

Basics of planning a pre-competitive mesocycle during taekwondo training

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Abstract

The purpose. To reveal and determine the effectiveness of planning a precompetitive mesocycle according to the «pendulum» principle in the training system of taekwondo athletes based on the definition of training and competitive loads, rational construction and duration of microcycles. **The object.** The training process of taekwondo fighters in the pre-competition mesocycle. **Participants.** The research was carried out during the Championships and Cups of Ukraine, in which 114 athletes in taekwondo of the junior age category (age 15-17 years) took part, on which the time and heart rate indicators were recorded when analyzing 248 performances (fights). Two groups were formed: the control group and the core group. Each group consisted of 10 athletes, aged 15-17 year. **Results.** The analysis of heart rate indicators in the process of competitive activity allowed us to develop a ranking of heart rate in points from 1 to 10, as well as a scale of intensity of training and competitive loads from 1 to 33. The information content of the developed scales is very high, since a high degree of connection between the intensity of training loads and the heart has been revealed rate and technical actions ($r = 0.78$ at $p > 0.001$; $r = 0.71$ at $p > 0.001$; $r = 0.73$ at $p > 0.01$). It was found that the construction of a precompetitive mesocycle according to the «pendulum» principle in the training system of taekwondo athletes at the stage of maximum realization of individual capabilities is effective, which is confirmed by the results obtained at the end of this mesocycle. There was revealed a significant increase in physical fitness indicators and coefficients of competitive activity ($p \leq 0.05$). The stabilization of the mental state (from 0 to 3 points) and the accuracy of muscle efforts (from -08 kg to 1.0 kg) were determined. **Conclusions.** Planning a precompetitive mesocycle according to the «pendulum» principle in the taekwondo training system allows planning significant training loads in waves with an emphasis on the recovery of the athlete's body in the range from 1 to 10 points, which made it possible to increase the level of physical fitness, the coefficients of competitive activity, stabilize the mental state, the accuracy of muscular efforts and sports performance.

Keywords: taekwondo, taekwondo fighters, heart rate, planning, pre-competition mesocycle, the «pendulum» principle, the stage of maximum realization of individual capabilities, training load, training load intensity.

Introduction

Taekwondo as an Olympic sport that became popular at the end of the 20th century. In 1996, at the XXVI Olympic Games in Atlanta (USA), he entered the program of demonstration performances, and in 2000, at the XXVII Olympic Games in Sydney (Australia), he became a full-fledged sport of the program.

Given the intensive development of taekwondo in the world and its technical and tactical potential of competitive activity, sports scientists are faced with global tasks related to improving the educational and training process at various stages of training athletes (Koshcheyev O.S., 2009, 2018). An important role in the system of sports training is played by the control of special abilities of taekwondo athletes (Hendarto S., Rahayu T., Anto S. 2018).

Let's pay attention to the basics of building the training process, since it affects the planning of the training load and types of sports training (physical, technical-tactical, psychological, and integral). L.P. Matveiev (1999, 2010), V.N. Platonov (2015), J. Sadowski (2015), S.N. Bubka (2017, 2018), Koshcheyev O.S., (2020) and other scientists confirm this fact, that planning and achieving a result are interrelated. They argue that when planning a one-year macrocycle, it is necessary to pay special attention to the following principles: «cyclic training process», «waveform and variability of load», as well as «unity and interconnection of the structure of competitive activity and the structure of readiness».

Analysis of national (Platonov V.N, 2015; Bubka S.N et al., 2017, 2018) and foreign (Matveiev L.P, 1999, 2010; Sadowski J., 2015; Zhelyazkov Ts., Dasheva D., 2011; Kang I.P, 2020; Stationery S., 2020) of popular science literature showed that the construction of a one-year macrocycle in most Olympic sports, including taekwondo, has a two or three cycle structure (it depends on the competition calendar and preparation stage). However, there are different approaches to their content of the periods of macrocycles of its construction. V.N. Platonov (2015), S.N. Bubka et al. (2017, 2018), L.P. Matveiev (1999, 2010), J. Sadowski (2015) L. Losik

(2018) talk about the classical theory of building a macrocycle, which is based on the processes of the formation of athletes' sports form, namely the preparatory, competitive and transitional periods, basic, control-preparatory, pre-competition, competitive and recovery mesocycles and ordinary, shock, model, competitive and recovery microcycles. A.N. Vorob'ev (1989), A.P. Bondarchuk (2005), V.B. Issurin (2008, 2010) propose the concept of block periodization. Scientists L.E. Brown, M. Greenwood (2005); D. Baker (2007) discusses periodization with strength training, T.O. Bomra, G.G. Haff (2009) and S. Guillermo (2020), taking into account the increase in the capabilities of the energy supply systems of the athlete's body.

Note that the pre-competition mesocycle and the combination of microcycles in it, which are directly related to planning the load and rest, play an important role in the periodization of the training of athletes. Many trainers plan their pre-competition mesocycle within 4 weeks with weekly microcycles, in which the volume and intensity of the load is intensified (gradually increased). However, such planning of the training load does not correspond to reality, since the planning is influenced by: the level of preparedness of the athlete with whom he enters the given mesocycle; orientation of the athlete and the coach to achieve a result for specific competitions; the specifics of the sport associated with the types of training, directly with technical, tactical and psychological, etc. V.N. Platonov (2013, 2015), S.N. Bubka et al. (2017, 2018), Ts. Zhelyazkov, D. Dasheva (2011) et al. indicate that traditionally in the pre-competition mesocycle, a gradual decrease from the first week of the volume of the training load and an increase in the intensity of training are carried out. This mesocycle should simulate competitive activity as accurately as possible, into a whole functional, technical-tactical and psychological potential and its implementation (Sakhnovskiy K., Driukov V., 2001; Matveev L.P., 2010; Sarajkin D.A., 2012; Platonov V.N., 2013, 2015; Losik L., 2018, Koshcheyev O.S., 2019). This model is universal («traditional») and is used in almost all sports. After reviewing the scientific works of 1960-1980 in martial arts, interesting approaches were found for planning the training load in precompetitive mesocycles according to the principle of the «pendulum» (Arosyev D.A., 1969, 1982), the principle of «variability» (Vorob'ev A.N., Ermakov A.D., 1972), the principle of «sequence» (Tumanian H.S., 1984). Therefore, regardless of the fact that there is a «traditional» model of building a precompetitive mesocycle, today it is relevant in studying and finding new opportunities to use and plan training loads according to the «pendulum principle» in the training system of highly qualified taekwondo athletes, as well as to identify their influence on the body of athletes.

Material and methods

Participants

The research was carried out during the Championships and Cups of Ukraine, in which 114 athletes in taekwondo of the junior age category (age 15-17 years) took part, on which the time and heart rate indicators were recorded when analyzing 248 performances (fights).

Two groups were formed: the control group and the core group. Each group consisted of 10 athletes aged 15-17 years.

Goals, methods and procedures

The aim of the study is an experimental in performing a comparative analysis of planning options for a precompetitive mesocycle based on the determination of training and competitive loads, a rational structure and the duration of weekly microcycles.

Certain goals of the research, prior to the assignment, were created and had tasks to be followed:

To solve these problems, the following research methods were used:

1. To analyze the scientific-methodical literature on the research problem.
2. Determination of the values of training and competitive loads in taekwondo.
3. Comparative analysis of planning options for pre-competitive mesocycles in taekwondo (traditional planning and planning according to the "pendulum principle").

To solve these problems, the following research methods were used:

1. Analysis and generalization of scientific and methodical literature in the study.
2. Natural experiment, which was carried out in the process of training taekwondo athletes at the stage of maximum realization of individual capabilities in the pre-competition mesocycle.
3. Determination of training and pre-competition loads based on heart rate indicators.
4. Carpal dynamometry for assessing the strength and accuracy of muscular efforts according to B.M. Rybalko, (1966) (wrist dynamometry was carried out in the course of training, alternately with the right and left hand, two bench presses two attempts - the first maximum bench press, the second 50% of the maximum, the best result is recorded).
5. Control testing:
 - the coefficient of special vitality of taekwondo players started with the unified methodology for A.G.

Buryindin (1973):

$$CSV = \Sigma F / 4F_{max} \text{ middle,}$$

F - number of strikes in a spurt; F_{max} is the maximum result in a group, 4 - a number of spurts, prior to the triviality of rounds);

- Cooper's test (running 12 minutes, km).

6. Evaluation of psychological state «Well-being - Activity - Mood (WAM)» procedure by V.A. Doskin, N.A. Lavrenteva, M.P. Miroshnikov, V.B. Sharay (1973).

7. Determining the efficiency of competitive activities according to the method by O.S. Koshcheyev (2014):

- *hit kick rate: HKR* = $\frac{\text{total amount kicks}}{\text{number of hits}}$;
- *strong kick rate: SKR* = $\frac{\text{number of hits}}{\text{number of hard hits}}$;
- *kick attack ratio: KAR* = $\frac{\text{total number of kicks}}{\text{number of hits}}$;
- *protection factor: PF* = $\frac{\text{total number of kicks A}}{\text{total number of defenses B}}$;
- *combat effectiveness factor: CEF* = $KAR + PF$;
- *combat stamina coefficient: CSC* = $\frac{\text{CEF in 3 round}}{\text{CEF in 1 + 2 round}}$.

8. Methods of Mathematical Statistics.

Instrument

The investigated material was processed using the methods of mathematical statistics on a personal computer using the software «Statistica 13.3» and the software application MS Excel (2019).

The main indicators of mathematical statistics were: - mean, SD - standard deviation, CV - coefficient of variation, r - correlation analysis. To confirm the hypothesis as to the effective influence of the author's technique on the level of technical preparedness of female gymnasts used t score - Student's t-test, the level of significance was taken as $p < 0,05-0,001$.

Ethical approval

The research related to human use has been complied with all relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki and the National Health Advisory Board, and has been approved by the authors' institutional ethics committee.

Informed consent

Informed consent was obtained from all individuals included in this study.

Results

The solution to these issues is primarily associated with the need to plan training loads. To do this, you need to have a clear understanding of the training and competition loads in taekwondo.

In sports practice, control of the values of training and competitive loads in taekwondo is carried out by external, internal and combined indicators. The magnitude of the external sides of the load is determined by the volume, the internal indicators of the absolute and relative intensity. The combined load value combines the volume of the outer side of the load and the absolute intensity of the inner side of the load.

The heart rate is most often used as an indicator for assessing the inner side of the load. This is due to the fact that the heart rate in a wide range of loads has a linear relationship with such indicators as the power (intensity) of work, oxygen consumption, and minute blood volume.

However, in taekwondo practice, the systematic registration of the heart rate is extremely difficult. In this regard, the use of internal load parameters becomes possible only in the conditions of well-equipped scientific laboratories. That is why we have developed a combined version of registering the load during training sessions, as well as in competitive conditions.

To develop the ranking of the heart rate in the points, we registered the time and heart rate indicators in 248 fights during training and competitions (championships and cups of Ukraine) among 114 highly qualified taekwondo athletes. The results of the study allowed us to establish that the heart rate indicators during the performance of various exercises fluctuate within the heart rate range of 120-210. The indicated range of heart rate fluctuations was divided with the heart rate interval of 10 and ranked in points: 1 point - heart rate 120-129; 2 points - heart rate 130-139; 3 points - heart rate 140-149; 4 points - heart rate 150-159; 5 points - heart rate 160-169; 6 points - heart rate 170-179; 7 points - heart rate 180-189; 8 points - heart rate 190-199; 9 points - heart rate 200-209; 10 points - heart rate 210.

On the basis of the ranking in heart rate points, a scale of the intensity of the load by exercise groups was developed, presented in table 1. For the convenience of analyzing the intensity of the load, exercise groups were distributed on the indicated scale according to the degree of specialization, i.e. by the degree of their similarity to competitive actions, conditions and situations. The planning of training loads, namely the intensity, should be assessed not only in absolute, but also in relative values. In the latter case, for the initial reference level, i.e. for 100%, the maximum intensity in each exercise group is taken.

Table 1. Characteristics of training and competitive loads used in taekwondo

GE	Name of exercises, peculiarities of their performance	heart rate	LNb	RI%
I	Running: steady pace	120-129	1	17
	high tempo	170-179	6	100
	Resistance exercises: medium pace, light weight, short-term accelerations	140-149	3	33
	Resistance Exercise: High Tempo, Medium and Heavy	150-159	4	67
II	Imitation exercises of movements:			
	slow pace	130-139	2	33
	average pace	150-159	3	50
	Shadowboxing: high tempo	160-169	5	83
	high tempo with long accelerations	170-179	6	100
	Exercises on the legs (practicing individual strikes):			
	low rate,	140-149	3	43
	average pace	150-159	4	43
III	steady pace	160-169	5	71
	high pace with acceleration	170-189	7	100
	Difficult technical and tactical actions (practicing individual techniques): low tempo (weak partner)	150-159	4	57
	average steady pace	160-169	5	71
IV	high pace with acceleration (strong partner)	170-179	6	86
	Conditional combat: medium pace			
	high pace with acceleration	180-189	7	100
IV	Free fight: medium pace (weak partner)	180-189	7	70
	high pace (strong partner)	190-199	8	80
	Competitive battle	210 и ↑	10	100

Note: GE - group of exercises, I - general developmental exercises, II - special preparatory exercises, III - Complex technical and tactical actions and conditional fights, IV - competitive exercises, LNb - load intensity in points, RI% - relative intensity in percent

In order to determine the informativeness of this method for assessing the intensity of the load, a correlation analysis was used, through which a high degree of connection was established both between the scores of the intensity and the average values of the heart rate for the training session ($r = 0.78$ at $p > 0.01$), and between corresponding marks for technical actions ($r = 0.71$ at $p > 0.001$) (Koshcheyev O.S., 2014).

Based on the data obtained, we propose to determine the relative intensity of the load in taekwondo in each group of exercises and express it as a percentage of the point assessment of the intensity of an exercise (determined by the intensity scale) to its maximum value in this group (Table 2).

Table 2. Intensity scale of training and competitive loads

The focus of the training impact	heart rate	heart rate (in 10 seconds)	score
Predominantly aerobic	114-150	19-25	1-3
Mixed aerobic-anaerobic	156-180	26-30	4-7
Anaerobic glycolytic	186-198	31-33	8-10

In order to reveal the informativeness of the indicated assessment of the load intensity, the degree of relationship with the average values of the heart rate in the training session was determined. The method for determining it was the same as in identifying the informativeness of the point assessment of the intensity of the load. As a result of the correlation analysis, a rather high degree of connection between the indicated indicators was revealed ($r = 0.73$ at $p > 0.01$). The data obtained indicate a rather high informativeness of the assessment of the relative intensity (Koshcheyev O.S., 2014).

Having determined the values of training and competitive loads in the training of taekwondo fighters, we can reveal and determine the peculiarities of planning a pre-competitive mesocycle according to the principle of a "pendulum". We note that the «traditional» system of the pre-competition mesocycle, the duration of which is 3 weeks (21 days), of which 17 training days, 4 days of rest, 36 trainings (25 trainings with high and maximum loads). This planning of the mesocycle provides for the planning of shock and model microcycles (Matveev L.P., 1999, 2010; Sarajkin D.A., 2012; Sadowski J., 2015; Platonov V.N., 2013, 2015; Bubka S.N. et al., 2017, 2018). The control group trained according to the «traditional» planning system of the precompetitive mesocycle.

The construction of a precompetitive mesocycle according to the principle of a «pendulum» (Arosyev D.A., 1969, 1982), according to which the main group was trained, is based on the planning of specialized and contrast microcycles, which allow intensifying the training loads and accelerating the recovery processes of the body in athletes. The specialized microcycle is aimed at improving the special, technical-tactical, physical, moral and volitional training of taekwondo players; the contrasting one is aimed at restoring the functional state of the athletes' organism (Table 3).

Table 3. Characteristics of the precompetitive mesocycle according to the «pendulum» principle (main group)

Indicators / microcycle	Specialized	Contrasting	Together
Training days, number	10	6	16
Training sessions, number	20	12	32
Holidays, number	-	-	2
Duration of classes, minutes	135	135	-
Classes with a large and maximum load, number	8	2	10

The intensity of the training load (control group) when performing special-preparatory and competitive exercises ranged from 17% to 95%, with heart rate from 120 to 220.

Each training lesson had a certain orientation, content, intensity of the load according to the assessment scales developed by us, presented in table 1, 2 (Table 4).

Table 4. Characteristics of training in the pre-competition mesocycle according to the «pendulum» principle

Pre-competition mesocycle																						
type of mesocycle	Contrasting		Specialized		Contrasting		Specialized		Contrasting		Specialized		Contrasting		Recovery		Specialized		Contrasting			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20			
Characteristic training loads	SPT		Speed		Speed		Speed		Power		Speed-power		Flexibility		Speed		Endurance		Speed-power		special endurance	
	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training		
Focus	Power		Speed-power		Speed		Speed-power		Power		Speed-power		Special endurance		Speed-power		Power		Speed-power		Speed	
	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training		
Content	RC		CTTA		GPP		CTTA		GPP		CTTA		SPT		CTTA		SPT		CTTA		RC	
	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training		
Load intensity (points) / Relative intensity (%)	2/20		1/17		3/35		1/15		2/20		2/25		3/35		4/45		1/20		5/50		6/65	
	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training	1 training	2 training		
	2/33	1/19	1/17	3/45	1/19	2/30	2/30	3/40	4/50	1/20	5/60	6/70	1/20	9/80	8/70	1/15	10/100					

CTTA - complex technical and tactical actions; SPT - special physical training; GPP - general physical preparation; RC – readiness control

To determine the effectiveness of pendulum planning on the principle of «pendulum», at the end of the pre-competition mesocycle, a control test of control and core group indicators of physical fitness, mental state, and accuracy of muscular effort and coefficients of competitive activity were performed.

The analysis of physical fitness indicators allowed to establish significant changes in the core group in the control tests «coefficient of special endurance» and «running eight with a change of direction» at p <0.05

(Table 5.). The coefficient of variation indicated an internal homogeneity of the results of athletes' training (CV = 0.01-10.3%).

Table 5. Indicators of physical fitness of highly skilled taekwondo fighters before and after the pre-competition mesocycle

Control tests to physical fitness	Stage of pedagogical experiment											
	Before						After					
	Control group (n=10)			Core group (n=10)			Control group (n=10)			Core group (n=10)		
	Statistical characteristics											
	\bar{x}	\pm SD	CV	\bar{x}	\pm SD	CV	\bar{x}	\pm SD	CV	\bar{x}	\pm SD	CV
Cooper's test (run 12 minutes), km	2,13	0,15	7,0	2,13	0,03	1,4	2,14	0,20	9,5	2,14	0,22	10,3
Coefficient of special endurance, point	0,2	0,02	10,0	0,19	0,01	5,3	0,19	0,01	5,3	0,17*	0,01	5,9
Running eight with a change of direction, s	14,1	0,16	1,1	13,1	0,31	2,4	13	0,1	0,8	11,4*	0,31	2,7

\bar{x} – mean, SD – standard deviation, CV – coefficient of variation, * level of significance p<0,05

The increase in indicators in the tests: «Cooper's test» in the main and control groups was 1.0%; «Coefficient of special endurance» in the control group 1.0%, in the main group 4.9%; «Running eight with a change of direction» was in the control group 7.8%, in the main group 12.9%.

One of the important criteria for training in the pre-competition mesocycle is to determine the mental state of taekwondo athletes according to the method of «VAM», which allows the athlete to assess their athletic health, activity and mood. According to the scale of evaluation of the method «VAM», the conditional unit from 0 to 3 is considered positive.

Figure 1 presents the average values of the level of mental state of the activity of athletes of the control and main groups. It was found that in the main group the activity rate was from 0 conventional units to 3 (conditional unit) conventional units, in the control group the range of oscillations ranged from - 2.8 conventional units up to 3 conventional units. Identical results are observed in the indicators of well-being and mood.

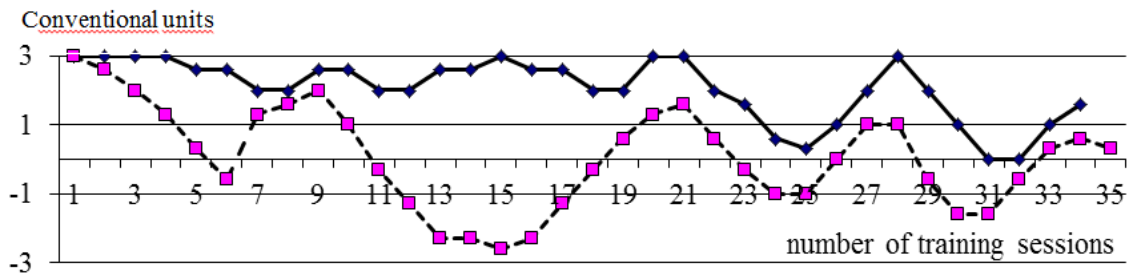


Figure 1. The value of activity indicators according to the method of «VAM» during the second pre-race mesocycle: core group; control group

A similar trend is observed in the average values in the indicators of the accuracy of muscular effort in the test of dynamometry of the hand (Figure 2). The range of fluctuations of muscle effort errors in the main group ranged from -0.8 kg to 1 kg, while in the control group - from -3 kg to 1.5 kg, at p < 0.05. This indicates that in the main group the level of fatigue is lower than in the control group at the end of each training session.

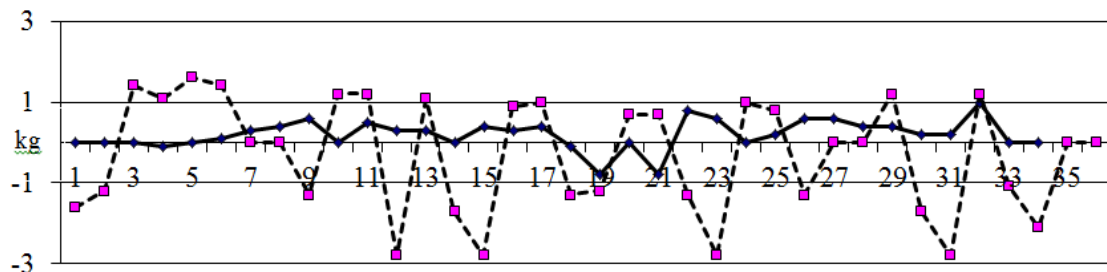


Figure 2. Range of fluctuations in the accuracy of muscular effort during the pre-race mesocycle: core group; control group

Analysis of the obtained indicators of «VAM» and the accuracy of muscular effort indicates a rational planning of the training load on the principle of «pendulum» (used in the main group) in the pre-competitive mesocycle, which confirms the analysis of the relationship ($t = 5,01-23,2$, at $r < 0.05-0.001$).

Indicators of the coefficients of effectiveness of competitive activity after the pre-competition mesocycle are presented in Figure 3. The most significant differences occurred in the main group in the coefficients: strong blows, attack, defense, combat effectiveness, endurance in battle ($p < 0.05$). The coefficient of hits in the control group was better than in the main group by 6% ($p < 0.05$), as well as in the coefficient of strong blows ($p < 0.05$).

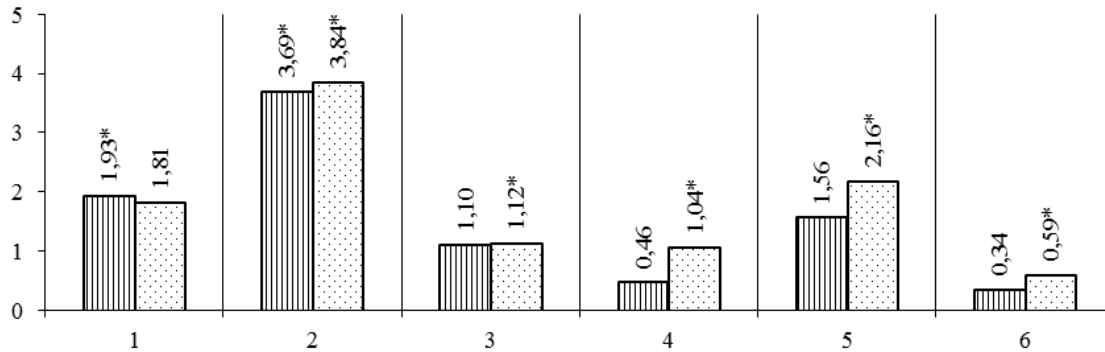


Figure 3. Coefficients of efficiency of competitive activity after pre-competition mesocycle: 1- coefficient of hits; 2 - the coefficient of strong blows; 3- attack factor; 4 protection factor; 5 combat effectiveness ratio; 6 coefficient of endurance in battle: * - significant difference at $p < 0,05$; ▨ - core group; ▩ - control group

A comparative analysis of the results of the competitive activities of the two groups showed that the main group, compared to the control, improved all its competitive performance by an average of 17%, which allowed most athletes to win prizes in the Ukrainian championship and take first place in the team standings.

Discussion

From the point of view of scientific discussion, there is a problem of planning training loads during preparation for a competition directly in the process of a precompetitive mesocycle. In sports practice, there are different methods for planning a pre-competitive mesocycle. Many scientists say that there is a traditional approach (Matveev L.P., 1999, 2010; Sarajkin D.A., 2012; Sadowski J., 2015; Platonov V.N., 2013, 2015; Bubka S.N. et al., 2017, 2018; Losik, L., 2018) which must be adhered to. However, some authors (Arosyev D.A., 1969, 1982; Vorob'ev A.N., Ermakov A.D. 1972; Tumanian H.S., 1984) talk about other approaches to planning a pre-competitive mesocycle, taking into account the characteristics of the athlete's body reaction to training loads.

In this study, for the first time, the construction of a precompetitive mesocycle on the principle of a «pendulum» in the training system of taekwondo athletes at the stage of maximum realization of individual capabilities was revealed. This is principle is based on the planning of two types of training: special and contrast, which allow you to regulate not only the training load, but also the recovery processes of the body of athletes.

Such planning is effective, which is confirmed by the results obtained at the end of this mesocycle (an increase in individual indicators of physical fitness, stabilization of the mental state, accuracy of muscular efforts) and the results of competitions (efficiency coefficients).

Practice shows that in the system of training athletes there are contradictions regarding the planning of the training load, taking into account its intensity. Therefore, in our study, for the first time, the ranking of heart rate indicators was performed, the characteristics of training and competitive loads in taekwondo were revealed, the intensity of the load in balls and the relative intensity were determined. Such a study allowed us, and later taekwondo trainers, to plan training loads more specifically with an emphasis on its orientation (aerobic, aerobic-anaerobic, anaerobic-glycolytic).

Scientific studies have proven that the performance of training loads of any intensity affects the psychological state of athletes and reduces the tone of muscle efforts. In our study, this fact is confirmed. However, thanks to a clear planning of training loads, taking into account the scales developed by us (Tables 1, 2), the athletes of the main group showed stabilization of their mental state according to the «Well-being - Activity - Mood» method (from 0 to 3 points) and the accuracy of muscle efforts (from -0.8 kg to 1.0 kg). The results of these studies allowed, in some cases, to make a planning correction for training loads.

Thus, the study made it possible to confirm the effectiveness of the scientific approach of D.A. Arosyev (1969) planning a precompetitive mesocycle according to the "pendulum" principle and to recognize it as more expedient than the traditional approach. Based on the results obtained, planning according to the "pendulum"

principle can be recommended in the system of training athletes specializing in martial arts and used at various stages of sports training.

Conclusions

1. Analysis of scientific and methodological literature showed the need to search for the direction of improving the system of training highly qualified athletes in the pre-competition mesocycle directly in taekwondo. It is stated that the achievement of a high sports result depends on the achievement of the peak of sports form for the main competitions, which is achieved precisely in the pre-competition mesocycle. In this regard, it became necessary to develop approbation of training planning according to the «pendulum» principle and to develop criteria for assessing the intensity of training loads.

2. Analysis of heart rate indicators in the process of competitive activity allowed us to develop a ranking of heart rate in points from 1 to 10, as well as a scale of intensity of training and competitive loads from 1 to 33. The information content of the developed scales is very high, since a high degree of connection between the intensity of training loads with heart rate and technical actions ($r = 0.78$ at $p > 0.00$; $r = 0.71$ at $p > 0.00$; $r = 0.73$ at $p > 0.01$).

These scales allow you to accurately plan individual training loads of a specialized orientation, in this case in a pre-competition mesocycle according to the «pendulum» principle.

3. Planning a precompetitive mesocycle according to the «pendulum» principle allows planning significant training loads in a specialized and contrasting microcycle, thanks to which overtraining can be avoided. This is due to the fact that in the process of training, the load is planned in waves with an emphasis on the recovery of the athlete's body in the range from 1 to 10 points.

4. It has been established that the construction of pre-competition mesocycles according to the «pendulum principle» is more effective in comparison with the «traditional» planning option. This is confirmed by the indicators of the main group, which were obtained at the end of the precompetitive mesocycle. A significant increase in physical fitness indicators and coefficients of competitive activity ($p \leq 0.05$) was revealed. The stabilization of the mental state (from 0 to 3 points), the accuracy of muscular efforts (from -0.8 kg to 1.0 kg) was determined.

5. Planning the training load in the pre-competition mesocycle according to the «pendulum» principle allowed increasing the competitive result in the main group by an average of 17%, which indicates its effectiveness and can be recommended in the training system of taekwondo athletes of a lower level of preparedness.

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Conflict of interest

The authors state no conflict of interest.

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