Original Article

Correlation analysis of readiness indicators of athletes and their competitive results in kettlebell sport

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Abstract:
        The correlation between the indicators of physical, functional and technical readiness of athletes of different qualification and their competitive results in kettlebell sport is investigated in this article. Eighty six sportsmen (17–28 years old) participated in the research. They were divided into 3 groups according to their level of readiness. Group A included athletes with 3 and 2 grades (n = 34), group B – athletes with 1 grade and master of sport candidates (n = 27), group C – high-level athletes [masters of sport (MS), masters of sport of international class (MSIC), n=26]. Reliable correlation (P <0.05) was found between the competitive results of athletes with high qualifications and their indicators in: 3-km running, squatting with a barbell, class traction, bar with two 32-kg kettlebells in the initial position, bar with two 24-kg kettlebells in the position of fixation; heart rate at rest, vital capacity, duration of recovery process; duration of static phases, size of corners between the parts of the body in the main phases, rate of exercise performance.
Keywords: physical fitness, functional readiness, technical readiness, correlation, athlete, kettlebell sport

Introduction

        The purpose of sports training is to achieve the level of physical, tactical, technical, psychological readiness that is most possible for a particular athlete determined by the specifics of the sport and the requirements of achieving the possible highest results in the competitive activity [3, 10]. Among the main tasks which are solved in the process of sports training is the development and continuous improvement of techniques in the chosen sport and provide the necessary level of development of physical qualities and capabilities of functional systems of the body which bear the main load in this sport [4, 5]. These tasks determine in general the main types of sports training – physical and technical. In this case, in training and especially in competitive activity, these types do not manifest themselves in isolation; they are combined into a complicated complex aimed at achieving the highest sports results. It is important that each side of the athlete's readiness depends on the degree of perfection of its other sides, is determined by them and determines their level [6, 7, 9].

        Modern methods of training the athletes in kettlebell sport are characterized by considerable volume and intensity of work, accentuated development of the most important physical qualities, a significant increase of special work with kettlebells on the basis of a high level of general physical fitness, increased requirements for the technique of performance of competitive exercises and a clear organization of the training process [1, 6]. The work performed by the high-skill kettlebell lifters is characterized by the following load factors: heart rate – 180-190 beats per minute or more, oxygen consumption – close to the maximum, the predominant nature of work – aerobic and anaerobic, oxygen duty – up to 12 liters with a high level of increase of lactic acid in the blood, the work of the respiratory system is maximal, the work of heart is sub-maximal [3, 9]. The strongest kettlebell lifters can lift in 10 minutes only at the jerk of two kettlebells up to 10 tons [4, 8]. Therefore, the energy consumption of their work can be equated with the running of distance of 10-15 km in ski races [2, 9]. This means that modern kettlebell sport is characterized by significant stress on the cardiorespiratory system and sets high requirements for the development of endurance of the athlete. As a result, there is an insignificant dependence of competitive results on the weight of the body of the kettlebell lifter – sometimes indicators of athletes in the middle category dominate the indicators of sportsmen in the heavy category [5, 6]. Therefore in the training plans of the outstanding sportsmen, special work with kettlebells and race training is an important part along with strength exercises [1, 2, 10].

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Thus, the achievement of high results in modern kettlebell sport depends on the level of development of the effective indicators of physical, functional and technical readiness of athletes but the question of determining the relationship between the indicators of readiness of sportsmen of different qualifications and their results in kettlebell sport remains insufficiently investigated.

Materials and methods

Eighty six athletes (17–28 years old) from Zhytomyr, which were divided into 3 groups according to their level of readiness, took part in the research. Group A included athletes with 3 and 2 grades (n = 34), group B – athletes with 1 grade and master of sport candidates (n = 27), group C – high-level athletes (masters of sport (MS), masters of sport of international class (MSIC), n=26).

The research of indexes of general physical fitness has been conducted according to the results of: 100-m running (speed qualities), pulling up on a cross-beam (power endurance), 3-km running (general endurance), squatting with a barbell (power of leg muscles), class traction (power of back muscles), press of barbell lying (power of chest muscles), inclination of trunk in sitting position (flexibility of back).

The research of indexes of special physical fitness has been conducted according to the results of: bar with 2 32-kg kettlebells in initial position, semi-squatting with 2 32-kg kettlebells in initial position, jumping out with 40-kg kettlebell for 2 minutes, bar with 2 24-kg kettlebells in the position of fixation.

The research of functional readiness of sportsmen has been conducted on the basis of the parameters of heart rate at rest, blood pressure (systolic and diastolic), vital capacity (VC), duration of holding of breathing during the inhalation, duration of holding of breathing during the exhalation, heart rate recovery time after standart loading (20 squats for 30 seconds).

Research of indexes of technical readiness has been conducted according to: duration of main phases during the performance of competitive exercises with kettlebells (phase of kettlebells holding on a chest before lifting, the phase of lifting, the phase of snatching); the corners between parts of body in the main phases of exercise (corner between body and legs during kettlebell lowering; corner between body and hands during kettlebell lowering, corner between body and legs at the moment of kettlebell stop in «dead point», corner between body and hands at the moment of kettlebells stop in «dead point», corner between body and hands at the at the time of snatching); the compliance of the rate of exercise at the first and tenth minutes with the overall result.

The aim of the article is to determine the correlation between the indicators of physical, functional and technical readiness of athletes of different qualifications and their competing results in kettlebell sport.

Tasks of article:

1. To determine the correlation between the indicators of physical, functional and technical readiness of athletes of different qualifications and their competing results in kettlebell sport.

2. To determine the effective indicators of physical, functional and technical readiness of athletes for achievement of high results in kettlebell sport.

Research methods: theoretical analysis and generalization of scientific and methodical literature, pedagogical supervision, testing, methods of mathematical statistics.

Results

To research the relationship between the indicators of physical, functional and technical readiness of athletes and their competitive results, we conducted a correlation analysis of the indicators of general physical fitness (results in 100-m running, pulling up on a cross-beam, 3-km running, squatting with a barbell, class traction, press of barbell lying, inclination of trunk in sitting position), special physical fitness (bar with 32-kg kettlebells in initial position, semi-squatting with 32-kg kettlebells in initial position, jumping out with 40-kg kettlebell for 2 minutes, bar with 2 24-kg kettlebells in the position of fixation), functional capabilities of main systems of the body (heart rate, blood pressure, vital capacity, duration of holding of breathing during the inhalation, duration of holding of breathing during the exhalation, heart rate recovery time after standart loading), and technical parameters (duration of the main phases, corners between the parts of the body in the main phases, the rate of the performance of the exercise) by the kettlebell lifter with different qualification (n=86) with the results of their performance at the competitions (with kettlebells of 32 kg).

The analysis of the correlation coefficients between the results of 100 m - running and the competitive results showed that in all groups (A, B and C) a weak correlation between the development of speed qualities and sports results is recorded (r = -0.19; - 0.18; -0.13 standard unit (s.u.)) (P>0.05) (table 1).

Investigating the correlation between the results of kettlebell lifters with different qualification in pulling up on a cross-beam and their results in the competitions, it was established that in the group of athletes of lower classes (group A) the correlation coefficient is the highest (r = 0.71 s.u.); in group B it is 0.62 s.u., in group C – the lowest (r = 0.49 s.u.) (P<0.05) (table 1). This indicates that a competitive result of the athletes of lower classes depends on the level of development of strength qualities more than those of high-class athletes, by which based on the high level of development of physical qualities, the result depends more on the level of technical readiness. Analysis of the correlation coefficients between the competitive results of the kettlebell

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lifters and their results in 3 km - running show a close correlation (P<0,05) of the level of development of endurance with the achievements in kettlebell sport. At the same time, with the increase of the qualification of athletes, this tendency becomes even more pronounced: in group A the correlation coefficient is -0.49 s.u., in group B – -0.51 s.u., and in group C – -0.66 s.u. (table 1) which emphasizes the need for continuous improvement of this quality in order to increase the results in kettlebell sport.

Table 1. Correlation between the indicators of physical readiness of sportsmen with a different qualification (n=86) and their competitive results in kettlebell sport (s.u.)

The indicators of physical readiness	Coefficients of correlation		
	Group A (n=34)	Group B (n=27)	Group C (n=26)
100-m running	-0.19	-0.18	-0.13
Pulling up on a cross-beam	0.71	0.62	0.49
3-km running	-0.49	-0.51	-0.66
Inclination of trunk in sitting position	0.36	0.38	0.50
Squatting with a barbell	0.79	0.62	0.41
Press of barbell lying	0.45	0.34	0.10
Class traction	0.83	0.77	0.52
Bar with 32-kg kettlebells in initial position	0.69	0.63	0.65
Semi-squatting with 32-kg kettlebells in initial position	0.88	0.78	0.81
Jumping out with 40-kg kettlebell for 2 minutes	0.59	0.46	0.37
Bar with 2 24-kg kettlebells in the position of fixation	0.81	0.75	0.72

r critical (P<0.05) for group A – 0.332 s.u.; for group B – 0.361 s.u.; for group C – 0.396 s.u..

According to the results of the analysis of correlation between the indicators of flexibility of kettlebell lifters with different qualifications and their results it was found that the correlation coefficient between the results in the inclination of trunk in sitting position and the competitive results by the high-class kettlebell lifters (r = 0.50 s.u.) is the highest; in group A it is 0.36 s.u., and in group B – 0.38 s.u. (P<0.05) (table 1). At the same time, in all groups of athletes, the link between the indicators of flexibility and competitive results is defined as average which confirms the importance of improving the flexibility of athletes in order to improve the results of the competition.

The analysis of the correlation coefficients between the competitive results and the results in the strength exercises of the kettlebell lifters showed that in group A in all exercises, the correlation coefficients are the highest compared to athletes of other groups (table 1). The lowest correlation coefficients were found between the competitive results and the results in the press of barbell lying (P>0.05) (r = 0.45, 0.34, 0.10 s.u.), and the highest – in the results in the squatting with a barbell and the class traction (r = 0.41-0.83 s.u.) (P<0,05), which indicates the importance of the development of strength of the legs and back muscles in kettlebell sport. In this case, in all strength exercises, the highest correlation coefficients were found in athletes of group A (table 1). Higher coefficients of correlation by the kettlebell lifters of lower classes indicate that they perform competitive exercises with kettlebells in more "power" way than in a "technical" one like high-class athletes.

Analyzing the correlation between the competitive results of kettlebell lifters with different qualifications and their indicators in special training exercises, there is verified close correlation (P<0,05) of the results of athletes of all three groups in bar with 32 kg - kettlebells in initial position, semi-squatting with 32-kg kettlebells in initial position and bar with 2 24-kg kettlebells in the position of fixation and the competitive indicators in kettlebells sport (Table 1). At the same time, in a bar with 32-kg kettlebells in initial position (r = 0.65 s.u.) and semi-squatting with 32-kg kettlebells in initial position (r = 0.81 s.u.) the coefficients of correlation are the highest by the kettlebell lifters of group C. In bar with 2 24-kg kettlebells in the position of fixation, the correlation coefficients in the groups A (r = 0.81 s.u.) and B (r = 0.75 s.u.) are slightly higher than in group C (r = 0.72 s.u.). In such a special preparation exercise as jumping out with 40-kg kettlebell for 2 minutes, the correlation coefficients characterize the average correlation with the competitive results of athletes in all three groups (P<0.05) (table 1).

Investigation of the correlation between the sports results of kettlebell lifters and the indicators of their functional readiness indicate that by the athletes of MS and MSIC level, correlation coefficients are higher than those of athletes of lower classes in all of the studied parameters (table 2). Verified close correlation (P<0.05) of competitive results in group C was revealed with heart rate (r = -0.57 s.u.), vital capacity (r = 0.53 s.u.), duration of holding of breathing during the inhalation and exhalation (r = 0.43 and 0.44 s.u.), and the heart rate recovery time after standart loading (r = -0.55 s.u.). This means that in order to improve the results in kettlebell sport you need to improve the functionality of the cardiovascular system and respiratory system. A weak correlation of almost all indicators is established in group B, and there was a lack of correlation of the functional capabilities of athletes with the results of competitions (P>0.05) in group A (table 2).

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Table 2. Correlation between the indicators of functional readiness of sportsmen with a different qualification (n=86) and their competitive results in kettlebell sport (s.u.)

The indicators of functional readiness	Coefficients of correlation		
	Group A (n=34)	Group B (n=27)	Group C (n=26)
Heart rate at rest	-0,24	-0,39	-0,57
Systolic blood pressure	-0,02	-0,09	-0,21
Diastolic blood pressure	-0,05	-0,15	-0,18
Vital capacity	0,22	0,45	0,53
Duration of holding of breathing during the inhalation	0,17	0,28	0,43
Duration of holding of breathing during the exhalation	0,21	0,30	0,44
Heart rate recovery time after standart loading	-0,29	-0,39	-0,55

r critical (P<0.05) for group A – 0.332 s.u.; for group B – 0.361 s.u.; for group C – 0.396 s.u..

The analysis of the correlation between the indicators of technical readiness of kettlebell lifters and their competitive results confirms that in the group of high-class athletes (group C) the correlation coefficients of the majority of investigated parameters are higher than in groups A and B (table 3). Thus, investigating the connection of the duration of the main phases during the performance of exercises in kettlebell sport with competitive results, the highest correlation coefficients are recorded in group C with the duration of phase of kettlebells holding on a chest before lifting in the jerk (r = -0.82 s.u.) and the duration of phase of lifting in the jerk (r = -0.83 s.u.) (P <0.05). In groups A and B in these phases, an average degree of correlation (r = -0.34, -0.39 and -0.59 and -0.55 s.u.) was found (P<0.05) (table 3).

Table 3. Correlation between the indicators of technical readiness of sportsmen with a different qualification (n=86) and their competitive results in kettlebell sport (s.u.)

The indicators of technical readiness	Coefficients of correlation		
	Group A (n=34)	Group B (n=27)	Group C (n=26)
Duration of phase of kettlebells holding on a chest before lifting in the jerk	-0.34	-0.59	-0.82
Duration of phase of lifting in the jerk	-0.39	-0.55	-0.83
Duration of phase of snatching in the snatch	-0.49	-0.53	-0.57
Corner between body and legs during kettlebell lowering in the snatch	0.21	0.28	0.57
Corner between body and hand during kettlebell lowering in the snatch	-0.11	-0.18	-0.54
Corner between body and legs at the moment of kettlebell stop in «dead point» in the snatch	-0.25	-0.31	-0.46
Corner between body and hand at the moment of kettlebells stop in «dead point» in the snatch	-0.29	-0.42	-0.76
Corner between body and hand at the at the time of snatching in the snatch	-0.25	-0.32	-0.65
Rate of exercise at 1-st minutes	0.54	0.58	0.37
Rate of exercise at 10-th minutes	0.09	0.26	0.71

r critical (P<0.05) for group A – 0.332 s.u.; for group B – 0.361 s.u.; for group C – 0.396 s.u..

In the phase of snatching the kettlebell in the snatch, a reliable connection of the average degree was found with the competitive results of the athletes of all three groups (r = -0.49, -0.53 and -0.57) (P <0.05) (table 3). Investigation of the connection of sports results of kettlebell lifters with the sizes of the corners between the parts of body in the main phases of the execution of the snatch shows that in all indicators the reliably higher correlation coefficients (P<0.05) are found in the group of high qualification athletes – the correlation is defined as close (r = -0.46 – -0.76 s.u.). The degree of correlation of the size of the corners between the parts of body in the main phases with competitive results in the snatch in group B is characterized as average (r = -0.18 - -0.59 s.u.), and in group A – a s weak (r = 0.09 – -0.34 s.u.) (table 3).

The analysis of the correlation between the competitive results of kettlebell lifters with different qualification in the jerk and their rate at the first and the tenth minutes showed that by the kettlebell lifters of groups A and B the correlation coefficients between the rate at the first minute and the competitive result (r =

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0.54 and 0.58 s.u.) indicate a high degree of connection and are significantly higher (P<0,05) than by athletes of group C (r=0,37 s.u.) (table 3). At the tenth minute, the higher correlation coefficient was found in group C (r = 0.71 s.u.) (P<0.05) which indicates that high-class kettlebell lifters begin to perform a competitive exercises at a lower rate and end with maximum acceleration. And athletes of lower classes start exercising at a high rate and finish at a lower rate.

Discussion

Correlation analysis of indicators of physical readiness of athletes and their results in kettlebell sport showed that for athletes of lower classes the effective physical qualities are strength qualities and endurance. However, with the increase in athletic skill, the requirements for the development of strength qualities of athletes are reduced, and for the development of endurance and flexibility are increasing. At the same time, the indicators of development of speed qualities, as well as the level of development of the chest muscles, have no effect on the competitive results of athletes with different qualifications. The investigation of the correlation between the results of athletes in the special training exercises and competitive results indicates the need for a constant increase in the volume of special training of athletes with the increase of their qualifications.

The analysis of the correlation between the indicators of the athlete's functional state and the competitive results shows that in order to achieve high results in kettlebell sport along with high requirements for physical fitness, high requirements for the functional state of athletes are also set – In all indicators of functional readiness, the correlation coefficients are significantly higher by high qualification athletes compared to athletes of lower classes.

Correlation analysis of indicators of technical readiness of athletes and their competitive results showed that with the improvement of skills of athletes, the requirements for improving the technique of exercising are increasing.

The conducted researches allow to assert, that effective indicators of physical fitness of athletes in kettlebell lifting are: strength of leg and back muscles, (general and strength) endurance, flexibility and the results in basic special preparation exercises (bar with 32-kg kettlebells in initial position, semi-squatting with 32-kg kettlebells in initial position, bar with 2 24-kg kettlebells in the position of fixation); functional readiness – functional capabilities of the cardiovascular and respiratory systems (according to indicators of heart rate, blood pressure, vital capacity, duration of holding of breathing during the inhalation and exhalation, heart rate recovery time after standart loading); technical readiness – duration of the phase of holding the kettlebells on the chest before lifting, the phase of lifting in the jerk and the phase of snatching the kettlebell in the snatch; position of the parts of body (corners) in the main phases of performance of competitive exercises; compliance of the rate at the first and tenth minutes of the competitive period of time with the competitive result.

Thus, the correlation analysis of the indicators of physical, functional and technical readiness of athletes and their competitive results has shown that in order to achieve high results in kettlebell sport, the focus must be on the development of endurance, strength qualities and flexibility; on improvement of special qualities through the implementation of appropriate special training exercises; on improvement of cardiovascular and respiratory functionality; continuous improvement of techniques of performing competitive exercises (jerk and snatch) in general and its individual parameters. This indicates that the effective indicators of physical fitness of athletes in kettlebell lifting are the strength of leg and back muscles, endurance, flexibility and results in the main special-training exercises; functional readiness – capability of cardiovascular and respiratory system; technical readiness – the duration of the phase of holding the kettlebell before lifting, lifting, snatching, the position of the parts of body in the main phases of the exercise, the compliance of the rate with the competitive result.

Conclusions

1. A reliable close correlation (P<0.05) was found between the competitive results of athletes of high qualification and the indicators of their physical fitness (in 3-km running, r = -0.66 s.u., in squatting, r = 0.41 s.u., class traction, r = 0.52 s.u., in bar with 32-kg kettlebells in initial position, r = 0.65 s.u., in semi-squatting with 32-kg kettlebells in initial position, r=0.81 s.u., in bar with 2 24-kg kettlebells in the position of fixation, r = 0.72 s.u.), functional readiness (heart rate, r = -0.571 s.u., VC, r = 0.53 s.u.; duration of holding of breathing during the inhalation and exhalation, r = 0.43 and 0.44 s.u., heart rate recovery time after standart loading, r = -0,55 s.u.), technical readiness (duration of the static phase before lifting, r = -0,82 s.u., duration of the phase of lifting, r = -0,83 s.u., duration of the phase of snatching, r = 0.57 s.u., the size of the corners between the parts of the body in the main phases, r = -0,54 - -0,76 s.u., the rate of execution of the exercise at the tenth minute, r = 0.71 s.u.).

2. It has been established that the indicators of physical fitness of athletes in kettlebell sport are the strength of leg and back muscles, (general and strength) endurance, flexibility and the results in the main special-training exercises; functional readiness – functional capabilities of the cardiovascular and respiratory systems; technical readiness – the duration of the phase of holding the kettlebell before lifting, lifting, snatching, the position of the parts of body (corners) in the main phases of the exercise, the compliance of the rate with the competitive result.

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