

*since curricula is designed in such a way that a student who does not attend any of the optional courses offered will be unable to complete a curriculum that involves the study of sciences disciplines to a certain extent. It is indicated that in US higher education institutions optional courses are selected with the consent of the University Consultative Committee from the list of courses offered by their own university or universities of other countries. It is noted that the study of the advanced ideas of future psychologists' natural sciences training in higher education institutions of the United States of America and their comparison with Ukrainian pedagogical experience will help to solve effectively the problems of its modernization in higher education institutions of Ukraine. In order to bring future psychologists' science preparation in Ukrainian higher education institutions in line with the world standards, it is expedient to modernize it taking into account native and foreign experience. The quality of future psychologists' science preparation in higher education institutions of Ukraine will increase if: its content will correspond to modern science achievements, will have a professional orientation, will contain general cultural information that will form future psychologists' understanding of the unity of science, culture and professional activity. It is necessary for modules and themes of the training courses to have logical sequence that will ensure unification of all knowledge, skills and abilities acquired during the learning process into a unified system, and implementation of science education and diagnosis of its quality will be carried out using innovative methods and modern technologies.*

**Key words:** *natural sciences training, future psychologists, higher education institution of the USA, foreign experience.*

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## **PROGRAMMING OF THE TRAINING PROCESS IN HANDBALL ON THE BASIS OF THE FUNCTIONAL CONDITION OF DIFFERENT SYSTEMS OF THE ORGANISM**

*The aim of the work was improving the effectiveness of training and competitive activity based on objective biomechanical assessments of the athletic adaptive capabilities. In order to achieve the goal, the methods of myometry and the system of video analysis of movements were used. As a result of the research conducted, skeletal muscle response to the proposed physical activities of various orientations and the speed of recovery processes of the skeletal muscle was revealed. Studies and results obtained allowed to establish the nature of changes in the elastic-viscous properties of skeletal muscles and to identify the optimal nature of the load activity.*

**Key words:** *myometry, functional state, skeletal muscles, load parameters, programming of the training process.*

**Introduction.** In sports games, the effectiveness of competitive activity is determined by the success of the game actions of the whole team. This implies

a high level of functional capabilities of the organism and technical skills of the players, adaptation of their organism to intensive work (Mishchenko et al., 1999). The criteria for the effectiveness of collective activity are the parameters of the competitive activity of the team, contributing to the achievement of victory both in a single match and in a series of games.

The effectiveness of collective action is determined by the level of individual preparedness of individual athletes. This contributes to creation and implementation of profitable game situations (Petracheva et al., 2016). This fact determines the presence of certain requirements to the state and competitive activities of individual players in accordance with their position (Bondarenko & Madzharov, 2010). These requirements are targeted at achieving high sport results and can serve as criteria for evaluating indicators of individual preparedness (Madzharov & Bondarenko, 2016).

Evaluation of training effects takes into account the processes of adaptation to strenuous muscular activity (Bosenko, 2017, p. 35). In this regard, regulation of training loads should be based on integrated analysis (Ignateva et al., 2005).

**Analysis of relevant research.** Training of an athlete is a multilateral process of expedient use of the totality of factors in order to ensure the necessary degree of his willingness to sporting achievements (Bondarenko, Kobets, 2010).

In the most general form, programming is a closed cycle of the closely related actions for the formulation, implementation and monitoring of specific decisions. Programming technology consists of several stages: decision-making, organization of performance, collection and processing of information, summarizing.

Determination of the behaviour of the organism of athletes serves as reference values and as a criterion of efficiency. Training of handball players, which is not based on the application of the criterion of effectiveness, on the basis of which is compared the effectiveness of different training systems, largely loses its focus, specificity, and therefore the validity (Ignateva & Petracheva, 2004).

The most relevant are the issues of training of handball players' control of techno-tactical skills. These issues relate to the evaluation of biomechanical parameters of movements of handball players. In earlier research we identified biomechanical characteristics of the movement of hands and feet when performing the throw (Pori et al., 2005); influence of kinematic characteristics of traffic on the performance of the final throw (Sibila, Pori, Bon, 2003).

Structure of training loads of handball players is determined by the qualitative and quantitative parameters. These settings are determined by the

criteria for urgent and long-term adaptation of skeletal muscles when executing special training. Some authors associate effectiveness of result in handball with optimization of technical actions (Wagner et al., 2008).

It seems that the requirements for increasing the efficiency of collective and individual competitive activities, as well as the state of the players, which are concretized as a result of the analysis of information, make it possible at the next management stage to begin the immediate planning of the training process.

The study of the biomechanical characteristics of the movements of handball players on the basis of taking into account the adaptive capabilities of the body of athletes is important. The data on the biomechanical structure of performing technical actions serve as the basis for purposeful work on improving the structure of the training process of handball players (Petracheva et al., 2016).

The study of the performance of skeletal muscles in the performance of special sports activities in recent years has been given great importance. At the same time, the vast majority of works are devoted to the study of the electrical activity of muscles (Vysochin & Denisenko, 2010). In the works of various authors the biomechanical features of the change in the technique of movement, depending on the functional state of skeletal muscles, are revealed. This interest of modern research indicates the relevance of the problem of optimization of physical activity, depending on the nature of the functioning of the neuromuscular apparatus (Bondarenko, 2016; Kobets, 2010; Chernous & Shilko, 2009).

**The study aims:** improving the effectiveness of training and competitive activity based on objective biomechanical assessments of the athletic adaptive capabilities.

During the study, the following tasks were solved:

1. Identify the criteria for training loads of handball players.
2. Determine the relationship of tools and methods of training in handball based on a biomechanical analysis of the actions performed.
3. Experimentally substantiate the structure of training loads of handball players.

It was assumed that programming of the training process of handball, based on an objective biomechanical assessment of the athletic adaptation capabilities, will provide a planned increase in the level of physical and technical-tactical fitness. The object of the study was the change in the level of physical and technical-tactical preparedness of the handball players, taking into account the biomechanical characteristics of skeletal muscles.

**Research methods.** The study was conducted in the laboratory of physical culture and sports of Francisk Skorina Gomel State University. It was

conducted in the framework of the State Program of Scientific Research of the Republic of Belarus "Convergence – 2020".

At the first stage, the functional state of skeletal muscles was determined by the the methods of myometry. We studied adaptation of skeletal muscles when performing physical activities with a special focus. The temporal parameters of the restoration of skeletal muscles after loads of special orientation were investigated.

The functional state of skeletal muscles is determined by the frequency of oscillations (frequency, Hz) – characterizing the muscle tension tonus; decrement (c.u.) – characterizing the parameters of skeletal muscle elasticity (the ability of the muscle to restore its original shape after contraction); stiffness (N/m) – characterizing the ability of a muscle to resist changes in shape as a result of exposure to external forces (force potential of a muscle).

Stiffness index ( $I_s$ ) characterizes the power potential of skeletal muscle. It was determined on the basis of the obtained indicators of the frequency of free damped oscillations of a relaxed muscle and the frequency of free damped oscillations of a stressed muscle. This parameter is interrelated with the change in the frequency of damped oscillations during the transition from a relaxed to a stressed state. Since, in the normal functional state of skeletal muscles, a parameter changes in the direction of a significant increase, the absence of a range of changes in the oscillation frequency when the muscle changes from relaxed to stressed indicates a disruption in normal functioning.

The decrement index ( $I_e$ ) characterizes the effectiveness of muscle work. It was calculated on the basis of the logarithmic decrement of free damped muscle oscillations in a relaxed and stressed state.

In order to assess the level of development of the motor abilities of the handball players, an informatively reliable battery of tests was used that were widely used in the theory and practice of handball.

The testing program included an assessment of the physical qualities that underlie physical training of handball players – strength, speed-strength qualities, endurance, explosive strength. The program also included tests that made it possible to judge the level of technical and tactical preparedness of athletes.

To determine the level of development of power and speed abilities, we used those exercises that are similar in structure to the motor actions of handball players, namely: pulling up on the crossbar, running 30 meters, a long jump from the spot and throwing a stuffed ball with both hands from behind the head.

To determine the level of development of coordination abilities a shuttle run of 10 meters by 10 meters was used. Endurance was determined by the motor Cooper's test.

The level of development of flexibility was determined by the test “lean forward from the sitting position”.

Technical training is characterized by the use of complexes of special physical exercises that contribute to the development of technical elements. From the entire list of tests, we selected the most informative ones, namely, performing 20 passes in a pair, dribbling the ball with obstructions and 5 throws the ball into the goal from the free throw line. These tests took into account the time of the assignment.

The analysis of the kinematic characteristics of the handball movement was carried out by the method of video filming, the system of video analysis of movements and the KinoVea software.

At the second stage, a pedagogical experiment was conducted to assess the impact of the experimental program on a sports result.

29 handball players from the handball club “Gomel” took part in the research.

**Results.** The functional state of skeletal muscles, when performing special exercises in handball, was carried out by the in vivo method, based on the data obtained in previous studies (Shilko & Chernous, 2007; Bondarenko, 2016).

The functional state of the following muscles was investigated: m. biceps brahii, m. triceps brahii, m. extensor Capri radialis longus, m. biceps femoris, m. rectus femoris, m. gastrocnemius (caput laterale and caput mediale). Individual performance indicators depended on the functionality of skeletal muscles. This was assessed by muscle tone (the difference in the frequency of oscillations in the muscle (frequency) in a relaxed and stressed state), adequate ability of the muscle to resist changes in its shape as a result of external forces (in terms of muscle stiffness in a relaxed and stressed state) and strength potential of skeletal muscle (in terms of stiffness parameters in a relaxed and stressed state).

We give an example of the reaction of skeletal muscle (m. Triceps brahii) when performing a series of repeated physical exertion (throws of a handball into the goal). The exercise was performed from two supporting starting position. The mode of operation is 30 seconds of active work after 1 min of rest. The functional state of the skeletal muscles was carried out at the end of each series of exercises, as well as every 24 hours after the exercise.

According to the results of the study we have revealed:

- the skeletal muscle tonus tension is in a state of normal (by the difference in the indicator in a relaxed and stressed state) during the first three exercise series. Starting from the 4th series, a decrease in the state of tension is observed, which is a consequence of the onset of fatigue;

- refusal to work marked after the 10th series. 24 hours after the exercise, a high level of muscle tonus in a relaxed state is observed, which indicates a low level of recovery of skeletal muscle and its inability to perform physical activity;

- recovery of muscle tone to normal occurs after 48 hours (shown in Fig. 1);

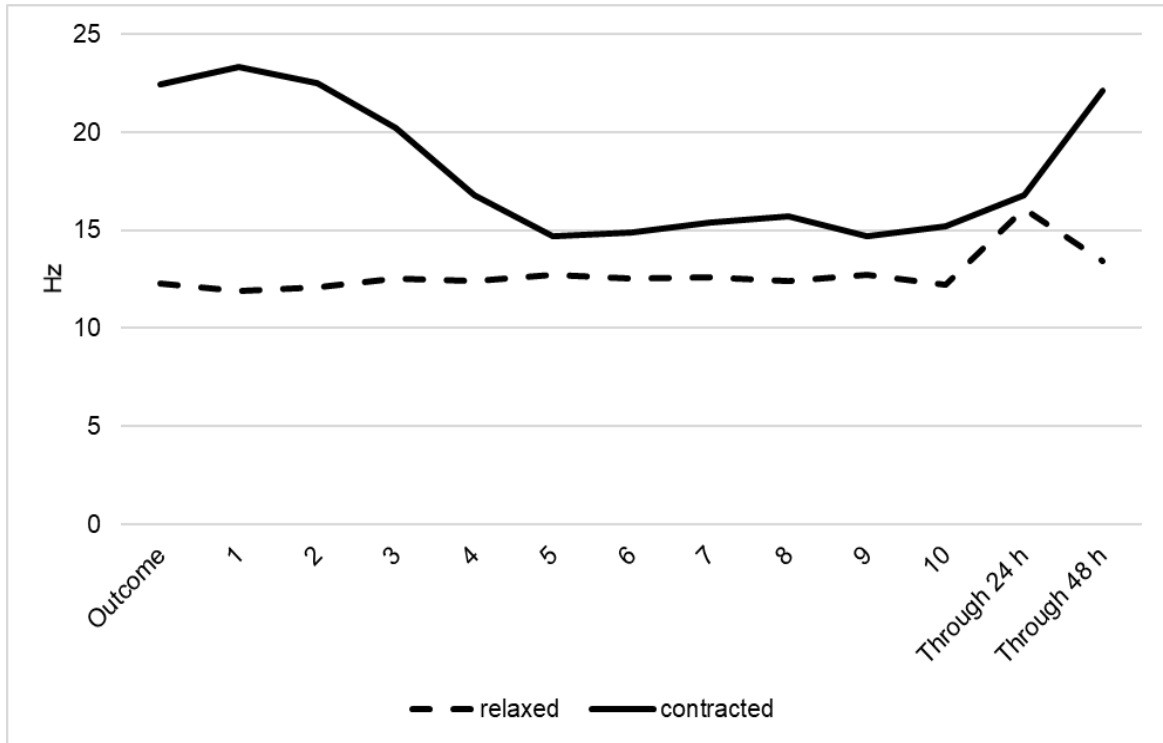


Fig. 1. Dynamics of change of vibration frequency of the triceps muscle of the shoulder when performing dynamic work to failure

- after the second repetition, a decrease in the elasticity of skeletal muscle occurs. Poor functional state is observed after the eighth repetition. In the future, there is an improvement in this indicator. In our opinion, this is a consequence of the activity of recovery mechanisms. Restoration of the elasticity index to the level of the norm is noted after 48 hours (shown in Fig. 2).

Adequate ability of the muscle to resist changes in its shape as a result of the action of external forces, determined by the indicator of muscle stiffness in a relaxed and stressful state, has a negative figure already after the fourth repetition. This indicates the onset of fatigue and the inability of the skeletal muscle to recover mechanical energy. Over the next six repetitions, this figure continues to decline. The worst indicators of this parameter, which determine the power capabilities of the skeletal muscle at a given time, are noted 24 hours after the end of the load. The restoration of the stiffness properties of the muscle to the level of the norm is noted after 48 hours. However, this time is not enough to restore to the initial level noted before the load began.

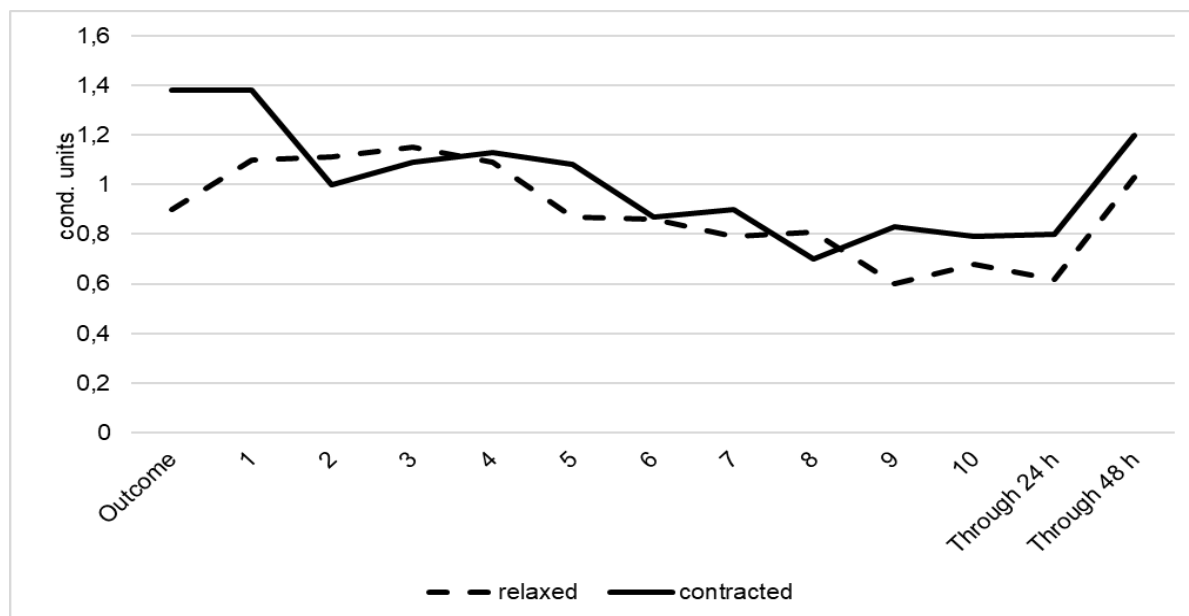


Fig. 2. Dynamics of changes in decrement indices of the triceps muscle of the shoulder when performing dynamic work to failure

Based on the results obtained in a preliminary study on the quantitative parameters of training loads, an experimental program of training sessions for the sports season was developed and tested.

In the course of a pedagogical study of indicators of physical and technical-tactical readiness of handball players, the following results were obtained:

- assessment of the level of physical fitness showed significant differences ( $p < 0.05$ ) in the following control tests: running 30 meters (before the experiment:  $4.49 \pm 0.19$ ; after the experiment:  $4.04 \pm 0.11$ ), Cooper's test (before the experiment:  $3155.4 \pm 93.1$ ; after the experiment:  $3550 \pm 157.2$ ) and long jumps from the spot (before the experiment:  $206.1 \pm 2.15$ ; after the experiment:  $214.4 \pm 3.03$ ). In the remaining control tests, no significant differences were found ( $p > 0.05$ );

- technical and tactical indicators of preparedness of handball players revealed significant changes at the end of the work. Table 1 shows the average group values of the tests used in the experiment.

To assess technical preparedness, the most informative tests were used: dribbling with obstructions, 20 assists in a pair, and 5 shots into the goal from the free-throw line.

When analyzing the results, significant differences were found in all control tests: dribbling with obstructions (before experiment:  $55.8 \pm 0.7$ ; after experiment:  $53.6 \pm 0.5$ ), 20 assists in a pair (before experiment:  $1.14, 8 \pm 0.036$ ; after the experiment:  $1.02.1 \pm 0.048$ ), 5 shots into the goal from the free-throw line (before the experiment:  $44.0 \pm 0.8$ ; after the experiment:  $41.0 \pm 0.2$ ).

Table 1

**Comparative analysis of technical and tactical preparedness of handball players**

Control test	Before	after
Performing 5 by throwing the ball into the goal from the line of free throws, s	44,0±0,8	41,0±0,2
t	3,64	
p	<0,05	
20 transmissions in pairs, min	1.14,8±0,036	1.02,1±0,048
t	2,17	
p	<0,05	
Running a ball with a stroke, s	55,8±0,7	53,6±0,5
t	2,56	
p	<0,05	

Based on the data obtained, it can be concluded that the level of physical and technical preparedness has significantly improved over the period of the experiment.

It can be stated that application of the experimental program has a positive impact on the level of technical and tactical preparedness of handball players (Fig. 3).

The improvement in the level of technical preparedness of the handball players can be judged by the percentage ratio of wins and losses in the game season (increase in winning games was 13 %).

**Conclusions.** On the basis of the data obtained, it is possible to judge the functional state of the skeletal muscles and make corrections in the training process, to make recommendations for implementation of rehabilitation measures.

The main direction of implementation of the effectiveness of the training process of handball players is organization and planning of physical activity based on the state of skeletal muscles.

The efficiency of managing training of handball players can be improved through the optimal use of the characteristics of their individual physical development, ergometric and biomechanical indicators, as well as the functional state of the body.

The main principles of the programming of the training process include the use of various options for constructing classes, which depends on the period in the annual cycle of the training process. The basis of the programming of the training process is the exercises that contribute to the preferential development of certain



properties and abilities that determine the level of special preparedness of handball players – speed or power qualities, anaerobic or aerobic performance, special endurance, etc. Besides, the solution of several tasks in one training session contributes to the integrated focus of the training process.

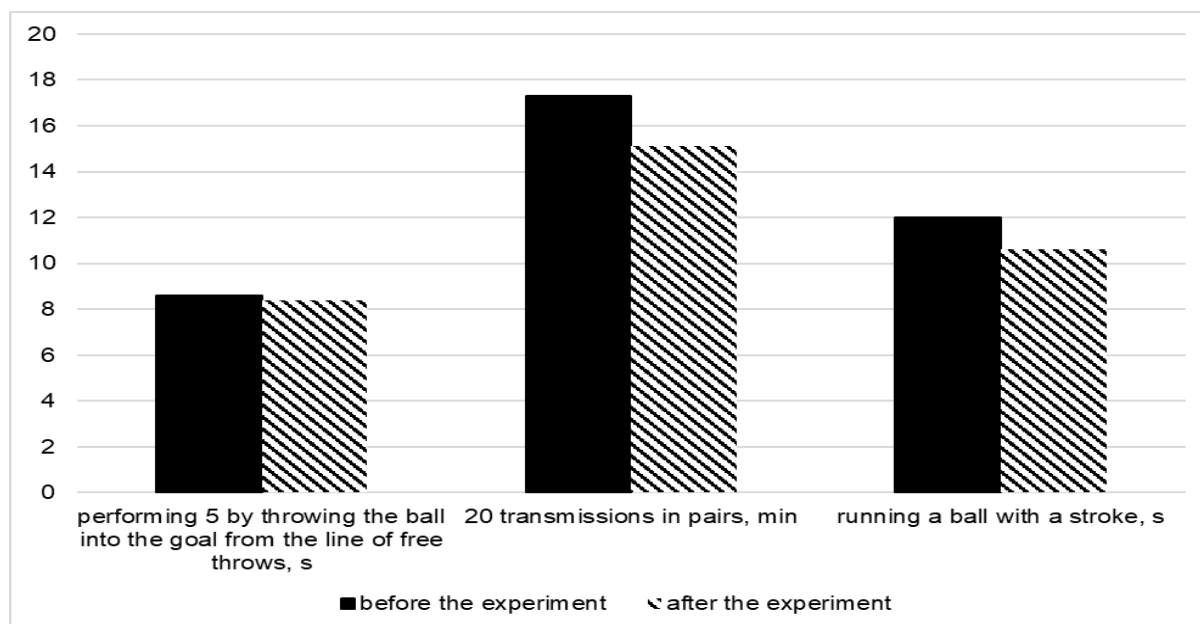


Fig. 3. Dynamics of technical preparedness of handball players

Implementation of the experimental training program was accompanied by a significant increase in speed, strength, endurance, as well as indicators of the technical preparedness of handball players. The results obtained make it possible to supplement the target settings of the stages of preparation, formation of the individual structure of morphofunctional properties and motor qualities of handball players, as well as provision on the implementation of type-specific and individual characteristics based on a differentiated approach to assessing their preparedness.

The results of our research allowed us to establish changes in the dynamics of the components of technical readiness of handball players. In the future it is planned to develop methodological criteria for the use of special physical loads in the training process of handball players.

The programming of the training process in the annual training cycle contributed to the increase in the game activity of both individual players and the team as a whole. The conducted pedagogical experiment revealed the problem of the unevenness of the processes of adaptation to physical loads. In further studies it is proposed to search for the relationship of physical and technical-tactical loads, as well as to identify the mechanisms for the urgent and long-term adaptation of the skeletal muscles of handball players during strenuous training activities.

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## АНОТАЦІЯ

**Бондаренко Костянтин, Маджаров Олександр.** Програмування тренувального процесу в гандболі на основі функціонального стану різних систем організму.

*Метою роботи стало підвищення результативності тренувальної та змагальної діяльності на основі об'єктивних біомеханічних оцінок адаптаційних можливостей спортсменів.*

*Для вирішення поставленої мети використовувалися методи міометрії та система відеоаналізу рухів. У результаті проведених досліджень виявлено відповідну реакцію скелетних м'язів на запропоновані фізичні навантаження різної спрямованості і швидкість відновних процесів скелетних м'язів.*

*Отримані дані дозволили судити про адаптаційні процеси, що протікають у скелетних м'язах спортсменів і вносити корекцію в навчально-тренувальний процес, давати рекомендації з проведення відновлювальних заходів.*

*Результати дослідження виявили напругу тонусу скелетних м'язів у нормальному стані, рівень відновлення скелетних м'язів і його тимчасові показники недоступності для виконання фізичної активності, швидкість відновлення функціональних можливостей скелетних м'язів.*

*Для оцінки рівня розвитку рухових здібностей гандболістів використовувалися тести для визначення сили, швидкісно-силових якостей, витривалості й вибухової сили. Програма також включала тести, які дозволили судити про рівень технічної та тактичної підготовленості спортсменів.*

*Отримані дані дозволили судити про адаптаційні процеси, що відбуваються в скелетних м'язах спортсменів, і зробити корекцію в тренувальному процесі, винести рекомендації з відновлення діяльності. Отримані результати дають можливість доповнити цільові установки етапами підготовки, а також положення про реалізацію специфічних для кожного типу та індивідуальних характеристик на основі диференційованого підходу до оцінки їх готовності. Дослідження дозволило підтвердити гіпотезу роботи та встановити, що отримані дані про пружно-в'язкісні властивості скелетних м'язів можуть бути використані як критерії ефективного управління педагогічним процесом підготовки спортсменів. У*

майбутньому передбачається пошук взаємозв'язку фізичних і техніко-тактичних навантажень, а також визначення механізмів термінової і тривалої адаптації скелетних м'язів гандболістів під час напружених тренувальних заходів.

**Ключові слова:** міометрія, функціональний стан, скелетні м'язи, параметри навантаження, програмування тренувального процесу.

### РЕЗЮМЕ

**Бондаренко Константин, Маджаров Александр.** Программирование тренировочного процесса в гандболе на основе функционального состояния разных систем организма.

*Целью работы стало повышение результативности тренировочной и соревновательной деятельности на основе объективных биомеханических оценок адаптационных возможностей спортсменов.*

*Для решения поставленной цели использовались методы миометрии и система видеонализа движений. Выявлена ответная реакция скелетных мышц на предлагаемые физические нагрузки различной направленности и скорость восстановительных процессов в скелетной мышце.*

*Данные позволили судить об адаптационных процессах, протекающих в скелетных мышцах спортсменов и вносить коррекцию в учебно-тренировочный процесс, давать рекомендации по проведению восстановительных мероприятий.*

**Ключевые слова:** миометрия, функциональное состояние, скелетные мышцы, параметры нагрузки, программирование тренировочного процесса.

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### ВЗАИМОСВЯЗЬ ДВИГАТЕЛЬНОЙ АКТИВНОСТИ ФИЗИЧЕСКОГО СОСТОЯНИЯ ШКОЛЬНИКОВ 13-14 лет

*В данной статье затрагивается тема двигательной активности и её влияния на физическое состояние школьников 13–14 лет.*

*В ходе исследования установлено, что увеличенный двигательный режим подростков благоприятно сказывается на жизнеобеспечивающих системах растущего организма и положительно влияет на уровень их физического состояния.*