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Optimization Of Physical Loads As A Basis For Formation Of The Coordination Features Of Young Taekwondo Athletes.

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ABSTRACT

To develop optimal models of training loads for the formation of coordination abilities of young taekwondo athletes. The study was conducted on young taekwondo athletes aged 16-17 having the level of training of the first sports category and candidate for master of sports. Difference sensorimetry of kinesthetic, visual and vestibular systems during the training session, methods of mathematical statistics. It was established that the sensorometry parameters were changing during the training session. Best level of perception of sensory systems was observed after warming up at a heart rate of 145-155 beats/min. In addition, it is established that the accuracy of the execution of technical elements depends on the level of certain sensory functions. The level of sensory perception depends on the specific heart rate. The most optimal heart rate is 145-155 beats/minute. The accuracy of technical elements depends on the level of individual sensor functions. Therefore, they must be trained in conditions of the competitive intensity.
Keywords: training, heart rate, sensory functions.

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INTRODUCTION

Materials of research of domestic and foreign literature, modern theories and concepts indicate that the study of mechanisms for controlling arbitrary movements was, is and will be an urgent problem. This is due to the fact that in sporting activities the requirements to the accuracy of performance of motor acts that occur under conditions of the time deficit against the background of physical and neuro-emotional stresses are significantly increased (Kozina, 2009; Platonov, 2007).

In this regard, the importance of the effectiveness of development of coordination abilities is increasing, as the basis for controlling motor activities in competitive activities (Gray, 2004; Pashkov, 2007; Pidorya, 1992; Sokalsky, 1991).

The current level of development of martial arts is characterized by a complex coordinated activity, which is carried out on the basis of perception, processing of information and on the basis of the reproduction of certain parameters of motion (Korobeynikov, Sakal & Rossokha, 2004; Malkov, 2008). Therefore, the definition of psychosensory perception of movement is the basis of coordination of movements (Ashanin & Romanenko , 2015; Rovniy & Lizogub, 2016; Tropin & Shatskikh, 2017).

The level of special working capacity of athletes determines the effectiveness of sports activities and depends on the rational construction of the training process (Platonov, 2007).

When make planning training sessions, it is very important to plan a warm-up, which prepares the musculoskeletal system and establishes a certain level of functional activity of the athlete's body systems (Korobeynikov, Sakal & Rossokha, 2004; Platonov, 2007).

When carrying out preparatory and special exercises for the warm-up, it is necessary to take into account that excessive or insufficient intensity of the exercises causes a negative state of the body in the subsequent parts of the training session, which causes the traumatism as well (Maccloskey, 1987; Maglevaniy, Huskivadze., Kravchuk & Strelbitsky, 2010).

The planning of training sessions should be built in such a way as to constantly improve the level of fitness, that is, the body's ability to adapt effectively to gradually increasing loads (Cafarelli, 1992; Beilock, Bertenthal, McCoy & Carr 2004; Rovniy, et al., 2017, 2018; Filenko, Ashanin, Pasko, Tserkovna, Filenko, Dzhym & Tykhorskyi, 2018).

However, such adaptation has its own "worth". Therefore, the forecasting of the body condition of athletes in the process of performing physical exertion should be aimed at identifying early signs of fatigue of regulatory systems, which will provide a modern correction of physical exertion.

The analysis of the scientific and methodological literature did not reveal recommendations on the improvement intensity of the warm-up and the main part of the training sessions in order to optimize the physical loads in developing the coordination abilities of young taekwondo athletes, which was the subject of our research.

Purpose of the research.

To develop optimal models of training loads for the formation of coordination abilities of young taekwondo athletes.

METHODS AND ORGANIZATION OF RESEARCH

Participants. 20 taekwondo athletes aged 16-17 years, having the level of training of the first sports category and candidate for master of sports took part in the research.

Basic research methods. Differential sensitivity of the kinesthetic sensory system – the number of differential thresholds was determined with an increase in weight from 50 g. up to 1000 gr. (Rovniy, 2000).

Differential sensitivity of the visual sensory system – the number of differential thresholds for increasing the brightness of light from 4.33 NIT to 800 NIT was determined.

Investigation of the dark adaptation took place on the ADM-2 adaptometer. The researcher looked at the ball with a brightness of 1.250 apostils for 2 minutes. After turning off the light, the subject should see a certain object in total darkness. Time was fixed.

Investigation of visual acuity was carried out with the help of the Best's slot-stick apparatus according to the method of Sachsenweger. Subject in sitting position looked in the window of the device, which stood at a distance of 1 meter. The lighting inside the device was matte-white and illuminated the black slot. In the middle of this gap there was a black rod that moved forward and backward. The subject recorded a visual finding of the rod in relation to the gap in mm.

Method of vestibular sensitivity. Vestibular sensitivity was determined by Rovny's A.S. method by recording the nystagmus during rotation. The threshold of vestibular sensitivity was determined at rotational speeds from 3º to 45º per second. Thus, the rotational speed was selected, which was threshold for each subject.

Method for reproducing a given effort. In order to characterize the coordination abilities, the technique of reproducing the given force was used. The subject reproduced a preset effort with the eyes closed, equal to 50% of the maximum. Of the 3 attempts, the average accuracy of the force was determined.

The method of reproducing the spatial parameter of motion consisted in reproducing a given angle of 60% by the method.

Study design. The training process was designed in such a way as to determine at what heart rate (125-135-145-155-165-175 beats/min) the subjects most accurately demonstrate their sensory and coordination abilities. The study was carried out in a preparatory mesocycle lasting 2 months.

Statistical analysis. Generalization of the studied characteristics was assessed by mean arithmetic value, standard deviation and error of mean arithmetic. Confidence of differences between mean values was stated by Student's t-criterion. Assessment of statistical hypothesizes based on 5% significance level. For statistical processing of data we used licensed program Microsoft Excel (2010). Statistical analysis of the received results was conducted, considering recommendations on the Microsoft Excel tables usage for computer data analysis.

RESULTS OF THE RESEARCH

The control of the accuracy of the motion depends on the functions of the state of the sensory systems and therefore one can assume that for their characterization the positions of the theory of functional systems are decisive. Consequently, the afferent synthesis forms the activity of the action acceptor, which indicates that each component of the movement control functions not as such, but as an integral part of the purposeful motor activity.

The constant increase in the requirements of special sports activity raises the need for a comprehensive study of sensory systems, their intersensory links, the leading sensory function in managing the complex coordinated actions of athletes in conditions of intense training and competitive activities. The study of the functional activity of sensory systems in various zones of intensity of the motor activity is the subject of our research.

During two months of the preparatory period, studies of sensory systems had been conducted under the same conditions of training exercises for the taekwondo athletes to determine the dynamics of their change.

Investigations of the activity of sensory systems were carried out in the following order: at rest (heart rate 65-70 beats/min), after warm-up (heart rate 145-155 beats/min), in the middle of training (heart rate 155-165 beats/min) and at the end of training (Heart rate of 175-180 beats per minute). Such changes in heart rate parameters are due to a large number of variational situations that arise in the process of competitive activity of the taekwondo athletes.

Dynamics of the functional state of sensory systems during the training sessions is presented separately.

In Table 1 shows the differential sensitivity of the kinesthetic system, its average differential threshold, accuracy of reproduction of a given force and a given parameter of motion (angle).

Table 1: Indicators of kinesthesia during the training session of young taekwondo athletes at the beginning of the preparatory mesocycle

Tests / Stages change	Before training Heart rate 65-70	After a warm-up Heart rate 145-155	In the middle of training heart rate 155-165	At the end of the workout Heart rate 170-180
Differential sensitivity (number of thresholds)	21.80±0.30	25.60±0.70	22.70±0.80	18.80±0.70
The average differential threshold (gr)	45.80±0.12	39.05±0.17	44.05±0.32	50.19±0.32
Playing the specified angle (degrees)	9.50±0.07	7.15±0.02	13.80±0.08	14.70±0.04
Reproduction of the given effort (kg)	6.40±0.08	5.80±0.02	6.80±0.04	7.40±0.08

The differential sensitivity of the kinesthesia testifies to this pattern, the greater the thresholds of sensation of weight gain the smaller the differential threshold. In this case, the greatest number of thresholds of sensations is observed after the warm-up, when the sensory perception system has reached the optimal level at a heart rate of 145-155.

The smallest error in the reproduction of the power parameter of motion and spatial one is observed in the same heart rate range.

The increased load and the development of fatigue at the end of the exercise cause a statistically significant decrease in the level of sensitivity.

An analysis of the change in the differential sensitivity at the end of the training session (previously in Table 2).

Table 2: Dynamics of kinesthetic sensitivity of young taekwondo athletes during the training session at the end of the preparatory mesocycle

Tests / Stages change	Before training Heart rate 65-70	After a warm-up Heart rate 145-155	In the middle of training heart rate 155-165	At the end of the workout Heart rate 170-180
Differential sensitivity (number of thresholds)	22.80±0.08	27.80±0.02	24.20±0.60	20.20±0.08
The average differential threshold (gr)	43.40±0.11	35.70±0.07	41.60±0.20	49.00±0.12
Playing the specified angle (degrees)	7.17±0.03	5.80±0.07	9.80±0.08	12.60±0.04
Reproduction of the given effort(kg)	5.80±0.02	4.60±0.01	6.20±0.05	7.00±0.07

Adequate changes have been established at the beginning of the training session. However, the level of change at the end of the training session is statistically lower than in the first case. Thus, the number of differential thresholds in the first case at the end of training decreased by 14.2% and at the end of the training session by 9.09%. The mean differential threshold at the beginning of the training session increased at the end of the training session by 15.09%, and at the end of the session by 11.2%. Thus, at the end of the training camp, despite the increase in the intensity of the loads, the biological stability of the kinesthetic sensory system is observed, which ensures an increase in the accuracy of the competitive activity.

Increasing the accuracy of the differential thresholds of the power and spatial parameter of movements is the basis of the exact performance of athletes in the competitive activities.

The sensitivity of the visual sensory system was studied by the method of differential sensorimetry, as well as the determination of the threshold of deep vision and the time of dark adaptation.

The conducted studies show similar changes in the state of the visual system during the training session (Table 3 and Table 4).

Table 3: Indicators of visual sensitivity of young taekwondo athletes during the training session at the beginning of the preparatory mesocycle

Tests / Stages change	Before training Heart rate 65-70	After a warm-up Heart rate 145-155	In the middle of training heart rate 155-165	At the end of the workout Heart rate 170-180
Differential sensitivity (number of thresholds)	18.80±0.30	21.30±0.09	19.70±0.20	10.80±0.70
The average differential threshold (gr)	42.23±0.80	37.51±0.70	40.60±0.30	46.90±0.50
Deep Vision (mm)	8.80±0.03	7.90±0.01	8.60±0.07	9.50±0.04
Dark adaptation (with)	14.40±0.09	14.80±0.03	13.50±0.06	15.80±0.20

Table 4: Dynamics of visual sensitivity of young taekwondo athletes during the training session at the end of the preparatory mesocycle

Tests / Stages change	Before training Heart rate 65-70	After a warm-up Heart rate 145-155	In the middle of training heart rate 155-165	At the end of the workout Heart rate 70-180
Differential sensitivity (number of thresholds)	20.80±0.02	23.30±0.07	20.70±0.09	18.20±0.05
The average differential threshold (gr)	38.46±0.10	34.33±0.30	38.80±0.40	44.90±0.12
Deep Vision (mm)	8.80±0.03	6.80±0.03	7.80±0.04	9.30±0.04
Dark adaptation (with)	12.20±0.09	10.70±0.02	12.80±0.06	14.90±0.08

Thus, at the beginning of the training session the dynamics, the number of differential thresholds varies according to the intensity of the heart rate. The greatest number of differential thresholds is observed after the warm-up, when the heart rate is within 145-155 bpm. With increasing load, the distinctive ability of the visual sensory system is reduced.

One of the important indicators in performing a difficult-coordinated motor activity is deep vision. As can be seen, the smallest threshold of perception of the approximation of the object is observed after warming up at an intensity of heart rate of 145-155 bpm.

The parameters of dark adaptation characterize the general adaptive ability of the visual system and depend on the oxygen saturation of the blood. The level of heart rate is 145-155 bpm is the most favorable in providing adaptation processes.

At the end of the training session, similar reactions of the visual sensory system are observed (Table 5), however the levels of sensitivity change are significantly lower than at the beginning of the training session. Thus, at the beginning of the session at the end of the training, the total number of differential thresholds decreased by 10.9%, and at the end of the training session by 8.8%. The indicator of deep vision at the end of the training session increased by 7.8%, and at the end of the session by 5.6%.

Analysis of the study materials revealed a high level of the truth in the threshold of vestibular sensitivity at the end of the training session ($p<0.01$). During the two-month training session the athletes performed the technical techniques of taekwondo in conditions close to the competitive ones. Gradually the sensitivity to vestibular irritants decreased, and the irritants of the strength increased in angular degrees.

Study materials show the dynamics of vestibular sensitivity throughout the training session, the intensity of which was determined by heart rate. Thus, in the middle of the exercise at a heart rate (155-165 bpm), the greatest vestibular stability is observed. The evidence of this phenomenon is the regularity of attunement of all systems of the organism at this intensity of heart rate. This is confirmed by the definition of vestibular stability based on changes in homodynamic under the influence of rotational loads. The level of blood pressure and heart rate determine vestibular stability in points (Table 5). The increase in vestibular stability is observed in the middle of the training both at the beginning and at the end of the training session $p<0.01$).

Table 5: Dynamics of vestibular sensitivity of young taekwondo athletes during the training session at the end of the preparatory mesocycle

Stages of training	Before training Heart rate 65-70	After a warm-up Heart rate 145-155	In the middle of training heart rate 155-165	At the end of the workout Heart rate 170-180
Vestibular sensitivity (angular degrees)				
At the beginning of the session	7.80±0.03	8.40±0.07	9.20±0.05	8.20±0.02
At the end of the session	8.40±0.06	8.80±0.04	9.60±0.04	8.90±0.07
All-viability stability (points)				
At the beginning of the session	3.76±0.03	3.91±0.01	4.15±0.02	3.67±0.07
At the end of the session	3.88±0.06	3.99±0.07	4.18±0.03	3.61±0.04

In order to identify the role of sensory functions in performing one of the main technical elements of competitive activity, kicks for 40 seconds (Ap dollyo chagi) were performed in the middle level. At the beginning of the training, young athletes performed an average of 65.3±0.78 beats per 40 sec. The application of regression analysis established the following pattern:

$$Aps=3,52CHS+4,06FS+2,53GS-1,74KS+1,09PS-$$
$$-0,87VS+0,57ZS+0,17TAS$$

where Aps is the number of beats per 40 sec; CHS – vestibular sensitivity; FS – threshold of accuracy of effort; GS – threshold of deep vision; KS – kinesthetic sensitivity; PS – the threshold of accuracy of the spatial characteristic of motion; VS – vestibular stability; ZS – visual sensitivity; TAS – dark adaptation.

The presented mathematical model makes it possible to evaluate the contribution of each factor to the performance of a given test. The method of reverse step regression allows you to identify the most important factors in providing this exercise:

$$KAps=4,38CHS+2,059PS$$

Where KAps – the number of strokes in 40 sec; CHS – vestibular sensitivity; PS – the threshold of accuracy of the spatial characteristic of motion.

Investigating the execution of Ap dollyo chagi in the course of the training session it is found that their number varies depending on the intensity of the loads performed at the heart rate.

So, after a warm-up at a heart rate of 145-155 bpm the main sensory functions of the inverse regression equation were:

$$KAp_1=3,066GS_1+0,243VS_1$$

where KAp_1 – the number of strokes in 40 sec; GS_1 – threshold of deep vision; VS_1 – vestibular stability.

In the middle of the training lesson against the background of high motor activity at a heart rate of 155-165 beats/min, the main factors in the performance of the test are:

$$KAp_2=1,864GS_2–1,482CHS_2+PS_2$$

where KAp_2 – the number of strokes in 40 sec; GS_2 – threshold of deep vision; CHS_2 – vestibular sensitivity; PS_2 – the threshold of accuracy of the spatial characteristic of motion.

At the end of the training lessons at the beginning of the training session with the intensity of the training load at a heart rate of 170-180 bpm, the number of Ap dollyo chagi beats depends on:

$$KAp_3=1,460KS_3+1,275VS_3+0,728FS_3$$

where KAp_3 – the number of strokes in 40 sec; KS_3 – kinesthetic sensitivity; VS_3 – vestibular stability; FS_3 – accuracy of the power parameter of motion.

At the end of the training session the sensor control system has significant changes. The equations of stepwise regression determine five factors on which the performance of Ap dollyo chagi impacts depends after a warm-up on the background of a heart rate of 145-155 bpm:

$$KAp_i=2,47CHF_1+4,74FF_1+1,86GF_1+0,38KF_1+0,114VF_1$$

where KAp_i – the number of strokes in 40 sec; CHF_1 – vestibular sensitivity; GF_1 – threshold of deep vision; KF_1 – kinesthetic sensitivity; VF_1 – vestibular stability.

Trainings at the beginning of the training session are characterized by increased intensity and therefore already in the middle of the training the equation of stepwise regression is determined by the main factors of the accuracy index of reproduction of the spatial and power characteristics of the motion:

$$KAp_2=1,914PF_2+0,79FF_2$$

where KAp_2 – the number of strokes in 40 sec; PF_2 – accuracy of the spatial parameter of motion; FF_2 – accuracy of the force parameter of motion.

At the end of the training lesson at the end of the session there is accumulation of fatigue, which causes a significant decrease in the functional activity of all sensory systems. Motor actions are performed against a background of constant vestibular irritation. Therefore, the equation of stepwise regression determines the main factor in the performance of shock movements vestibular stability:

$$KAp_3=3,649VF_3$$

where KAp_3 is the number of strokes; VF_3 – vestibular stability.

Thus, the presented studies indicate that at the beginning and at the end of the training session the performance of the coordinated actions of the taekwondo athletes depends on the level of vestibular sensitivity and stability. However, this dependence varies according to the level of fitness.

DISCUSSION

Complexly coordinated activities in martial arts and in particular in Taekwondo put forward constantly changing tasks to achieve the accuracy of motor actions in the conditions of competitions (Tropin, Romanenko & Ponomaryov, 2016).

Specificity of motor activity of taekwondo athletes consists in the instantaneous transition from protective actions to attackers. In this respect, the development of coordination abilities is the basis for the management of the training process (Rovniy, 2015).

Modern studies (Rovnaya, Ilyin & Rovniy, 2010; Rovniy & Rovnaya, 2014) indicate that complexly coordinated activities are carried out on the basis of perception, information processing and reproduction of certain parameters of motion on its basis. Therefore, the study of individual sensory functions and their role in performing precision movements is one of the main tasks in the preparation of martial artists (Laming, 1985; Enoka, 1994).

The level of special working capacity of athletes ultimately determines the effectiveness of sports activities and the rational distribution of training load (Roll & Vedal, 1982).

In the preparatory part of the training lesson there should be a rational load in order to achieve the highest level of perception of information by sensory functions (Rovnaya, Ilyin & Rovniy, 2010; Rovniy & Rovnaya, 2014). To accelerate the perception of information, its processing and making an instant decision, it is necessary to conduct training s in conditions close to the competitive ones (Strelets & Gorelov,1995; Rovniy, 2015).

Hypoxic conditions of competitive activity reduce the level of visual perception and then the processing of this information. However, a gradual increase in hypoxic effects will contribute to the stability of the functions of the visual sensory system (Sybil M.G., Svysch Y.S., 2009).

The use of a variety of complex coordinated actions contributes to the increase of vestibular stability, which is the basis for increasing the accuracy of movements in competitive activity (Tkachuk & Kharitonova, 1992).

The conducted researches testify that sensory functions are involved in the management of the accuracy movements of taekwondo, but the level of their participation depends on the intensity of the movements performed (Rovniy, 2015).

Confirmation of our studies are the results of studies (Maglevaniy, Huskivadze, Kravchuk & Strelbitsky, 2010; Rovnaya, Ilyin & Rovniy, 2010; Maglovykh, Yavorsky & Tjorlo, 2012), which show that the accuracy of reproduction of sensory perceptions depends on the intensity of motor activity.

CONCLUSIONS

The analysis of the reference data of the experience of leading trainers on taekwondo testifies to the role of sensory functions in the complex coordinated activity of athletes.

The conducted researches testify that intensity of the carried out loading influences on a level of perception by sensory functions of the information on movements of the opponent. The most favorable intensity of movements at a heart rate is 145-155 beats/min.

The motor actions in the competitive activity considerably exceed the intensity and, therefore, significantly reduce the accuracy of the elements of taekwondo. Therefore, the sensory functions are trained at the intensity of the movements close to the competitive one.

Studies have established that the accuracy of motor actions in the conditions of competition depends on vestibular stability.

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