцарским крестом Международной федерации объединённых стилей борьбы (FILA), он всегда оставался удивительно чистым, честным, открытым для людей человеком и этим снискал себе признательность и уважение своих коллег.
Добрая и светлая память о нем навсегда останется в сердцах друзей, коллег и учеников. Выражаем искренние соболезнования родным и близким, а также всем тем, кто знал и любил Александра Александровича.

Професор доктор Борис Подливаев

INSTRUCTIONS FOR AUTHORS

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