ORIGINAL ARTICLE

Interrelation between predisposition to work under different energy modes and individual characteristics of skilled wrestlers' tactical approach

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

Stanislaw Sawczyn[1AD], Władysław Jagiełło[1ABC], Valentin I. Fetisov[2ABE], Viktor S. Mishchenko[1AD]

[1] University of Physical Education and Sports, Gdańsk, Poland
[2] European University, Kiev, Ukraine

Source of support: Departmental resources

Received: 19 April 2012; **Accepted:** 30 April 2012; **Published online:** 8 May 2012

Abstract

Background and Study Aim: It is known that athletes have different development levels of individual aspects of energy capacity. This is determined to a great extent by the unique, innate physiology of the individual. Therefore, these differences may influence a wrestler's individual inclinations to a specific manner of action during competition. The objective of this study was to reveal the relation between individual predisposition to work under different energy modes as indicated by particular aspects of specialized physical fitness and the tactical approach of free-style wrestlers.

Material/Methods: The participants of the study included 31 free-style wrestlers, aged 19–26, and weighting 63–89 kg, of a national or international level, with 5–13 years of competitive wrestling experience. Wrestlers performed three types of ergometric tests: anaerobic alactate (10 s), anaerobic lactate (30 s) and aerobic power estimation (VO_2 max). Tactical approach, indices of wrestling tests and some indices of special physical fitness were determined.

Results: A significant range of individual capacities of anaerobic alactate, lactate and aerobic systems of work energy supply were demonstrated in a homogeneous group of skilled wrestlers. Three groups of wrestlers were singled out according to criterion of expressed power development of one of the aforementioned work energy supply aspects. Relative independence of various aspects of energy capacity development level indices was noted among the groups. They were related to the specific activity of wrestlers during matches (characteristics of attack and volume of technical actions), tactical approach (technical, functional and speed-strength) and characteristics of specific physical fitness tests.

Conclusions: Thus, a relationship exists between the prevalence of one or another aspect of energy capacity in a wrestler, as indicated by certain characteristics of specific fitness and the wrestler's tactical approach.

Key words: free-style wrestling • work energy supply • specific matches activity • specialized physical fitness

Author's address: Władysław Jagiełło, Department of Games Sports and Judo, Faculty of Physical Education, University of Physical Education and Sports, K. Górskiego 1, 80-336 Gdańsk, Poland; e-mail: wjagiello1@wp.pl

Background

Competitive tournaments in free-style and Greco-Roman wrestling are characterized by highly intensive physical loads and high energy expenditures. Modern wrestling has been trending towards even greater intensity, and accordingly, the role of specific endurance currently determines the level of mastery [1–5]. The above is due to both an increase in the level of competition and changes in the policy of the International Wrestling Federation. One may observe a recent tendency to enhance the spectacle of competitive tournaments at the expense of increasing their intensity [1,6,7]. In elite wrestlers, the heart rate (HR) after training is 174–186 bt·min^{-1},

Energy mode – Characteristics of the relationship in metabolic capabilities of anaerobic glycolytic, phosphagen and aerobic work energy supply systems for sports specific exercises.

Tactical approach – Individual inclination of a wrestler to a certain manner of technical-tactical actions and activity during a match.

Wrestling tests – Sports specific tests of various manifestations and characteristics of particular aspects of specialized physical fitness.

reaching 180–200 bt·min^{-1} after competitions[1,8,9]. The above is confirmed by a number of cases (5–17%) of myocardium overexertion [1].

A great number of actions (holds) connected with strenuously overcoming an opponent's resistance, his lifting, and force one's own hold upon him a within short time interval necessitate a very high level of speed-strength capacities. The abilities of the anaerobic alactate and glycolytic systems of wrestlers represent an energy prerequisite for these capacities [10–15]. Many authors accentuate the importance of the ability to resist increasing metabolic acidosis (lactate-acidosis) for maintenance of high movement coordination under conditions of increased fatigue rather than the high anaerobic glycolytic power [15–18]. Blood lactate concentration reaches 10–12 mmol·L^{-1} and 14–19 mmol·L^{-1} after training and competition, respectively [1,18–21]. The above highlights the importance of speed-strength endurance, which depends upon the recovery process. The abilities of the system to supply aerobic energy represent an important prerequisite for the body's recovery capacity under competitive wrestling conditions [20,22–25]. This is indirectly confirmed by high levels of maximum aerobic power (VO_2 max about 51–65 ml·kg^{-1}·min^{-1}) of skilled wrestlers [17,20,24,26]. The development level of each aspect of energy capacity is known to vary among athletes, which is determined to a greater extent by the innate characteristics of the athlete. Therefore, of great significance is the role of individual work energy supply system distinctiveness and individual inclination of a wrestler to a certain manner of technico-tactical action during a match [27–30]. Most often "combinational" (technical type), "tempo" (functional type) and "strength" (speed-strength type) approaches are distinguished [2,27,29,30]. It has been shown that the ratios of speed, endurance, agility, flexibility, strength and morphofunctional traits of body type are different in wrestlers with different tactical approaches [1,24,29,31].

Since the wrestling energy load has a distinct interval and variable character, one may assume that there are differences in kinetic characteristics of body functions, fatigue and recovery responses in wrestlers according to their tactical approach. Interindividual variability of these characteristics is related to involvement of different energy systems in the process of wrestling. While wrestling, the periods of active attacking actions (spurts) are alternated with those of decreased motor activity. The frequency of these alternations tends to increase relative to competition level [1,7]. Also the duration of "spurts" and intervals between them is various in different athletes [4,21,30,32]. They are presumably related to innate energy production preferences in response to varying loads. These aspects of individual capacities of wrestlers have been studied insufficiently.

We proceeded from the fact that wrestlers are a homogeneous group according to sports classification, however, have differences in anaerobic alactate, anaerobic lactate and aerobic power. On this basis, individual predisposition to work under different energy modes may be differentiated. This predisposition may influence both individual characteristics of specialized physical fitness and the cultivation of an individual's specific tactical approach. In this regard, new aspects of the methods for individualizing wrestler preparation may be determined.

In this regard, the aim of the study was to ascertain the relationship between individual predisposition to work under different energy modes and individual characteristics of specialized physical fitness in conjunction with tactical approach among free-style wrestlers.

Material and Methods

Subjects and organization of studies

The participants of the study included 31 free-style wrestlers, aged 19–26, weighing 63–89 kg, of a national or international level, with 5–13 years of competitive wrestling experience. The main studies were carried out during a 24-day training camp, a special preparatory period of the annual training cycle. The content of the study was approved by the local Commission for scientific study ethics. The individual tactical approach of the wrestlers was evaluated less than 12 weeks before the start of training camp. During the same period, the existing approaches to individualizing the wrestlers' training were studied on the basis of expert evaluators. 23 leading coaches with 9–17 years experience contributed analysis. At the second stage of study, all subjects performed three types of ergometric tests: anaerobic alactate, anaerobic lactate and aerobic power estimation. They were performed less than two days after the recovery microcycle in the form of control training sessions. Anaerobic tests were performed the day after the test of aerobic power. According to indices of each test, wrestlers were divided into three groups. Athletes with the highest indices in the anaerobic alactate test (70–100% of percentile zone) were included in the first group (n=9, body mass 77.5±1.4 kg), those with the highest indices in the anaerobic lactate test – in the second group (n=8, body mass 76.8±1.5 kg) and those with the highest indices in the aerobic test – in the third group (n=7, body mass 74.6±1.2 kg). Athletes which were difficult to assign to one of the above groups were excluded from further analysis. The indices of the wrestling tests, as well as some other indices of specific physical fitness, were then determined among wrestlers of the three groups. In the process of subsequent analysis the results of measurements in ergometric and special wrestling tests were compared with individual tactical approach.

Tests and measurements

The basic premise was the fact that the specifics of a wrestler's anaerobic capacities require testing of its various manifestations. In this respect, two types of anaerobic tests were applied: short (10 s) and intermediate (30 s) [33,34]. The time interval between these anaerobic tests was 30–35 min. Energy output for 10 s and 30 s, and peak power for 1 s and 5 s, respectively, were determined. Tests were performed twice (with a one-day break) in laboratory conditions using a Monark bicycle ergometer. The higher value was chosen from the results of two measurements. The test which was used to estimate aerobic power (VO_2 max) was a graded (2 min) load power increment on the bicycle ergometer until failure (12–16 min). Anaerobic (ventilatory) threshold was determined as well. An Oxycon Pro (Jeager) in breath by breath mode was used. Lactic acid concentrations in capillary blood were determined in the 3rd minute after the 30 s test (LP-420, Dr Lange). Wrestlers were divided according to tactical approach (types of wrestlers) based on the assessment of five experts, coaches with 8–15 years experience. An approach which aimed to distinguish the following three tactical approaches (types of wrestlers): "combinational" (technical type), "tempo" (functional type) and "strength" (speed-strength type) was applied [27,29,30]. Technical observations and videotaped footage of the wrestlers during both practice sessions and matches served as a basis for assigning an athlete to a specific tactical type. Attack interval, coefficient of attack reliability and technical action volume were averaged on the basis of measurements in 6 matches [1,2]. The following special wrestling tests were used: 1. Time of 8 throws of man-simulator at maximum pace. Man-simulator weight constituted 40–46% of athlete body mass; 2. Total time of three "spurts"; 3. Time of simulation of taking opponent off balance; 4. Time of simulating hip throw. 5. Time of 10 pull-ups at maximum pace; 6. Maximum number of pull-ups (cycle per 3 s). In addition, maximum number of transitions from initial standing position to lying in 10 s was determined. Time was measured according to the video-recording display.

Statistical analyses

Statistical analyses were performed to determine differences between groups using a statistical software package (STATISTICA 8). Data were assessed for normal distribution by Kolmogorov-Smirnov test. All data were found to be normally distributed; therefore analysis was carried out using parametric statistical tests. Paired t-test was used to compare of the variables between groups of different anaerobic alactatic, lactatic and aerobic power levels and different tactical approach. Spearman rang correlation was used. Values were represented by means of ± standard deviations, and significance was set at the $p<0.05$ level.

Table 1. Indices of maximum anaerobic and aerobic power and the range of individual variations in skilled wrestlers (n=31).

Indices	Mean	SD	Min-max
Alactate working capacity in 10 s, J·kg	130.2	9.1	106–154
Lactate working capacity in 30 s, J·kg	297.1	29.1	235–370
Blood lactic acid concentration after 30 s test, mmol·L	13.8	1.8	9.5–17.1
Maximum oxygen intake, ml·min·kg	57.4	3.4	48.5–65.1
Anaerobic threshold oxygen intake,% VO_2 max	74.1	4.1	64.2–79.4

Results

The determination of individualized approaches to wrestler preparation on the basis of expert evaluation revealed that the role of different tactical approaches (39% of respondents) and extreme weight categories (71% of respondents) are most frequently used. The task was set to determine the range of individual distinctiveness according to the level of anaerobic and aerobic capacities of the analyzed group of wrestlers. These data were obtained according to the results of laboratory tests performed on a bicycle ergometer (Table 1).

The levels of minimum and maximum specific (per kg of body mass) indices of aerobic and anaerobic capacities among a homogeneous group of wrestlers were significantly different. The lowest the levels of minimum and maximum specific indices was noted in anaerobic threshold oxygen intake in% of VO_2 max.

Three groups of wrestlers most distinctly characterized by expression of developed power in one particular energy system – alactate, lactate and aerobic – were singled out. Wrestlers with insufficiently distinct differences of such types relative to 70–100% percentile zones were not included in the abovementioned groups. Those included in groups were subjected to further analysis. There were no differences in the body mass among of all groups of wrestlers ($p>0.05$). They were characterized by the following level of specific values of different energy system power (Table 2).

The groups of athletes differed in high indices of one of three characteristics of work energy supply. All three groups of wrestlers reflected nearly maximum degrees of development of the given power characteristic in all components of work energy supply within their respective categories. The level of alactate, lactate and aerobic power of all wrestlers (n=31) relative to average level of

Table 2. Characteristics of groups of skilled wrestlers singled out according to the level of capacities of anaerobic alactate, anaerobic lactate and aerobic properties of work energy supply (predisposition to a particular character of work energy supply).

Group number	Indices	N	Min-max in 70–100% of percentile zones	Mean ±SD	Percent relative to average level of all wrestlers (n=31)
1	Anaerobic alactate: – working output for 10 s, J·kg^{-1} – peak power, w·kg^{-1}	9	139–154 15.1–16.7	145.1±6.9 15.9±1.1	111.4*
2	Anaerobic lactate: – working output for 30 c, J·kg^{-1} – peak power, w·kg^{-1}	7	303–370 13.3–15.9	339±24.2 14.2±1.3	87.6 *
3	Aerobic power: VO_2 max, ml·min^{-1}·kg^{-1}	8	56.3–66.1	62.7±1.6	91.5*

* – statistically significant (p<0.001).

Table 3. Differences in specific indices of competitive wrestling activity among groups which differ in anaerobic alactate power (group 1), anaerobic lactate power (group 2) and aerobic power (group 3) work energy supply, M ±SD.

Indices	Groups of wrestlers			Significance of differences
	1	2	3	
Attack interval, s	34.2±0.04	31.5±0.04	38.8±0.05	2–3 (p<0.001)
Coefficient of attack reliability	0.58±0.02	0.62±0.02	0.69±0.03	1–3 (p<0.050)
Number of technical actions	10.1±0.3	10.9±0.2	9.9±0.3	ns

these indices were 111.4%, 87.6% and 91.5% for the 1st, 2nd and 3rd group, respectively. All indicated differences were statistically significant (p<0.001).

The degree of difference in expression (relative to average data for all wrestlers) in the above groups of wrestlers indicated a significant positive middle correlation between specific values (per kg of body mass) of maximum aerobic (estimated according to VO_2 max) and anaerobic alactate power (0.69, p<0.010). A low degree of correlation between differences in alactate and lactate power (0.48, p<0.050) was also revealed. Presented data demonstrate distinct differences between groups of wrestlers in criterion of developed power expression in one of the aspects of work energy supply, whereas indices of the development level of various aspects of energy capacities carry independent information.

Subsequently, differences in certain indices of competitive activity during wrestling matches (characteristics of attack and technical action volume) were analyzed in groups of athletes with different characteristics of energy supply system power (Table 3).

The most expressed differences relating to wrestler predisposition to work output under different energy modes were noted in attack interval. As a rule, attack interval is shorter in wrestlers with highly developed anaerobic lactate capacities. Attack reliability coefficient appeared to be significantly higher in wrestlers predisposed to explosive energy expenditure as compared to those distinguished by high specific maximum oxygen intake (group 3). With respect to total volume of technical actions used during matches, there were no significant differences between analyzed groups of wrestlers observed.

As soon as wrestler types were differentiated according to tactical approach, which has no quantitative expression, an analysis of the relationship between these types of wrestlers and their differing work energy supply predispositions was performed. This was done according to the percent of wrestlers as part of each three groups of wrestlers with different energy predisposition. The results of this analysis are presented in Figure 1.

The group of wrestlers with high alactate power (group 1) includes the greatest (40%) number of wrestlers who apply a speed-strength tactical approach ("strength" type of wrestlers). Almost the same number of wrestlers (36%) of the same tactical approach is represented in the group of wrestlers with the highest lactate power (group 2). About 76% of wrestlers with a speed-strength tactical approach ("strength" type of wrestlers) are represented in the two groups of wrestlers with high alactate and lactate power of anaerobic processes of work energy supply. Certain degree regularity was noted with regard to

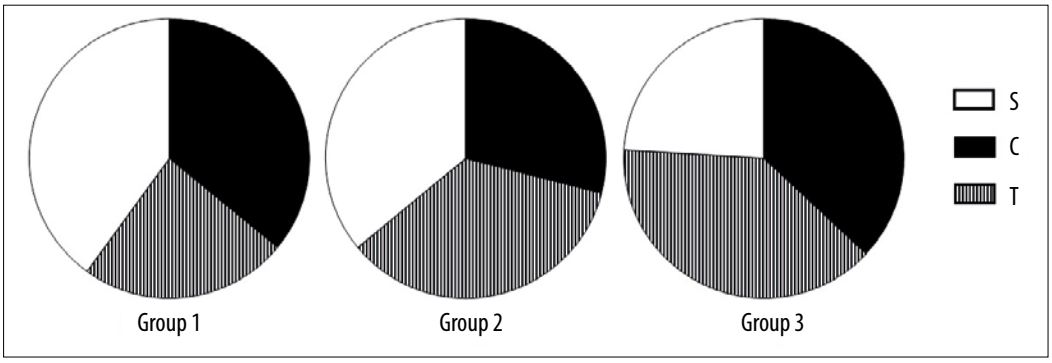

Figure 1. Distribution of wrestlers with different tactical approaches (types of wrestlers) in groups with different predisposition to anaerobic alactate (group 1), anaerobic lactate (group 2) and aerobic (group 3) work energy supply: S – speed-strength tactical approaches ("strength" type), C – technical tactical approaches ("combinational" type), T – functional tactical approaches ("tempo" type).

distribution of wrestlers with a functional tactical approach ("tempo" type of wrestlers) relative to groups of wrestlers with different predispositions to work under different power energy modes. Of all wrestlers with a functional tactical approach, 74% belonged to wrestlers with predispositions to high anaerobic glycolytic and aerobic power processes (2nd group – 35% and 3rd group – 39%). Wrestlers with a technical approach ("combinational" type of wrestlers) were almost equally distributed among groups of different energy predisposition (1st group – 36%, 2nd group – 29% and 3rd group – 37%).

Analysis of specialized physical fitness indices of wrestlers of different energy predispositions is presented in Table 4.

Significant differences in most indices of special physical fitness tests were noted between groups of wrestlers with predispositions to work under different power modes. In tests of about 10 s duration (5 and 7) significant differences were noted between the 1st and the 3rd group only. In a longer anaerobic test of maximum type (6) significant differences were noted between the 2nd and the 3rd group. During tests of an intermediate duration (1), significant differences were observed between both the 1st and the 3rd, and the 2nd and the 3rd group. It is noteworthy that while simulating specialized speed technical actions (3 and 4) significant differences were noted not only between the 1st and the 3rd and the 1st and the 2nd, but also the 2nd and the 3rd group as well. During performance of three consecutive technical actions (2), which took more than one minute, significant differences were observed between only the 2nd and the 3rd group.

Discussion

Expert opinions were a basis for studying the relation between a wrestler's tactical approach and individual characteristics of body energy systems. Individual differences among skilled wrestlers' approaches are usually related to differences in the type of higher nervous activity and neurodynamics [30,35] or related to some anthropometric and motor variables [3,11,30,36]. The results of the given study showed a relationship among the level of various aspects of wrestler energy capacities, the tactical approach, and certain indices of specialized fitness.

A significant range of individual capacities of work energy supply system were demonstrated in a homogeneous group of skilled wrestlers. The levels of minimum and maximum specific (per kg of body mass) indices of anaerobic and aerobic power (per kg of body mass) was higher in wrestlers as compared to cyclists and rowers of the same skill level [37,38]. The significance of these differences is accentuated by the fact that athletes with the highest and the lowest body mass were excluded from analysis. Similar data for aerobic and anaerobic power were obtained in some other studies of wrestlers [5,13,20,23,26]. The lowest the levels of minimum and maximum specific indices were noted in relation to anaerobic threshold oxygen intake in % of VO_2 max. As far as the given index sufficiently reflects the conditioning level of athletes, it may, therefore, indicate insignificant interindividual differences in conditioning level of the studied group of wrestlers. A great range of differences served as grounds for differentiating of groups of wrestlers, which were distinguished by high power in one of three different aspects: alactate energy supply (i.e., „explosive" character of energy expenditure), aerobic energy supply (with the highest VO_2 max) and anaerobic glycolytic energy supply. The above results could be interpreted as an innate predisposition to differing involvement of various energy systems during wrestling activity. The importance of the above predisposition is due to recent drastic increases in the specific endurance requirements in wrestling, as well as the significance of its various components [4,5,15,18,20]. A high level of one or another aspect of work energy supply power in differentiated groups

Table 4. Differences in some indices of specialized physical fitness of skilled wrestlers in groups which differ in predisposition to anaerobic alactate (group 1), anaerobic lactate (group 2) and aerobic (group 3) work energy supply, M ±SD.

Tests content	Group 1	Group 2	Group 3	Significance of differences,at p<0.05
1. Time of 8 throws at maximum pace, s	16.1±0.2	17.2±0.3	19.5±0.3	1–3; 2–3
2. Total time of three "spurts", s	67.8±1.1	63.1±0.9	72.3±1.0	2–3
3. Time of simulation of taking opponent off balance, s	0.896±0.012	0.918±0.013	1.095±0.021	1–3; 2–3
4. Time of simulating hip throw, s	0.798±0.02	0.905±0.02	0.896±0.15	1–3; 1–2
5. Time of 10 pull-ups at maximum pace, s	10.9±0.1	11.3±0.1	11.8±0.2	1–3
6. Maximum number of pull-ups (cycle per 3 s)	32.1±0.3	34.2±0.4	28.1±0.4	2–3
7. Maximum number of transitions to lying support in 10 s	16.0±0.3	15.3±0.4	13.8±0.3	1–3

of wrestlers is noteworthy in comparison with normative characteristics of aerobic and anaerobic energy supply for athletes of other disciplines at a comparable level of mastery [34,37,38]. Guided by terms used in cycling disciplines, one may emphasize strongly pronounced abilities of the first group for a short sprint („explosive" work), the second group – for a long sprint („local" endurance) and the third group – for aerobic endurance [10,16,38].

A comparison of power differences (in%) of various energy supply systems among the groups using average data of all wrestlers indicated a significant positive correlation of these differences only between specific values (per kg of body mass)of aerobic and anaerobic alactate power. It should be stressed that the above correlation was close to that earlier observed in skilled cyclists (0.69 *vs.* 0.77) [38]. That is, this correlation was not limited to wrestling. Besides, a correlation of differences in averages for all wrestlers' alactate and lactate power (0.59) was revealed, which was probably related to the use of a relatively short test for lactate power testing. Such indices of wrestler activity as interval of attack, coefficient of attack reliability and volume of technical actions were connected with the level of power of one or another energy supply system. For instance, the shortest interval of attack was observed in wrestlers with highly developed anaerobic lactate capacities. This may be due to the fact that the attacks are performed in "spurts" which in this particular group of wrestlers may be either longer or is more often. The coefficient of attack reliability turned out to be significantly higher in wrestlers predisposed to explosive energy expenditure. One may assume that this is related to these wrestlers' greater speed in reaching peak strength, which is an essential condition of efficient attack [32,36].

Analysis of work energy supply system power among wrestlers with different tactical approaches showed that wrestlers in group 2 (with expressed development of lactate anaerobic power) had the most similar values. In group 1 (with the highest development of alactate power) and group 3 (with the highest aerobic power) wrestlers with different tactical approaches had the most diverse values. The above may be indicative of the fact that tactical approach does not correlate exclusively with individual predisposition to work under certain energy modes.

Analysis of specialized wrestling test results showed that in the group with a predisposition to high lactate power (group 2) the best indices were observed in long anaerobic tests reflecting strength endurance. Test results of this group significantly differed from data for the group of wrestlers predisposed to high power of aerobic processes (group 3). The above coincides with the notion that the energy for 30–90-s of high power activity for the entire duration is preferentially provided at the expense of glycolytic energy sources [34]. Specific tests of wrestler strength endurance were narrowly within those limits of duration. Test analysis showed that there were no significant differences between the group of wrestlers with high anaerobic alactate power and those of athletes with predisposition to high lactate power. It is interesting to note that wrestlers of the high anaerobic alactate power group did not differ in strength endurance from wrestlers with the highest level of aerobic power, which may be related, among other reasons, to differences in maximum strength and on/set of fatigue [6,16,36]. Maneuvers featuring more high speed components were observed in the high alactate energy supply group in comparison to those of other groups. These differences were most evident usually with respect to speed of integral technical maneuver performance[6,19], namely, they become more distinct during specialized motor actions of wrestlers and are less expressed during non-specific strength tests. The above indicate important aspects of specialized

test selection for skilled wrestlers with different energy system predispositions. Wrestlers may be significantly differentiated according to reliability indicators of maximum effort speed components during special motor actions. The correlation between individual predispositions to work under different energy modes and the specific activity of wrestlers during matches is probably determined by differences of degree of fatigue as well as speed of recovery. The character of fatigue increases during the course of a match (as well as in training and competitive cycles) varies among individuals [7,11,29,32]. They are related to preferential use of anaerobic alactate, anaerobic glycolytic and aerobic energy potential during a match. The above is indirectly indicated by the presented data. One may assume that wrestlers realizing specific motor potential due to preferential usage of anaerobic lactate energy sources would recover faster in the course of a match as compared to other wrestlers. This assumption is confirmed by data indicating that the degree of fatigue of skilled wrestlers depends upon the load content and especially on individual differences of speed of recovery [10,12,21].

Conclusions

Therefore, the data presented above indirectly indicate that the relation between predisposition to work under different energy modes and individual characteristics of competitive activity is based on one's innate ability to develop maximum work energy supply power in short, middle and long time intervals. In the process of long-term sports engagement, these innate particularities tend to distinctly modify all aspects of wrestling motor abilities. In this regard, commonly used wrestler preparation tests are insufficiently distinctive from the angle of identifying wrestler predisposition to working capacity under different energy modes. In our opinion, the abovementioned assessment raises a question about the necessity of special wrestling tests applied to measure energy criteria of one or another work energy supply system. On these grounds, further implications of each aspect of special working energy supply capacity could be attained analogously through the study of cycling and/or other disciplines. This problem, however, requires further research.

References:

1. Jushkov OP: Control system of impacts on preparedeness structure of wrestlers. Moscow: Doctoral Dissertation, Russian University of Physical Culture, 1994 [In Russian]
2. Podlivayev BA: Analyse of competitive activity of free and greco-roman styles for Olympic tournament in Sydnej. Teoria and Practice of Physical Culture, 2001; 9: 33–40 [In Russian]
3. Kalina RM, Chodała A, Dadeło S et al: Empirical basis for predicting success in combat sports and self-defense. J Kinesiology, 2005; 37: 64–73
4. Hackenschmidt G: Complete science of wrestling. London: Health and Strength LTD; 2011
5. García-Pallarés, López-Gullón JM, Muriel X et al: Physical fitness factors to predict male Olympic wrestling performance. Eur J Appl Physiol, 2011; 111(8): 1747–58
6. Akopian AO, Pankov VA, Kim AJ: Technic of wrestlers formation in new condition of competitive activity. Teoria and Practice of Physical Culture, 2006; 6: 21–23 [In Russian]
7. Sterkowicz S, Lech G, Almansba R: The course of fight and the level of sports achievements in judo. Arch Budo, 2007; 3: 72–81
8. Kraemer WJ, Vescovi JD, Dixon P: The physiological basis of wrestling: implications for conditioning programs. J Strength Cond Res, 2004; 26(2): 10–15
9. Barbas I, Fatouros IG, Douroudos II et al: Physiological and performance adaptations of elite Greco-Roman wrestlers during a one-day tournament. Eur J Appl Physiol, 2011; 111(7): 1421–36
10. Tumanian NS, Shyjan VV, Nevzorov VI: Bioenergetic basis of preparedeness system improving in skilled wrestlers. Years book – Sport Wrestling , 1986;42–44 [In Russian]
11. Begidov VS, Parhomenko AN, Shyjan VV: Interrelation of aerobic possibilities and technic-tactical potential realization of wrestlers in competitive matches. Teoria and Practice of Physical Culture, 1988; 11: 45–47 [In Russian]
12. Jost J, Ruch L, Schrey R: A metabolic load model for the control and increase in quality of training in Greek and Roman style wrestling. Leistungssport-Münster, 2001; 31(6): 25–31
13. Utter AC, O'Bryant HS, Haff GG, Trone GA: Physiological profile of an elite freestyle wrestlers preparing for competition: A Case Study. J Strength Cond Res, 2002; 4: 308–15
14. Vardar SA, Tezel S, Ozturk L, Kaya O: The relationship between body composition and anaerobic performance of elite young wrestlers. J Sports Sci Med, 2007; 6: 34–38
15. Martínez-Abellán A, García-Pallarés J, López-Gullón J et al: Anaerobic factors to predict wrestling performance. Cuadernos de Psicología del Deporte, 2010; 10: 1017–23
16. Shyjan VV, Karazanov BK, Sariev KS: Impact of aerobic loads on dynamic of working capacity indices of wrestlers. Teoria and Practice of Physical Culture, 1991; 4: 30–32 [In Russian]
17. Callan SD, Brunner DM, Devolve KL et al: Physiological profiles of elite freestyle wrestlers. J Strength Cond Res, 2000; 14: 162–69
18. Hrvoje K, Tocilj Z, Uljević O, Erceg M: Lactate profile during Greco-Roman wrestling match. J Sports Sci Med, 2009; 8: 17–19
19. López-Gullón JM, Muriel X, Torres-Bonete MD et al: Physical fitness differences between Freestyle and Greco-Roman elite wrestlers. Arch Budo, 2011; 7(4): 217–25
20. Mirzaei B, Rahmani-Nia F, Ghhremani-Moghadam M: A comparative study of body composition, aerobic power, anaerobic power and strength of Iranian Freestyle and Greco-Roman style wrestlers participating in The Beijing Olympic Games 2008. J Sports Sci, 2009; 49(1): 192–94
21. Hubner-Wozniak E, Kosmol A, Lutoslawska G, Bem EZ: Anaerobic performance of arms and legs in male and female free style wrestlers. J Sci Med Sport, 2004; 7: 473–80
22. Dadajan AD: Effects of aerobic loads on working capacities improving in various skilled wrestlers. Moscow: Doctoral Dissertation, Russian University of Physical Culture, 1996 [In Russian]
23. Yoon J: Physiological profile of elite senior wrestlers. J Sport Med Phys Fitness, 2002; 32: 225–33
24. Apti A, Yildiz S, Apti DA: The relationship between aerobic capacity and somatotype in elite male Turkish wrestlers. 15th Annual ECSS Congress, Antalya, 2010
25. Pashintsev V, Podlivaev B, Korjenevsky A: Influence of power loading on the aerobic readiness of judoists. Intern J Wrestling Sci, 2011; 1(2): 41–47
26. Curby DG, Rahmani-Nia F, Moghadasi M: Physiological profile of elite Iranian junior freestyle wrestlers. JStrengthCondRes, 2009; 23(8): 2339–44
27. Novikov AA, Chujko JI, Morozov SA: Orientation of wrestlers' preparation on the base of those individualities. Teoria and Practice of Physical Culture, 1984; 11: 19–21 [In Russian]
28. Stankov AG, Klimin VN, Pismensky IA: Individualization of wrestlers preparation. Moscow: Physical Culture and Sport, 1984 [InRussian]
29. Pilojan RA: Individualization of preparation in combat sports. Moscow: Doctoral Dissertation, Russian University of Physical Culture, 1985 [In Russian]
30. Ivlev VG: Types of competitive activity of high skilled wrestlers in relation to those individualities. Moscow: Doctoral Dissertation, Russian University of Physical Culture, 1990 [In Russian]
31. Cvetkovic Č, Maric J, Marelic N: Technical efficiency of wrestlers in relation to some anthropometric and motor variables. Kinesiology, 2005; 37(1): 74–83
32. Shyjan VV: Effects of physical fatigue on kinetics of timing interval of throws. Теория и Практика Teoria and Practice of Physical Culture, 1996; 6: 48–50 [In Russian]
33. Bar-Or O. The Wingate anaerobic test: an update on methodology, reliability, and validity. Sports Med, 1987; 4: 381–94

34. Bouchard C, Taylor AW, Simonau JA, Dulac S: Testing anaerobic power and capacity. Physiological Testing of the High - Performance Athlete. Champaign J.: Human Kinetics, 1992; 175–222
35. Korobeynikov G, Mazmanian K, Korobeynikova L, Jagello W: Psychophysiological states and motivation in elite judokas. Arch Budo, 2010; 6: 129–36
36. Schmidt WD, Piencikovski CL, Van Dervest RE: Effects of competitive wrestling season on body composition, strength, and power in national collegiate athletic association division III college wrestlers. J Strength Cond Res, 2005; 19: 505–8
37. Wilmore JH. The assessment and variation in aerobic power in world class athletes as related to specific sports. Amer J Sports Med, 1984; 2: 64–70
38. Mishchenko V, Monogarov V: Fisiologia del deportista (Sec ed). Barcelona: Paidotribo; 1998; 396 [In Spanish]