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The journal is intended for teachers, coaches, athletes, postgraduates, doctoral students research workers and other industry experts.

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1. Physical education of different population groups.
2. Improving the training of athletes of different qualification.
3. Biomedical Aspects of Physical Education and Sports.
4. Human health, physical rehabilitation and physical recreation.
5. Biomechanical and informational tools and technologies in physical education and sport.
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Method of non-contact remote determination of the current functional state of the athlete

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Purpose: *development of a non-contact method for monitoring the current functional state in the process of the direct implementation of professional activities.*
Materials & Methods: *analysis of scientific and methodological literature; biomechanical analysis of kinematic, dynamic and static characteristics of motor activity; computer simulation of the dynamics of interaction of controlled indicators; methods of mathematical statistics.*
Results: *based on the results, their analytical dependencies were determined, on the basis of which the corresponding mathematical models were built. They allow you to study the dynamics of the interdependence of controlled parameters in the expected modes of their interaction without the participation of the object of study.*
Conclusions: *analytical patterns that describe the interdependence of the biomechanics of motor activity and mathematical models of reflection, as well as modern means of video recording and computer processing, provide an advantage for an effective assessment of the motor activity of an individual.*

Keywords: *contactless control, fatigue, mathematical modeling, rationalism method.*

Introduction

Kinematic and dynamic characteristics of body motion obey physical laws. The difficulty of using them directly in studying the biomechanics of the movement of a "living" body lies in the multicomponent structure of the body, which suggests the need to consider the entire interdependence of the kinematic elements of the body in the movement [10].

Any performed motor action, which is associated with the displacement of the common center of mass (CCM) and is interdependent with the displacement of all biokinematic parts of the body involved in its implementation. One of the most important components in the implementation of the movement is the provision of a working posture. It is characterized by static stress with a certain ratio of the work of synergists and antagonists. Using video control of a moving object allows you to track the kinematic movements of both a single element of the body and its center of mass, and the total center of mass of the whole body.

Purpose of the study: to develop a non-contact method for monitoring the current functional state in the process of the direct implementation of professional activities.

Material and Methods of the research

Methods: analysis of scientific and methodological literature on the research problem; biomechanical analysis of kinematic, dynamic and static characteristics of motor activity; high-speed video recording of movements; computer simulation of the dynamics of interaction of controlled indicators; integration of empiricism and rationalism.

Results of the research

A detailed analysis of the biomechanical fundamentals of sprinting techniques based on high-speed video recording revealed that start and start acceleration have a decisive influence on the final result of running [4; 7]. According to the results of research by domestic and foreign authors, it was found that the contribution of these parameters reaches 64% of the total result in running 100 meters and significantly more at a shorter distance [5; 9]. An important conclusion is that the authors divide the running step into phases of support and supportless movement. In the reference phase, in the process of accelerating the movement of body mass, the depreciation phase and the repulsion phase are distinguished. In sprinting, acceleration is such a part of it, in which the kinematic characteristics in each step are the most dynamic. In the process of acceleration, changes occur in the ratio of the frequency and length of steps, the duration of the support and flight phases, the position of the athlete's body at the time of the support phase. To assess the dynamics of changes in the marked parameters during acceleration, a dimensionless activity index was introduced, which represents the ratio of flight time to support time $\frac{t_п}{t_о}$. The determining factor in the development of speed in running and characterizing this process are the actions of kinematic units in the support phase. In the stage of acceleration of the body, the sequence of relations $\frac{t_п}{t_о}$ is changing. Support time is reduced, and flight is increased and activity index (I_a) as a function of these relations tends to 1, i.e. $I_a = \frac{t_п}{t_о}$ and its value changes at the initial stage of acceleration from 0 to 1 (therefore, $0 \le I_a \le 1$). With further acceleration, the support time becomes shorter, and the flight time increases. In this case, the activity index becomes more than one $0 \le I_a \le (1+\alpha)$. The value of α is an indicator of the effectiveness of the acceleration of the movement of the body's CCM and reflects the individual's ability to high-speed actions. This value depends on the inborn phylogenetic predisposition and the level of its development, as well as on the current functional state (measures of fatigue). In this regard, the activity index with further continuation of the run has the opposite tendency to change, which returns it to unity and a subsequent decrease. This information is not given for the purpose of further improving the kinematics of

start and acceleration in sprinting, but in order to show the possibilities of non-contact remote evaluation in real time of the athlete's current functional state.

The peculiarity of this method is that the assessment is carried out not by monitoring the operation of individual functional systems, but by the final equifinal result of their joint provision. This justification was based on the principle of statistical construction of the final equifinal result in any multiparameter system of its support [2; 6].

In turn, [8] indicate that the integral indicator of fatigue is manifested in a decrease in perceptibility. This leads to an increase in inaccuracy in perception and an increase in the tolerance of environmental influences. In accordance with the theory of behavior in a system of tolerant spaces and the first theorem of V.N. Samsonkin, it follows that the complexity of the organization of behavior is significantly reduced [8].

Thus, monitoring the magnitude of the increase in error during the reproduction of standard motor actions is an objective indicator of the development of fatigue. In this case, variants of the manifestation of this process are possible, associated only with an increase in "fuzziness" relative to the stationary average value, or a simultaneous increase in "fuzziness" and transgression of the average value itself. This allows you to determine the individual characteristics of the integral indicator of the flow of functional processes that lead to the development of fatigue [1; 3].

However, without sufficient attention there were such characteristics of motor activity: static stress; dynamic efforts; static tension of a working pose; the relationship of the working pose with the kinematic movements available to it; dynamic efforts that ensure their implementation; the ratio of the magnitude of static stress to the magnitude of dynamic efforts in connection with the energy consumption of the potential reserve of the body.

It is known that the greater the angle of extension of the legs in the knee joint, the more effort is noted on the dynamograph (Figure 1).

The use of dynamographs made it possible to determine the duration of the conservation of static effort, the speed of its development, and to determine the maximum developed force. Simultaneous separate measurement of the strength of the legs with a fixed position of the angle of extension of the knee joint with different effort, specified as the initial condition of static stress, allows you to set the duration of its conservation. After a certain period of time, a clearly pronounced oscillating asymmetry of the efforts of the left and right legs is observed. This is observed for the entire range of changes in the angle of extension of the legs in the knee joint (Figure 2).

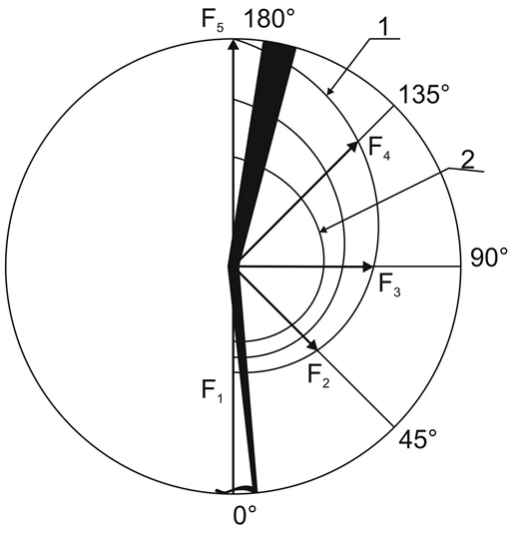

Fig. 2. Increment dependency $\frac{dF}{d\varphi}$ from the angle of extension of the biokinematic pair "drumstick-thigh":
1 – logarithmic spiral, reflecting changes $\frac{dF}{d\varphi}$ at a high level of performance; 2 – logarithmic spiral, reflecting changes $\frac{dF}{d\varphi}$ with extremely high fatigue.

The combination of all intermediate values of the given initial conditions allows us to note the regularity of the preservation of the strength of static voltage and the duration of its reduction. By setting separately for each leg a different extension angle in the knee joint, it is possible to empirically establish the consistency of the jointly developed efforts of each of the legs, which is observed under conditions of low start. Similarly in any other case, when the working pose has support with different position of the legs (when throwing).

The combination of all these characteristics into a single complex of interdependent relationships in ensuring the performed motor activity expresses a certain dependence of the magnitude of the effort on the extension angle between the biokinematic links and the rate of its change over time. In an analytical form it can be represented:

$$\frac{dF}{dt} = \frac{dF}{d\varphi} \cdot \frac{d\varphi}{dt} \quad (1),$$

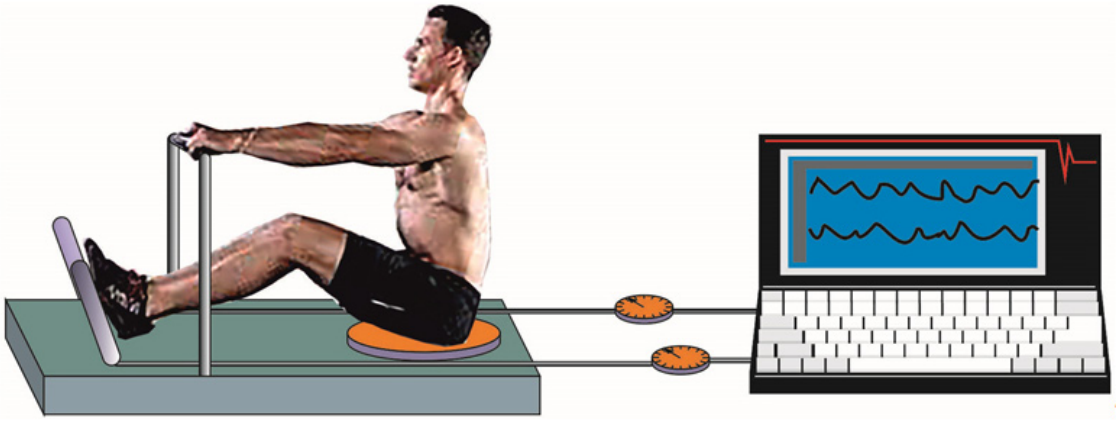

Fig. 1. Dynamography to record leg muscle strength

where $\frac{dF}{d\varphi}$ – boundary conditions of static tension of muscles of a working pose; $\frac{d\varphi}{dt}$ – initial conditions of the movement; $\frac{dF}{dt}$ – the speed of development of effort under given boundary and initial conditions of motion.

It should be noted that the quantity $\frac{dF}{d\varphi}$ includes the boundary value from which the movement begins. This is the basic value of static voltage, which is not reflected in the kinematics of the motion of the body's CCM, but requires a significant expenditure of energy potential. By controlling the movement of the body's CCM in space, we can calculate the total amount of work done to move it and highlight the amount of perfect useful work. Their ratio shows the efficiency coefficient of the technique of the performed movement. The value of these indicators reflects the potential reserve for improving the technique of the movement in motion. The first characteristic of the relationship between the quantities of work is connected with the regularity of the behavior of geometric progression, where the ratio of ratios acts as its denominator. The second characteristic of the difference in the values of the perfect work is associated with the behavior of arithmetic progression and reflects how much the energy expenditure changes with each completed movement cycle.

Using the example of determining the maximum deadlift with different values of the angle of extension in the knee joint, it is possible to assess the functional state of the individual's neuromuscular apparatus. The change in the angle of extension can be set with any accuracy, while observing the increment of the dead force (values $\frac{dF}{d\varphi}$). This dependence of the change in magnitude is expressed in the polar system by a logarithmic spiral. When incrementing the magnitude of the angle of extension in the knee joint in arithmetic progression, the magnitude of the application of force along the radius of the vector of rotation of the angle of extension changes. It is logical to single out a spiral that reflects the most excited state and utter fatigue. All other states are intermediate. Among them there is an optimal condition.

An individual feature of the manifestation of this pattern is the curvature of the spiral, which does not depend on the functional state of the individual.

This process can be most clearly represented as the path of the end of the radius vector, which, with successive uniform rotation moving along the vertical axis, describes a spiral on a cone that determines the direction of sliding of the end of the radius of the vector. The cone angle determines the coefficient of curvature of the logarithmic spiral in the perpendicular plane to the axis of its formation. The analytical description of this process is called the "cone of distinguishability" and has the features of its construction, revealing the boundaries of an extremely high level of working capacity and extremely low, arising from severe fatigue. This kind of mathematical model is based on the method of constructing the Apollonius circle and the principle of stability of dichotomous interdependent relationships. To maintain the equilibrium relationship of two opposing processes (dichotomies), their coefficient of "active" interdependent relationship should be equal to 1, which ensures the preservation of their full stability of relations. Otherwise, the dichotomy is destroyed.

The definition of the Apollonius circle, which is given to them, is the geometrical location of the points, the ratio of the distances of which from these two points is a constant value (λ). If A, B are the given points, C, D are the intersection points of the line AB with the circle (Figure 3), then since the points C and D by definition belong to the circle, for them, as for all points of this circle, the equality conditions $\frac{AC}{BC}=\lambda$, $\frac{AD}{BD}=\lambda$, from here $\frac{AC}{BC}=\frac{AD}{BD}$. This means that the four points of ABCD are harmonic.

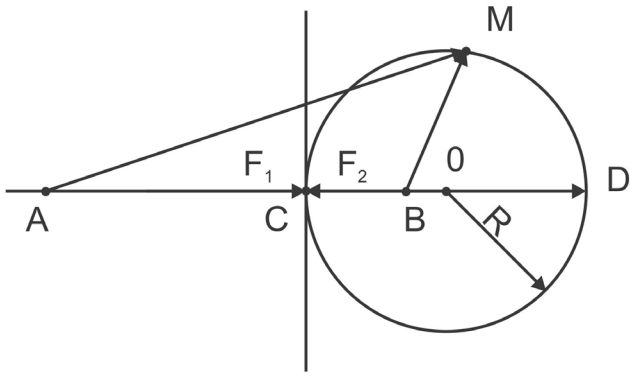

Fig. 3. Circum Apollonius

The Apollonius circle represents a zone of equal relations between two opposing forces, which in this case will be AC = F_1, BC = F_2 in the presented drawing. From any point and circle, by definition, the ratio of the distances AM / BM = λ. Therefore, the change in the length of the AC vector and all AM1, AM2 ... AD reflect the change in the direction of action of the force F1 and its magnitude from AC (F_1 = min) to AB (F_1 = max). In accordance with the change in the values of the force F1, the force of the vector F_2 will change from its minimum value BC (F2 = min) to BD (F_2 = max). At all points of relationship $\frac{F_1}{F_2}=\lambda$.

Due to the fact that the construction of the "cone of distinguishability" will be carried out in three-dimensional space of Cartesian coordinates, a perpendicular line is drawn in Figure 3, which acts as the Y axis. Its intersection with the line AB at point C corresponds to the origin, and the line AD, being a continuation, is X axis. In this case, given: AM=F_1; BM=F_2; $\frac{AC}{BC}=\lambda$; $\frac{F_1}{F_2}=\lambda$. AB is divided by point C in relation to λ. For convenience, let us designate further entries AC = a, BC = b. Need to find: the geometrical location of the ends of the radius of the vectors F_1 and F_2, preserving $\frac{F_1}{F_2}=\lambda$.

From geometric constructions in Cartesian $F_1=\sqrt{y^2+(a+x)^2}$ $F_2=\sqrt{y^2+(x-b)^2}$; from conditions $\frac{F_1}{F_2}=\lambda\Rightarrow\frac{y^2+(a+x)^2}{y^2+(x-b)^2}=\lambda^2$;

$y^2+a^2+2ax+x^2=\lambda^2y^2+\lambda^2b^2-2bx\lambda^2+\lambda x^2$; $\lambda^2y^2-y^2+\lambda^2x^2-x^2-2bx\lambda^2-2ax=a^2-\lambda^2b^2$;

as $a=\lambda b\Rightarrow a^2-\lambda b^2=0$ in this case $y^2(\lambda^2-1)+x^2(\lambda^2-1)-2x(\lambda^2b+a)=0$;

$y^2+x^2-2x\frac{(\lambda^2b+a)}{(\lambda^2-1)}=0$; $y^2+x^2-2x\frac{a(\lambda+1)}{(\lambda^2-1)}=0$; $y^2+x^2-2x\frac{a}{\lambda-1}=0$;

$y^2+x^2-2\frac{a}{x-1}+\frac{a^2}{(a-1)^2}=\frac{a^2}{(\lambda-1)^2}$; $y^2+(x-\frac{a}{\lambda-1})^2=\frac{a^2}{(\lambda-1)^2}\Rightarrow$

which in the Cartesian coordinate system represents the center (O) of the circle of Apollonius shifted by $\frac{a}{\lambda-1}$, therefore, CO=R=$\frac{a}{\lambda-1}$.

Thus, if you make an offset by R=$\frac{a}{\lambda-1}$, then the center of the circle coincides with the origin and the ratio $\frac{F_1}{F_2}=\lambda$ will be true for any values of F_1 and F_2, the ratio of which gives the value λ. This relation represents the control of a line passing through the center of coordinates, where λ=tg*L*, or the angle of inclination of the line, which can be graphically represented as Figure 4.

This indicates that practically a set of values of F_1 and F_2 as a pair of numbers, the ratio of which is equal to λ represents an infinite number.

In turn, the attitude $\frac{F_1}{F_2}=\lambda$ can be represented as the equation of a circle, which indicates a limited interval in the values of F_1 and F_2, which can satisfy the ratio $\frac{F_1}{F_2}=\lambda$. If we define these relations as the possible lengths of the vectors

F_1 and F_2, fixed at the beginning at the fixed points, and their ends touching at some point M, then this point will describe the circle, which was shown in Figure 3.

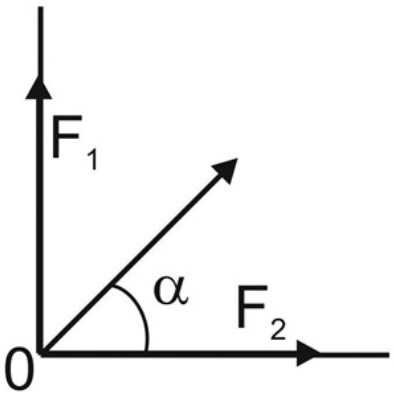

Fig. 4. The equation of a line passing through the center of coordinates

These vectors are represented in the Cartesian coordinate system and have a numerical value in the coordinates (x, y). Since the basic requirement is that the relation $\frac{F_1}{F_2} = \lambda$, then we can construct a sequence of decreasing values of F_1 and F_2 while maintaining the value λ. This sequence of circles decreasing in their diameter, whose centers lie on one straight line, representing the third Z axis of Cartesian coordinates and generate a "cone of distinguishability". In its construction, the reasons limiting the interval of changes in the values of F_1 and F_2 are revealed.

The main essence of this phenomenon lies in the structure of the construction of the circle of Apollonius. The vector F_2, whose origin lies at point B (Fig. 3), is at a distance from the center of the circle $a/\lambda-1$, where *a* reflects the initial value of F_2, which has a minimum value in the range of its change in the construction of each circle of Apollonius. Thus, at point C, the force vector F1 and F_2 meeting, has the smallest value. At point D, their values reach their maximum size, after which the reverse process occurs in the construction of the Apollonius circle. In the sequence of arrangement of decreasing Apollonius circles, when constructing the "cone of distinguishability" taking into account the uniform step of their distance from each other, a constant value of the vector F_2 will be encountered in its minimum manifestation of the first circle, which is the basis of the "cone of distinguishability". Therefore, for each step of the displacement of the subsequent circle, a constant value F_2 in its minimum value will make a rotation by a certain angle *L.* This process will continue until it reaches a 180˚ turn in the last circle and in it its minimum value in the first circle, which is the base of the cone, becomes the minimum value in the last circle. This ends the first half-cycle of the motion of the vector F_2 in the construction of the upper half of the "cone of distinguishability".

The construction of the lower half of the "cone of distinguishability" has several options for solving this problem, but it is not the subject of this article, despite its exceptional importance.

In the construction of the "cone of distinguishability" (upper part), a number of determining components of its structure are distinguished. These include: the diameter of the base of the cone, or the initial circle of Apollonius, on which the points C are determined, at which the vectors F_1 and F_2 come into contact at their minimum values. Point B, which is the beginning of the vector F_2, point O is the center of the Apollonius circle with its radius R. Point D, at which the ends of the vectors F_1 and F_2 meet at their maximum value. All points lie on the coordinate axis X. Outside of the circle on the X axis lies point A, which is the beginning of the vector F_1. As noted above, points A, C, B, D are a harmonic four.

The diameter of the truncation of the cone by the circle of Apollonius, on which all the points mentioned are determined in their multiple reduction. The distance A between the circles of the base and the truncation, which determines the length of the line passing along the Z axis through all the circles from the base of the cone, at which the maximum values of the vectors F_1 and F_2 meet at point D. The relationship of these characteristics in the structure of the construction of the distinguishability cone is shown in Figure 5.

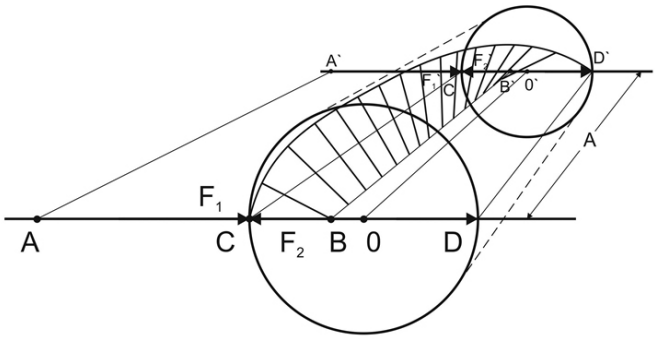

Fig. 5. Cone of legibility perceptions

Where A defines the range of F_2 in Apollonius circles in the corresponding section of the "cone of distinguishability". At the base of the cone, F_2 = min and F_2 = max comprise the diameter of the circumference of the base. In the final, last, smallest circle of Apollonius, the vector F_2 in the size of its minimum value represents the largest part of its diameter, being in this case the maximum of F_2 at its previous value. Thus, A is the range of distinguishability of perceptual states.

The diameter of the base circle represents the sum (F_2min + F_2max) and acts as a range of perceptibility distinguishability within the state.

Projection of each *Mi* Apollonius circle points on its diameter is an assessment of perception within the state. This estimate is measured in degrees of inclination of the vector F_2 to the diameter, which allows us to introduce the commensurability of the sensitivity of perception in different states in the same parts of the distinguishability scale within each state.

Constant $\lambda = \frac{F_1}{F_2}$ reflects the value of the share of perception in the redistribution of each (*i)* state where F_1*i* defines the upper limit of sensitivity, F_2 – reflects the lower limit, beyond which the measurement assessment is not available.

On condition $F_1 > F_2$ the basis of the construction of the sensitivity measure is the Fibonacci numbers, since F_1min + F_2min represent an integer from point A to point B. The ratio of the whole (F_1min + F_2min) to the majority (F_1min) with the ratio of the majority (F_1min) to the smaller part (F_2min) gives the "golden section" and point C belonging to the circle of Apollonius, in which $\frac{F_1}{F_2} = \lambda$ determines the most effective structure for constructing a "cone of distinguishability".

In each individual state, we can talk about the maximum manifestation of opportunities and the minimum sufficient. Between them there is a regime of optimal sufficient activity, which is most characteristic and most often occurs according to all three criteria for its evaluation: duration, intensity, volume of morphofunctional structures involved.

Similarly, from the entire range of functional states, one

can select the optimal one that is adequate to the environment of staying along the boundaries of the variation in the required activity, short duration, and the total volume of the request for potential opportunities for its occurrence.

Regardless of the level, the processes of morphofunctional activity, which proceeds according to a uniform pattern for a given individual, are considered; one can distinguish the corresponding logarithmic spiral with a constant coefficient of its curvature. In this case, it is necessary to take into account the level of organization of the processes under consideration, especially when the absolute values of the considered characteristics are compared.

Due to the fact that the potential energy reserve of the body in the process of performing professional activity is spent on static stresses, emotional state, a method for the overall assessment of the fatigue index, which is the "cone of distinguishability" of the functional state described above, is needed. This will allow us to differentiate the energy consumption for static stresses and the level of emotional stress.

When analyzing the kinematic displacements of the centers of mass of the parts and the body's CCM, an important component is their trajectories, which minimize energy consumption when a positive final equifinal result is achieved. Such trajectories are parabola in unsupported motion, cycloid and brachistochron in the supporting position. In some cases, this trajectory is a straight line, if an additional mass is included in the movement of the body's CCM, which is part of the general structure of the performed motor act. In addition to these trajectories, as generators, circles: helicoid, ellipse, logarithmic spiral, chain line, are important in the analysis of motor activity.

In most cases, movements that are performed under natural conditions are carried out with the participation of all elements of the body with a different share contribution to the equifinal end result. In this case, it is necessary to take into account the various ratios of the parts of the body that comprise the two-link pendulums. The two-link pendulum is the lower limbs and the trunk. All the two-link monuments involved in organizing the movement can work simultaneously or sequentially. They constitute the kinematics of motion at a fixed static voltage of other links, which provide a working pose for the current moment of organization of the kinematics of the movement of the body's CCM. A common unifying feature of their movement in providing complex-coordinated movements is that they carry out their movement around the circle. The compatible movement of each link of the two-link pendulum ensures the movement of the CCM around the circumference, which creates a lifting force.

The most thoroughly studied movement of a falling body with the support search at the moment of its fall is a low start when accelerating the center of gravity and raising it to the height of movement along the distance. The most effective trajectory of the body's CCM movement is a parabola with an initial departure angle of 45°. In most cases, this requirement is not implemented. As an example of the performance of this movement, high-speed video recording of the first low-start step of the ex-world record holder in the 100 m race of Asafa Powell can be used (Figure 6).

When ordering the placement of frames of video recordings of the first step of low start relative to the projection of the body CCM perpendicular to the axis of the start line on the last frame and based on the pattern of movement of the body MSC along the parabola, it does not make it difficult to calculate the components of the vertical velocity of the body MSC to reach the required height in distance running and acceleration horizontal running speed. The peculiarity of this task is that it is necessary to determine the starting position of the start and location of the CCM to calculate the departure path along a parabola with an angle of 45°, given that the starting point of departure is the location of the CCM. In the case under consideration, the axial straight line passes through the start line, and the CCM moves along the parabola path with a departure angle of 40 ° at the CCM point, the angle is 32.5°, which significantly redistributes the decomposition of the total speed in the direction of the horizontal component. But at the same time, the body's CCM output to the height of its necessary movement to the "smooth" run distance is reached only by the fifth step. Under the condition that the body's CCM departures in a parabola at an angle of 45°, reaching this altitude is already achieved in the second step, but with a lower horizontal component, the speed continues to increase to its maximum activity index, which reaches its value more than 1, when the flight phase of the CCM body exceeds the phase of the support and the speed of horizontal movement reaches its maximum.

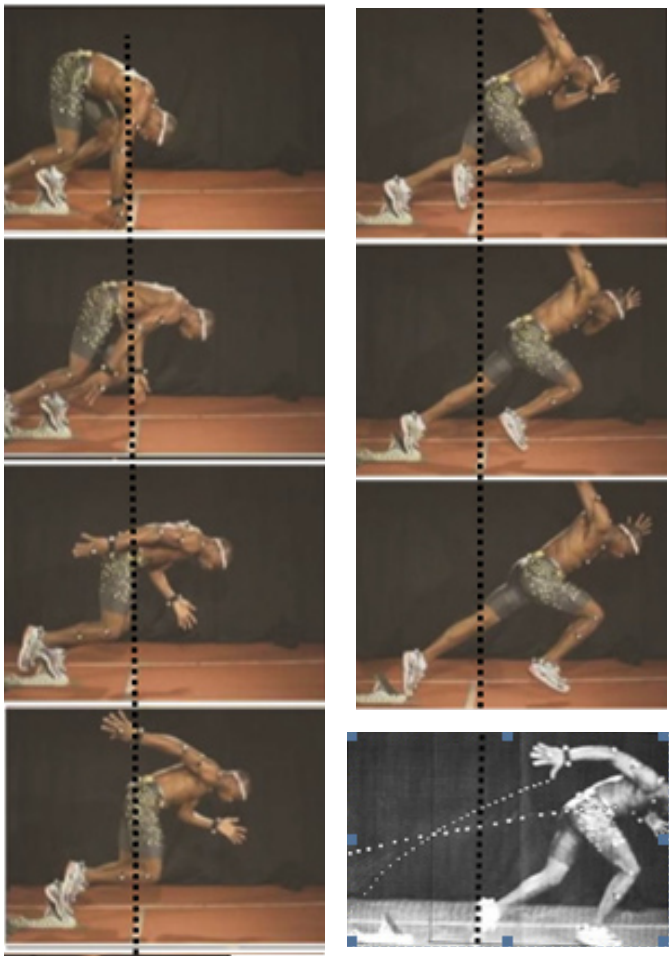

Fig. 6. First step of the crouch start rt in the 100 m run

Optimal, in the energy consumption of the potential reserve, is the trajectory of the parabola, which ensures the departure of the body's CCM and its horizontal acceleration at an angle of 45°.

When considering the trajectory of the body's CCM in the frontal plane, its movement in the longitudinal-transverse direction and stepwise rise to the required running

distance along the distance are observed. The movement of the body's CCM in the longitudinal transverse direction resembles rolling during acceleration in the ridge race. In the considered technique of performing a crouch start, these fluctuations have a sufficiently large amplitude of movement with a corresponding energy consumption, which reduces the endurance of the athlete and, as a consequence, worsens the final result. The observed oscillations of the body's CCM in three directions give rise to a helicoid trajectory in the space of movement (Figure 7).

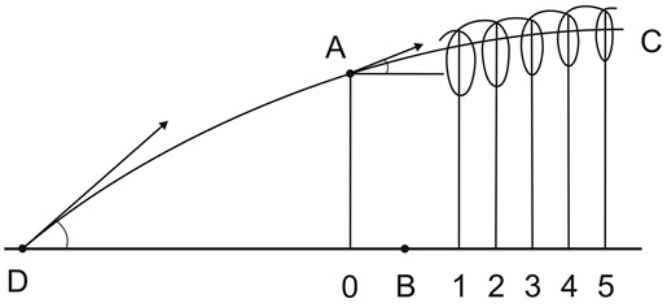

Fig. 7. Trajectory of the body CCM at the stage of starting acceleration:

1) Point A – the initial position of the body's CCM in front of the "attention" command; Point B -s the start line; Point O is the projection of the CCMB in the starting position on the plane; AS – the asymptotic line of motion of the CCMB; A 1.2.3.4.5 is the helicoid of the real movement of the body's CCM. 2) 0, 1, 2, 3, 4, 5 – the fulcrum of the running steps in the starting acceleration of the CCMB.

Thus, having a video recording of the athlete's body movement, it is possible to establish the economics of the technique of the performed motor actions with any required accuracy, focusing on the generalizing component characterizing its effectiveness. A decrease in the efficiency of performing motor activity is associated with a decrease in potential energy in the current state of the body, which is observed in a change in dependence when observing the kinematics of the movements performed, which are available at possible dynamics of the developed efforts.

Conclusions / Discussion

Based on these provisions, various manifestations of the activity of a functional state were presented as a mutual opposition of endurance and fatigue. The intensity of the work performed and its duration in Cartesian coordinates are interdependent by an exponential dependence, which in polar coordinates is represented by a logarithmic spiral.

If we imagine a certain state of equilibrium endurance relations as potential opportunities for doing work of the corresponding intensity and fatigue as a phenomenon associated with a violation of homeostasis, then a purely theoretical description of this phenomenon and analysis of the obtained mathematical model allows us to reveal those laws that cannot be detected by empirical methods in any way. The Apollonius circle reveals the peculiarities of the behavior of the "endurance – fatigue" dichotomous pair in one of the states, and the set of states gives rise to a "cone of distinguishability", covering the full range of various possible states.

The presence of established patterns and their analytical description, determination of the individual characteristics of their course, as well as modern technical means of video recording and computer processing of the information received allow us to talk about the presence of a dynamic computer simulation method, which not only solves the issue of contactless remote real-time determination of the athlete's current state, but predicting the subsequent state with the determination of optimal modes of its stabilization.

The reflection of the total volume of energy potential consumption on the surface of the "cone of distinguishability" will be reflected in a certain region of the state range corresponding to the zone of these states. When monitoring and evaluating the work associated with moving the body in space and the dynamics of changes in the working posture in the observed movements, one can judge the profitability and effectiveness of the activity carried out, or in general its availability for this individual in his current state.

On the whole, this nature of organization underlies interdependent relationships in the process of adaptation of an organism to its environment. The lack of the necessary accuracy of control in this process limits the level of complexity and cost-effectiveness of the organization, and in some cases leads to a quick «burnout» of potential opportunities and the unsuitability of further high-quality implementation of professional activities.

Any interaction with the environment entails the consumption of potential opportunities and manifests itself in fatigue. Monitoring its level is an effective means of optimizing the process of interaction with the environment in the optimal mode of its course. Evaluation of the optimality of the performance of any activity is determined by the number of errors and their «rudeness», which in turn requires a certain standard of comparison and the availability of correction tools.

For motor activity, such comparison standards are the most economical trajectories of body movement in space, taking into account the specific structure and conditions of the activity. In this case, we can talk about optimizing the kinematics of body motion in its support and supportless movement.

Prospects for further research. In the future, the developed control technique will be tested in the training and competitive process of athletes of various specializations.

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Methodology for improving the body balance of athletes in acrobatic rock'n'roll at the stage of preliminary basic training

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An analysis of the content of the competitive programs of various categories of athletes in acrobatic rock'n'roll (sports couples and formation teams) allows us to determine that all motor activity occurs in complicated and sometimes extreme conditions with a constant change in body position in three planes: sagittal, frontal and horizontal. Given this, we can say that for a rational construction of the technique of motor actions, athletes are constantly faced with the need to restore and maintain the balance of the body, which has a close interaction with the general level of physical preparedness [1; 2; 4; 10; 12]. Based on the analysis of literary sources, we can state that at this stage in the development of acrobatic rock'n'roll there are too few scientific and methodological literature on the issues of purposeful and proportionate development of the ability of athletes to maintain body balance, as one of the determining factors for successful mastery of the technique of acrobatic rock'n'roll. This fact reduces the effectiveness of the training process of athletes.

Purpose: *to consider ways to solve the problem of improving the balance of the body of athletes in acrobatic rock'n'roll at the stage of preliminary basic training.*

Material & Methods: *the study was conducted in Kharkov on the basis of the sports and dance club "Rapid". The experiment was attended by 28 athletes 10–12 years old. Athletes practice acrobatic rock'n'roll at the stage of preliminary basic training. We have chosen modern research methods: theoretical analysis and generalization of sources of scientific, methodological and specialized literature, pedagogical observations, pedagogical testing, methods of mathematical statistics.*

Results: *as a result of the implementation of the developed sets of exercises, including means of gymnastics, acrobatics and health preparedness, a significant increase was achieved in the indicators of maintaining body balance by athletes in acrobatic rock'n'roll at the stage of preliminary basic training.*

Conclusions: *the developed methodology for improving the body balance of athletes in acrobatic rock'n'roll at the stage of preliminary basic training has proved its effectiveness. There were significant changes in all the studied indicators of athletes EG $p<0,05$, $p<0,01$. The developed technique has a positive effect on the body systems that ensure the balance of the body. The effectiveness of a combination of acrobatic rock'n'roll exercises, gymnastics and health fitness has been experimentally proved in training acrobatic rock'n'roll athletes at the stage of preliminary basic training.*

Keywords: *acrobatic rock'n'roll, body balance, stage of preliminary basic training.*

Introduction

Over the past decade, acrobatic rock'n'roll has expanded the boundaries of its popularity and turned into a spectacular dynamic sport. The structure of the technique of movement of acrobatic rock'n'roll is similar to the structure of the technique of movement in complex coordination sports, in which dance combinations and acrobatic elements combined with musical accompaniment in a single program [8; 13; 25].

Competitive programs of all categories have a large number of rotational movements and acrobatic elements, which are performed both without contact and in pair interaction, except for the category «children» [2; 22].

Despite the general increase in the complexity of competitive programs, a high level of motor fitness, there is a small number of those athletes who demonstrate motor actions that are adequate to the motor task [1; 10].

So, the peculiarity of performing acrobatic rock'n'roll movements, the constant complication of competitive programs and high competition on the world stage requires finding effective ways to economize the energy spent when performing complex technical coordination actions in competitive programs by improving the mechanisms for ensuring the athlete's body balance.

Purpose of the study: to increase the capabilities of body systems that ensure the balance of the body of athletes from acrobatic rock'n'roll at the stage of preliminary basic training.

Objectives of the study:

1. To analyze modern approaches to the development of the balance of the body of athletes in complex coordination sports of an aesthetic orientation and, in particular, in acrobatic rock'n'roll.
2. To determine the indicators of monitoring the balance of the body of athletes from acrobatic rock'n'roll at the stage of preliminary basic training.
3. Experimentally verify the effectiveness of the methodology aimed at improving the balance of the body of athletes from acrobatic rock'n'roll at the stage of preliminary basic training.

Material and Methods of the research

To conduct this study, the following methods were used: theoretical analysis and generalization of sources of scientific, methodological and specialized literature, pedagogical

observations, pedagogical testing, methods of mathematical statistics. The study was conducted on the basis of the sports and dance club "Rapid", Kharkov. The experiment was attended by 28 athletes 10–12 years old. Athletes practice acrobatic rock'n'roll at the stage of preliminary basic training.

Results of the research

Mastering the technique of dance movements is no exception to the general rules of teaching motor actions, both in sports in general and in acrobatic rock'n'roll, in particular. These principles are based on fundamental research that has been carried out by scientists in the field of sports earlier and supplemented by specialists in complex coordination sports of an aesthetic orientation [1; 3; 5; 9; 11; 14; 17; 18; 19; 21; 24].

High-quality performance of technical actions of acrobatic rock'n'roll makes high demands both on the general motor and functional preparedness of athletes, as well as on the high level of development of flexibility, coordination, speed and strength abilities, the integrated work of the body's sensory systems and the general coordination of motor actions.

This is due to the fact that according to the requirements of the WRRC (World Federation of Acrobatic Rock'n'roll), competitive exercises are performed with high dynamics and combine complex choreographic movements, which are saturated with a large number of revolutions, changes in the seats of partners and acrobatic elements, which are performed in contact partners and solo [7; 23].

Also, elements of the program should be represented by athletes at three levels: in full growth; on the floor; without contact with the floor, performing elements in the air [10].

Variation of changes in body positions in various planes constantly requires sensorimotor correction of movements to maintain the required body position [15].

Each deviation of the athlete's body from the optimal position corresponds to a certain effort to restore this position using balance actions. At the same time, the minimum amplitude of balancing will indicate the quality of the exercise in a squeal, and the maximum - vice versa. Improving the ability of the body of athletes to maintain body balance will significantly increase the efficiency of the process of training athletes [3; 6; 16].

So, to solve the tasks we conducted a pedagogical experiment.

The functional state of the vestibular analyzer of the studied athletes was monitored by recording the magnitude of the change in the duration of autonomic, sensory and motor reactions that occur in response to the load of the vestibular apparatus. To determine the indicators of static equilibrium while standing with closed eyes, we used the complicated "Romberg test", to determine the indicators of static equilibrium while standing on one leg with open eyes, we used the "Swallow" test, to determine the indicators of dynamic equilibrium we used the "Walk in a straight line" test without visual control, as well as to determine the ability to restore body balance, a test was used according to the methodology of Arnoth and Gaines.

The results are presented in Table 1.

The average age of athletes from acrobatic rock'n'roll is 11.1±0.9 years, but the youngest athlete is 10 years old, and an adult is 12 years old.

In the Romberg test, the average result of the static equilibrium of athletes on the right foot is 18.2±10.3 s, on the left 16.4±10.2 s. According to the scientific literature summarized by L.P. Sergienko [20], indicators of static equilibrium for children 10–12 years old are below normal. The obtained indicators may indicate the focus of funds in the training process.

In the Swallow test, we obtained the following results: on the right foot, the average value is 21.7±12.7 s, on the left foot, 24.4±15.1 s, the score is lower than normal. Analyzing the performance of athletes in this test, we can say that on the left foot the athletes showed a slightly better result than on the right.

According to the results of dynamic equilibrium, the athletes' results are as follows: the average deviation from the trajectory during this exercise is –24.8±13.6 cm, the indicators are within the normal range, however, significant deviations of the indicators from each other and to the left are traced, which indicates problems orientated athletes.

This fact cannot but cause concern, since the high-quality performance of many dance figures, acrobatic elements and the composition as a whole depends on the development of spatial orientation. Also, when performing group exercises of the "formation" nomination, coordinated actions of all team members are required, which can control the dynamics of their movements around the site.

A significant number of elements in which athletes perform various rotations, tilts of the head and body, after which it is necessary to maintain a stable position of the body in poses requiring a high manifestation of balance. In the group, the average time to restore equilibrium after rotations is 34.2±16.1 s. According to [20], indicators correspond to a low level.

After analyzing the results of the initial testing, according to the uniformity of signs, the athletes who took part in the experiment were divided into two groups: control (CG), the training process of which took place without changing the means, and experimental (EG), in the training process of which specially developed sets of exercises were introduced to develop the balance function of athletes. At the beginning of the experiment, the performance of athletes did not have significant differences at $p<0.05$.

Table 1

Indicators of static balance of athletes in acrobatic rock'n'roll at the stage of preliminary basic training (n=28)

Statistical indicators	Test	Romberg Sample, s		Swallow, s		Walking without visual control, see: + right – left	Restoration of balance, s
	Age, years	right	left	right	left		
$\bar{X}$	11,1	18,2	16,4	21,7	24,4	–24,8	34,2
σ	0,9	10,3	10,2	12,7	15,1	13,6	16,1
m	0,3	1,9	1,9	2,4	2,9	2,6	3,0

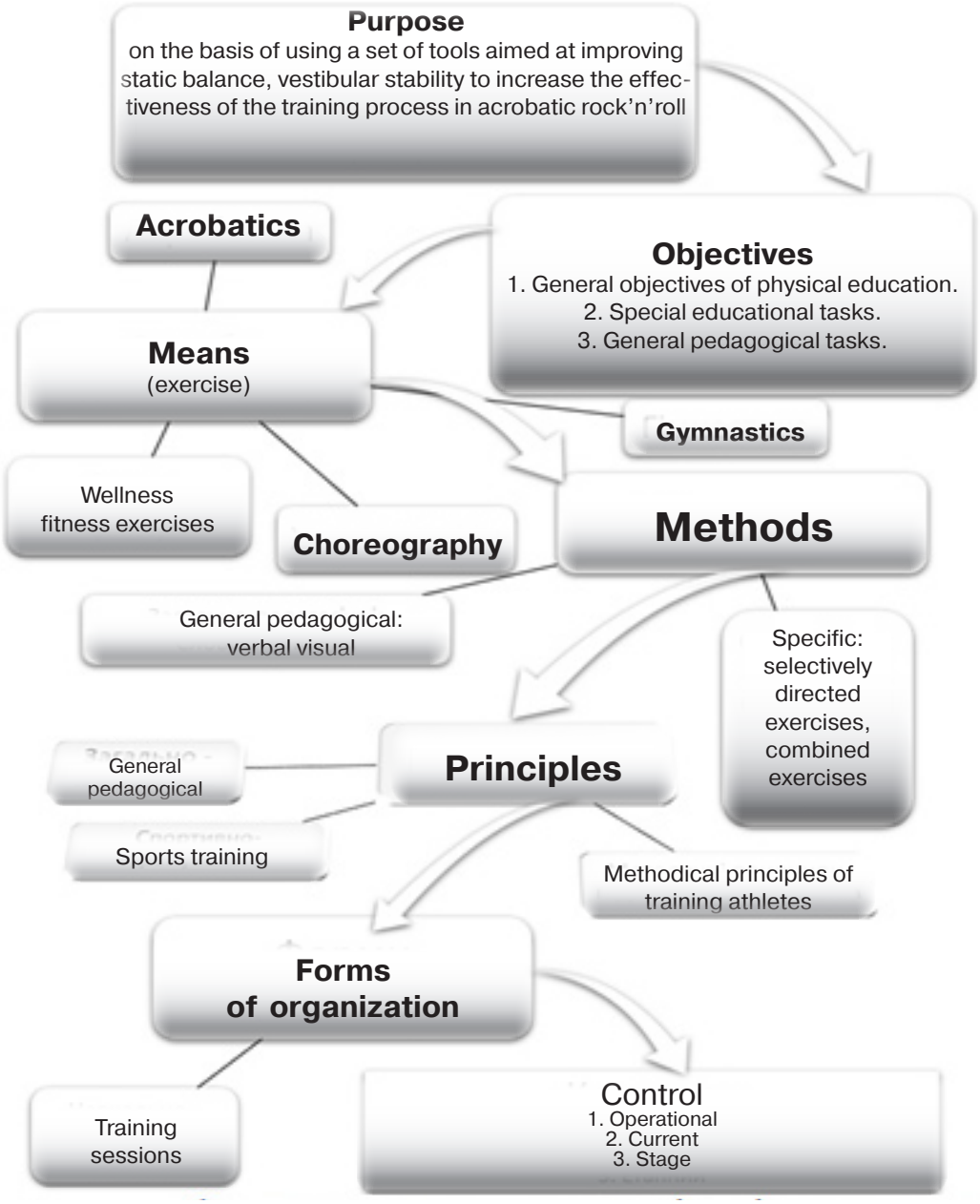

Fig. 1. Structure of the methodology for improving the body balance function

The construction of an experimental technique is based on three subdivisions of principles:

– general educational (consciousness and activity, accessibility and individualization, visibility and progression)

– the principles of sports training (specialization and individualization, the unity of all aspects of training, continuity and cyclicality, maximization and gradual increase in requirements, wave-like dynamics of loads)

– methodological foundations for training athletes with acrobatic rock'n'roll ("advancing", contingency, proportionality, excess, modeling).

A diagram of the equilibrium development technique is depicted in Figure 1.

When selecting funds for the development of equilibrium, it was supposed to use the most diverse exercises possible to improve all analyzers that provide the equilibrium function. Each exercise that was introduced to improve balance, at the same time solved other related tasks of preparation, that is, the development of motor qualities, the mastery of the technique of movements.

Exercises for the development of the equilibrium function alternated with others, aimed both at solving the problems of general physical training (to improve proper posture, to develop motor qualities, etc.), and to form the necessary motor skills.

The data of many studies have established that uprightness is an inborn reflex and body installation. However, along with conditioned reflex prerequisites for the implementation of the body balance function, a person needs constant training (from birth) of organs and systems that ensure body stability [6].

Therefore, we provided for a gradual and systematic increase in the degree of influence of the special tools used on improving the systems of analyzers in the framework of one

lesson and from lesson to another lesson.

To gradually increase the load in an appropriate combination, the following were used: a) an increase in the pace of implementation; b) an increase in the number of repetitions and the number of exercises performed by athletes; c) increasing the complexity of exercises; d) performance of tasks with the exception of individual analyzer systems (for example, with eyes closed).

We have developed complexes of special exercises that are included in all parts of the training session. They were combined into separate blocks of acrobatics exercises, modern choreography and health fitness (exercises on fitball and the BOSU platform).

In the preparatory part, rotational movements were performed under ordinary conditions and with eyes closed, exercises for static stability were also added (choreography exercises – the content of various poses). In the main part of the lesson, to the usual arsenal of acrobatic rock'n'roll exercises, which improve the body balance function, we included acrobatics exercises, exercises on fitball and an unstable platform and various relay races exercises on dynamic balance. In the final part were added exercises for the development of static equilibrium.

At the end of the pedagogical experiment, to test the effectiveness of the complexes of exercises developed and introduced into the training process for developing the equilibrium function of the body of athletes, repeated testing was carried out and a comparative analysis of the initial and control indicators was made. The results of the CG and EG of athletes are presented in tables 2 and 3.

Analyzing the data of the control group of athletes, which are presented in Table 2, we can note a positive change in the average values of the balance indicators of the body of athletes.

We have found that for athletes 10–12 years old attending acrobatic rock'n'roll classes, the ability to static and dynamic balance and vestibular stability improves during training.

During the pedagogical experiment, at $p<0.05$, the indicators of static equilibrium in the Romberg test (right and left leg) and dynamic equilibrium in the Walk without visual control test changed significantly. Without significant changes at $p>0.05$, there remained an indicator of static equilibrium in the test Swallow (right and left leg) and vestibular stability in the test Restoring equilibrium.

Analyzing the change in the studied indicators of body balance of athletes in the experimental group, we can speak about the positive impact of exercises that were introduced and performed by athletes in the training process of acrobatic rock'n'roll.

During the study, all investigated parameters were significantly changed at $p<0,05$, $p<0,01$.

The dynamic equilibrium index changed more significantly, the least changes in the static equilibrium index occurred.

We also analyzed the increase in body balance indicators of athletes of both groups, and Figure 2 shows their comparative analysis.

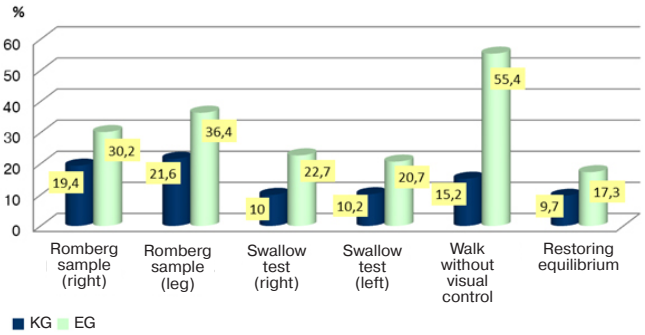

Fig. 2. Comparative analysis of the growth of the equilibrium indicators of the body of athletes in the control and experimental groups, in%

In the test, the Romberg test on the right of athletes in the EG increased by 10.8%, the left – by 14.8% more than the athletes of the CG. In the test, the Swallow on the right of the athletes of the EG increased by 12.7%, the left by 10.5% more than the athletes of the CG. In the test Walking without visual control, athletes in the EG increase by 40.4% more than athletes in the CG. In the test, Equilibrium recovery in athletes of the EG increased by 7.6% more than in athletes of the CG.

The results obtained in the pedagogical experiment do not contradict the already known scientific facts of L.P. Matveev (2008), V.I. Lyakha (2006), V.N. Platonov (2015), which claim that the most favorable period for the development of equilibrium ability in children is the age of 7 to 12 years, and by 13–14 years, the indicators of body stability reach the values characteristic of an adult. Meanwhile, focused training can provide earlier improvement in the capabilities of the systems responsible for the equilibrium function [14; 16; 19].

Conclusions / Discussion

1. In the process of analyzing the scientific and methodological literature on the development of the body balance of athletes attending classes in complex coordination sports of an aesthetic orientation, we found sources that contributed to solving this issue. These sources touch upon the development of the balance of athletes in rhythmic

Table 2

A comparative analysis of the change in the estimates of the equilibrium indicators of athletes of the CG in acrobatic rock'n'roll during a pedagogical experiment (n=14)

Test		BE $\bar{X}\pm m$	AE $\bar{X}\pm m$	Increase, %	t	P
Romberg Sample, s	right foot	18,2±1,9	22,6±2	19,4	2,2	<0,05
	left foot	16,3±1,9	20,8±2,2	21,6	2,2	<0,05
Swallow, s	right foot	21,7±2,4	24,1±2,2	10	1,1	>0,05
	left foot	24,4±2,9	27,2±2,4	10,2	1,2	>0,05
Walking without visual control, see: + to the right; - to the left		–34,7±2,7	–29,4±2,9	15,2	2,2	<0,05
Restoration of balance, s		34,3±3	38±3,1	9,7	1,5	>0,05

Table 3

A comparative analysis of the change in the estimates of the equilibrium indicators of athletes of the EG in acrobatic rock'n'roll during a pedagogical experiment (n=14)

Test		BE $\bar{X}\pm m$	AE $\bar{X}\pm m$	Increase, %	t	P
Romberg Sample, s	right foot	18,2±1,9	26,1±1,8	30,2	4,0	<0,01
	left foot	16,4±1,9	25,8±1,9	36,4	4,8	<0,01
Swallow, s	right foot	21,7±2,4	28,1±2,2	22,7	3,0	<0,05
	left foot	24,4±2,9	30,8±2,5	20,7	2,7	<0,05
Walking without visual control, see: + to the right; - to the left			–15,2±1,7	55,4	9,3	<0,01
Restoration of balance, s			41,4±3,1	17,3	3,0	<0,05

and artistic gymnastics, acrobatics and figure skating. Unfortunately, in the literature accessible to us from acrobatic rock'n'roll, a limited amount of information has been found that would reveal the development of balance in athletes from acrobatic rock'n'roll.

2. An analysis of the source data showed that when assessing static equilibrium, the results of athletes are below normal (Romberg test: rights 18.2±10.3 s, left 16.4±10.2 s; test "Swallow": rights 21.7±12 7 s, left 24.4±15.1 s. The results of the athletes' dynamic equilibrium are as follows: the average deviation from the trajectory when performing this exercise is –24.8±13.6 cm. Significant deviations from the midline give reason to state a low level of development of abilities orientation in space and dynamic balance of athletes.

In the group, the average time to restore equilibrium after rotations is 34.2±16.1 s. According to the authors, the indicators are low.

3. During the pedagogical experiment, at $p<0.05$, the static equilibrium of the athletes of the CG in the test of the Romberg test (right and left leg) and the dynamic balance in the Walk without visual control test changed significantly. Without significant changes at $p>0.05$, there remained an indicator of static equilibrium in the test Swallow (right and left leg) and vestibular stability in the test Restoring equilibrium.

In EG athletes, a significant change in all the studied parameters is observed at $p<0.05$, $p<0.01$. The indicator of dynamic equilibrium has changed more significantly, the changes in the indicator of static equilibrium have occurred less. Therefore, we can argue that the tools for developing equilibrium that we developed and introduced into the educational process of EG athletes at the stage of preliminary basic training turned out to be more effective.

In the future prospect of further research, it is supposed to determine the relationships between the equilibrium indicators and the anthropometric parameters of athletes from acrobatic rock'n'roll at the stage of preliminary basic training.

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Effectiveness of the program for restoring the function of the upper limb in traumatic and compression-ischemic injuries of the peripheral nerves and brachial plexus

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Purpose: *to determine the effectiveness of the developed program for the restoration of upper limb function in traumatic and compression-ischemic injuries of the peripheral nerves.*

Material & Methods: *the study involved 173 patients who were divided into 2 main rehabilitation groups: group I – patients with acute traumatic damage to the peripheral nerve or plexus (132 people), group II – patients with compression-ischemic (tunnel) neuropathies and plexopathies (41 people). The study was conducted on the basis of the Institute of Neurosurgery acad. A. P. Romodanova of the National Academy of Medical Sciences of Ukraine" (2015–2018) and on the basis of neurological departments No. 1 and No. 2 of the Kiev City Clinical Hospital No. 4 (2017–2019). To assess impaired motor function of the nerve and sensitivity, a 6-point scale was used according to the method of R. B. Zachary, W. Holmes, N. Millesi. The Boston Questionnaire (Boston Carpal Tunnel Questionnaire) was used to assess the severity of symptoms, activity, and participation in daily life.*

Results: *during the initial examination, we found that in the majority of patients of the 1st rehabilitation group, motor disorders on a 6-point scale were at the level of M1-M2 in 27,3% and 31,8% of individuals, respectively, and M3 in 15,9% of patients. In patients of the rehabilitation group II, the indicators of motor disorders were not so pronounced: patients with impaired motor function at the level of M2-M3 prevailed (34,1% and 24,4% of patients, respectively). According to the scale of functional disorders of the Boston questionnaire, the patients with the studied groups experienced the greatest difficulties when bathing and putting on clothes – 17,4%, doing homework – 13,6% of people, fastening buttons on clothes – 15,2%. In patients of the rehabilitation group II, approximately the same results were observed. In the main group, we used the program of rehabilitation measures that we developed, in the comparison group, the program that is used in the hospital for this category of patients. The therapy lasted 3 months. Upon repeated examination in patients of the main I rehabilitation group, motor disorders decreased under the influence of physical therapy, which were used in them. In the main group, a greater number of patients (12,3%) showed normal strength in the affected limb (M5), in the control group this indicator was lower (7,5%). Movements with overcoming the weight of the limb (M3) and movements with overcoming the resistance (M4) were observed in 24,6% and 30,8% of patients in the main group, which significantly exceeds similar indicators of the control group.*

Conclusions: *as shown by the results of studies, physical therapy and occupational therapy in the complex treatment of people with traumatic and compression-ischemic neuropathies of the upper limb contributed to a more intensive restoration of arm functions and increased results of motor therapy. The following rehabilitation measures are most effective for this category of patients: kinesiotherapy, taping, massage, physiotherapy, mechanotherapy and hydrotherapy.*

Keywords: *neuropathy, upper limb, trauma, physical therapy, ergotherapy.*

Introduction

Damage to the peripheral nerves reaches 4% of all injuries, constitutes a major medical and social problem, since they are characterized by a significant and long-term decrease in limb function, and a high level of patient disability [1; 2]. As the analysis of world literature shows, despite the introduction of new diagnostic and microsurgical techniques, a number of problems remain in the treatment of peripheral nerve injuries, associated primarily with the timely use of physical therapy and occupational therapy [3; 7].

According to Yu. V. Demin, up to 40% of patients sought specialized care more than 6 months after the injury, 19,9% were treated conservatively unreasonably for a long time [5]. This leads to an increase in the share of unsatisfactory treatment results, since with an increase in the time after injury the prognosis for a further functionally useful degree of nerve repair worsens. Injury can cause concussion, bruising, compression, stretching, a complete cross section of the nerve, that is, damage to certain structures of the nerve of varying severity.

The complexity of the use of rehabilitation measures lies in the severe consequences of injuries and compression of the peripheral nerves and brachial plexus of the upper limb, a long treatment period, the development of motor, sensory disorders, leading to disability of patients of working age.

All of the above indicates the relevance of the topic of application and study of the effectiveness of physical therapy and occupational therapy with this pathology.

Purpose of the study: to determine the effectiveness of the developed program for the restoration of upper limb function in traumatic and compression-ischemic lesions of the peripheral nerves.

Material and Methods of the research

A content analysis of 424 medical records of patients was carried out, of which 353 were medical records of patients with the consequences of traumatic and compression injuries of the peripheral nerves of the upper limb, which were operated on at the Department of Reconstructive Neurosurgery of the

Institute of Neurosurgery named after acad. A.P. Romodanova of the National Academy of Medical Sciences of Ukraine "from 2015 to 2018, and 71 medical history of patients with compression-ischemic (tunnel) neuropathies who underwent conservative treatment on the basis of neurological departments No. 1 and No. 2 of Kiev City Clinical Hospital No. 4 (2017–2019). When analyzing medical records, we studied the etiopathogenesis of this disease, trauma mechanisms, age, sex of patients, the duration of the disease, methods, results of conservative and surgical treatment, the number of relapses in tunnel syndromes, the number and types of surgical intervention for traumatic neuropathies of the upper limbs, functional disorders of the damaged upper limb that arose as a result of an injury or illness, etc.

The study involved 173 patients who were divided into 2 main rehabilitation groups: group I – patients with acute traumatic damage to the peripheral nerve or plexus (132 people), group II – patients with compression-ischemic (tunnel) mononeuropathy and plexopathy (41 man). In addition, in each rehabilitation group, we still identified the main and comparison groups (Fig. 1).

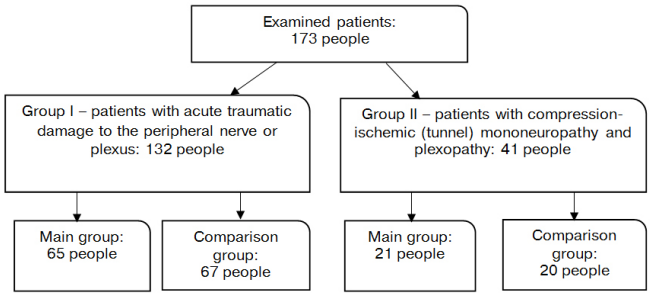

Fig. 1. Distribution of patients examined by rehabilitation groups

Among the patients with neuropathies of the peripheral nerves of the upper limb, men predominated – 129 (74.6%) people, women – 44 (25.4%) people. For patients who underwent surgical treatment, the duration of the disease ranged from 3 to 12 months, with conservative treatment – from 1 to 6 weeks. The age of the examined varied from 18 to 69 years, an average of 45.9 ± 4.6 years. The distribution of patients by clinical syndromes is presented in Table 1.

Table 1

Distribution of patients according to clinical syndromes (I rehabilitation group, n=132)

Clinical syndromes	Number of patients
Brachial plexus injuries	68 (51,5%)
Injuries of the ulnar nerve	27 (20,5%)
Injuries to the radial nerve	23 (17,4%)
Injuries to the median nerve	8 (6,1%)
Injuries to the median and ulnar nerves	6 (4,5)

As can be seen from the table. 1, half of the observations were patients with the consequences of damage to the brachial plexus – 68 (51,5%) people. Carpal tunnel syndrome – 23 (56,1%) people and cubital syndrome – 16 (39,0%) patients prevailed among tunnel neuropathies.

According to the mechanism of trauma, traumatic damage to the peripheral nerves and brachial plexus in most cases occurred as a result of traffic accidents – 47,7% and a fall from a motorcycle – 21,9% (Table 2).

Table 2

Distribution of patients according to the mechanism of trauma (I rehabilitation group, n=132)

Mechanism of trauma	Number of patients
traffic accidents	63 (47,7%)
motorcycle injuries	29 (21,9%)
chopped, chipped	18 (13,7%)
traction	7 (5,3%)
gunshot	6 (4,5%)
mixed	9 (6,9%)

In patients with tunnel neuropathies, the main reason was compression of the nerve in the anatomical tunnel.

To assess the functional state of the upper limb, a clinical and neurological (by a doctor) and rehabilitation (physical therapist) examination was carried out, the purpose of which was to establish the presence of neuropathy, damage level, degree of neurological deficit, muscle hypotrophy and atrophy, joint and muscle contractures. When collecting an anamnesis, it was found out the presence of trauma in the past (traffic accidents, falls, fractures, stab wounds, gunshot wounds, etc.), provoking factors (profession, occupation), the time of symptom manifestation and its development in the course of treatment was clarified in SI «Institute of Neurosurgery named. acad. A.P. Romodanova of the National Academy of Medical Sciences of Ukraine", a history of concomitant diseases and previous surgical interventions was collected.

We used the following research methods: to assess the state of impaired motor function of the nerve and its recovery after surgery, as well as to study sensitivity disorders, we used the generally accepted scheme of English surgeons R. B. Zachary; W. Holmes, Austrian surgeon N. Millesi, modified by the Leningrad Research Institute of Neurosurgery [4]. According to this scale, motor function is evaluated by the ability to contract muscles from M0-M5 (M0 – lack of muscle contraction (complete paralysis) – M5 – normal strength, complete clinical recovery) and sensitivity S0-S5 (S0 – anesthesia in the autonomous innervation zone – S5 – normal pain sensitivity). The Boston Questionnaire (Boston Carpal Tunnel Questionnaire, BCTQ) was used to assess the severity of symptoms, activity, and participation in daily life. [6].

In the main groups, we used the rehabilitation program developed by us, in the comparison group – the standard one, which is used in this category of patients. The therapy lasted three months.

Results of the research

It is known that injuries of the peripheral nerves of the upper limb significantly reduce the motor function of the limb and sensitivity in the affected segment, require additional surgical interventions, increase the duration of treatment and rehabilitation, increase the number of patients with unsatisfactory treatment results [3]. At the initial examination, we found that in most patients and the rehabilitation group, motor disorders on a 6-point scale were at the M1-M2 level – weak and rare muscle contractions without signs of movement in the joints and movement when the limb weight was turned off (27,3% and 31,8%, respectively) and M3 – movements

Table 3

Indicators of motor disorders in the examined patients before the rehabilitation course

Indicators	I rehabilitation group (n=132)		II rehabilitation group (n=41)	
	Abs. units	%	Abs. units	%
Lack of muscle contraction (complete paralysis) (M0)	19	14,4	2	4,9
Weak and rare muscle contractions without signs of movement in the joints (M1)	36	27,3	7	17,1
Movement when turning off the weight of the limb (M2)	42	31,8	14	34,1
Movement with overcoming limb weight (M3)	21	15,9	10	24,4
Movement with overcoming resistance (M4)	14	10,6	8	19,5
Normal strength, complete clinical recovery (M5)	0	0	0	0

Table 4

Indicators of sensitive disorders in the examined patients before the course of rehabilitation

Indicators	I rehabilitation group (n=132)		II rehabilitation group (n=41)	
	Abs. units	%	Abs. units	%
Anesthesia in the autonomous innervation zone (S0)	8	6,1	3	7,3
Uncertain pain (S1)	27	20,5	6	14,6
Hyperpathia (S2)	31	23,5	12	29,3
Hypesthesia with a decrease in hyperpathy (S3)	34	25,7	7	17,1
Moderate hypesthesia without hyperpathy (S4)	26	19,7	8	19,5
Normal pain sensitivity (S5)	6	4,5	5	12,2

with overcoming the weight of the limb (15,9%).

In patients of the II rehabilitation group, the indicators of motor disorders were not so pronounced: patients with impaired motor function at the level of M2-M3 predominated (34,1% and 24,4%, respectively). This is due to the fact that with traumatic neuropathy, a more severe nerve damage is observed (neuropraxia, axonotmesis, neurotmesis), which leads to peripheral paresis or paralysis, compared to tunnel hand syndromes, in which paralysis rarely occurs (Table 3).

According to A. S. Gilveg, V. A. Parfenov et al., in cases of lesions of the peripheral nerves of the upper limb, sensitivity disorders are manifested in the appearance of zones with complete or partial loss of sensitivity, but along with this, nerve irritation phenomena - hyperesthesia, paresthesia [3]. At the initial examination in patients of both groups, the sensitivity indicators were at the level of S1-S3 (vague pain, hyperpathy, hypesthesia with a decrease in hyperpathy) (Table 4).

The indicators of the Boston questionnaire showed that on the symptom severity scale (Symptom Severity Scale, SSS) during the initial examination in patients of both groups, mainly moderate and severe pain in the affected upper limb prevailed, which bothered patients both day and night. An analysis of sensitivity disorders in the indicated questionnaire confirmed the data of a previous study: most patients complained of a moderate expressed feeling of numbness.

According to the scale of functional disorders of the Boston questionnaire (Function Status Scale, FSS), the patients of the studied groups experienced the greatest difficulties when bathing and putting on clothes – 17,4%, doing homework – 13.6% of people, fastening buttons on clothes – 15,2%. In patients of the II rehabilitation group, approximately the same results were observed.

To restore and improve the function of the affected upper limb for patients of the main groups, we developed

Table 5

Indicators of functional disorders in the examined patients before the rehabilitation course

Actions	I rehabilitation group (n=132)		II rehabilitation group (n=41)	
	Abs. units	%	Abs. units	%
Writing difficulties	16	12,1	4	9,8
Button fastening on clothes	20	15,2	7	17,1
Reading book content	9	6,8	5	12,2
Phone handset content	15	11,4	4	9,8
Bottle opening	17	12,9	4	9,8
homework	18	13,6	7	17,1
Carrying food bags	14	10,6	6	14,4
Bathing and putting on clothes	23	17,4	4	9,8

an algorithm of rehabilitation measures depending on the treatment method (surgical, conservative), the severity and level of the lesion, and the results of the initial examination.

In the first rehabilitation group of patients with acute traumatic damage to the peripheral nerve or plexus, surgery was used. Before carrying out rehabilitation measures, the patients and the rehabilitation group were randomly divided into 2 groups: the main (65 people) and the comparison group (67 people).

In the main group of patients with acute traumatic damage to the peripheral nerve or plexus (and the rehabilitation group), the developed algorithm of rehabilitation measures was used: kinesitherapy (passive and active exercises, resistance exercises, in isometric mode, with objects), taping, massage, apparatus physiotherapy, mechanotherapy and hydro rehabilitation. Patients of the comparison group were engaged in the rehabilitation program of the medical institution (physical exercises, massage, hardware physiotherapy). All funds in both groups were allocated in accordance with the rehabilitation period: the period of preoperative preparation; early postoperative period; immobilization period; post-immobilization period; period of stage functional therapy. To correct the performance of household actions in patients, means of ergotherapy were used.

Tunnel neuropathy was treated conservatively. In patients of the rehabilitation group II of tunnel neuropathies in the main group, the rehabilitation measures included the same physical therapy as in the first group, but they were supplemented by neurodynamic techniques. In the comparison group, rehabilitation measures were applied according to the program of the medical institution. Period: acute, subacute recovery.

After 3 months, a re-examination of patients was conducted. In patients of the main group and the rehabilitation group, motor disorders improved under the influence of physical therapy, which were used in them. As can be seen from table 6, in the main group, a greater number of patients (12.3%) showed normal strength in the affected limb (M5), in the control group this indicator is lower (7.5%). Movements with overcoming the weight of the limb (M3) and movements with overcoming the resistance (M4) were observed in 24.6% and 30.8% of individuals, respectively, in the main group, which significantly exceeds similar indicators of the control group.

After the rehabilitation course, we noted an improvement in sensitivity in the affected limb in the main and comparison groups, however, in the main group, a greater number of patients showed indicators at the levels of S3 (33.8% of cases) and S4 (29.2% of people). In the comparison group, we found sensitivity at the S1 level in 19.4% of individuals, S3 in 28.5 patients, S4 in 22.4% of patients (Table 7).

After a rehabilitation course, most patients in both groups decreased pain according to the Boston questionnaire (symptom severity scale). The use of ergotherapy helped to improve self-care skills in patients of both the main and comparison groups (I rehabilitation group). However, the patients of the main group could do their homework better, carry bags of food, bathe and dress in comparison with the control group (Table 8).

Patients of the rehabilitation group of tunnel neuropathies of the II rehabilitation group before physical therapy and

Table 6

Indicators of motor disorders in patients of the rehabilitation group I after a rehabilitation course (n=132)

Indicators	Groups of surveyed			
	Main group (n=65)		Comparison group (n=67)	
	Abs. units	%	Abs. units	%
Lack of muscle contraction (complete paralysis) (M0)	4	6,2	6	8,9
Weak and rare muscle contractions without signs of movement in the joints (M1)	8	12,3	12	17,9
Movement when turning off the weight of the limb (M2)	9	13,8	15	22,4
Movement with overcoming limb weight (M3)	16	24,6	11	16,4
Movement with overcoming resistance (M4)	20	30,8	18	26,9
Normal strength, complete clinical recovery (M5)	8	12,3	5	7,5

Table 7

Indicators of sensitive disorders in patients of the rehabilitation group I after a rehabilitation course (n=132)

Indicators	Groups of surveyed			
	Main group (n=65)		Comparison group (n=67	
	Abs. units	%	Abs. units	%
Anesthesia in the autonomous innervation zone (S0)	4	6,2	6	8,9
Uncertain pain (S1)	7	10,8	13	19,4
Hyperpathia (S2)	9	13,8	12	17,9
Hypesthesia with a decrease in hyperpathy (S3)	22	33,8	19	28,5
Moderate hypesthesia without hyperpathy (S4)	19	29,2	15	22,4
Normal pain sensitivity (S5)	4	6,2	2	2,9

Table 8

Indicators of functional disorders in the examined patients after a rehabilitation course (I rehabilitation group, n=132)

Actions	Groups of surveyed			
	Main group (n=65)		Comparison group (n=67)	
	Abs. units	%	Abs. units	%
Writing difficulties	6	9,2	4	5,9
Button fastening on clothes	13	20,0	14	20,9
Reading book content	3	4,6	2	2,9
Phone handset content	4	6,2	5	7,5
Bottle opening	7	10,8	5	7,5
homework	9	13,8	11	16,5
Carrying food bags	11	16,9	12	17,9
Bathing and putting on clothes	12	18,5	14	20,9

Table 9

Indicators of motor disorders in patients of the II rehabilitation group after a course of rehabilitation (n=41)

Indicators	Groups of surveyed			
	Main group (n=65)		Comparison group (n=67)	
	Abs. units	%	Abs. units	%
Lack of muscle contraction (complete paralysis) (M0)	1	4,8	2	10,0
Weak and rare muscle contractions without signs of movement in the joints (M1)	2	9,5	4	20,0
Movement when turning off the weight of the limb (M2)	3	14,3	5	25,0
Movement with overcoming limb weight (M3)	5	23,8	4	20,0
Movement with overcoming resistance (M4)	4	19,0	2	10,0
Normal strength, complete clinical recovery (M5)	6	28,6	3	15,0

Table 10

Indicators of functional disorders in the examined patients after a rehabilitation course (II rehabilitation group, n=41)

Actions	Groups of surveyed			
	Main group (n=65)		Comparison group (n=67)	
	Abs. units	%	Abs. units	%
Writing difficulties	2	9,5	1	5,0
Button fastening on clothes	4	19,0	3	15,0
Reading book content	1	4,9	1	5,0
Phone handset content	2	9,5	1	5,0
Bottle opening	2	9,5	2	10,0
homework	4	19,0	6	30,0
Carrying food bags	3	14,3	2	10,0
Bathing and putting on clothes	3	14,3	4	20,0

occupational therapy were also divided into 2 groups: the main group (21 patients) and the comparison group (20 people). The motor function improved in most patients of the main group to the level of M4-M5, in the comparison group these indicators are lower to the level of M3-M4 (Table 9).

After a course of rehabilitation in the examined patients, we noted an improvement in the sensitivity to S3-S4.

Patients with tunnel syndromes (rehabilitation group II) also improved the performance of various domestic activities. As can be seen from Table 10, difficulties in homework were observed in 19.0% of the main group, in the comparison group this indicator was significantly higher – 30.0% of cases, when bathing and dressing - 14.3% and 20.0 cases, respectively.

Conclusions / Discussion

As the research results showed, the means of physical therapy and ergotherapy in the complex treatment of people with traumatic and compression-ischemic neuropathies of the upper limb contributed to a more intensive restoration of the functions of the hand and increased results of motor therapy.

The following rehabilitation measures are most effective for this category of patients: kinesitherapy (passive and active exercises, exercises with resistance, in isometric mode, with objects), taping massage, apparatus physiotherapy, mechanotherapy and hydro rehabilitation.

Prospects for further research are to develop technology for restoring quality of life in this pathology.

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Study of the possibilities of using a 6-minute rowing on a Concept2 ergometer to assess the level of endurance in students

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Purpose: *to study the possibilities of using 6-minute rowing on a Concept2 ergometer in physical education of students with determining the distance that students overcome and develop a scale for assessing the level of endurance.*
Material & Methods: *students of the Pyotr Mogila Black Sea State University (Mykolaiv) (n=200) participated in the study, among them 125 students from Ukraine (n=69 young men; n=56 girls) and 75 students from India (n=48 boys; n=27 girls). Testing was carried out on Concept2 rowing ergometers at the water sports complex. Methods used: analysis of scientific sources, analogy method, pedagogical testing, anthropometric measurements and methods of mathematical statistics.*
Results: *use of a 6-minute walking test was examined to determine functionality; the use of rowing ergometers to determine the time for which students can cover a distance of 1000 m, 500 m. We proposed the use of Concept2 ergometers to assess the level of endurance of students, we developed a 5-point scale: we determined the length of the distance that students covered in 6 minutes of rowing on an ergometer. The differences in the physical development of students from Ukraine and India are determined.*
Conclusions: *the possibility of using rowing ergometers in the system of physical education of students is confirmed. The correlation between body weight and the length of the distance that students covered in 6 minutes on a rowing ergometer was revealed. Attention is drawn to the differences in the distance length indicators (m), which students of India (1210,50±113,40) and Ukraine overcame (1391,32±113,69).*

Keywords: *student, 6-minute test, rowing, Concept2 ergometer, body mass index, endurance, physical education.*

Introduction

Today, computerization, a sedentary lifestyle of young people, an insufficient level of effectiveness of physical education lead to a deterioration in the physical health of students. The effectiveness of the physical education system in higher education institutions is limited by many factors: a decrease in hours for compulsory classes in the discipline «Physical Education», a low level of motivation for students to engage in physical activity, «post-crediting» discipline (outside of student loans), simplification of student assessment in the classroom physical exercises, uniformity and formality of the nature of classes, low level of development of the material base of educational institutions and other factors.

The results of monitoring the physical fitness of students indicate a decrease in the level of physical qualities. The effectiveness of student learning depends on the level of physical performance. Underdevelopment of endurance leads to fatigue, rejection of new material in specialized training sessions. The importance of endurance, the improvement of assessment standards, attracted the attention of scientists. According to the resolution of the Cabinet of Ministers of Ukraine (December 9, 2015 No. 1045), in order to determine and improve the level of physical fitness of the population of Ukraine, the Order of the Ministry of Education and Science of Ukraine approved tests and standards for individuals whose annual physical fitness assessments are carried out on a voluntary basis. The test, which determines the level of endurance, running at medium and long distances (2000 m, 3000 m, 12-minute run) is carried out on the treadmill of the stadium or on any flat terrain. The test result is the time to overcome the distance to the nearest tenth of a second (Order of the Ministry of Education and Science of Ukraine, 2018). The aforementioned test is considered difficult for students, both teachers and test participants note.

As you know, the assessment standards should reflect the individual and age-related characteristics of the body, contribute to increasing motivation to achieve a high level of physical health. Scientists note that running at a distance of 2000–3000 m is the ultimate test, difficult for modern students. The introduction of the standard “without taking into account time” is proposed, which envisages the end of the distance without a specific temporary result and will allow students with low endurance to receive grades (V.A. Senkevich, A.A. Averbakh, 2018). Studying the dynamics of improving physical abilities, as you know, it is necessary to carry out various types of control, apply tests that would be safer, reliable and varied. As noted in the monograph by V.M. Sergienko (2015), the question of the features of monitoring and evaluating the development of endurance in the course of practical exercises in physical education is insufficiently studied (V.M. Sergienko, 2015, p. 40).

Thus, there are contradictions between the need to increase the level of endurance, improving the system for assessing the development of physical qualities and the current state of development of tests and types of control.

In connection with the foregoing, solving the problem of assessing the level of development of endurance, developing new tests and types of control, introducing them into the

educational process is an urgent task. Thus, there is a need for research to improve the control system, the introduction of new motor tests, which were characterized by reliability, safety, accessibility for students.

In physical education, the Cooper test (12-minute run) is used to assess endurance. According to the results of control tests, it was found that the initial level of indicators of general endurance in girls is 1.55 conv. units, and for boys – 1.95 conv. units, which corresponds to 1 point (V.M. Sergienko, 2015, p. 40). In some Universities, to assess endurance, they use running for 3000 m, 1000 m. It has been established that about 70% of the time of the main part of the lesson is appropriate for developing endurance, the rest of the time to cultivate other qualities (N.V. Ignatenko, 2015). As a result of studies, it was found that the level of endurance with the test running at 1000 m is deteriorating: comparing the results of 17-year-old and 20-year-old students, the decrease is characterized by 3.37%. For students (young men), a test was run for 2000 m: a low level of development is observed in 9% of the 17-year-old boys studied (V.M. Sergienko, 2015, p. 72). We studied the possibilities of using correlation analysis in order to establish the relationship between the results of traditional testing and indices, which allowed us to take into account individual characteristics in the physical education of students. In most groups, to assess the students' speed-power abilities, we replaced the "long jump from the spot" on the calculation of the speed-power index. The endurance index indicators depended on body length and running speed at a distance of 2000-3000 m and in the opposite, on body weight (I. Bondarenko, 2008).

In order to optimize the educational process of physical education of university students, it is recommended to use comprehensive monitoring, which would include tests to determine the functional state, and tests to assess the level of development of physical qualities (I. Samokish, 2017).

Distance measurement is overcome for a certain period of time was first described in the early 1960s. It was determined that a test with 6 minutes of walking, by the definition of the distance that a person walks in 6 minutes, is a reliable and reliable indicator of aerobic fitness of a person (Patrick J. VanBeveren, Dale Avers, 2012). It was noted that a load of 6 minutes walking can be used for people of all ages of different preparedness to assess the effectiveness of rehabilitation measures (N.V. Trushenko, 2018). Also, a 6-minute test with walking is used to study the functional parameters of the respiratory system in patients with chronic lung disease (N. Peregudov, A. Kosyakov, 2019). Recently, a 6-minute test has been used to assess functional performance in chronic cardiopulmonary diseases, strokes in the population of African countries (O.A. Ajiboye, C.N. Anigbogu, 2014). French scientists analyzed several modifications of the walking tests: 2 minutes, 5 minutes, 9 minutes and 12 minutes. The greatest effectiveness of the 6-minute test was found out. The predicted formula for adults without health disorders has been created:

6mWT = 218 + (5,14 x height in cm) – (5,32 x age in years) – (1,80 x weight in kg) + (51,31 x gender*),

gender: 1 for men 0 for women (J.-M. Casillas, A. Hannequin 2013). In 2014, in the process of research, it was found that the average values of the 6-minute walking distance, which were measured in the study participants from Nigeria (517.6–72.2 m), were lower than this indicator was observed in groups of Americans (647.3±91,04 m; p <0.001), Brazilians (616,6±23,1 m, p<0,001) and Tunisians (830.3±84.1) m, p<0.001), and were higher, than men of Arab origin (472,3±21,1, p<0,001). Close relationships of the distance were observed with body length (r_{xy}=0,470), age (r_{xy}=–0,375) and BMI (r_{xy}=–0.356) (Olufunke A. Ajiboye, Chikodi N. Anigbogu, 2014). In other studies, the 6-minute test (6MWT) was used to evaluate the functionalities of Hong Kong's Chinese elderly. Each participant performed two 6-minute walk tests (6 MWT). The average value of the test was 563±62 m and was significantly associated with age (r=–0,62) and body length (r=0,39) and did not depend on the level of motor activity, the length of the lower extremities (Shirley P. C. Ngai, Alice Y. M. Jones, 2014).

Analyzing scientific sources, it can be noted that 6-minute walking with determining the distance began to be widely used in the field of rehabilitation and health-improving physical culture to assess functional capabilities, physical performance, assess aerobic capabilities and endurance of various segments of the population. Some sources indicate that the test involves a submaximal load to improve functionality. We drew attention to the possibility of using a 6-minute rowing on an ergometer to assess the level of endurance in students.

Purpose of the study: to explore the possibilities of using a 6-minute rowing on a Concept2 ergometer in physical education of students with determining the distance length and creating, according to the results of its passage, a 5-point scale for assessing students' endurance level.

Objectives of the study:

1. To determine the indicators of physical development, the length of the 6-minute rowing distance on the Concept2 ergometer of Ukrainian students and students from India who are studying at the Petro Mogila Black Sea National University.

2. Find out the degree of correlation between indicators of 6-minute rowing on a Concept2 ergometer and indicators of students' physical development.

3. Develop a 5-point scale for assessing the results of 6-minute rowing on a Concept2 ergometer for students.

The connection of research with scientific programs, plans, topics. The Decree of the President of Ukraine On the National Strategy for Improving Motional Activity in Ukraine for the period until 2025 "Motive activity - a healthy lifestyle - a healthy nation" (02/09/2016 No. 42/2016) notes that in Ukraine there has been a positive trend towards the increase in the number of people using different types and forms of recreational physical activity. Achieving this goal involves solving many problems, one of which is the development of a set of indicators to assess the level of physical health of various population groups (Decree of the President of Ukraine dated 09.02.2016 No. 42/2016). The plan of organizational and practical measures for the implementation of the aforementioned strategy in educational institutions of the Nikolaev region for 2020 provides for the modernization of physical education systems in educational institutions, an increase in weekly motor activity of students, conducting sectional classes in sports (4 hours per week) and optional classes in physical education (2 hours per week) (Order of the Nikolaev regional branch of the Committee for Physical Education and Sports of the Ministry of Education and Science of Ukraine dated January 31, 2020 No. 10). The study was conducted in order to study the possibilities of using a 6-minute rowing on a Concept2 ergometer in physical education of students with determining the length of the distance that students overcome, and developing a 5-point scale for assessing the endurance level of students according to the test results.

Material and Methods of the research

The study was attended by students of the ChNU named after Pyotr Mohyla (n = 200), who study at different faculties and chose a rowing section for physical education, including 69 Ukrainian youth students and 56 girls. Also, Indian students who study at a medical institute took part in the test (boys – 48, girls 27). During the academic year, Concept2 rowing ergometers are used in the lessons of the sports section in rowing. The physical education program of the ChNU named after Peter Mohyla provides for mandatory classes in physical education once a week. Since the beginning of 2019/2020 d. the university introduced the students' choice of sports sections. Testing was carried out on Concept2 ergometers (8 pcs.), Located at the water sports complex of the ChNU named after Pyotr Mogily. All students for health reasons were assigned to the main department.

Methods were used: analysis of scientific sources, analogies, pedagogical testing, anthropometric measurements and methods of mathematical statistics: checking compliance with the normality of the sample (one-chi-square test), determining the mean and standard deviation, comparison criteria, correlation analysis. All data was analyzed using the SPSS package.

Results of the research

The interest of youth, athletes in rowing ergometer classes is growing in the world, as evidenced by the holding of competitions: European Championships, indoor championships in rowing ergometers. Rowing classes at the Petro Mohyla Black Sea National University in 2019/2020 g. selected about 500 students, among whom are students from India studying at a medical institute.

Every year, a rowing competition is held at the Petro Mohyla Chernihiv National University for students at certain distances of 500 m and 2000 m. Both student athletes attending the rowing section and students with a physical education program take part in these competitions. obligatory rowing classes are planned.

At the end of the first semester (December 2019), we conducted a study to determine the length of the distance that students covered in 6 minutes on the Concept2 ergometer.

Students were offered rowing on an ergometer for 6 minutes, with an intensity of about 90% of the maximum effort. The study protocols indicated the numbers of ergometers in order to copy data to computer storage media.

All students studied rowing ergometers for about 2 months, mastering the rowing technique. Before performing, students were explained the key aspects of rowing technique on a Concept2 ergometer. In addition to determining the distance that students traveled on the simulator, we examined heart rate before and after exercise, measured body length and weight, took into account age and calculated body mass index (BMI) (Table 1).

It was determined that there is an adequate reaction of the body to a 6-minute load, heart rate fluctuations after a load within 171.89±24.52 – 182.92±22.02 beats per minute. The body length of students from Ukraine (182.51±6.75 cm) differs from the indicators that other scientists received (176.4–178.2 cm) (A. Sabirov, V. Pantik, 2016). In our opinion, higher rates of body length among students at the Petr Mohyla ChNU are explained by the free choice of motor activity at the university. The rowing section was chosen by students who believe that they have success in physical education, having advantages in body length.

To determine the samples to establish their compliance with the normal distribution law, the one-chi-square chi-square test was used. In the process of data analysis, we determined correlation relationships. It was found that the distance that Ukrainian students (young men) traveled on the ergometer in 6 minutes is significantly affected by body weight (r_{xy}=0.432, p<0.01), respectively, and body mass index, but there is a decrease in the correlation coefficient (r_{xy}=0.309, p<0.01), distance length indicators weakly correlate with body length (r_{xy}=0.274, p<0.05) and age (r_{xy}=0.253, p<0.05). Similar results were obtained in a group of girls: the length of the distance on an ergometer for 6 minutes in Ukrainian students significantly depends on body weight (r_{xy}=0.373, p<0.01), respectively, and on the body mass index (r_{xy}=0.344, p<0, 01), body length indicators are not related to distance length (r_{xy}=0,110, p>0,05).

Studying factors that can affect the distance on an ergometer among young students from India, we did not find statistically significant relationships: body length (r_{xy}=0,209, p>0,05). Among foreign students, the effect of body length on the distance on the ergometer was determined: (r_{xy}=0.482, p<0.05) and statistically unreliable - the effect of body weight on the distance for 6 minutes (r_{xy}=0,290, p>0,05).

Table 1

Indicators of physical development, functional preparedness, results of rowing on an ergometer in 6 minutes for students, $\bar{X}$±S

Indicators	Ukrainian students (various faculty)		Students from India (Medical University)	
	boys, n=69	girls, n=56	boys, n=48	girls, n=27
Age years	19,06±1,37	19,04±1,17	19,92±1,72	19,67±1,27
Dist. length for 6 minutes rowing, m	1391,32±113,69	1163,71±107,32	1210,50±113,40	956,89±210,67
HR before exercise, beats min^{-1}	113,16±14,68	107,91±18,29	115,38±16,12	113,15±16,00
HR after exercise, beats min^{-1}	178,32±17,02	171,89±24,52	182,92±22,02	179,26±18,20
Height, cm	182,51±6,75	166,19±5,82	175,33±6,51	161,96±5,85
Body weight kg	72,16±12,17	59,71±12,88	64,92±14,26	53,15±9,67
BMI, c. u.	21.66±3,51	21,63±4,62	21,12±4,55	20,21±3,13

Table 2

Example of a 5-point scale for evaluating the results of a 6-minute rowing on an ergometer Concept2 students (m)

Quality assessment				
low	lower than average	average	higher than average	high
Points				
1	2	3	4	5
from $\bar{X}$ – 2,5S to $\bar{X}$ – 1,5S	from $\bar{X}$ – 1,5S to $\bar{X}$ – 0,5S	from $\bar{X}$ – 0,5S to $\bar{X}$ + 0,5S	from $\bar{X}$ + 0,5S to $\bar{X}$ + 1,5S	from $\bar{X}$ + 1,5S to $\bar{X}$ + 2,5S
Results of a 6-minute rowing students from Ukraine (youth), n=69				
from 1107,10 m to 1220,79 m	from 1220,79 m to1334,48 m	from 1334,48 m to 1448,17 m	from 1448,17 m to 1561,86 m	from 1561,86 m to 1675,55 m
The results of a 6-minute rowing students from India (youth)), n=48				
from 927,00 m to 1040,40 m	from 1040,40 m to 1153,80 m	from 1153,80 m to 1267,20 m	from 1267,20 m to 1380,60 m	from 1380,60 m to 1494,00 m
Results of a 6-minute rowing students from Ukraine (girls), n=56				
from 895,42 m to 1002,74 m	from 1002,74 m to 1110,06m	from 1110,06 m to 1217,37 m	from 1217,37 m to 1324,69 m	from 1324,69 m to 1432,01 m

Using the table "Boundaries and norms of a 5-point sigmoid scale for assessing results" in the monograph by V.M. Sergienko (2015), we attempted to develop a 5-point scale for evaluating the results of a 6-minute rowing on a Concept2 ergometer for students. The statistical indicators of the distance over 6 minutes were taken into account: mean and quadratic deviations 1391.32±113.69 (Ukrainian students), 1210,50±113,40 (youth students from India), 1163.71±107.32 (Ukrainian students) (Sergienko, 2015, p. 65).

Comparing the average distance traveled by Ukrainian and Indian students in 6 minutes, it can be noted that there were significant differences between the groups. Statistical significant differences are also observed in terms of physical development (Table 3). In the calculations, the t-test for independent samples and the Mann-Whitney test were used.

Since in the process of correlation analysis a significant dependence of the distance length on body weight was found out, we drew attention to the differences in BMI indices of Ukrainian and Indian students. The largest number of students with normal weight (75.36%) were identified among Ukrainian students (Figure 1).

Analyzing the distribution of students according to the classification of BMI indicators, it is determined that not a single foreign student is obese. Almost every third student and every fourth student from India is characterized by reduced body weight. Among Ukrainian students (n=125), there are about 10% of obese people. Comparing BMI indicators to the results of studies by other scientists, it can be noted that 52.08% of foreign and 75.36% of Ukrainian students are characterized by body weight within normal limits. Other researchers found normal body weight in 57.9% of students (A. Sabirov, V. Pantik, 2016).

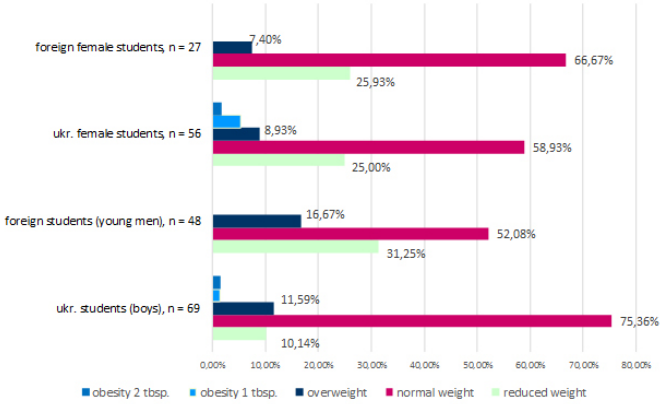

Fig. 1. The number of students of the Petro Mohyla Chernihiv National University according to the classification of BMI indicators

Conclusions / Discussion

Scientists have already made attempts to assess the re-

Table 3

Comparison of average indicators of physical development and the length of the distance that students covered in 6 minutes on an ergometer

Indicators	Sex	$\bar{X}$±m		Criterion t	Significance level p
		Ukrainian students	Students from India		
Length of distance is 6-min. ergometer, m	boys	1391,32±13,69	1210,50±16,36	8,47	0,000
	girls	1163,71±14,34	956,89±40,54	5,93	0,000
Body weight, kg	boys	72,16±1,47	64,92±2,06	2,95	0,004
	girls	59,71±1,72	53,15±1,86	2,34	0,021
Body length, cm	boys	182,51	175,33	675,00*	0,000
	girls	166,19±0,77	161,96±1,12	3,10	0,003

Remark: ** – Mann-Whitney criterion.*

lationships between anthropometric indicators and the level of endurance of students at various distances using a rowing ergometer. The study, which was conducted among university students (Olsztyn, Poland) (n=204, youth), allowed us to determine the relationship between somatic parameters and the time required to cover a distance of 500 m on a rowing ergometer. The length and body weight, the length of the lower and upper extremities, BMI significantly affected the time during which students covered a distance of 500 m. Students noted a significant load on both the lower limbs and the trunk and upper limbs (45.5% and 44% respectively) (D. Choszcz, R. Podstawski, S. Konopka, 2012). Similar studies using a distance of 1000 m were conducted in a group of students (n = 258) with compulsory physical education classes. Studies have shown correlations between anthropometric parameters and the time required to cover a distance of 1000 m on a rowing ergometer: with increasing mass, the distance traveled increases, contrary to the results of studies conducted with trained athletes. It was found that a group of students whose BMI ranged from 17 to 21 showed the best results in overcoming a distance of 1000 m on a rowing ergometer. Thus, the anthropometric parameters of the girls influenced the result of rowing on an ergometer with overcoming a distance of 1000 m (R. Podstawski., D. Choszcz., 2012).

In 2014, scientists from Poland conducted studies to determine anthropometric indicators, their effect on the time to overcome the distance of 500 m on an ergometer in women aged 19–23 (n=196) who did not systematically engage in physical exercises. It was found that the length and body weight, the length of the upper and tender limbs, BMI, and harmony index affect the test result. Scientists have noted the maximum efforts of participants to complete the distance (Podstawski, R., Choszcz, D., 2014).

Thus, with the use of Concept2 ergometers, scientists conducted studies to determine the time of rowing at a distance of 500 m and 1000 m.

It has been determined that the length of the distance covered by students on a rowing ergometer in 6 minutes can be affected by the level of rowing technique. Therefore, it takes time to master the basics of rowing technique on the simulator. The use of tests with walking or running greatly simplifies testing the level of development of endurance in students, does not require additional training. On the other hand, there are growing trends in increasing the level of students' motivation in choosing the types of physical activity associated with exercise machines. It is known that Concept2 is equipped with modern computerized systems, it allows you to control the load, time, distance, power, effort and other parameters.

It should be noted that the results of studies to determine the length of the distance that representatives of various ethnic groups overcome in 6 minutes of walking differ significantly. Scientists noted that the difference in test scores is due to different BMI scores among Asians, including Chinese, Malays, and Indians living in Singapore. Different diets and lifestyles significantly affect BMI and vary between Chinese living in the USA and China (Shirley P. C. Ngai, Alice Y. M. Jones, 2014). Thus, when developing a 5-point scale for evaluating the results of a 6-minute rowing on a Concept2 ergometer, it is necessary to take into account the ethnic characteristics of students and factors of their place of residence.

It should be noted that some scientists conduct a 6-minute walk test only once for all participants in order to exclude the learning effect, and some, on the contrary, recommend to go the distance 2 times with the restoration of the respiratory and cardiovascular system after the first test.

Thus, we have found that the length and body weight indices of Ukrainian and Indian students studying at the Petro Mohyla National University are statistically significantly different for both girls and boys: the average body weight of Ukrainian students are characterized by the data: 72,16±1,47 kg (boys), 59,71±1,72 kg (girls), students from India – 64,92±2,06 kg (boys), 53,15±1,86 kg (girls), the average body length of Ukrainian students is 182.51 cm (boys), 166.19±0.77 cm (girls), students from India – 175,33 cm (boys), 161,96±1,12 cm (girls). For 6 minutes of rowing on a rowing ergometer, foreign students (boys) showed the result: 1210.50±113,40 m, students from Ukraine – 1391,32±113,69 m; Ukrainian female students – 1163,71±14,34 m, students from India – 956,89±40,54 m.

We confirm the results of studies by other scientists on the effect of body weight on the length of the distance that students overcome on a rowing ergometer. In the indicators of the groups of Ukrainian students, correlation relationships between body weight and distance length were revealed (boys, r_{xy}=0.432, girls, r_{xy}=0.373, $p<0.01$). We partially confirmed the results of scientists from Poland on revealing a correlation between students' body length and distance: the positive correlation is observed among the indicators of a group of students from India (r_{xy}=0,482, $p<0,05$) and Ukrainian students (boys) (r_{xy}=0,274, $p<0,05$). We have not determined a statistically significant effect of age on the length of the distance that students covered in 6 minutes on a rowing ergometer, except for a group of Ukrainian students (boys) (r_{xy}=0,253, $p<0,05$).

We have confirmed the possibility of using rowing ergometers in the system of physical education of students, there is an adequate reaction of the body to a 6-minute load, heart rate fluctuations after a load in the range of 171,89±24,52 to 182,92±22,02 beats per minute.

An attempt was made to develop a 5-point scale for assessing the results of a 6-minute rowing on a Concept2 ergometer of students with subsequent use in the physical education system to determine the level of endurance in the group of Ukrainian students: 1 point is awarded for the length of the distance from 1107,10 m to 1220,79 m; 2 points – from 1220,79 m to 1334,48 m; 3 points – from 1334,48 m to 1448,17 m; 4 points – from 1448,17 m to 1561,86 m, 5 points – from 1561,86 m to 1675,55 m.

Prospects for further research in this direction are:

- in the further development of 6- and 12-minute tests using rowing ergometers to assess the level of endurance of people of different age and ethnic groups;
- in the further use of rowing ergometers in the study and assessment of strength abilities in students;
- in the development of databases, with the help of which it will be possible to significantly simplify the analysis of the dynamics of indicators of power abilities, endurance, physical development of students, is connected with the ability to connect ergometers to personal computers for the purpose of analyzing information for a long time (for a year);
- in establishing correlations between distance length indicators for 6 minutes of rowing with other tests that determine the level of endurance, in particular, Cooper's 12-minute test, running for 3000-2000 m;
- in the further use of the 6-minute test with walking (6MWT or 6MWD) in the physical education of students to assess their level of endurance;
- further substantiating the use of 6-minute rowing on an ergometer to assess students' endurance with the involvement of more participants (possibly as a sample – 6 mRD - 6 minute rowing test, 6-minute rowing, by analogy with 6MWT,

6MWD – 6 minute walk test), attract the attention of scientists from studies on determining the time taken for certain distances (500 m, 1000 m, 2000 m), which are mostly used to assess the level of preparedness of athletes, to determine the length of the distance for 6 minutes rowing on an ergometer.

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Improving the technical skills of gymnasts 8–9 years old in exercises with clubs

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Purpose: *to justify the effectiveness of the use of organizational and pedagogical technology, increases the level of technical preparedness of gymnasts of 8–9 years old in exercises with clubs and helps to form a positive attitude towards rhythmic gymnastics.*
Material & Methods: *the study involved athletes of 8–9 years engaged in rhythmic gymnastics. The control group consisted of 10 gymnasts and the experimental – 10 gymnasts. To solve the tasks, the following research methods were used: theoretical analysis and generalization of literary sources; pedagogical observations, testing the level of technical preparedness in exercises with clubs, experiment; expert assessment method; methods of mathematical statistics.*
Results: *the author developed the organizational and pedagogical technology "Exercises with clubs", which increases the level of technical readiness of young gymnasts in exercises with clubs and provides a steady interest in performing gymnastic exercises. The positive impact of the use of the proposed organizational and pedagogical measures that enhance the level of technical preparedness of gymnasts of 8–9 years old in exercises with clubs, accuracy of movements, development of a sense of rhythm is revealed.*
Conclusions: *the analysis of the results of the study indicates that the use of organizational and pedagogical technology "Exercises with clubs" increases the level of technical skill of young gymnasts in exercises with clubs and contributes to the formation of a positive attitude towards rhythmic gymnastics.*

Keywords: *rhythmic gymnastics, gymnasts 8–9 years old, organizational and pedagogical technology, exercises with clubs, technical skill.*

Introduction

The rapid development of rhythmic gymnastics, the cyclical changes in the rules of FIG competitions [1] with increasing requirements for the technical preparedness of gymnasts and the constant complication of the components of the competitive activity of athletes determine the improvement of their sportsmanship and require the search for new ways to increase results [2; 3]. The aggravation of sports competition of national teams makes it necessary to pay special attention to coaches and scientists to increase the effectiveness of long-term training of athletes, to find various means of their preparation, which contribute to a more effective mastery of competitive exercises by young athletes [4; 5]. Modern fierce competition in rhythmic gymnastics leads to constant changes in the competitive programs of gymnasts. With the introduction of the new competition rules FIG [1] in rhythmic gymnastics, the development of complex competitive technical programs became a priority. An analysis of the video materials of international competitions and our own sports experience indicates that gymnasts who perfectly perform basic profiling elements (balances, turns, jumps) and demonstrate perfect work with the subject will be the leaders. This is possible only if modernization and increase the effectiveness of the training process, which is directly dependent on the means used in the classroom with athletes [4; 6; 7].

Thus, problems arise in sports training, which specialists in rhythmic gymnastics [2, 3, 8] associate before with insufficient basic training of exercises with objects, in particular, exercises with clubs. It is this theoretical and practical collision that determines the problematic situation of this study.

Purpose of the study: to substantiate the effectiveness of the use of organizational and pedagogical technology, increases the level of technical preparedness of gymnasts of 8–9 years old in exercises with clubs and helps to form a positive attitude towards rhythmic gymnastics.

Material and Methods of the research

The study was conducted on the basis of a sports school "KPTI" in rhythmic gymnastics in Kharkov. The experiment was attended by 20 athletes 8–9 years old. In the course of the study, the following methods were used: theoretical analysis and generalization of literary sources; pedagogical (observation, testing, experiment); expert assessment method; methods of mathematical statistics. Testing the level of technical preparedness of gymnasts of 8–9 years old in exercises with clubs was carried out at the beginning and at the end of the annual training cycle. According to the results of initial testing, gymnasts were divided into two equivalent groups – control (CG) and experimental (EG) of 10 athletes. Training sessions of the CG gymnasts were conducted according to the generally accepted curriculum [9]. In the training process of the gymnasts of the EG, the developed technology was used, aimed at increasing the level of technical preparedness of young athletes in exercises with clubs. It provided for the use of gymnasts in the training process: a) a technique for increasing the level of technical preparedness for performing exercises with clubs; b) game and competitive tasks were developed that were used to increase the interest and motivation of gymnasts to master the technique of performing elements with clubs; c) a system of measures to attract gymnasts to training activities (Figure 1).

According to the author's organizational and pedagogical technology "Exercises with clubs", at the *first stage* of formation of motor skills of the gymnasts of the EG

in the preparatory part of the training session, the athletes performed a specially developed basic set of exercises. In the main part of the training session, according to the developed technology, the young gymnasts mastered the "foundation", the "school of movement" with clubs. At the end of this stage, the control provided for verification of the assimilation of the developed set of exercises and is better conducted by young athletes, as well as the assimilation of basic movements with clubs for evaluation.

A feature of the *second stage* was the gymnasts' independent exercise of the basic set of exercises with its subsequent complication: performing exercises on toes, without visual control, with an increase in the number of repetitions, using various positions of the head, arms, torso, as well as the use of rhythmic gymnastics and a combination of basic gymnastic exercises with dynamic work of the subject.

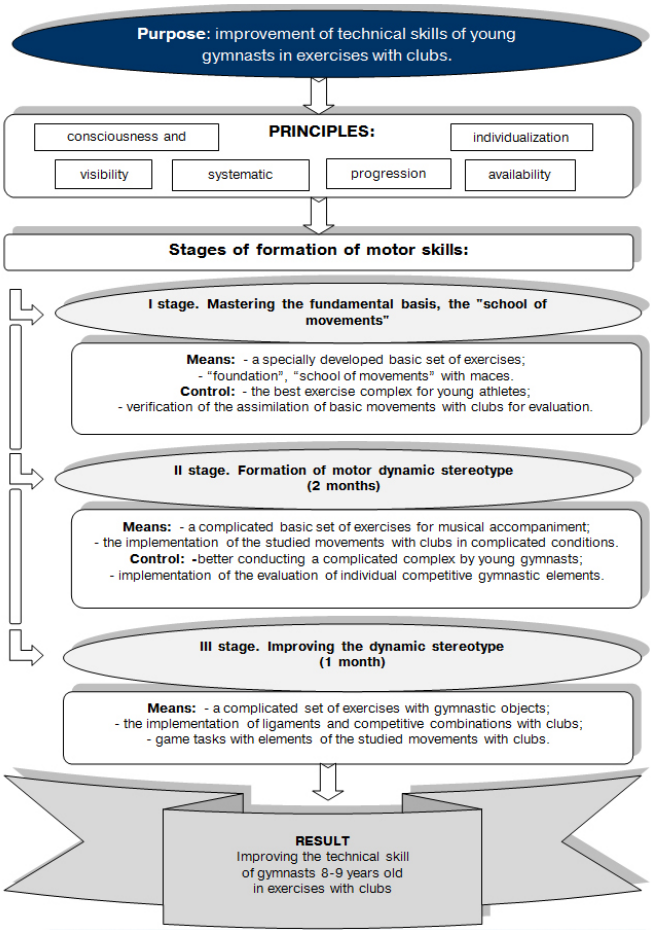

Fig. 1. Organizational and pedagogical technology "Exercises with clubs"

The exercises of the main part of the second stage were aimed at the formation of a motor dynamic stereotype in exercises with clubs. Athletes performed separate competitive gymnastic elements (jumping, balance, revolutions) simultaneously with the basic movements of the clubs, which was also a means of control at the end of the second stage.

The goal of the *third stage* was to improve the dynamic stereotype of performing exercises with clubs. In the preparatory part of the gymnast, a basic set of exercises was performed using objects of rhythmic gymnastics. In the main part of the training session, the gymnasts did not perform separate movements and elements with clubs, but their combination in communication and competitive combinations. To increase the interest and motivation of young gymnasts, the competitive-game method was used.

Results of the research

To test the effectiveness of using the original technology of "Exercises with clubs," at the end of the study, a second test was conducted of the level of technical preparedness of gymnasts in the control and experimental groups (Table 1).

As can be seen from the materials presented, the expert assessment for the gymnasts performing the "Small circles with clubs" exercise is as follows: in the EG – 5,9 points, which corresponds to the average level of technical preparedness for these test tasks, and in kg – 7,0 points, which corresponds to a high level. The difference in the average group results by the Student criterion is statistically significant, since $t_p=3,46>t_{gr.}=2,10$. This means that in the EG, the results objectively improved in relation to the CG. Their growth amounted to 18.6% (Table 1). The following exercise "Vertical Mill" was evaluated by experts in gymnasts of the CG and EG, respectively, at 4.3 and 5.5 points – the average level of technical preparedness in exercises with clubs. Comparison of these results by the Student criterion shows that the difference between the group mean values is statistically significant ($p<0,05$). The study indicates an improvement in the experimental group in relation to the control by 27.9% (Table 1). According to the results of the study, the gymnasts performed the "Asymmetry" exercise by experts at 6.4 points – EG (average level) and 7.3 points – CG (high level). In accordance with the student criterion, the difference between the average group results shown by gymnasts in this test task is statistically significant, since $t_p>t_{gr}$ (Table 1). It should be noted that the improvement in the result in the EG relative to the CG was 14.1%. An analysis of the results of the table indicates that the exercise "Alternate small throws of two clubs" by gymnasts of the CG, experts rated at 5.9 points, which corresponds to the average level of development of technical preparedness, and gymnasts of the EG at 7.3 points – corresponds to a high level of technical preparedness for this exercise . The difference between these indicators by the Student criterion is statistically significant, since $t_p>t_{gr}$. The increase in the results shown by the gymnasts of the EG in comparison with the CG is 23.7%. In the process of performing the exercise "Big throws and catching one club" with the right hand, the athletes of the CG received 4.6 points, and the EG - 5.8 points, which corresponds to the average level of technical preparedness in this exercise. In accordance with the student criterion, the difference between the average group indicators of this test exercise are statistically significant ($p<0.05$). It should be noted that in the EG relative to the CG result improved by 26.1% (Table 1). The results of the introduction of the organizational and pedagogical technology "Exercises with clubs" also indicate that the greatest improvement in the result in the EG with respect to the CG – 35.7% – was observed according to the results of the same test exercise with only the left hand. The mark for performing the exercise "Big throws and catching one club" with the left hand in the CG and the EG is 2.8 points (low level) and 3.8 points (average level), respectively. The difference between these indicators is statistically significant, since $t_p=2,83>t_{gr.}=2,10$ (Table 1).

Positive changes in increasing the level of technical preparedness for the test exercises "Small circles with clubs," "Vertical mill" and "Asymmetry" were due to the use

Table 1

Level of technical preparedness of athletes 8–9 years old in exercises with clubs at the end of the experiment ($t_{gp.}$=2,10 at p<0,05)

	Indicators of technical preparedness in exercises with clubs		Gymnasts $\bar{X}$±m (LTPEC*) CG (n=10)	EG (n=10)	t_p	p	Increase in results
1.	Small circles with clubs		5,9±0,22 (**C**)	7,0±0,24 (**B**)	3,46	<0,05	**18,6%**
2.	Vertical mill		4,3±0,19 (**C**)	5,5±0,27 (**C**)	3,52	<0,05	**27,9%**
3.	Asymmetry		6,4±0,24 (**C**)	7,3±0,26 (**B**)	2,62	<0,05	**14,1%**
4.	Alternating small throws of two clubs		5,9±0,22 (**C**)	7,3±0,19 (**B**)	5,03	<0,05	**23,7%**
5.	Big throws and catching one club	right	4,6±0,21 (**C**)	5,8±0,30 (**C**)	3,25	<0,05	**26,1%**
		left	2,8±0,24 (**H**)	3,8±0,25 (**C**)	2,83	<0,05	**35,7%**

Remark. *LTPEC – level of technical preparedness in exercises with clubs; H – low level; C is the average level; In – a high level.*

of a specially developed set of exercises with its subsequent complication and the use of rhythmic gymnastics during its implementation. The improvement of the results for throwing test tasks can be explained by the inclusion of these exercises during relay races, game and competition tasks in the training process of young gymnasts of the EG. It should be noted that the greatest increase in the results of athletes of the EG in comparison with the results of the CG was observed in the exercise "Big throws and catching one club" with the left hand. This result can be explained by the fact that usually in the training process, young gymnasts perform most of the throwing movements with their dominant (right) hand. And the proposed organizational and methodological techniques provided by the technology "Exercises with clubs" were aimed at overcoming this drawback. It should be noted that the independent conduct by gymnasts in the preparatory part of the training session of the developed basic set of exercises contributed to the formation of a steady interest and positive attitude towards rhythmic gymnastics. The use of musical accompaniment and rhythmic gymnastics items brought the implementation of this basic complex closer to competitive exercises, contributed to the interest of gymnasts and increased the emotional background of the training session.

Conclusions / Discussion

The results of the study complement the theoretical provisions formulated in the works of G. Andreeva [3], N. Andreeva [10], P. Kizima, N. Bateeva [11] on the importance of basic technical training, especially substantive, in the training process of young gymnasts. Problems and existing difficulties of technical skills of athletes involved in rhythmic gymnastics, associated, in particular, with regular changes in the rules of competitions and constant complications of their program of performances. Specialists, I. Wiener [2], R. Andreev, V. Leonov [12]; A. Mullagildina, I. Krasova [13], emphasize that one of the most relevant areas of advanced technical training in rhythmic gymnastics has been and remains to be the development of basic exercises with objects, the primary quality learning of which is the key to further successful progress in rhythmic gymnastics. The study also confirms the findings of V. Stooped, A. Deineko, A. Ryabchenko [4], A. Mullagildina [7], R. Andreeva [12] and other scientists that the constant complication of the components of competitive activity and the ultimate realization of the individual capabilities of gymnasts result in the exhaustion of reserves for improving their sportsmanship, prompting the search for additional tools that contribute to more effective mastery of motor skills by young athletes, and require new ways to increase results. Therefore, the results of a study to improve the skills of young gymnasts in exercises with clubs are relevant.

Prospects for further research are to introduce the developed organizational and pedagogical technology "Exercises with clubs" into the educational process of the Children's and Youth Sports School, Sports School, sports clubs and specialized educational institutions for its further improvement.

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Assessment of the reaction of the cardiovascular system to dosed physical activity of patients with metabolic syndrome under the influence of the use of physical therapy

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Purpose: *study of the reaction of the cardiovascular system to dosed physical activity of patients with metabolic syndrome in the process of applying a physical therapy program.*
Material & Methods: *28 young women with metabolic syndrome took part in the study, CG – 14 women, MG – 14 women. The mean age of the patients with MG was 31,49±0,71 years, and the CG was 31,06±0,57 years. In order to determine and assess the tolerance of the cardiovascular system to dosed physical activity in the examined patients, the Martine-Kushelevsky test was used.*
Results: *analyzed and summarized the results of a study of the reaction of the cardiovascular system to dosed physical activity according to the Martin-Kushelevsky test. According to the initial examination in the main and control groups, the indicator of the quality of the reaction according to the Martine-Kushelevsky test was less than normal, which indicates an unsatisfactory reaction of the cardiovascular system of patients to physical activity. After applying the physical therapy program, LRP increased in the main group from 0,40±0,17 to 0,54±0,01 c. u. (by 35,0%), in the control – from 0,41±0,17 to 0,49±0,12 c. u. (by 19,5%).*
Conclusions: *the analysis of the reaction quality indicators in patients of the main and control groups showed that they were better at repeated examination in the main group of patients after applying the author's physical rehabilitation program.*

Keywords: *metabolic syndrome, Martine-Kushelevsky test, physical therapy, women.*

Introduction

Metabolic syndrome is a pathological condition characterized by the development of abdominal obesity, dyslipidemia, arterial hypertension and impaired carbohydrate metabolism (the phenomenon of insulin resistance) [12; 14; 19; 44; 45]. The main etiological factors of the metabolic syndrome are genetic predisposition, excessive consumption of fats and lack of exercise [1; 32]. From literary sources it is known that in industrialized countries among the population over 30 years of age, the prevalence of this pathology ranges from 14 to 24%. It was established that there are age and gender characteristics of the development of metabolic syndrome. In particular, with age, the proportion of patients with this pathology increases. So, in age groups from 20 to 49 years, metabolic syndrome is more often observed in men aged 50–69 years – almost the same in men and women, and in people over 70 years old – more often diagnosed in women. Older women are more likely to have metabolic syndrome due to menopause. This conclusion is confirmed by the data of a study conducted in the United States among women immigrants from the former USSR. In 25% of women, metabolic syndrome was noted according to the criteria of the National Education Program for Cardiovascular Diseases, and its frequency was higher in postmenopausal women [36].

An important role in the development of the metabolic syndrome is given to a genetic predisposition, excessive consumption of high-calorie foods and reduced physical activity. According to G. Reaven, insulin resistance can be detected in 25% of people with a sedentary lifestyle. [50].

It is generally accepted that the current MS under the name "Syndrome X" was described by Gerald Reaven in 1988 [51]. It is important to emphasize that his main merit lies in the fact that he named the common reason for the development of arterial hypertension (AH) in one patient [23; 26; 35], dyslipidemia with an increase in triglycerides (TG), a decrease in high density lipoproteins (HDL), as well as impaired glucose tolerance (IGT) - insulin resistance [11; 13; 25; 27]. Also in the study of this syndrome, studies can be noted in the 30–40s of A. L. Myasnikov, G. F. Lang [47; 48], and later – P. Avogaro [43], N. Mehnert, N. Kaplan [47] and many other domestic and foreign scientists [8; 45; 54].

The mechanisms of the pathogenetic development of the metabolic syndrome are multifaceted and quite complex, since it is difficult to explain at which pathogenesis link the malfunction of the body occurred and what was primary in the development of pathology, since the so-called vicious circle arises.

A key point in the formation of MS is insulin resistance, which triggers a vicious cycle of symptoms, resulting in severe cardiovascular complications - myocardial infarction, cerebral stroke, and circulatory failure [15]. At the same time, IR does not occur spontaneously, according to modern concepts, the moment initiating both insulin resistance and the entire metabolic cascade is most often obesity, which, in turn, leads to the development of arterial hypertension (AH) [16; 22] and can cause a decrease in the sensitivity of peripheral tissues to insulin and further accumulation of excess body weight [20; 29; 30].

The likelihood of developing AH and any cardiovascular disease in people with overweight is 50% higher than in people with normal body weight, according to the Framingham study [49; 52]. In accordance with WHO criteria, the identification and determination of the degree of excess body weight is

based on the calculation of body mass index. Its standard values are 18.5–24.9 kg·m^{-2}. There is convincing evidence that obesity can be both an independent risk factor and a burdensome moment, which significantly worsens the course and prognosis of arterial hypertension, as well as coronary heart disease (CHD) [17; 37]. It was noted that the risk of developing cardiovascular mortality increases even when the body mass index reaches the upper normal range. According to the results of the Nurses Health Study [41], women with body mass index within the upper normal range (from 23 to 24.9 kg·m^{-2}) had a 2-fold higher risk of developing CHD than their counterparts with body mass index (BMI) of less than 21 kg·m^{-2}. It was established that in patients with arterial hypertension, obesity, the risk of developing coronary heart disease is increased by 2–3 times, and the risk of stroke is 7 times. According to the results of the Framingham study [39; 40, 49; 52], it was noted that both systolic and diastolic blood pressure increased by an average of 1 mm Hg with an increase in body weight by 1 kg.

From the point of view of modern ideas, the pathogenetic mechanisms of the development of the metabolic syndrome are based on the violation of purine, carbohydrate and lipid metabolism. As recent studies have shown, adipose tissue has auto, steam and endocrine function and secrets a large number of substances that have various biological effects that can cause the development of concomitant complications, in particular, insulin resistance [9]. The most studied to date is the tumor necrosis factor (TNF-a) and leptin. Scientists see TNF-a as a mediator of insulin resistance in obesity. It has been proven that leptin in the liver can inhibit the action of insulin on gluconeogenesis by affecting the activity of phosphoenolpyruvate carboxykinase, an enzyme that limits the rate of gluconeogenesis. In adipose tissue, leptin can suppress insulin-stimulated glucose transport. Insulin-mediated glucose utilization is reduced by 30–40% in individuals with overweight by 40%, but not only central obesity, but visceral or intra-abdominal fat localization is of fundamental importance. It should be noted that glucose and insulin are important factors in uric acid homeostasis, and an imbalance of these indicators of carbohydrate metabolism leads to hyperuricemia and hyperuricosuria. Under the influence of hyperinsulinemia, the clearance of uric acid in the proximal tubules of the kidneys decreases, which confirms the relationship of insulin resistance and hyperuricemia. Hyperinsulinemia can also increase the activity of the sympathetic nervous system, which leads to an increase in the level of uric acid in the blood serum. Uric acid crystals cause a macrophage reaction. Activated macrophages express adhesion molecules of pro-inflammatory cytokines (IL-1, IL-2, IL-4, IL-6, IL-8, TNF-a), which contribute to the fibroblast degeneration of kidney interstitial cells with loss of their synthetic function. There is a delay in sodium and water, the volume of circulating blood, total peripheral resistance, activation of the sympathetic nervous system and, as a result, the development of arterial hypertension increase [6; 28; 31].

It is extremely important that in patients with metabolic syndrome there are disorders of carbohydrate and lipid metabolism, increased blood pressure, as well as a high risk of coronary heart disease. Therefore, correction of all major pathogenetic disorders should be carried out [38].

The primary task facing medicine is the timely treatment of the metabolic syndrome, including non-drug and drug methods for the correction of metabolic disorders and obesity, and when choosing drugs it is necessary to take into account their metabolic effects and organ protective effect [10; 14; 18; 24; 60].

Thus, among a large number of works on the problem of rehabilitation in the metabolic syndrome, no therapeutic physical culture methods were found that take into account the presence of the components of the metabolic syndrome (abdominal obesity, hyperglycemia, arterial hypertension), there are conflicting data on methods of monitoring and regulating physical activity in accordance with the state patients, that is, optimal pedagogical control is not carried out during group exercises of physical therapy. In addition, the recommendations on the use of diet therapy, massage and physiotherapy are quite contradictory but not individualized.

Purpose of the study: to conduct, analyze and generalize the results of a study of the types of reactions of the cardiovascular system to dosed physical activity of patients with metabolic syndrome using a Martine-Kushelevsky test in the process of applying a physical therapy program.

Material and Methods of the research

Examination of patients was carried out before the use of physical therapy (initial examination) and 4 months after the introduction of comprehensive physical therapy programs (re-examination).

The examination of patients with metabolic syndrome was carried out on the basis of the Kharkiv City Hospital No. 3 under our supervision, there were 28 young women who were arbitrarily divided into two groups: the main group – 14 patients and the control group – 14 patients. The mean age of patients with MG was 31.49±0.71 years, and that of CG was 31.06±0.57 years. By the number of patients, age, and the presence of concomitant pathology, the main and control groups of women were homogeneous. Patients of the main group underwent rehabilitation measures according to the author's program of physical rehabilitation, to patients of the control group – according to the program, they are used for the metabolic syndrome at the outpatient stage in the specified medical institution.

The studies were conducted in compliance with international documents on the regulation of biomedical research: "Helsinki Declaration" adopted by the General Assembly of the World Medical Association (BMA, 1964, 1975, 1983, 1989, 1996, 2000, 2002, 2004, 2008, 2013) on the "ethical principles of medical research involving a person as a subject "[53]; "Universal Declaration on Bioethics and Human Rights" (UNESCO, 2005) [5]; "Convention for the Protection of Human Rights and Dignity of the Human Being with regard to the Application of Biology and Medicine" adopted by the Council of Europe (1997) [42].

In order to determine and assess the tolerance of the cardiovascular system to dosed physical activity in the examined patients, we used the Martine-Kushelevsky test – 20 squats in 30 s [20; 21; 55].

The results of the functional test were evaluated by the following indicators: the degree of increased heart rate (%), changes in systolic and diastolic pressure, the recovery time of the pulse and blood pressure after exercise, the reaction quality index (RQI) was determined, which was calculated by the formula:

$$RQI\ (c.u.) = PP_2 - PP_1 / PS_2 - PS_1,$$

where PP_2 – pulse pressure at the 1st minute of the recovery period;

PP_1 – pulse pressure before the load;

PS_2 – pulse in the 1st minute of the recovery period;

PS_1 – pulse before the load.

Normal RQI = 0.5–1.0 c. u. [21; 55].

Using the Martine-Kushelevsky test, the type of reaction of the cardiovascular system to dosed physical activity was determined:

– *Normotonic* – the pulse increases by 60%, systolic blood pressure increases by 20-40 mm Hg, diastolic blood pressure decreases by 5–15 mm RT. Art. or does not change, the pulse pressure increases, the recovery time of the pulse rate and blood pressure is 2–3 minutes.

– *Hypotonic* – the pulse increases more than 120%, the systolic blood pressure practically does not change, the diastolic blood pressure either decreases or does not change, the pulse pressure does not change, the recovery time of the pulse rate and blood pressure is 3–4 minutes, sometimes longer.

– *Hypertensive* – the pulse reacts as if it were a normotonic type, systolic blood pressure rises to 180–200 mm Hg, diastolic blood pressure rises to 90 mm RT. Art. and above, the pulse pressure rises, the restoration of the pulse rate and blood pressure for 3–4 minutes may not take place.

– *Dystonic* – the pulse reacts like in the normotonic type, systolic blood pressure – like in the normotonic type, diastolic blood pressure drops to 0 (the phenomenon of infinite or zero tone), the pulse pressure rises, the restoration of the pulse rate and blood pressure – 3–4 minutes, may and not take place.

– *Step rise in maximum blood pressure* – the pulse reacts as in the normotonic type of reaction, systolic blood pressure is 2–3 minutes higher than the first, diastolic blood pressure as in the normotonic type of reaction, recovery time is 3–4 minutes or recovery is delayed.

– *Dissociated reactions* – proceed according to the type of so-called "scissors" when a negative phase is observed from one of the indicators (pulse or systolic blood pressure). When the pulse rate decreases with increasing systolic blood pressure, a reaction such as cardiovascular dystonia occurs, and, conversely, in the presence of a negative phase on the part of systolic pressure, a reaction such as cardiovascular dissociation [56; 57].

Results of the research

When determining the type of reaction to dosed physical activity during the initial examination in both groups of people with normotonic type of reaction was not detected (Figure 1).

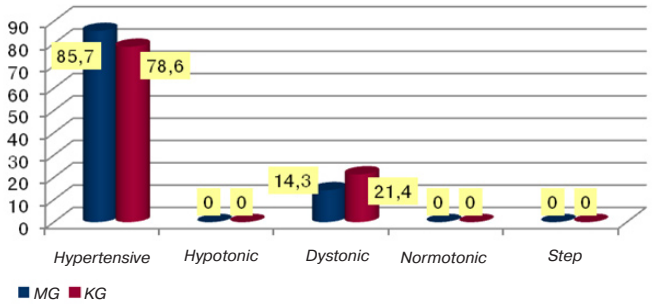

Fig. 1. Characterization of the type of reaction to a Martinine-Kushelevsky test in patients of the main and control groups in the initial study (%)

In both groups the hypertonic type of reaction prevailed. So, in the main group 12 people (85.7%) with a hypertonic type of reaction were identified, with a dystonic type – 2 (14.3%) people; in the control group with a hypertonic type of reaction, 11 (78.6%) people were identified; with a dystonic type – 3 (21.4%) people.

According to the initial examination in the main and control groups of the RQI, the Martin-Kushelevsky test was less than normal, which indicates an unsatisfactory reaction of the patients' cardiovascular system to dosed physical activity (Table 1).

Table 1

Quality indicators of the reaction according to the Martine-Kushelevsky sample of the groups of surveyed in the initial study (M±m)

Indicators	Norm	Groups of surveyed		t	p
		MG, n=14	CG, n=14		
RQI, c. u.	0,5–1,0	0,40±0,17	0,41±0,17	0,57	>0,05

The physical therapy program had a differentiated approach, and included a hypocaloric diet with a lipid-lowering orientation (lipid-lowering diet No. 1) for sick women of the main group, the basic principles of which were developed by the American Heart Association [58; 59]; therapeutic massage according to the methodology of P. B. Efimenko [7] for patients with alimentary-constitutional obesity; medical gymnastics; morning hygienic gymnastics; self-study (SS) dosed walking. Physical exercises were used for the muscles of the upper extremities and the shoulder girdle, neck, torso with elements of sports-oriented aerobics with full amplitude, medium and fast pace; special physical exercises based on Pilates gymnastics using fitballs and expanders; exercises for coordination and training of the vestibular apparatus at an average pace, with a maximum amplitude depending on the capabilities of the patient; regulated breathing exercises when walking, taking into account the activity of the ANS; rest pauses and relaxation exercises.

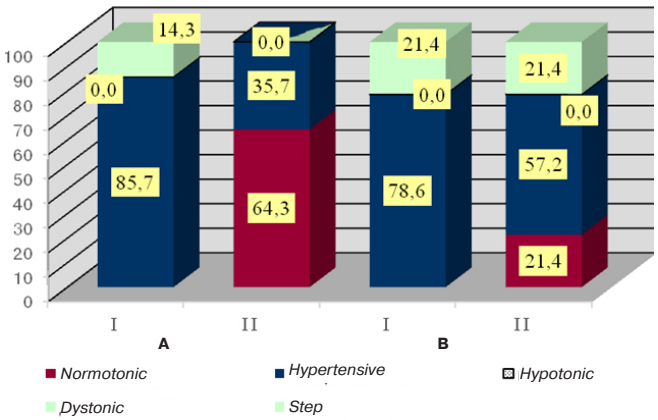

Fig. 2. Types of reaction to dosed physical activity in patients with MG and CG during the primary (I) and repeated (II) studies:
A – main group, B – control group

In the control group of women, a physical therapy program was used, which included diet therapy using a hypocaloric diet, therapeutic massage according to the method of A. F. Verbov [3; 4], medical gymnastics, morning hygienic gymnastics, self-study, dosed walking, running, walking, outdoor and sports games. Therapeutic physical training was carried out according to the methods of S. M. Popov [33; 34], N. A. Beloy [2] for patients with alimentary-constitutional obesity and diabetes mellitus with the exception of exercises,

Table 2

Dynamics of indicators of the quality of the reaction according to the Martin-Kushelevsky test in patients of both groups during the initial and repeated studies (M±m)

Indicators	Norm	Study periods		t	p
		Initial studies	Repeated studies		
Main group (n=14)					
RQI, c. u.	0,5–1,0	0,40±0,17	0,54±0,01	2,35	<0,05
Control group (n=14)					
RQI, c. u.	0,5–1,0	0,41±0,17	0,49±0,12	1,27	>0,05

Table 3

Quality indicators of the reaction according to the Martine-Kushelevsky sample of the examined groups during repeated examination (M±m)

Indicators	Norm	Groups of surveyed		t	p
		MG, n=14	CG, n=14		
RQI, c. u.	0,5-1,0	0,54±0,01	0,49±0,12	3,70	<0,05

are contraindicated in arterial hypertension (static exercises, accompanied by an increase in intra-abdominal pressure, torso).

When determining the *type of reaction to dosed physical activity* during repeated examination, 9 (64.3%) people with normotonic type of reaction, 5 (35.7%) people with hypertonic type of reaction were revealed in the MG. In the control group, upon repeated examination, 3 (21.4%) people were found to have a normotonic type of reaction, 8 (57.2%) of the hypertonic type, 3 people (21.4%) of the dystonic type (Figure 2).

After applying physical therapy programs, RQI increased in the main group from 0.40±0.17 to 0.54±0.01 c.u. (35.0%), in the control – from 0.41±0.17 to 0.49±0.12 c.u. (19.5%) (Table 2).

Analyzing the indicators of the quality of the reaction in patients of the main and control groups, we came to the conclusion that they were better after repeated examination in the main group of patients after applying the author's physical rehabilitation program (Table 3).

Conclusions / Discussion

To analyze the effectiveness of physical therapy in patients with metabolic syndrome, we used the conduct, analysis and generalization of the results of a study of the types of reactions of the cardiovascular system to dosed physical activity using the Martine-Kushelevsky test.

When determining the type of reaction to dosed physical activity during the initial examination in both groups of people with normotonic type of reaction was not found. In both groups the hypertonic type of reaction prevailed. According to the initial examination in the main and control groups of RQI, the Martin-Kushelevsky test was less than normal, which indicates an unsatisfactory reaction of the cardiovascular system of patients with physical activity.

When determining the type of reaction to dosed physical activity during repeated examination, 9 (64.3%) people with normotonic type of reaction, 5 (35.7%) people with hypertonic type of reaction were revealed in the MG. In the control group, upon repeated examination, 3 (21.4%) people were found to have a normotonic type of reaction, 8 (57.2%) of the hypertonic type, and 3 people (21.4%) of the dystonic type. After applying physical therapy programs, RQI increased in the main group from 0.40±0.17 to 0.54±0.01 c.u. (by 35.0%), in the control – from 0.41±0.17 to 0.49±0.12 c.u. (19.5%). Analyzing the indicators of the quality of the reaction in patients of the main and control groups, we came to the conclusion that they were better after repeated examination in the main group of patients after applying the author's physical rehabilitation program.

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The use of running and jumping exercises in special motor training of young forwards 13–14 years old

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Purpose: *to determine the effect of using complexes of various athletics running and jumping exercises on the indicators of the quantity and quality of technical and tactical motor actions of young forwards-football players 13–14 years old.*
Material & Methods: *the study involved forwards-football players of the children and youth football club Arsenal in Kharkiv from May to October 2019. As the initial data of technical and tactical motor actions, we used the indicators obtained by football players during 10 games of the previous competitive period (May-October 2018). In the preparatory period, complexes of special athletics exercises were used for young football players of the 13–14 years old research group in each training session, which were held 4 times a week, the control group carried out the training process according to the Youth Sports School program, in which classes were also held 4 times a week for 90 minutes.*
Results: *the study made it possible to establish the influence of athletics running and jumping exercises on the special motor fitness of young forwards-football players 13–14 years.*
Conclusions: *the use of specialized athletics running and jumping exercises for young forwards-football players attacking 13–14 years during the preparatory period allowed us to improve the results of indicators of the quantity and quality of performing motor and technical and tactical actions.*

Keywords: *athletics exercises, forwards-football players, technical and tactical actions, motor actions, quantitative and qualitative indicators.*

Introduction

Interest in football is growing every year, not only among boys, but also among girls, so in terms of mass and popularity, it is ahead of many sports. So, systematic football lessons have a comprehensive impact on the body of children and youths, increase the general level of their physical activity, improve the functional activity of the body, ensuring proper physical development.

In football, tactics and technology are closely intertwined. When deciding to whom and how to make a pass, apply a stroke to beat an opponent or use a partner, to make a shot at the goal, the player uses tactical thinking, and after taking the decision itself, he shows his technical skill [6]. So, the technique is a means of transforming the tactical intentions of the player into action.

Currently, youth football is at the stage of modernization and positive update. Development of new scientific and pedagogical technologies is underway, contributing to the improvement of the physical, tactical, technical and psychological training of young football players. The experience of preparing a football reserve in the leading countries of Western Europe indicates the need to attract specialist trainers with in-depth knowledge of the anatomical and physiological characteristics of the structure and development of the child's body to ensure adequate responses to the load, volume and intensity, which in recent years have increased dramatically [2; 10].

Analysis of scientific and methodological literature on issues of children's and youth football [7; 8; 11; 12] showed that the main works are devoted to the history of the development of this sport, technical, tactical and physical training of football players and do not take into account the particular features of the educational process of children and youths.

Two groups of exercises are used in the preparation of football players aimed at developing physical qualities: non-specific (running, jumping, exercises on power simulators) and specific (tactical and technical). Exercises of the first group contribute to the development of basic physical qualities (endurance and strength), while exercises of the second group turn these basic qualities into specific [3; 11].

The technical and tactical preparedness of young football players has always been in the field of vision of scientists and coaches [1; 3; 7]. At the same time, in the works of these authors the questions of the dependence of the level of technical and tactical preparedness of young football players on the level of special physical fitness are not completely disclosed.

In scientific papers [1; 8], age-related volumes of performing technical and tactical actions of football players different in nature and conditions are given, as well as complexes of technical and tactical actions with a subsequent analysis of the consequences of the effectiveness of their implementation [5; 9].

For each player who occupies a particular game position in the general arrangement of players on the field, it is necessary to select individual exercises from the field of tactical and technical training. These exercises should be as close as possible to that real gaming environment and to those events that occur before the player during the match, in that part of the field where this player is located. In other words, it is necessary to develop a series of exercises designed for more in-depth training of football players in each individual position. Based on this, the scientific and methodological justification, practical development and implementation of the methodology for the development of motor qualities in conjunction with technical training is an actual scientific direction in the theory and methodology of physical education during youth football training.

Purpose of the study: to determine the effect of using

complexes of various athletics running and jumping exercises on the indicators of the quantity and quality of technical and tactical motor actions of young attacking football players 13–14 years old.

Material and Methods of the research

The study involved forward football players of the children and youth football club Arsenal in Kharkov, from May to October 2019.

The initial data used are indicators obtained by football players during 10 games of the pre-competitive period (May-October 2018). In the preparatory period, complexes of special athletics exercises were used for young football players of the 13–14 years old research group in each training session, which were carried out 4 times a week, the control group carried out the training process according to the program of the Children's Sports School, in which classes were held 4 times a week for 90 minutes.

Results of the research

The motor actions of the attackers are significantly different from the players of other game roles, since their main function is to carry out attacking actions. Therefore, in the experimental program of young football players of an attacking nature, athletics running and jumping exercises were used to the full, providing for improving primarily speed and speed-strength qualities.

During the implementation, the number of actions inherent in attackers increased, namely: jerks ($t=6,51$; $p<0.001$), accelerations ($t=2,61$; $p<0,05$), running backwards ($t=4,40$; $p<0.001$), tackle ($t=4,17$; $p<0,001$) and head games ($t=4,06$; $p<0,001$) (Table 1).

Thus, the number of runs per game increased by 11,5% ($t=5.93$; $p<0.001$), while other activities (walking, jogging, etc.) decreased by 20.6% ($t=12,11$; $p<0,001$).

An increase in the number of motor actions per game, mainly due to those specific to the forwards, did not negatively affect the quality of their performing (Table 2).

On the contrary, performance of short and medium pass ($t=5.44$; 5.09; $p<0.001$), groundmove ($t=5,40$; $p<0.001$), dribbling ($t=2,14$; $p<0,05$), ball stop ($t=2,64$; $p<0,05$), kicking to the goal ($t=5,10$; $p<0.001$) and head ($t=4,71$; $p<0.001$). The above significantly ($t=3,73$; $p<0,01$) influenced the average quality of performance of movement actions of young football players of 13–14 years of the experimental group.

The obtained indicators of technical and tactical actions after the introduction of complexes of special running exercises allowed young attacking football players of the research group, in relation to the control, to increase the data on quantitative and qualitative motor actions (Table 3). The number of offensive-specific actions, namely jerks 15–20 m and backwards running increased by 2,2% and 1,1%, respectively ($t=2,18$; 2,97; $p<0,05$; 0,01) Also, the attackers of the experimental group performed significantly more single combats by 3,3% ($t=2,21$; $p<0,05$) and head games by 1,6% ($t=2,32$; $p<0,05$). In general, the number of running movements of young attackers of the experimental group was 4,8% ($t=2,53$; $p<0,05$) more than in the control group, which contributed to the use of 9,7% more specific for the attacking motor actions.

Table 1

Quantitative indicators of the performance of motor actions of young attacking football players 13–14 years of the experimental group during 10 games (n=20), %, $\bar{X}\pm m$

No.	Motor actions	At the beginning	At the end	t	p
1.	Jerks 15–20	16,7±0,76	23,8±0,78	6,51	<0,001
2.	40–50 m acceleration	10,4±0,46	12,2±0,52	2,61	<0,05
3.	Running backwards	5,8±0,25	8,0±0,27	4,40	<0,001
4.	Cross-step running	3,0±0,22	3,2±0,23	0,63	>0,05
5.	Shuffle running	1,8±0,11	2,0±0,12	1,25	>0,05
6.	Tackle	16,1±1,05	22,4±1,08	4,17	<0,001
7.	Head game	9,8±0,46	12,6±0,51	4,06	<0,001
8.	Number of runs per game	37,7±1,36	49,2±1,38	5,93	<0,001
9.	Other motor actions	36,4±1,28	15,8±1,11	12,11	<0,001

Table 2

Performance indicators of the technical and tactical actions of young attacking football players 13–14 years of the experimental group during 10 games (n=20), %, $\bar{X}\pm m$

No.	Motor actions	At the beginning	At the end	t	p
1.	Short pass	28,8±1,28	38,7±1,30	5,44	<0,001
2.	Medium pass	24,4±1,17	32,9±1,19	5,09	<0,001
3.	Long pass	9,1±0,51	10,5±0,53	1,89	>0,05
4.	Groundmove	20,1±1,04	28,2±1,08	5,40	<0,001
5.	Dribbling	24,8±1,02	27,9±1,03	2,14	<0,05
6.	Slide tackle	15,0±1,19	15,5±1,20	0,30	>0,05
7.	Ball stop	23,6±1,11	27,8±1,14	2,64	<0,05
8.	Kicks to the goal	22,0±1,07	29,8±1,10	5,10	<0,001
9.	Headshot	21,1±1,06	28,3±1,10	4,7	<0,001
	$\bar{X}$, %	21,0±1,05	26,6±1,07	3,73	<0,05

Table 3

Quantitative indicators of the performance of motor actions of young attacking football players 13–14 years of the control and experimental group during 10 games (n=20), %, $\bar{X}$±m

No.	Motor actions	Control group	Experimental group	t	p
1.	Jerks 15–20	21,6±0,64	23,8±0,78	2,18	<0,05
2.	40–50 m acceleration	10,9±0,48	12,2±0,52	1,83	>0,05
3.	Running backwards	6,9±0,25	8,0±0,27	2,97	<0,01
4.	Cross-step running	3,1±0,22	3,2±0,23	0,31	>0,05
5.	Shuffle running	1,9±0,11	2,0±0,12	0,63	>0,05
6.	Tackle	19,1±1,02	22,4±1,08	2,21	<0,05
7.	Head game	11,0±0,46	12,6±0,51	2,32	<0,05
8.	Number of runs per game	44,4±1,30	49,2±1,38	2,53	<0,05
9.	Other motor actions	25,5±1,24	15,8±1,11	5,81	<0,001

Table 4

Performance indicators of the technical and tactical actions of young attacking football players 13–14 years of the control and experimental group during 10 games (n=20), %, $\bar{X}$±m

No.	Motor actions	Control group	Experimental roup	t	p
1.	Short pass	34,0±1,28	38,7±1,30	2,58	<0,05
2.	Medium pass	28,7±1,16	32,9 ±1,19	2,53	<0,05
3.	Long pass	10,0±0,52	10,5±0,53	0,68	>0,05
4.	Groundmove	24,7±1,03	28,2±1,08	2,35	<0,05
5.	Dribbling	26,3±1,01	27,9±1,03	1,11	>0,05
6.	Slide tackle	15,1±1,18	15,5±1,20	0,31	>0,05
7.	Ball stop	26,3±1,11	27,8±1,14	0,94	>0,05
8.	Kicks to the goal	25,7±1,05	29,8±1,10	2,70	<0,05
9.	Headshot	25,1±1,04	28,3±1,10	2,12	<0,05
	$\bar{X}$, %	23,0±1,04	26,6±1,07	2,42	<0,05

The number of motor actions in the indicators determining the technical and tactical actions of attacking football players of the experimental group during the game did not negatively affect the quality of their performance, significantly higher than in the control group, in the performance of short and medium passes of 4.7 and 4.2% (t=2,58; 2,53; p<0.05, respectively), strokes by 3.5% (t=2,35; p<0,05), kicking to the goal 4,1% (t=2.70; p<0.05) and the head by 3.2% (t=2,12; p<0,05) (Table 4). The average performance indicator of technical and tactical actions among the young strikers of the experimental group per game has increased significantly and in relation to the players of the control group has reached 3,6% (t=2,42; p<0,05).

Thus, the use of complexes of athletics running and jumping exercises aimed at increasing the quantity and quality of motor actions, effective to improve the performance of technical and tactical actions of the forwards.

Conclusions / Discussion

1. The use of athletics running and jumping exercises for young attacking football players of 13–14 years during the preparatory period allowed the players of the experimental group to increase the quantitative indicators in relation to the control group players in jerks by 15–20 m (t=2,18 p<0.05), backwards running (t=2.97; p <0.01), tackle (t=2.21; p<0.05), head game (t=2.32, p<0.05) and the amount of run per game (t=2.53; p<0.05), which affected the reduction of other (less significant) motor actions (t=5,81; p<0,001).

2. The increase in the number of motor actions performed by the players of the experimental group did not negatively affect the quality of the performance of technical and tactical actions, which is higher in relation to the players of the control group in the performance of short (t=2.58; p<0.05) and medium passes (t=2,53; p<0,05), strokes (t=2,35; p<0,05), kicks to the ball (t=2,70; p<0,05) and headshot (t=2.12; p<0.05), which is generally 3.6% (t=2.42; p<0.05) higher among young football players 13–14 years of the research group.

The motor actions of the attackers are significantly different from other players of the football team and are related to the organization and completion of the team's attacks. Our previous study allowed us to develop a methodology for the use of athletics running and jumping exercises for defenders [4; 5] and midfielders and experiment to verify the effectiveness of their application.

At the same time, these exercises do not fully correspond to the attackers. Therefore, in view of the foregoing, we have developed sets of exercises that allow for striker actions related to jerking to receive assists, to conduct martial arts in the fight for the ball, to increase the distance of distance running and other football-specific actions.

The results obtained allowed us to confirm the effectiveness of the developed methodology for using specific running and jumping exercises for attackers in terms of the quantity and quality of the implementation of technical and tactical actions during the game.

Prospects for further research. The research results presented are the initial link in determining the features of constructing training sessions for young attacking football players 13–14 years old and require further identification of the level of manifestation of physical qualities and techniques.

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Change in indicators of the development of flexibility of students 13–15 years old under the influence of differentiated learning

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Purpose: *to determine the degree of influence of differentiated learning on the level of flexibility of students in grades 7–9.*
Material & Methods: *analysis and generalization of scientific and methodological literature, pedagogical testing, pedagogical experiment, methods of mathematical statistics. The study involved 226 children 13–15 years old.*
Results: *in the course of the initial study, a "low" level of development of flexibility of students in grades 7–9 was revealed. In the age aspect, the wave-like nature of age-related changes was revealed, however, these differences are mostly not significant ($p>0,05$). In the sexual aspect, mainly significant prevalence of girls 'indicators over boys' data was revealed ($p<0,01$; $0,001$). After the experiment, it was found that the flexibility indicators of schoolchildren of the main groups significantly improved and these differences are statistically significant ($p<0,05–0,001$).*
Conclusions: *significant changes in the indicators of development of flexibility indicate the effectiveness of the introduction of differentiated motor tasks, taking into account the individual capabilities of students in grades 7–9.*

Keywords: *flexibility, differentiation, physical education, middle school students.*

Introduction

The modern education system is mainly aimed at obtaining a significant amount of information, as a result of which the mental load and emotional stress of students are significantly increased, and physical activity is significantly reduced, which leads to a deterioration in health and a decrease in the level of physical fitness [2; 4; 23]. This problem is especially acute during the period of study at school. So, according to a number of authors [17; 22; 24], among children graduating from institutions of complete general secondary education, only 11% are practically healthy, and 89% have various deviations in their state of health, and a greater number (over 60%) have a low level of physical preparedness. One of the key factors to improve this problem is physical education. However, leading experts note that the existing system of physical education in secondary schools is not effective enough and justify this by the fact that the content of the educational process is mainly filled with generally accepted types of educational material [6]; physical education lessons are conducted according to the standard scheme [16]; the key criterion for assessing academic achievement is the achievement of program standards [5], etc. Therefore, the scientific community continues to search for fundamentally new educational technologies aimed at raising a healthy, physically prepared and socially active person.

The problem of optimizing the process of physical education in order to increase the physical fitness of adolescent children remains relevant today.

The analysis of available publications revealed a number of improvements dedicated to improving the level of physical fitness of teenage children through the introduction of various means, methods and approaches: cheerleading [3]; rugby 5 [26]; badminton, running and sports dancing classes [9]; a rational combination of variable modules [21], etc. At the same time, a number of specialists note that one of the operational methods for the formation and improvement of the motor sphere is a differentiated approach, which takes into account not only age and gender differences, but also the individual capabilities of each child separately.

Thus, the conducted studies proved the effectiveness of applying a differentiated approach in the process of motor training of schoolchildren, taking into account various criteria: the rate of biological development [20]; psychoemotional state [7]; physical health of students [25]; the level of development of individual motor abilities [14; 15] and others.

However, it should be noted that the issue of differentiating the content of the educational process in the framework of school physical education, taking into account the individual level of functional and physical fitness, directly indicators of the development of flexibility of children 13–15 years old, has not been investigated. In our opinion, the introduction of the developed differentiated individual motor tasks will positively affect the level of development of flexibility of students in grades 7–9, which determined the direction of our study.

Purpose of the study: to determine the degree of influence of differentiated learning on the level of flexibility of students in grades 7–9.

Objectives of the study:

1. Determine the level of development of flexibility of children 13–15 years old.
2. To trace changes in the obtained indicators in the process of applying differentiated motor tasks, taking into account the individual capabilities of students in grades 7–9.

Material and Methods of the research

To achieve this goal, the following methods were used: theoretical analysis and synthesis of scientific and methodological literature; pedagogical testing; pedagogical experiment; methods of mathematical statistics. To determine the level of development of flexibility of children 13–15 years old, motor tests were proposed by L.P. Sergienko [19]. Thus, the level of development of spinal mobility was determined by the performance indicators of torso forward from the initial sitting position (cm) of the shoulder joints – twisting of straight arms back and forth with a gymnastic stick (cm) of mobility in the hip joints – transverse twine (cm).

The study was conducted on the basis of secondary

school No. 150 of Kharkov. It was attended by 226 students of grades 7–9. 3 main groups were formed (66 boys, 79 girls) and 3 control groups (41 and 40, respectively).

According to the results of a stating experiment, a program was developed to differentiate the content of educational classes, taking into account the level of functional and motor preparedness of schoolchildren of the main groups. The program consists of theoretical, methodological, substantive and applied components. The theoretical and methodological component contains goals, objectives and basic methodological principles of training; the content component is divided into the main section, which meets the requirements of the state program, and the variable sections, the content of which was developed by us taking into account the functional state of the basic systems of the body and the level of development of physical qualities and contains physical exercises and outdoor games aimed at improving functional and physical fitness. The practical component reveals the features of the organization of physical education lessons in the framework of the developed program.

The innovations we proposed included: adjustments to the content of the variable section of the program based on the differentiation of educational material, taking into account the functional and physical fitness of students; the introduction of differentiated motor tasks, taking into account the individual capabilities of students in grades 7–9; improving the applied component of the program, through the organization of independent activities of students and the phased implementation of the developed program material of a variable type; improving the system for monitoring and evaluating the results of educational activities of students.

Results of the research

An analysis of the results of the stating pedagogical experiment indicates the identity of the control and main groups for all indicators that were studied ($p>0.05$). The analysis of primary data in the age aspect revealed a wave-like dynamics of changes, but these differences are mainly not significant ($p>0.05$). In the sexual aspect, it was found, mainly, that the prevalence of girls 'indicators over the boys' data is likely ($p<0.01$; 0.001). Comparing the indicators of the manifestation of flexibility to normative assessments proposed by L.P. Sergienko [19], it was found that the results of students in grades 7–9, on average, correspond to a score of 1 point ("low" level).

Analyzing the data obtained after the pedagogical experiment, it was found that the flexibility indicators of schoolchildren of the main groups improved and these changes were statistically significant ($p<0.05$–0.001) (Table 1).

So, the increase in the indicators of torso forward is: for boys of 7th grade – 0.50 cm, which is a percentage ratio (7.56%), of 8th grade – 0,83 (24.90%), 9th grade – 1,42 (46.24%), among girls – 1,27 (51.43%), 0.74 (12.91%), 1.35 (36.80%), respectively (Fig. 1) .

According to the data on straight arms twisting, the increase in the result is for boys of 7th grade – 1,11 cm, which is a percentage ratio (1,55%), of 8th grade – 1,48 (1,53%), 9th grade – 3,32 (3.42%), among girls – 2,09 (2,54%), 4.57 (6.27%), 3,57 (4,67%), respectively (Figure 2) .

The increase in the indicators of transverse twine is: for boys of the 7th grade – 2,78 cm, which in percentage terms is (7,33%), of the 8th grade – 1,34 (2,97%), of the 9th grade – 2,16 (5,19%), among girls – 1,67 (7,41%), 2,09 (8,60%), 2,52 (9,90%), respectively (Figure 3).

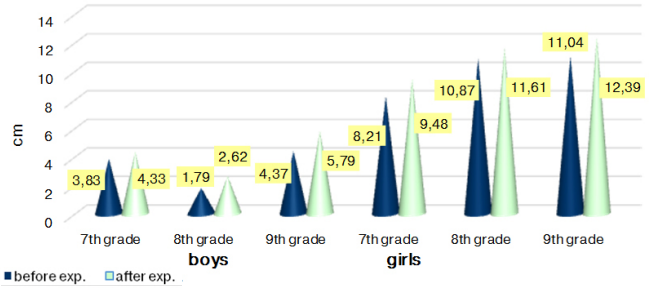

Fig. 1. Indicators of the torso forward of students of the main groups before and after the experiment

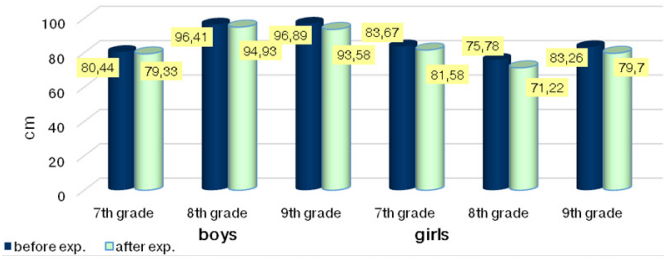

Fig. 2. Indicators of twisting of the straight arms of students of the main groups before and after the experiment

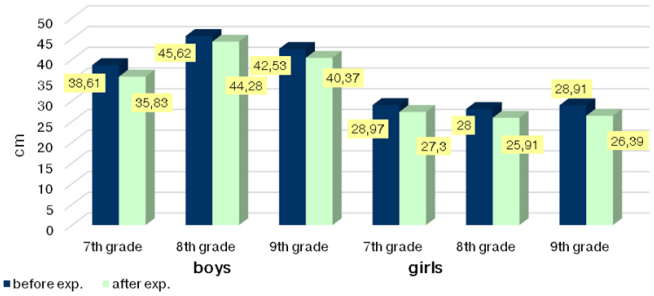

Fig. 3. Indicators of transverse twine of students of the main groups before and after the experiment

The analysis of secondary indicators of students of the main groups in the age and sex aspects did not reveal significant changes compared to the initial data, with the exception of the results of twisting the children's straight arms, where age differences began to be significant ($p<0.05$).

However, positive changes in the secondary results of students aged 13–15 of the main groups at the general level of development of flexibility did not significantly affect and it did not change ("low").

Taking into account possible changes and a rather substantial percentage increase in indicators, we came to the conclusion that the use of differentiated motor tasks, taking into account the individual abilities of students in grades 7–9, had a positive effect on the level of flexibility of students in the main groups. The indicators characterizing spinal mobility (29,97%) improved most significantly. In terms of age, the greatest increase in indicators is observed among schoolchildren of 15 years old (17,7%), according to all the parameters that were studied, while a more significant increase in results was found in girls (15,5%) than in boys (11,2%).

Table 1

Development indicators of the flexibility of schoolchildren of the main groups before and after the experiment

	7 grade		8 grade		9 grade	
	n	$\bar{X}$±m	n	$\bar{X}$±m	n	$\bar{X}$±m
Boys						
Torso forward from sitting position (cm)						
before exp.	18	3,83±0,71	29	1,79±0,33	19	4,37±0,66
after exp.	18	4,33±0,74	29	2,62±0,30	19	5,79±0,64
t		2,62		8,26		10,20
p		<0,05		<0,001		<0,001
Twist straight arms back and forth (cm)						
before exp.	18	80,44±3,55	29	96,41±0,81	19	96,89±2,28
after exp.	18	79,33±3,64	29	94,93±0,79	19	93,58±2,20
t		5,08		13,89		11,17
p		<0,001		<0,001		<0,001
Transverse twine (cm)						
before exp.	18	38,61±2,17	29	45,62±0,89	19	42,53±2,40
after exp.	18	35,83±2,25	29	44,28±0,88	19	40,37±2,36
t		3,13		11,79		8,40
p		<0,01		<0,001		<0,001
Girls						
Torso forward from sitting position (cm)						
before exp.	33	8,21±0,93	23	10,87±1,56	23	11,04±1,72
after exp.	33	9,48±0,78	23	11,61±1,47	23	12,39±1,63
t		5,14		4,71		7,94
p		<0,001		<0,001		<0,001
Twist straight arms back and forth (cm)						
before exp.	33	83,67±2,38	23	75,78±4,19	23	83,26±3,86
after exp.	33	81,58±2,43	23	71,22±4,09	23	79,70±3,91
t		3,81		4,40		16,19
p		<0,001		<0,001		<0,001
Transverse twine (cm)						
before exp.	33	28,97±2,00	23	28,00±2,31	23	28,91±2,53
after exp.	33	27,30±2,02	23	25,91±2,37	23	26,39±2,48
t		11,21		4,65		5,09
p		<0,001		<0,001		<0,001

Conclusions / Discussion

The analysis of secondary data indicates a significant improvement in the indicators of manifestation of loudness of schoolchildren of the main groups (p <0,05-0,001). So, the increase in the results of students of 13 years of the main groups is 12,97%, 14 years of age – 9,53%, 15 years of age – 17,71% (increase in the performance of students in control groups – 2.25%, 0.24%, 1.64% respectively).

The above results are consistent with data from other authors. Thus, the research of H. Dzhangobekovoi, L. Vovkanich, F. Muzyka [9] established the positive impact of sports dance classes on the development of motor qualities, direct flexibility, middle school students; A. Agippo, I. Kuzmenko [1] proved the positive impact of specially targeted exercises, taking into account the functional state of sensory systems; B.G. Zadvornaya [10] – stretching; T.N. Bala [3] – cheerleading.

The greatest increase in indicators was determined in schoolchildren of 15 years old (17.71%).

Our data are confirmed by studies of several authors [8; 11; 13; 18], according to which flexibility develops up to 14–15 and even up to 17 years. The authors attribute this to the fact that in adolescents the ossification of the skeleton is not yet complete, therefore their spine is still quite flexible and mobile; a sufficiently high mobility in the joints remains, associated with the improvement of the processes of inhibition of the central nervous system, as a result of which the muscle tone

decreases, and their elasticity improves, which contributes to the development of flexibility.

Analyzing the data of students in the control groups obtained after the experiment, it was found that they also improved, however, these changes are not significant ($p>0.05$).

Thus, it can be stated that the introduction of complexes of physical exercises of the developed variable type had a positive effect on the level of development of flexibility of schoolchildren of the main groups. In our opinion, this is due to the fact that the content of physical education lessons was supplemented by active, passive exercises and muscle relaxation exercises, which were aimed at stretching the muscles, ligaments and tendons; to increase the range of motion in various joints.

Prospects for further research in this direction are to introduce the proposed innovations into the educational process of another age group.

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Improving the physical qualities of volleyball players using aerobics at the stage of specialized basic training

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Purpose: *theoretically develop and experimentally substantiate aerobic complexes to improve the physical qualities of volleyball players at the stage of specialized basic training.*
Material & Methods: *24 athletes of the main medical group (16–18 years old, girls and boys) took part in the experimental part of the study. 2 groups were formed, control and experimental with 12 athletes each. A set of scientific research methods was used: analysis of special scientific and methodological literature, pedagogical observations, pedagogical experiment, pedagogical testing, methods of mathematical statistics.*
Results: *studied the current state of the training process and existing methods for improving the physical qualities of volleyball players at the stage of specialized basic training. Developed differentiated aerobic complexes for the development and improvement of the leading physical qualities of volleyball players. The effectiveness of using aerobics in the process of improving the physical qualities of volleyball players at the stage of specialized basic training has been confirmed.*
Conclusions: *an increase in the level of development of the basic physical qualities of athletes was obtained. Indicators of coordination abilities increased by (7%), speed-strength (3,9–1,79%), strength (4,5%, 3,1% and 2,8%) and speed qualities (4,5–3,7%) and, as a result, an increase in endurance indicators (6,2%) and flexibility (6,5%).*

Keywords: *volleyball, physical qualities, aerobics, stage of specialized basic training.*

Introduction

Volleyball is characterized by intensification of competitive activity, manifested in an increase in the density of game actions, a decrease in the execution time of both technical techniques in general and their individual phases, in the speed and swiftness of tactical interactions [2; 5; 7 etc.]. All this is based on a high level of physical fitness of players [8; 9; 10; 16], which is based on the ability of each volleyball player to display opportunities in the process of competitive activity [2; 3; 17].

In the process of competition, the maximum voltages and durations of the load affect the body of volleyball players, they require the utmost mobilization of the players' capabilities [3, 4, 11; 15 etc.]. Volleyball teams more and more need players who have not only high growth, but also high speed, endurance, dexterity, good coordination and can navigate in space, with increased functionality and special abilities based on them (high-speed, power and high-speed power) , stability of receptions and actions [2; 6; 11; 20 etc.].

The evolution of the rules of the game of volleyball has led to changes in the system of training players [3; 4; 18 etc.]. With a relatively constant arsenal of techniques over the course of a century, the existing system of technical and tactical actions has undergone significant modernization, which has led to the need for changes in the physical fitness of volleyball players [6; 13; 21].

Changes in the competitive activity of volleyball players should undoubtedly lead to changes in the methodology of training players in modern conditions, including using non-traditional means of developing the physical qualities of players.

Aerobics classes are an effective means of a comprehensive effect on the body of athletes [1], they help strengthen all muscle groups, develop joint mobility, elasticity of ligaments and tendons, increase the level of development of aerobic capabilities, strengthen the cardiovascular and respiratory systems, improve coordination, enrich the motor arsenal [1; 7; 14 etc.]. Diverse, logically structured, science-based programs allow aerobics to maintain a high rating among other types of non-traditional means, helping to increase physical fitness and improve motor skills of volleyball players. The problem of improving the physical fitness of volleyball players is devoted to a large number of basic research in sports [8; 13; 19 etc.], However, aerobics – such studies are fragmented. Therefore, the problem of developing complexes for aerobics to improve the physical qualities of volleyball players is relevant.

Purpose of the study: theoretically develop and experimentally substantiate aerobic complexes to improve the physical qualities of volleyball players at the stage of specialized basic training.

Objectives of the study:

1. To study the current state of the training process and existing methods for improving the physical qualities of volleyball players at the stage of specialized basic training.
2. Theoretically develop and experimentally verify the effectiveness of using aerobics in the process of improving the physical qualities of volleyball players.

Material and Methods of the research

The study was conducted on the basis of the National Law School named after Yaroslav Mudryi (Kharkov) in the conditions of training sessions during the one-year training cycle of volleyball players from September 2018 to September 2019. 2 groups were formed – control and experimental with 12 athletes each. The contingent that took part in the study was of one age group, first and second year students of the

main medical group (17–19 years old, girls and boys). All players had the first sports rank, experience in participating in student competitions, the University Spartakiad and amateur volleyball teams. We studied the training regime, planning documents for the training process of teams. Based on the data of the scientific and methodological literature, 9 tests were selected, most of which are traditionally used in the practice of scientific research for a comprehensive assessment of the level of development of physical preparedness of volleyball players. Indicators were measured at the beginning and at the end of the annual preparation macrocycle [8; 10].

To solve the tasks and obtain objective data, we used a set of scientific research methods: analysis of special scientific and methodological literature, pedagogical observations, pedagogical experiment, pedagogical testing, methods of mathematical statistics [12].

Results of the research

The pedagogical experiment was carried out in specialized basic training groups during the year. Classes were held four times a week for a duration of 120 minutes. The control group was engaged in a curriculum for sports schools and clubs [4], and aerobics complexes were introduced in the experimental group as a means of increasing and improving the physical qualities of volleyball players. The volume and intensity of training in the groups were the same, but in the experimental group aerobics complexes were used, which allow to purposefully increase the level of physical qualities of athletes. The complexes are based on taking into account the specifics of the motor activity of this sport [1; 3; 8], sensitive periods of development of physical qualities and contribute to comprehensive physical development, comprehensive physical fitness, laying a specific functional base for effective training in movement technique and further improvement of athletes.

We have put together differentiated aerobic complexes for the development and improvement of the physical qualities of volleyball players:

- sets of exercises of classical aerobics – contributed to the development of the general endurance of players;
- step aerobics complexes – aimed at improving special (power and hopping) endurance and speed-power qualities;
- dance aerobics – contributed to the development of coordination of movements;
- power aerobics;
- TAI-BO, the direction of aerobics using boxing exercises, kick-boxing and various martial arts;
- Stretching was used to increase the flexibility of muscle groups, ligaments and joints.

The content of the complexes was formed from the exercises described in the scientific and methodological literature, which are used in aerobics practice. In the training process the following methods were used: interval training method, combined, repetitive, holistic training method, right and in parts [1; 8]. The ratio of aerobic complexes used in training volleyball players at the stage of specialized basic training is shown in Figure 1.

In the experimental group, step aerobics, power aerobics and stretching were used, in addition, with the goal of more intensive training of the cardiovascular system, muscle strength, coordination of movements, providing the greatest load on the muscles of the hands, shoulder girdle, back, improving the reaction rate, reducing unnecessary emotionality, mental tension for volleyball players, we recommended Tai-Bo complexes using movements from different types of martial arts. For volleyball players, dance aerobics was used, which allows improving the state of the cardiovascular system, improving endurance and flexibility of muscle groups, coordinating movements using the isolated work of various parts of the body, develops the ability to maintain balance, and also provides emotional coloring for the session. In the classes, regardless of gender, power equipment was used (fixed and adjustable encumbrances for arms and legs, tubular and tape shock absorbers, aerobics rods, dumbbell balls, gymnastic sticks for strength fitness training), as well as additional equipment – step platforms , allows you to develop coordination, as well as vary the level of load, changing the height of the platform.

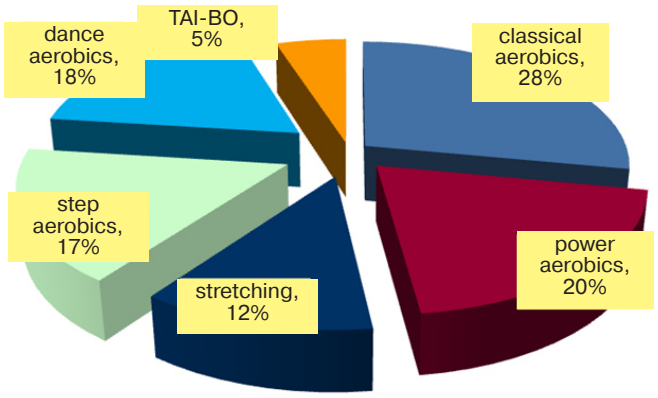

Fig. 1. Ratio of aerobic complexes in the experimental group in the annual training cycle

Before and after the experiment, the volleyball players of both groups were examined according to a unified methodology (Table 1).

As a result of the use of aerobic complexes, more substantial gains of the studied parameters were obtained. So, in the experimental group, the strength indicators statistically significantly increased, the increase is 6,7%, 3,7% and 4,0% ($p<0,05$) relative to the control group, where 4,5% ($p<0,001$), 2,8% and 3,1%, respectively ($p<0,05$). Speed-strength abilities increased by 3.9% and 1,79% ($p<0,05$), relative to the control group, where 3,5% ($p<0,01$) and 1,6% increase ($p<0,001$) . Flexibility increased by 6,5%, respectively, of the control group, where this indicator was 5.2% ($p<0,01$). Performance abilities improved by 4,5% ($p<0,05$) and 3,7% ($p<0,001$), relative to the control group, where the increase is 4,2% ($p<0,05$). and 3,07% ($p<0,001$), and endurance increased by 6.2% in the experimental group, compared with the control – 4,7% ($p<0,001$).

It should be noted that in the main group there was an increase in the indices of coordination abilities by 7,0%, relative to the control group – 5,2% ($p<0.05$).

Thus, the use of differentiated aerobic complexes developed by us is an effective means of developing and improving the physical qualities of volleyball players at the stage of specialized basic training, and creates a functional basis for the growth of special technical preparedness in long-term training of volleyball players.

Conclusions / Discussion

Theoretically developed and experimentally justified aerobic complexes as a means of increasing and improving

Table 1

Indicators of the level of development of the physical qualities of volleyball players before and after the experiment

No. i/o	Indicators	Experimental group (n=12)				Control group (n=12)			
		BE ($\bar{X}\pm\sigma$)*	AE ($\bar{X}\pm\sigma$)	%	t; p	BE ($\bar{X}\pm\sigma$)	AE ($\bar{X}\pm\sigma$)	%	t; p
	Coordination abilities								
1.	Shuttle running 4x9 (s)*	9,66±2,5	8,98±2,2	7,0	0,68<0,05	9,62±2,1	9,05±1,9	5,2	0,57; <0,05
	Strength abilities								
2.	Flexion and extension of the arms in the supine position (number of times)	47,25±1,9	50,67±1,8	6,7	3,42<0,05	47,63±1,9	49,88±1,9	4,5	2,25; <0,01
3.	Throwing a stuffed ball 1 kg behind the head with two hands (m) - sitting - standing	 9,31±1,7 13,55±1,9	 9,67±1,5 14,12±1,8	 3,7 4,0	 0,36<0,05 0,57<0,05	 9,01±1,4 10,25±1,9	 9,27±1,3 10,58±1,8	 2,8 3,1	 0,26; <0,05 0,33; <0,05
	Speed abilities								
4.	Running 30m (s)	4,87±1,5	4,66±1,3	4,5	0,21<0,05	4,96±1,5	4,76±1,2	4,2	0,2; <0,05
5.	Running 92 m with a change in direction (s)	25,75±1,9	24,83±1,8	3,7	0,92<0,001	25,03±2,0	24,28±1,9	3,08	0,75; >0,001
	Speed-strength r qualities								
6.	Long jump from place (m)	246,18±1,9	256,26±1,7	3,9	10,08<0,05	247,21±1,5	256,22±1,4	3,5	9,01; <0,01
7.	Jump up from place (m)	71,75±1,8	73,05±1,5	1,79	1,31<0,05	72,15±1,5	73,35±1,5	1,6	1,2; <0,001
	Flexibility								
8.	Torso forward from sitting position (cm)	12,8±0,7	13,7±0,5	6,5	0,9<0,01	12,06±0,5	12,73±0,5	5,2	0,67; >0,01
	Endurance								
9.	Running 3000 meters (s)	14,32±1,5	13,43±1,2	6,2	0,89<0,001	14,55±1,7	13,89±1,5	4,7	0,66; <0,001

Remark: *BE – initial data (before the experiment); AE – final data (after the experiment) (cm) – centimeters; (s) – seconds; (m) – meter; (Number of times) – the number of times.*

the physical qualities of volleyball players at the stage of specialized basic training. Differentiated complexes contribute to the improvement of basic physical qualities, comprehensively affecting the body of athletes, providing a more significant increase in indicators: coordination abilities (7%), speed-strength (3,9–1,79%), strength (4,5%, 3,1% and 2,8%) and speed qualities (4,5-3,7%) and, as a result, indicators of endurance (6,2%) and flexibility (6.5%).

Prospects for further research: it is planned to develop aerobic complexes not only with the deduction of gender differences, but also taking into account the game role of athletes.

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Selection of female athletes 10–11 years old in group exercises in rhythmic gymnastics

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Purpose: *to identify effective directions for the selection of athletes 10–11 years old in group exercises in rhythmic gymnastics.*
Material & Methods: *ten athletes of 10–11 years old, who train at the Children's Sport School in rhythmic gymnastics in Kharkov, took part in the study. Using sixteen generally accepted tests for rhythmic gymnastics, the level of development of flexibility, strength, speed, jumping ability, balance, coordination and endurance of athletes was monitored. The level of technical preparedness was determined in nine tests to fulfill the difficulties of the body in each group of elements: jumping, rotation, balance.*
Results: *gymnasts showed a high level in the tests: "forearm bridge" – (–18 cm), angle retention (65,7 s), double jumps (110,6 times). The average level was shown in the tests: "right twine" (59,7 cm), "raising legs in the hang" (13 times), "leaning to the side" (1,1 min), "lifting the body" (10,8 times), "Lifting the torso back" (11,8 times), "pass on the left" (62,6 s), "juggling the right" (22 times). The female athlet made the least mistakes in the tests: "forward balance" (0,2 points), in the jump "step into the ring" (0,9 points), rotation "in the ring" (1,0 points). The gymnasts demonstrated an average level in the technique of working with the body with a deduction of 1,2 points in the tests "Jet Boucle," "Jet Anturnan", "90° rotation with the foot forward".*
Conclusions: *the selection of athletes for the acquisition of a team for group exercises in rhythmic gymnastics was carried out according to the results of technical and physical preparedness; six gymnasts were selected, who showed a high and medium level of testing of motor qualities and body work techniques.*

Keywords: *selection, artistic gymnastics, group exercises, body work, preparedness.*

Introduction

Group exercises represent an independent Olympic type of rhythmic gymnastics, where five gymnasts are in a single system of interactions [2]. The results of competitive activity in this sport depends on the teamwork, the compliance of all sides of preparedness, the state of the sports form of each gymnast [1; 6]. The rapid growth of sports achievements, early specialization in an individual program and group exercises makes it necessary to improve the training system of gymnasts [4; 7; 9].

Currently, the problem of improving the process of training gymnasts who specialize in group exercises is being diversely studied. The authors consider issues of technical training of athletes, which are associated with the need to perform joint technical actions [1]. Attention is paid to improving team performance due to a similar level of physical, technical and tactical fitness of gymnasts [3; 6; 8].

The dissertation by I. S. Sivash is devoted to the formation of specialization of young athletes based on the material of group exercises of rhythmic gymnastics at the stages of initial and preliminary basic training [4]. In the dissertation research V. Lenishin [2] substantiated the improvement of special training in group exercises of rhythmic gymnastics at the stage of specialized basic training. G.A. Topol [6] developed a comprehensive system for assessing the preparedness of qualified gymnasts, which is based on the identified leading factors and types of training that ensure the effectiveness of competitive activity in group exercises.

Studying the peculiarities of training athletes in group exercises in rhythmic gymnastics, the authors emphasize the relevance of improving the process of selecting gymnasts to perform group exercises based on identifying complex indicators of their special preparedness [3; 5; 6].

Purpose of the study: to identify effective directions in the selection of athletes 10–11 years old for group exercises in rhythmic gymnastics.

Objectives of the study: 1) determine the level of special physical preparedness of athletes; 2) determine the level of technics of work with the body.

Material and Methods of the research

The study involved ten athletes 10–11 years old, who train at a sports school in rhythmic gymnastics in Kharkov. Using sixteen generally accepted tests for rhythmic gymnastics, the level of development of flexibility, strength, speed, jumping ability, balance, coordination and endurance of athletes was monitored. The level of technical preparedness was determined by nine tests, the exercises of which included fulfilling the difficulties of the body in each group of elements: jumping, rotation, balance.

Results of the research

In athletes, the level of development of flexibility, strength, speed, jumping ability, balance, coordination and endurance was determined (Table 1).

To determine the flexibility in the vertebral column, athletes from a standing position performed the maximum tilt back with the advancement of the arms beyond the line of legs. The average value of the distance from the heels to the end of the third finger in the group – (–18 cm) corresponds to a high standard level. The amplitude of the twine with the support of

Table 1

Statistical indicators of the results of testing the level of development of physical qualities of female athletes

Female athletes	Average value (X)	Standard deviation (σ)	Coefficient of variation (V)	Average level standard	High level standard
Bridge stand, cm	–18	17,3	96	from 10 cm to –10 cm	(–11) and more
Twine right, cm	59,7	13,7	23	50–69	70 and more
Twine left, cm	28,6	14,2	49	50–69	70 and more
Transverse twine, cm	34,9	13,1	37	19–10	9 and less
Pike seat, s	65,7	19,8	30	28–58	59–90
Abdominal raise, the number of	13	4,44	34	11–15	16–20
Side bends, min	1,1	0,8	73	1–2	2–3
Front handspring, s	1,2	0,37	31	1,0–1,1	0,6–0,9
Torso lifting, the number of	10,8	0,78	7	11	12
Torso lifting back, the number of	11,8	2,5	21	13	14
Jump up, cm	44,4	6,9	15	45–54	55–60
“Passe” on the left, s	62,6	22	35	56–89	90 and more
“Passe” on the right, s	48,7	20	41	51–84	85 and more
Juggling the right, the number of	22,0	9,3	42	22–34	60–65
Juggling the left, the number of	7,9	4,1	52	10–15	20–25
Double jumps, the number of	110,6	32,4	29	75–100	101 and more

the right on the gymnastic wall – 59.7 cm corresponds to the average level, and with the support of the left – 28.6 cm, which is much worse than even the low level (49 cm or less). The gymnasts did very poorly in performing the transverse twine between two chairs 44 cm high, the average result was 34.9 cm (low level – 20 cm or more).

The strength of the abdominal muscles was determined by the time of holding the pike seat by an angle (legs together raised by 135°) and by the number of leg lifts in the hanging on the gymnastic wall for 20 s. The gymnasts coped with the first exercise at a high level with a result of 65.7 s, the second – on average with a result – 13 times. The strength of the lateral back muscles was determined by the time the body was held in an inclined position to the horizontal side with arms up to the castle. The result in this test – 1.1 min – corresponds to the average level.

The assessment of the development of speed in young gymnasts was determined by the time of the forward turn and by the number of torso lifts for 10 s. Average rates of speed development are low. So, the athletes performed a forward turn in 1.2 s (low: 1.2–1.3 s). The torso was raised by 60° from the supine position, hands behind the head into the “lock”, knees bent, feet fixed, average result 10.8 times (low level 10 times). Lifting the body back 60°, the gymnasts performed from the supine position, hands behind the head into the “lock”, the feet were fixed, the average result was 11.8 times (low level – 12 times). The average value of the height of the jump up (according to Abalakov) in the studied group of athletes is 44.4 cm, which corresponds to a low standard level (30–44 cm).

The degree of development of the equilibrium function was determined by maintaining the “pass” pose on the right and left foot. The gymnast maintained her balance by rising to the toe of the supporting leg, while the second leg was bent to touch the supporting leg at the level of the knee and set aside. The balance result on the left foot – 62,6 s corresponds to the average standard level, on the right foot – 48,7 s – to the low standard level (50 s or less).

The coordination abilities of athletes were determined by juggling with two clubs. The number of rolls in the first loss of the item was calculated. The number of throws with the leading right hand corresponds to the average standard level – 22 throws, with the leading left hand – to the low standard level – 7.9 throws (low level from 3 to 9 throws). Athletes showed high results in testing speed endurance, the number of jumps with a double circle of a rope for each jump, the average value in the group was 110.6 jumps.

Thus, it was determined that the gymnasts have well developed flexibility in the spinal column, but compared with the requirements of the sport, the mobility of prisoners in the hip joint is not enough. The strength of the muscles of the body meets the requirements of the sport. In tests for speed, gymnasts showed a low result. The average value of the height of the jump in the group also corresponds to a low level. Athletes are given better balance on their left foot than on their right foot. And the gymnasts perform juggling with clubs with their leading right hand much better than with their left. It should be noted that the coefficients of variation according to the test results are quite large; only two (7% and 15%) of them indicate homogeneity of the group.

The following table presents the individual results of testing the physical qualities of ten athletes (Table 2).

When selecting athletes for a team from group exercises, preference is given to gymnasts who have a high as well as an average level of special physical preparedness. The best results in the testing were shown by athletes under No. 4, 5 and 9. Athletes under No. 1, 6 and 8 also showed sufficient results. Other athletes (under No. 2, 3, 7, 10) were tested at a low level.

The next stage of the study was to identify the level of technical preparedness of gymnasts when performing body difficulties. Athletes performed three test tasks in each group of elements: jumping, rotation, balance. Evaluation was carried out in accordance with the rules of the competition in a group exercise. According to the rules of judging for techniques of working with the body, the maximum reduction is 0.5 points. To control the gymnasts, each exercise was performed from the right and left legs, and the best version was evaluated. The table below shows the individual reduction of athletes for each test, the sum of discounts of all gymnasts for each test and the sum of discounts of each gymnast for all tests (Table 3).

Three jumps were investigated: Jete Boucle, step in the ring, Jete Anturnan. To assess the gymnasts performed each jump in a row three times. Before each series of jumps, the gymnasts did the preparatory exercise "shose". Typical errors during all jumps were not enough repulsion, which resulted in a small amplitude of the jump, lack of fixation of the pose in flight, landing with an error (heavy landing). In almost all gymnasts, the amplitude of leg dilution was less than 180°.

According to the technology jump performance Jete Boucle the gymnast after rotation of 360° pushing off with

Table 2

Results of the testing of physical qualities of athletes

Test	Result									
Female athletes	1	2	3	4	5	6	7	8	9	10
Bridge stand, cm	**–31**	10	0	**–32**	**–35**	**–20**	8	**–28**	**–31**	**–21**
Twine right, cm	**74**	*40*	52	**74**	**74**	60	*35*	60	65	63
Twine left, cm	52	*20*	*20*	52	*10*	*25*	*15*	*30*	*35*	*27*
Transverse twine, cm	18	*50*	*44*	12	*34*	*44*	*50*	*40*	*30*	*27*
Pike seat, s	58	50	**90**	**88**	**75**	**69**	*23*	**59**	**79**	**66**
Abdominal raise, the number of	12	*8*	14	**17**	**16**	**20**	*5*	13	15	*10*
Side bends, min	*0,49*	*0,44*	1	**2,3**	**2,01**	1, 50	*0,5*	1, 45	1, 57	1
Front handspring, s	1,0	*1,3*	1,1	**0,9**	1,1	1,0	*1,5*	*1,2*	**0,9**	1,0
Torso lifting, the number of	11	*10*	**12**	11	11	*10*	11	*10*	**12**	*10*
Torso lifting back, the number of	**14**	*7*	*10*	**14**	13	13	*8*	13	13	13
Jump up, cm	46	*36*	*40*	**55**	52	50	*34*	45	47	*39*
"Passe" on the left, s	*40*	*33*	57	**95**	78	60	*33*	66	85	79
"Passe" on the right, s	*32*	*27*	*48*	**85**	66	*43*	*20*	*42*	64	60
Juggling the right, the number of	22	*14*	*19*	30	31	*8*	*8*	28	33	26
Juggling the left, the number of	*7*	*5*	*4*	11	10	*4*	*2*	12	15	*9*
Double jumps, the number of	80	88	75	**170**	**150**	100	79	**110**	**124**	**130**
Levels	**Number of results by level**									
High	3	–	2	11	6	3	–	3	5	3
Average	9	3	7	5	8	7	3	8	9	7
Low	4	13	7	–	2	6	13	5	2	6

Remark. *Results that correspond to the high level are marked in bold, the results correspond to the low level in italics.*

Table 3

Reduction gymnasts when performing body work techniques

Test	Reduction when performing body work techniques, points										
Female athletes	1	2	3	4	5	6	7	8	9	10	Σ
"Jete the Boucle"	0	0,2	0,2	0	0	0,1	0,3	0	0,1	0,3	1,2
"Step into the ring" jump	0,1	0,2	0,1	0,1	0,1	0	0,1	0	0,1	0,1	**0,9**
"Jete Anturnan"	0	0,3	0	0	0,1	0,1	0,3	0,1	0	0,3	1,2
90 feet forward rotation	0,2	0,2	0,1	0,1	0,1	0	0,2	0	0,1	0,2	1,2
Rotation "into the ring"	0,1	0,4	0,1	0	0	0	0,3	0	0	0,3	**1,0**
Rotation "Panshe"	0	0,3	0,4	0	0	0,2	0,2	0,1	0,1	0,4	*1,7*
"Front" balance	0	0	0,1	0	0	0	0	0	0	0,1	**0,2**
"Lateral" balance	0	0,3	0,3	0	0,1	0,2	0,3	0,1	0	0,3	*1,6*
"Back" balance	0,1	0,4	0,1	0,1	0,1	0,1	0,4	0,3	0,3	0,1	*2,0*
Total reduction	**0,5**	*2,3*	*1,4*	**0,3**	**0,5**	0,7	*2,1*	0,6	0,7	*2,1*	

one foot, the toe of the bent leg of the second summing performed simultaneously perform a swing back. When performing the Jete Boucle jump, most gymnasts made the following mistakes: insufficient amplitude of the jump, lack of fixation of the pose in flight, legs apart less than 180°, bent fly leg. To perform the "step into the ring" jump, the gymnast, pushing with one foot, opened her legs 180°, while the second leg performed the "ring". During the "step in the ring" jump, there was an extra "swing" movement, the amplitude of leg extension was less than 180° and their opening was not simultaneous, the legs were not touching the head, and the back deflection in the last phase of the flight before landing. In the "Jet Anturnan" jump, which was performed with the legs split into twine after 180° rotation, the legs were less than 180° apart, the knees bent, and the "swing" movement was unnecessary.

The sportswomen performed three 360° rotations: with 90° feet forward, "into the ring", "Panshe". To assess the gymnasts, each rotation in a row was performed three times in a row. Typical errors of all calls were: insufficient amplitude of rotations, it was not fixed, that body shape was not retained, support on the heel, bouncing, extra steps at the end of rotation. When performing the rotation with the leg set forward 90°, it turned out that most gymnasts allowed resistance to the heel, did not always keep the leg 90° and the shape of the body at the end of the rotation. The rotation "into the ring", which the gymnasts performed with the swing of the legs back with its grip above the head, was better than the other rotations, but the gymnasts observed an irregular body shape with a slight deviation, bouncing without moving and with it. During the execution of the Panshe rotation (in which the legs open into twine, the body is held in a horizontal position or lower) the body shape was not fixed and the rotation was not contained and at the end of the rotation the gymnasts took extra steps, but all the rotations should end the legs together.

Three equilibria were studied: front, lateral, and back. To assess the gymnasts, each balance was performed three times with a content of 2 s. Typical errors of all equilibria were the fuzzy and non-fixed form of the body. The "front balance" (in which the body is tilted forward to the horizontal or lower), most gymnasts performed without obvious errors, but two athletes could not demonstrate the position of the twine. The "lateral balance" (the leg rises to the side of the splits, the torso parallel to the floor) turned out to be more difficult for the girls, the gymnasts made mistakes, namely, a fuzzy and unfixed body shape was observed. To perform the "back balance", the gymnast did a forward roll with the content of the position of the twine, the body tilted backward, her hands did not touch the floor. During the performance of the "back balance" the gymnasts made the most mistakes: the irregular shape of the body with medium and large deviation, loss of balance, extra steps at the end of the exercise.

Analyzing the number of discounts on tests, it can be noted that most of the mistakes were made when performing the "back balance", the total amount of discounts is 2.0 points. Also, a significant number of errors turned out to be during Panshe rotation (1.7 points) and when performing "lateral balance" (1.6 points). It should be noted that from each subgroup of body work: jumping, rotation, balance, you can identify the basic elements that gymnasts are at a sufficient level. Analyzing the number of discounts received by each gymnast, it can be argued that it was better for the athletes under No. 1, 4 and 5. The athletes under No. 6, 8 and 9 showed sufficient results. In other athletes (under No. 2, 3, 7, 10) a low result.

Thus, an analysis of the individual results of testing athletes found that according to the indicators of special physical fitness, the leading athletes were No. 4, 5, and 9, and the indicators of technical fitness were No. 1, 5, and 4. The athlete No. 1 took the fourth place in testing motor qualities , and when performing the body work technique, she shared the second place with the athlete under number 5. A low level of special physical and technical preparedness was determined in gymnasts under number 2, 3, 7, 10.

Conclusions / Discussion

The studies confirmed the information of V. Lenishin [2, 3] that for group exercises it is necessary to develop a special program on SPP, which reflects the specifics of training in this type of rhythmic gymnastics. The level of physical fitness of gymnasts in group exercises was determined using integrated control of the motor qualities of athletes. Gymnasts showed a high level in the tests: "bridge stand" – (–18 cm), angle holding (65.7 s), double jumps (110.6 times). The average level was shown in the tests: "right twine" (59.7 cm), "raising legs in the hang" (13 times), "leaning to the side" (1.1 min), "lifting the body" (10.8 times), "Lifting the torso back" (11.8 times), "passe on the left" (62.6 s), "juggling the right" (22 times). Recent tests showed a low level.

Most rhythmic gymnastics trainers put forward the criteria for the selection of athletes in group exercises in the first place the level of technical skill of athletes, in the second – the level of development of physical qualities [5; 6]. In the course of the work, information on the technique of working with the body of gymnasts 10–11 years old was supplemented. The female athletes made the least mistakes in the tests: "forward balance" (0.2 points), in the jump "by step in the ring" (0.9 points), rotation "in the ring" (1.0 points). The most mistakes were made in the tests: "back balance" (2.0 points), "Panshe" rotation (1.7 points), "lateral balance" (1.6 points). The gymnasts demonstrated an average level in the technique of working with the body at a discount of 1.2 points in the tests "Jete Boucle", "Jete Anturnan" "rotation with the foot forward 90".

Due to the fact that this age of gymnasts is the main stage in the formation of a reserve of national teams with subsequent orientation towards individual and group exercises, the need to control the individual motor potential of gymnasts increases, and the most important selection criteria for group exercises are the level of development of physical qualities and the degree of technical skill of athletes [4]. The selection of athletes to recruit the team from group exercises in rhythmic gymnastics was carried out according to the results of the revealed level of their technical and physical preparedness. To prepare group exercises, six gymnasts were selected, who showed a high and average level of testing of motor qualities and body work techniques. The last four gymnasts showed low results.

Prospects for further research in this direction include the identification of the level of technical readiness of work with objects, as well as the compatibility of gymnasts for team formation.

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Features of goal kicks by football players in games of high-level teams

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Purpose: *to establish the peculiarities of goal kicks by highly qualified football players in the conditions of competitive activity.*
Material & Methods: *the registration of technical and tactical actions was carried out using the games of teams participating in the group stage of the UEFA Champions League 2019/2020 season as an example. The games of Group C teams of FC Manchester City (Manchester City, England), FC Atalanta (Bergamo, Italy), FC Shakhtar (Donetsk, Ukraine), FC Dynamo (Zagreb, Croatia) were analyzed. In total, 290 shots were recorded and analyzed in 12 games of four teams. To solve the tasks in the work, the following research methods were used: analysis of scientific and methodological literature, registration of team technical and tactical actions, methods of mathematical statistics.*
Results: *the paper presents data that characterize the features of kicks by players in the games of high-level teams. In total, 290 kicks were recorded and analyzed in 12 games of four teams participating in the UEFA Champions League 2019/2020 season. Kicks on goal were classified according to the result (goals, on target, past the goal, into the goal frame, blocked shots), at the place of execution (from the goal area, from the penalty area, from outside the penalty area), along the trajectory (upwards kicks, low kicks).*
Conclusions*: the results of the study indicate differences in the quantitative indicators of kicks on goal of teams participating in the UEFA Champions League season 2019/2020 in group "C". It was established that highly qualified football players most often performed kicks on the right foot, which is explained by the lateral advantage. In addition, football players carried out more kicks from the bottom and from the zone between the goal area line and the penalty area line, which should be reflected in the construction of exercises aimed at improving the technique and tactics of kicks.*

Keywords: *kicks, goals, penalty area, goal area, shots on target, goal frame.*

Introduction

The structure of the competitive activity of football players of different ages and qualifications in our time is quite well studied. Studies were conducted with young soccer players [3; 9], professional soccer players of teams of different levels [1; 7; 8; 11], footballer-veterans [10], female footballers [2], footballers with disabilities.

The study undergoes a fairly wide range of technical and tactical actions (TTA): individual [7; 12] and team [4; 5; 18] TTA, defensive [8] and attacking [4; 6; 17; 19] TTA, passing the ball [6; 14; 16], strokes of the opponent, TTA of goalkeepers [13; 20] and others.

Of particular interest among the experts is studying the TTA, which, in their opinion, make the largest contribution to the outcome of the game. Specialists attribute shots to the goal to such a TTA [11; 15; 17; 19].

So, in a previous study [19], the authors found that high-level teams on average perform 13.2 shots on target per game. Of them:

– from the game – 11.9 shots, after the drawing of standard provisions - 1.3 shots;

– foot – 11.4 shots, head - 1.8 shots;

– after the ball bounces from the goal frame, goalkeeper or defender – 2.1 shots, after passing the ball from a partner – 9,8 shots;

– one touch – 5,0 shots, second touch – 3,4 s shots, after the ball – 3,4 shots;

– from the ground – 10,0 shots, on a ball flying – 3,2 shots.

– from the limits of the goal area – 0,6 shots, from the zone between the goal area and the penalty mark – 2,7 shots, from the zone between the penalty mark and the penalty area line – 2,4 shots, from the outside of the penalty area – 7,5 shots.

Purpose of the study: to establish the peculiarities of goal shots by highly qualified football players in the conditions of competitive activity.

Material and Methods of the research

Registration and analysis of the TTD was carried out in the games of the group stage of the UEFA Champions League 2019/2020 season in accordance with well-known recommendations. We analyzed 12 games of four teams of group C of FC Manchester City (Manchester City, England), FC Atalanta (Bergamo, Italy), FC Shakhtar (Donetsk, Ukraine), FC Dynamo (Zagreb, Croatia))

Results of the research

Table 1 shows the quantitative indicators of shots on goal with different performance of the teams participating in the UEFA Champions League season 2019/2020 group "C".

The table shows that of the four teams in this group for 6 games, the players of the Manchester City team delivered the most hits - 92 shots (group winner), and the Dynamo players performed the least shots – 50 shots (last place in the group).

It should be noted that the number of shots on goal in the games of the teams of this group ranged in a wide range – from 2 (Dynamo, Croatia) to 23 (Atalanta, Italy).

Table 1

Efficiency indicators of goal shots against the teams participating in the UEFA Champions League season 2019/2020 of Group "C" (indicators for 6 games)

Indicators	Manchester City	Atalanta	Shakhtar	Dynamo	Group total
Total number of shots	92 (100,0%)	87 (100,0%)	61 (100,0%)	50 (100,0%)	290 (100,0%)
Goals	16 (17,4%)	8 (9,2%)	8 (13,1%)	10 (20,0%)	42 (14,5%)
On target (except goals)	23 (25,0%)	24 (27,6%)	16 (26,2%)	9 (18,0%)	72 (24,8%)
Past the gate	37 (40,2%)	37 (42,5%)	20 (32,8%)	14 (28,0%)	108 (37,2%)
To the gate frame	3 (3,3%)	3 (3,4%)	2 (3,3%)	3 (6,0%)	11 (3,8%)
Blocked shots	14 (15,2%)	15 (17,2%)	15 (24,6%)	14 (28,0%)	58 (20,0%)

Remark. *the first value is the number of shots, in parentheses is the percentage of the total number of shots.*

Table 2

Indicators of goal shots from different areas of the football field of teams participating in the UEFA Champions League season 2019/2020 group "C" (indicators for 6 games)

Indicators	Manchester City	Atalanta	Shakhtar	Dynamo	Group total
Total number of shots	92 (100,0%)	87 (100,0%)	61 (100,0%)	50 (100,0%)	290 (100,0%)
From the goal area	8 (8,7%)	12 (13,8%)	5 (8,2%)	8 (16,0%)	33 (11,4%)
From the penalty area (except for the goal area)	54 (58,7%)	52 (59,8%)	31 (50,8%)	23 (46,0%)	160 (55,2%)
From outside the penalty area	30 (32,6%)	23 (26,4%)	25 (41,0%)	19 (38,0%)	97 (33,4%)

Remark. *the first value is the number of shots, in parentheses is the percentage of the total number of shots.*

An analysis of the effectiveness of shots on goal shows that only 14.5% of shots ended in a goal. At the same time, Dynamo players (20.0%) had the highest performance in strikes, while the Atalanta team showed the lowest efficiency (9.2%). Despite the fact that the players of the Manchester City team scored 2.7±0.7 goals per game, the percentage of productive shots is only 17,4%.

In addition, as a result of the study, it was found that in addition to goals, 24,8% of all shots were on target, 37,2% – on target, 3,8% – on target and 20,0% of shots were blocked.

Table 2 shows the quantitative indicators of shots on goal made by football players of teams participating in the UEFA Champions League season 2019/2020 group C from different zones of the football field.

The results of the table indicate that the players of the teams participating in the Champions League more often shots from outside the penalty area (except the goal area) - 55.2% of all shots. Teams made 97 shots (33.4%) from outside the penalty area, 33 shots (11.4%) from the outside of the goal area.

Table 3 shows the quantitative indicators of kicks and goals by the teams participating in the UEFA Champions League season 2019/2020 group "C".

The table shows that almost half (49.7%) of shots on goal by the players in the games of the Champions League hit with the right foot. 34.5% of the shots were made with the left foot and 15.9% of all shots on target by the head. This situation can be explained by the lateral advantage. It is well known that the majority of the population are right-handed. Worldwide, there are approximately 10% left-handed people. Left-handers are much less observed than right-handers in football.

From table 4 it can be seen that highly qualified footballers are more likely to score shots on goal by low shot. So, 80.7% of all shots on target by the players were low.

The leader in this regard was the Manchester City team, whose players hit 87.2% of shots on target. More often than

Table 3

Indicators of goal shots and head shots for teams participating in the UEFA Champions League season 2019/2020 Group C (indicators for 6 games)

Indicators	Manchester City	Atalanta	Shakhtar	Dynamo	Group total
Total number of strokes	92 (100,0%)	87 (100,0%)	61м (100,0%)	50 (100,0%)	290 (100,0%)
Right leg	45 (48,9%)	40 (46,0%)	27 (44,3%)	32 (64,0%)	144 (49,7%)
Left leg	35 (38,0%)	28 (32,2%)	25 (41,0%)	12 (24,0%)	100 (34,5%)
Head	12 (13,0%)	19 (21,8%)	9 (14,8%)	6 (12,0%)	46 (15,9%)

Remark. *the first value is the number of shots, in parentheses is the percentage of the total number of shots.*

Table 4

Indicators of accurate low shot and high shot of teams participating in the UEFA Champions League season 2019/2020 group "C" (indicators for 6 games)

Indicators	Manchester City	Atalanta	Shakhtar	Dynamo	Group total
Total number of shots on goal	39 (100,0%)	32 (100,0%)	24 (100,0%)	19 (100,0%)	114 (100,0%)
High shots	5 (12,8%)	6 (18,8%)	5 (20,8%)	6 (31,6%)	22 (19,3%)
Low shots	34 (87,2%)	26 (81,2%)	19 (79,2%)	13 (68,4%)	92 (80,7%)

Remark. *the first value is the number of shots, in parentheses is the percentage of the total number of shots.*

Table 5

Indicators of performance low shot and high shot of teams participating in the UEFA Champions League season 2019/2020 group "C" (indicators for 6 games)

Indicators	Manchester City	Atalanta	Shakhtar	Dynamo	Group total
Total number of shots on goal	16 (100,0%)	8 (100,0%)	8 (100,0%)	10 (100,0%)	42 (100,0%)
Hihg shots	3 (18,8%)	1 (12,5%)	1 (12,5%)	4 (40,0%)	9 (21,4%)
Low shots	13 (81,2%)	7 (87,5%)	7 (87,5%)	6 (60,0%)	33 (78,6%)

Remark. *the first value is the number of shots, in parentheses is the percentage of the total number of shots.*

other teams, high shots was performed by Dynamo team players (31.6%).

We obtained similar data when analyzing effective shots on goal, was performed by the low shots and high shots players of the teams participating in the UEFA Champions League season 2019/2020 group "C" (Table 5).

Thus, an analysis of productive shots shows that out of 42 goals 33 (78.6%) were scored low and only 9 (21.4%) high.

The players of the Manchester City team scored 16 goals with 13 (81.2%) low and 3 (18.8%) high. In turn, the players of the Atalanta and Shakhtar teams with 8 goals scored 7 (87.5%) low and 1 (12.5%) high. Significantly different performance indicators of the Dynamo team, whose players scored 4 (40.0%) goals on high and 6 (60.0%) low goals.

Conclusions / Discussion

1. As a result of the study, it was found that the teams participating in the UEFA Champions League season 2019/2020 in the games performed a different number of shots on goal with different efficiency and effectiveness.

2. Group "C" teams averaged 12,1±1.0 shots on target per game. Most often, kicks against the opposing teams were carried out by the players of the Manchester City team (group winner) – 15,3±1,5 shots. Less often, the opponents 'goal was threatened by Dynamo players (last place in the group), who, on average, performed 8,3 ± 1,6 shots on target.

3. The results of the study indicate that the teams of this group on average 1.4 ± 0.3 shots per game from outside the goal area, 6.7±0.7 from the penalty area and 4.0 ± 0.4 from outside penalty area.

4. Football players of these teams on average 6.0±0.6 shots per game with the right foot, 4.2±0.5 shots with the left foot and 1.9±0.3 with the head.

5. It was found that high-level teams perform more shots from the low. So, the teams participating in the UEFA Champions League, on average, for a game 0.9 ± 0.1 shots, performed on high and 3.8±0.5 shots on the low. The number of effective strikes on high was 0.4 ± 0.1, below – 1,4±0,3.

Prospects for further research in this direction. Further research may be devoted to the study of the features of goal kicks by young football players in the games of CYFL of Ukraine of different age groups.

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Features of morphological and functional characteristics and physical preparedness of sprinters 15–16 years old, specializing in various swimming methods

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Purpose: *to develop model morphological and functional characteristics and indicators of physical preparedness of 15–16-year-old sprint swimmers specializing in various swimming methods.*
Material & Methods: *analysis and generalization of scientific and methodological literature, pedagogical observation, testing, anthropometric measurements, methods of mathematical statistics.*
Results: *scientific knowledge on the features of the morphological and functional characteristics and physical preparedness of sprint swimmers specializing in various methods of swimming is supplemented. The study of the level of physical fitness showed a difference in the development of motor qualities of sprinters depending on their main way of swimming, which is due to the structure of the technique of performing movements in water.*
Conclusions: *the results allow us to say that the objectivity of sports orientation in sprinting depends on the integrated use of morphological, functional and pedagogical criteria, which can make it possible to establish the tendency of young athletes to this or that way of swimming.*

Keywords: *swimmers, sprinters, specialization, physique, preparedness, orienteering.*

Introduction

The constant growth of sports achievements in sports swimming requires further study of the individual capabilities of athletes. In accordance with this, the development of criteria for the selection and prediction of the prospects of young swimmers is an urgent problem in the preparation of athletes. Along with the sports result, which is currently the only indicator of a swimmer's giftedness, coaches should also take into account other scientifically based selection criteria, such as body proportions, body length and weight, functional features, and physical fitness [2; 3]. The justified orientation of young swimmers to this or that distance should be based on indicators of its morphotype and physical fitness. In swimming, sports orientation mainly covers the stage of specialized basic training [3; 9; 10].

The purely sprinter type is quite rare (6%). At distances of 50 and 100 m, athletes with a high quantitative content of AL-fibers (at least 70%) achieve success [1; 9]. Sprinters are distinguished by large values of length and body weight, size of coverage, limb length, anaerobic power and functional mobility [1]. High adolescents with long limbs, well-developed muscles of the upper extremity belt, light legs, with a front crawl shape and great mobility in the joints should be oriented towards specialization in back swimming. Specializing in butterfly – adolescents of medium and above average height, with a relatively long body, with developed muscle groups of the whole body, greater mobility in the joints and high strength indicators. Adolescents of relatively small stature with relatively long strong legs, large foot and hand sizes, and high mobility in the ankle and knee joints are generally more prone to swimming breaststroke [2; 4; 8; 11]. So, the selection should not be based on one or two, even important criteria, but in the whole complex of indicators that could objectively evaluate the individual characteristics of athletes.

Purpose of the study: to develop model morphological and functional characteristics and indicators of physical preparedness of 15–16 year old swimmers-sprinters specializing in various swimming methods.

Objectives of the study:

1. To establish the features of the morphological and functional indicators of swimmers-sprinters 15–16 years old, specializing in various methods of swimming.

2. To evaluate the level of physical fitness of young swimmers-sprinters, representatives of various swimming methods.

Material and Methods of the research

Research methods: analysis and synthesis of scientific and methodological literature, pedagogical observation and testing, anthropometric measurements, methods of mathematical statistics.

The work examined morphological and functional indicators, their ratio, and also tested the physical fitness of athletes. The studied contingent consisted of 15 qualified sprint guys aged 15–16 years, specializing in various swimming methods. The level of sports qualification of swimmers corresponded to the level of CMS and MS.

Results of the research

The results of the study of anthropometric indicators of 15–16 year old swimmers specializing in various swimming methods are shown in Table 1. Among total body sizes, sprinter athletes specializing in crawling on their backs have the largest average body lengths and exceed the results of the generalizing model. Slightly lower indicators of body length in young men specializing in freestyle swimming and in the method of breaststroke. The smallest body length is recorded in sprinters specializing in butterfly stroke. There is no significant difference in body mass indices among young

men, representatives of different swimming methods. Values range from 65.80–64.0 kg. The greatest body weight is set for sprinters who specialize in swimming the way the crawl on the chest. The length of the limbs of swimmers, of various specializations depends on the nature of the working movements and their relative contribution to the swimming speed. However, in such parameters as the length of the arm, hand, forearm, trunk, lower leg and foot, the greatest results belong to representatives of swimming by the breaststroke method. The greatest leg lengths belong to athletes specializing in back crawl swimming.

The measurement results of the swimmer's body size allow us to judge their strength capabilities, as they pass through muscle groups that perform the main work when swimming [2, 9; 11]. So, among the indicators of coverage of the forearm, wrist, ankle and lower leg, the greatest indicators are for rabbits. At the same time, the largest girth sizes of the waist and hips were set in the sprinter swimming with a crawl on the back, and the shoulders and knee of athletes specializing in the breaststroke. In terms of shoulder widths, the results between the swimmers are not significantly different.

The body proportions indices make it possible to judge the features of physique and physical development and can be used as criteria for selecting and determining specialization in a particular swimming method. The greatest proportionality indices of the body are "shoulder width to body length" (0.25±0.01 conv. units), "Width of shoulders to the width of the pelvis" (1.19±0.06 conv. units) It is among the of swimmers by the method of breaststroke (Figure 1). They also have the largest index "leg length to body length" – 0.56±0.01 conv. units In terms of absolute body surface area, representatives of sprinter swimming with a crawl on the chest and on the back are ahead of other specializations (1.76±0.05 ml, respectively). According to the Ketle index, representatives of swimming using the butterfly stroke method (20.44±0.53 kg·m²) and free style (20,26±0,23 kg·m²) have the highest values, and the lowest value was found for swimmers on the back (19 64 ± 1,04 kg·m²).

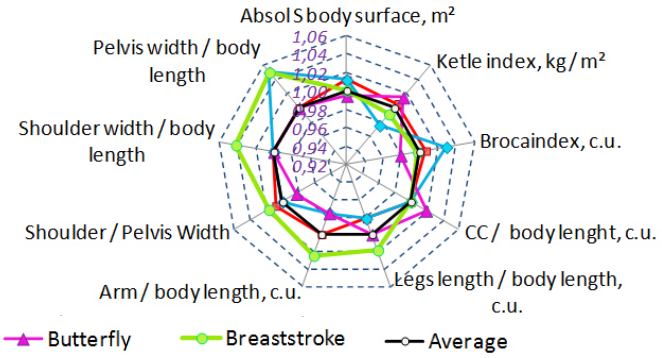

Fig. 1. Ratio of the body proportions indices of sprinters 15–16 years old, specializing in various methods of swimming

Studies of the external respiration function of young

Table 1

Model characteristics of the physical development of young swimmers-sprinters 15–16 years old, specializing in various methods of swimming

No. i/o	Parameters	F/c (n=5)		B/c (n=2)		Butterfly (n=4)		Breaststroke (n=4)		X̄ (n=15)
		X̄	±σ	X̄	±σ	X̄	±σ	X̄	±σ	
1.	Body length, cm	179,60	4,04	182,00	2,83	178,00	4,62	179,50	4,20	179,47
2.	Body weight	65,80	2,77	65,00	1,41	64,00	3,56	64,25	1,71	64,80
3.	VC, L	4,18	0,27	4,05	0,07	4,10	0,28	4,25	0,26	4,16
4.	Arm length, cm	74,80	4,21	73,50	3,54	72,00	4,24	75,00	4,69	73,93
5.	Brush length, cm	17,80	1,30	18,00	0,00	17,50	1,29	19,50	1,00	18,20
6.	Forearm length, cm	29,40	2,30	28,00	0,00	30,25	2,63	30,75	1,50	29,80
7.	Body length, cm	53,00	2,55	54,50	2,12	53,50	3,70	54,75	2,06	53,80
8.	Foot length cm	98,60	2,70	100,00	0,00	97,75	3,10	99,25	2,06	98,73
9.	Shin length, cm	46,60	3,36	46,50	2,12	46,00	3,16	50,25	1,71	47,40
10.	Thigh length, cm	52,40	1,14	49,50	3,54	51,00	1,41	49,00	1,83	50,73
11.	Foot length, cm	26,80	0,84	26,50	0,71	26,25	1,71	27,75	0,50	27,07
12.	Shoulder width cm	46,80	1,64	46,00	1,41	45,50	1,29	46,00	1,83	46,13
13.	Width of the pelvis, cm	38,00	1,00	38,50	2,12	37,25	1,89	38,50	2,08	38,00
14.	Brush Width cm	10,40	0,55	10,50	0,71	9,75	0,96	10,00	0,82	10,13
15.	CC in rest, cm	96,20	1,92	96,50	3,54	96,25	2,75	96,25	1,50	96,27
16.	CC on inspiration, cm	102,60	2,51	104,00	1,41	102,25	3,50	102,25	3,30	102,60
17.	CC on the exhale, cm	91,80	1,64	92,50	2,12	91,75	2,22	91,50	1,29	91,80
18.	Shoulder circumference, cm	34,60	1,52	33,00	1,41	34,50	2,08	35,00	2,83	34,47
19.	Forearm circumference, cm	26,80	1,79	25,50	0,71	26,75	2,50	26,00	2,16	26,40
20.	Wrist girth, cm	20,20	1,48	20,00	1,41	18,75	0,96	18,75	0,96	19,40
21.	Waist circumference, cm	78,80	2,77	81,50	2,12	76,50	2,52	79,25	3,59	78,67
22.	Hip circumference, cm	61,20	2,77	62,50	2,12	58,50	3,79	61,00	2,94	60,60
23.	Girth of the knee, cm	36,00	2,35	34,00	1,41	35,50	3,11	36,00	2,71	35,60
24.	Ankle circumference, cm	24,00	1,58	21,50	0,71	23,00	1,41	23,50	2,52	23,27
25.	Girth of the leg, cm	42,00	3,08	37,50	4,95	38,25	6,13	37,75	3,59	39,27

Table 2

Assessment of the physical preparedness of 15–16 year old sprint swimmers specializing in various swimming methods

Parameters	F/c (n=5)		B/c (n=2)		Butterfly (n=4)		Breaststroke (n=4)		$\bar{X}$ (n=15)
	$\bar{X}$	±σ	$\bar{X}$	±σ	$\bar{X}$	±σ	$\bar{X}$	±σ	
Mobility in the shoulder joints, cm	63,40	8,73	65,00	8,49	64,50	5,07	65,50	3,51	64,47
Torso forward, cm	11,40	1,52	11,00	1,41	11,50	3,00	11,00	1,41	11,27
Jumping up for 30 s, times	16,00	1,58	15,00	1,41	15,50	2,38	17,50	1,73	16,13
Flexion-extension of the arms in the supine position for 30 s, times	20,00	2,00	16,50	0,71	18,50	2,08	20,75	1,26	19,33
Raising bent legs in a hang for 30 s, times	16,60	3,05	15,00	0,00	15,75	1,89	17,75	1,50	16,47
Long jump, cm	212,00	11,90	197,00	1,41	207,25	20,89	215,00	11,97	209,53
Dynamometry of the right hand, kg	48,20	4,87	54,00	2,83	47,50	4,36	47,75	4,50	48,67
Dynamometry of the left hand, kg	47,40	5,64	52,00	1,41	45,50	5,07	48,75	3,30	47,87
Power index, F/kg	0,75	0,04	0,83	0,06	0,74	0,06	0,78	0,05	0,75
Speed at 50 m, m s^{-1}	2,10	0,04	1,81	0,03	1,92	0,04	1,66	0,02	1,90
Speed at 100 m, m·s^{-1}	1,91	0,04	1,73	0,01	1,72	0,03	1,50	0,04	1,72
ICB V100/50 m	0,91	0,01	0,95	0,01	0,90	0,00	0,91	0,03	0,91

sprinter swimmers, representatives of various specializations, made it possible to assess the characteristics of the development of the body of athletes and the possibility of their functional systems. The analysis showed that the greatest indicators of chest coverage (CC, cm) at rest (96.50 cm), while inhaling (104.0 cm) and exhaling (92.50 cm) belong to representatives of swimming with a crawl on the back. A little inferior to them and have almost the same meaning sprinters who specialize in other methods of swimming. Excursion of the chest (EC) among swimmers of various specializations is almost the same (10.50–11.50 cm), and the largest among swimmers on the back (11,50±0,71 cm). The highest levels of VC in athletes, representatives of swimming by the method of breaststroke and crawl on the chest, and range from 4.18 to 4.65 liters. In sprinters in swimming with a crawl on the chest, the highest indices of the Stange test were recorded (48.60±3.97 s), and for representatives of swimming by the breaststroke method – Genchi (28,75±6,40 c).

Thus, in the course of the study, the morphological and functional characteristics of young men-sprinters of 15–16 years were established, which made it possible to identify some differences among athletes, representatives of various swimming methods.

A study of the various aspects of the physical fitness of the young sprints showed a difference in the development of their motor qualities (Table 2).

In young men, under the influence of training loads, the indicators for testing mobility in the shoulder joints are not significantly different. So, in the test «twisting straight arms back and forth» for young men specializing in swimming в/с and butterfly stroke, the best results were found. The representatives of the breaststroke take the last place, which is associated with the specifics of the swimming technique in this way. In the test "torso forward", which characterizes the level of development of flexibility in the spinal column, the results vary from 11.0 to 11.50 cm. Under the influence of training loads, swimmers have sufficiently developed mobility in the shoulder joints and in the spinal column, allowing more efficient performance of technical movements one way or another swimming.

A comparative analysis of the results of the study allowed us to assess the level of power qualities of sprinters 15–16 years old, representatives of various swimming methods. Depending on the method of swimming, the strength of the muscles of the hand (right and left) is also different in swimmers. Young men who specialize in crawling on their backs have the best results. For swimmers specializing in butterfly and breaststroke swimming methods, the results are slightly lower. Swimmers specializing in backstroke also have the highest strength index values. (0,83±0,06 F/kg). Among swimmers, the level of speed-strength preparedness is significantly different. So, the best results belong to swimmers who specialize in breaststroke in the exercises "jumping upwards in 30 s" (17.50±1.73 times). "Flexion-extension of the arms at the stop lying down in 30 seconds" (20.75±1.26 times), "Lifting of bent legs in a hang in 30 s" (17.75±1.50 times.) "Long jump from a place" (215.0±11.97 cm). Slightly inferior to swimmers who specialize in breaststroke are young men who specialize in crawl swimming on their chests. Physical fitness on land for swimmers of various swimming methods corresponds to the ability of muscles to show strength, as well as the biomechanical conditions of its implementation in a competitive exercise.

The analysis of the data of the index of special anaerobic endurance (ISO), as the ratio of swimming speed at a distance of 100 m to 50 m, showed that the best results are representatives of back crawl (0.95 conv. units), slightly lower among swimmers specializing in crawl and breaststroke (0.91 conv. units). Young men who specialize in butterfly swimming have the lowest ISO values, which is 0.90 conv. units. Thus, the results of the studies made it possible to establish differences in the structure of the physical fitness of young sprinters, representatives of various swimming methods.

Conclusions / Discussion

The findings of the study suggest that the objective conduct of sports orientation in sprinting depends on the integrated use of morphological, functional and pedagogical criteria that will establish the predisposition of young athletes to one or another way of swimming at a certain stage of long-term improvement. It should be borne in mind that at the first

and second stages of long-term sports selection, the main role is played by genetically determined traits characteristic of small variability under the influence of training.

The results confirm the conclusions of specialists [1–12] that morphological and functional indicators and indicators of physical development, according to which sprint swimmers are somewhat different from each other, determine success in a particular swimming method. However, one must take into account the fact that the hallmark of the strongest swimmers in the world at a distance of 50 m freestyle is that the vast majority of them successfully participate in swims and at other distances. A generalization of the practical experience of the leading swimmers shows that most of them are able to show high results at several competitive distances. So, it is advisable to consider the issue of orientation choice of competitive disciplines taking into account the individual capabilities of the athlete's body.

Prospects for further research are connected with the establishment of modern model characteristics of young swimmers, representatives of other distance specializations.

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Modern methods of determining the individual norm of volumes and premising intensity of the exercisable motor activity

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The problem of individual approach in the organization of physical activities always assumes need of accounting of the current functional state, the level of preparedness and according to it the choice of available physical activity on intensity and duration and also admissible complexity of its performance for the purpose of improving orientation of their use. All these criteria can be defined with success on condition of accounting of dynamics and individual norm of course by adaptation reaction to the offered physical activity. The tasks still remain insufficiently resolved in many ways that defined orientation of the stated results of the conducted researches.

Purpose: *determination of optimum volumes of load, its intensity, duration and admissibility of structure of the offered motive actions with the subsequent determination of nutrition state and rest sufficient for holding another training; determination of static stress providing a working pose necessary for the implementation of kinematic movements of parts of a body and dynamic efforts defining these movements.*

Material & Methods: *high-speed video filming; assessment of static stress on bending angle of biokinematic links; method of pliometric loads; method of creation of semantic spaces for ordered submission of empirical data; method of assessment of qualitative structure of a somatotype according to M. Ya. Breitman and Ch. Hirata; geometrical methods of ordered structuring of the empirical data revealing regularities of responses of organism to alteration influences.*

Results: *the consistent pattern of increment of size of lifting force on bending angle of knee joint is determined at control of change of static stress on bending angle of biokinematic couple "hip-shin". This pattern is expressed by a logarithmic spiral that is determined by the phylogenetic nature of morphofunctional dependence of dynamics of change of lifting force. Static stress is the most effective indicator of measure of exhaustion. The used standard pliometric exercises allow estimating an exhaustion measure for change of a way of damping of movement of body in a reaction phase with support at jumping off from the standard height. It is estimated on the basis of video filming of nature of movement of a supporting leg in a support phase in run or walking. The established exponential dependence allows determining the greatest possible volume of work and intensity of its performance in the current state of the individual by mathematical calculation. Such processing is carried out in real time. The technique is developed in KhSAPC.*

Conclusions: *the presented methods of assessment of individual norm of optimum volume of physical activity and its intensity in actual scale become possible as a result of use of modern technical means of video filming and computer programs providing creation of animation structure of movement of an object. This technique has no analogs in the world in practice of researches in sport now.*

Keywords: *static stress, dynamic effort, individual norm.*

Introduction

The problem of individual approach in the organization of physical activities always assumes need of accounting of the current functional state, the available level of preparedness and according to it the choice of available physical activity on intensity and duration and also admissible complexity of its performance for the purpose of improving orientation of their use. All these criteria can be defined with success on condition of accounting of dynamics of individual norm of course of adaptation reaction to the offered physical activity.

Unfortunately, these tasks still remain insufficiently resolved in many ways that defined orientation of the stated results of the conducted researches.

Performance of any physical activity by all means is followed by power expenses and need of their subsequent recovery that is an integral part of improving effect of the organization of training process.

Thus, the making tasks in its construction are: determination of optimum volumes of load on its intensity, duration and availability of structure of the motive actions, which are offered for performance with the subsequent definition of nutrition state and rest sufficient for holding training. Performance of any physical activity is possible only at the coordinated ratio of the statistical tension providing a working pose necessary for implementation of the dynamic efforts forming kinematic movements of parts of a body.

Material and Methods of the research

Use of the adequate methods of the research, having necessary resolvability of objectives, was required for this purpose, to which were: high-speed video filming; assessment of static stress at change of bending angle between biokinematic links; method of pliometric loads; method of creation of semantic spaces for ordered submission of empirical data; assessment of qualitative structure of a somatotype according to the method of M. Ya. Breitman and Ch. Hirata; geometrical methods of ordered structuring of the empirical data allowing to determine consistent patterns of course them at influence of alteration factors.

The stated tasks and methods of the research, adequate for their decision, were directed to achievement of the main objective, which consists in establishment of the regularities, defining mechanisms of manifestation of individual norm of

reactions of an organism to action of alteration factors of the environment of stay.

Results of the research

Static stress is in the integral component at structure of creation of any motive act. It defined need more in details to consider its importance and features of participation in formation of course of process of creation of acting movement. In this regard it was necessary to develop allocation methods in structure of the controlled motive act as separately proceeding, but interdependent components of its construction which treat static stress forming a working pose and dynamic effort providing kinematic movement of links of a body and its general center of masses.

The dependence between bending angle of kinematic couple «hip-shin» and the developed statistical tension was defined for clarification of features of manifestation of static tension. The essence of the determined consistent pattern, connecting this dependence, consists that it is described by the logarithmic spiral reflecting communication of the developed static stress and bending angle of biokinematic couple «hip-shin». This pattern is defined by phylogenetic features of morphofunctional dependence reflecting dynamics of change of lifting force. (Fig. 1).

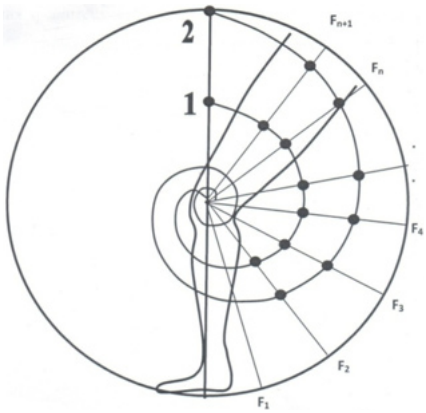


Fig. 1. Dependence of size of static stress on bending angle of biokinematic couple "shin-hip"

Importance of the opened pattern is that change of static stress as a compound component of any motive act is the most effective way of assessment of measure of exhaustion. The characteristic of logarithmic spiral carries strictly certain specific features in its construction which are expressed in coefficient of curvature of spiral. Depending on exhaustion measure, these characteristics don't change. Its indicator is the turn of the spiral concerning the pole, as acts as the quantitative characteristic of change of measure of exhaustion of rather previous state. The made interdependence between an angle of rotation of the fixed radius vector of spiral and the developed static stress, measured in kilograms, act as equivalent scales of assessment of measure of exhaustion. The made individual passport reflecting this pattern allows telling about the current state of weariness on change of an angle of damping at the movement in a reaction phase from a support when landing in the subsequent using standard test of jumping off from a certain height.

This control method of measure of development of exhaustion gives the chance to follow this process both in carrying out theoretical researches of kinematics of movements and divisions of energy consumption leaving on static stress and providing on the kinematic movements, and directly in its practical application during training process by means of video filming of run or walking in real time. The method of pliometric damping of movement and the established individual logarithmic spiral of increment of efforts to the bending angle of biokinematic couple "shin-hip" allow defining energy uses of performance of purely static stress of certain intensity and duration of its manifestation.

In practical application it found wide use in acrobatic rock'n'roll of the ancestor of this sport in Ukraine, the honored coach of Ukraine, the associate professor of the chair of gymnastics, sports dances and fitness of KhSAPC Kizym Piotr Nikolaievich and also the leading expert of federation of rock'n'roll of Ukraine, the associate professor of the chair of modern and ballroom choreography of Kiev national university of culture and art Bateieva Natalia Petrovna. They have developed the technique of definition of the optimum pose of a partner when using "fus" in which a sportsman can transfer the maximum impulse of strength of a partner at its throwing out up.

Determination of dependence of increment of force on bending angle between biokinematic couple is designated as $\frac{dF}{d\varphi}$.

At each concrete moment static stress reflects entry and boundary condition of speed of increase of force that is designated as $\frac{dF}{d\varphi}$.

Boundary conditions of static stress determine that size of effort which can be reached at a concrete arrangement of kinetic couple. In the corresponding pose it can't be more some value of boundary size, but initial tension can be any in the range from zero to boundary value. Duration of deduction of boundary size of tension in each value of an angular extension is limited and remains the less, than closer to the maximum, that is has hyperbolic dependence described by the law "force-duration". The complexity of use consists in definition of zone of hyperbolic curve within which it acts. Now this task is solved [2; 3].

The geometrical solution of problem of manifestation of pattern of interdependent dependence of size of static stress and accompanying with its pulsation of dynamic efforts reflects the general pattern of manifestation of this phenomenon observed in any functional activity as it reflects process transitions of potential energy of the corresponding morphofunctional formation to its product of activity which reflects decrease in potential power depot in each concrete manifestation as the considered system, and complete organism when accounting of the pulsing activity of its functional systems [4].

The theoretical research of empirical data of pulsations of static stress and on its background of the corresponding dynamic effort providing kinematic movements of links of a body with use of method of geometrical ordering of their representation in special semantic spaces from the single measure of comparison of the considered characteristics entered into them allowed to open the general pattern of the interdependent relations in distribution of power uses of static stress and dynamic effort. Results of such construction allow to establish individual norm of size of static stress and adequate to its dynamic efforts; zone of functional optimum of their manifestation and control of current state of the person at the moment its activity when performing by its admissible complexity [5; 6].

This result is achieved on the basis of the fact that representation of pulsation of static stress, its direct average value and borders of amplitude of changes of variation of dynamic efforts is carried out in the special nomogram. A perfect analogy of construction and use of such nomogram are accept-

able for assessment of arterial blood pressure which is characterized by pulsation of wall of arterial vessels of rather some average pressure with concrete data of limits of maximum and minimum value of pulse.

The essence of creation of such nomogram consists in combination of two coordinate rectangular spaces for submission of empirical data. One of them is intended for reflection of values of maximum and minimum limit of pulse and reflects the size of pulse pressure at the arterial blood pressure corresponding to it average arterial blood pressure. The second coordinate space is turned concerning the first on 45° counterclockwise. In the joint zone of crossing of these coordinate spaces, each of four noted characteristics has the only general point reflecting them interrelation. The curve, representing pattern of behavior of the generalized point, is deleted in the course of its movement in this zone. This point in the movement reflects the general analytical dependence of all four indicators which are presented in Fig. 2.

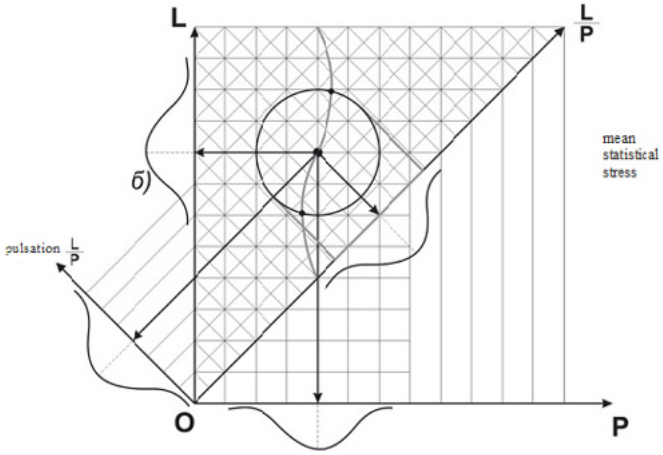
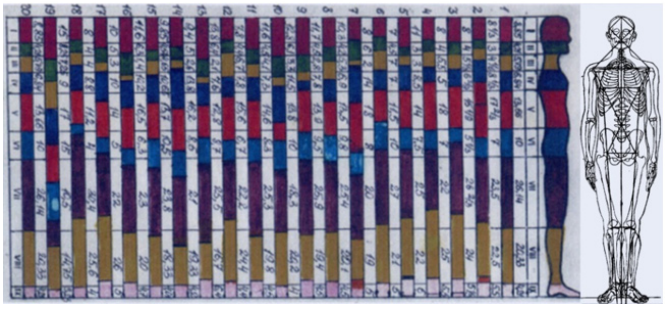
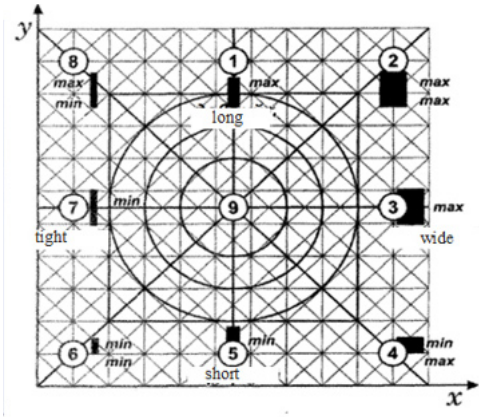


Fig. 2. Pattern of movement of the generalized point of each of the considered four characteristics



a)



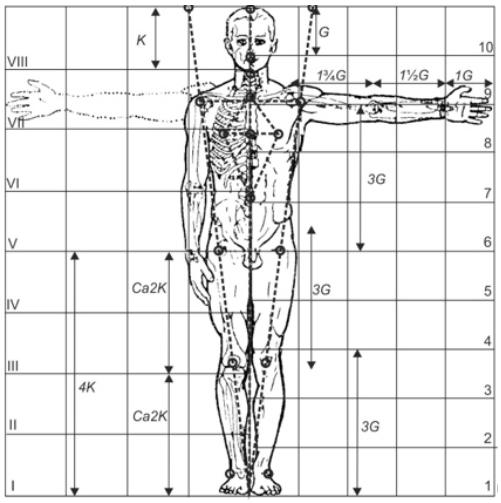
b)

In all cases of representation of the pulsing behavior of any morphofunctional system these indicators have phylogenetic conditionality and are expression of long-term criteria for evaluation of abilities of mechanisms of trophic endurance of static stress with the indication of specific features of their course. Use of the presented patterns in essential measure allows to expand possibilities of creation of monitoring of physical development, physical fitness and physical condition of various groups of the population and promotes the solution of the problem of implementation of the directed formation of "physical activity of the individual taking into account his health". The essence of pattern is connected with reflection of individual adaptation opportunities as characteristics of the operational short-term energy potential directed to the focused adaptation to conditions of the environment and the long-term energy potential reflecting the level of its phylogenetic conditionality of the put physical health [7; 8].

The ratio of short-term operational adaptation potential as dynamic characteristics of the pulsing behavior directed to preservation of an equilibrium condition of viability of organism in the environment of its stay and long-term energy potential as an indicator of static stock of viability of organism fully corresponds above the described analytical dependence. Based on theoretical provisions of Geoffroy – Saint – Hilaire, Behncke, Sheldon, M. Ya. Breitman, Ch. Hirata that the structure of somatotype is external display of exchange processes of organism and also donosological constitutional diseases bears in itself information on features of course of biological maturing, the modified general concept of these provisions was developed [9; 10].

The idea of course of physical development as two independent, but interdependent processes as which growth of body weight and its shaping acts, was its basis. In this case growth of body weight acts as static expression of the saved-up potential of viability of the developing organism. This process can lag behind or advance chronological norm of the development.

The process of shaping of development of a body, hav-



c)

Fig. 3. Graphical representation of variation of structure of a somatotype:
a) Body structure variation concerning his growth (M. Ya. Breitman).
b) Body structure variations concerning his mass of the determined chronological age (Ch. Hirata).
c) *Human body proportions relative to height (Heller).*

ing three-dimensional focus, can also create the most various morphofunctional structures of body from one volume of a body, as defines features of individual biological development from the corresponding available volume of accumulation of mass of chronological age. The third independent making characteristic of process of physical development is the intensity of course of shaping (maturing of structure) that generates emergence of such concept as "biological" age. It should be noted that intensity of course of process of maturing of morphofunctional structures of systems of organism demands a certain synchronization from interaction in the interdependent joint relations. Violation of such synchronization brings to different pathological violations [11; 12]. Graphical representation of variations of high-quality structural shaping of somatotype is presented in Fig. 3.

The integrated technique of assessment of biological age which allows to carry out the ranged creation of level of deviation of various criteria in assessment of biological age of separate morphofunctional systems from norm of the development with any degree of accuracy that is the cornerstone of manifestation of pathological changes in their functioning is developed on the basis of passport modifications of techniques of assessment of qualitative structure of a body.

Conclusions / Discussion

Two components, to which static stress and dynamic efforts belong, are allocated in the mode of implementation of any motive acts. These characteristics are strictly interdependent analytical dependence that allows establishing individual norm of their course.

The main power uses of potential opportunities of an organism are spent for static stress of a working pose in any motive act. The static stress defines boundary and entry conditions of speed of development of force. In turn, static stress increases the value according to logarithmic spiral on the uniform growth of bending angle of biokinematic couple.

This pattern has broader application, except assessment of motive activity, it is shown in all cases when there is an expense of energy potential of a complete organism against the background of a certain static stress to the pulsing its fluctuations of rather current adaptive activity of morphofunctional systems of an organism and also at the description of features of course of biological age as a possible variation of process of shaping of potential of chronological growth of body weight.

The existence of modern technical means of receiving and processing of materials of the carried out researches, computer programs providing fast data processing, the developed new methods of representation of results of researches, the determined mathematical consistent patterns of morphofunctional interconditionality of the relations allowed considerably increase resolvability of the used technologies that allows to conduct more in-depth knowledge in the field of the organization of the mass forms of physical culture, taking into account specific features which are engaged regardless of their age.

Further development of scientific research in this direction will be connected with practical reaction of the received results of researches.

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Study of the influence of recreational swimming classes on the physical development, functional status and physical preparedness of women

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Purpose: *to study the influence of recreational swimming classes on physical development, functional state and physical preparedness of women aged 17–19.*

Material & Methods: *data collection was carried out in the fitness groups of the Pioneer pool. A group of 15 women aged 17–19 years was formed. Classes were held for 21 weeks, 3 times a week. The duration of one lesson is 45 minutes. During the study, testing was conducted of the physical development, functional state and physical preparedness of the subjects. To analyze physical development, anthropometric data were measured; functional status was determined using the Harvard step test and heart rate measurement. Testing of physical preparedness was carried out in accordance with State tests and standards for assessing physical fitness of the population of Ukraine. The obtained quantitative data were processed by methods of mathematical statistics.*

Results: *studies indicate that in women aged 17–19 years of health-improving swimming cause positive changes in physical development, physical preparedness and functional status. Changes in indicators are reliable.*

Conclusions: *at the initial stage of the study, the anthropometric indicators of the respondents were age-appropriate; the physical preparedness of women aged 17–19 years on almost all indicators was at the level of "unsatisfactory"; Harvard step test indices were below the average. After lengthy swimming lessons, the majority of anthropometric indices of the studied contingent improved ($P(t)<0,01–0,001$). All indicators of physical fitness of young women improved ($P(t)<0,01–0,001$). Recovery processes after dosed muscular work (Harvard step test) and heart rate ($P(t)<0,05–0,01$) significantly improved.*

Keywords: *women, swimming, physical preparedness, functional state.*

Introduction

Physical education is an organic part of general education, should ensure the development of mental, physical, strong-willed qualities and professionally applied skills of youth. The level of their physical fitness and health, as well as their attitude to physical culture in general, depends on the quality of organization and conduct of classes with young people [8; 9].

Scientific studies indicate that human health is more than 50% determined by the conditions and lifestyle, that is, most depends on the proper organization of motor activity. Motor activity is an unconditional component of the life of every person. The optimal level of locomotor activity is such a volume and content of locomotor activity, which should provide a person's natural need for movement in order to strengthen and ensure his health in the future, contribute to the prevention of non-communicable diseases and increase professional ability to work, and also positively affect the intellectual component of human life. However, with the active introduction of computer technology, motor activity of both children and adults has sharply decreased, especially for young people. The consequence is an increase in the percentage of young people with poor health. Therefore, the search for new, non-traditional forms and methods of conducting organized classes on various forms of physical activity, which contribute to a healthy lifestyle, which in turn positively affects the general state of health, prevention of noncommunicable diseases, is relevant today; reduction of the influence of bad habits on the body, the number of asocial manifestations and depression [1; 4; 7; 12–15].

One of the types of motor activity is recreational swimming [1; 2]. Regular swimming classes train the body, have a healing effect on the body systems, that is, make those engaged more healthy. In addition, those engaged in recreational swimming, possess the ability to differentiate tension and muscle relaxation, to perform various movements in an unusual environment - in water. Improving swimming, in addition to recovery, also actively contributes to the aesthetic education of youth [3; 11].

I.V. Adamova, E.A. Zemskov (2000), V.S. Cheburaev, G.M. Legostaev, S.I. Izaak, T.V. Chibizova (2002), L.V. Sheiko (2016; 2017; 2018) and other authors investigated changes in various indicators under the influence of occupations with health-improving types of physical activity [8–10; 12–14; 16–20]. However, in their works there is little scientific data on changes in anthropometric indicators, the level of physical and functional fitness of young women under the influence of recreational swimming classes. Thus, in the available literature an insufficient amount of scientific research in this area was found, which was the reason for the development of this problem.

Purpose of the study: to determine the impact of recreational swimming classes on physical development, functional status and physical fitness of women aged 17–19.

Objectives of the study:

1. Determine the level of physical development, physical fitness and functional status of women 17–19 years old.
2. To identify changes in physical development, physical fitness and functional state of the studied contingent under the influence of swimming classes.

Material and Methods of the research

The study was carried out in the fitness groups of the Pioneer pool (Sports School for Water Sports of Yana Klochkova). To conduct the study, a group of 15 women aged 17–19 years was formed. Classes were held for 21 weeks 3

times a week. The duration of one lesson is 45 minutes.

At the beginning of the study, a preliminary familiarization with the level of swimming preparedness of the subjects was carried out. As you know, during training in swimming for adults, the applied task of mastering the technique of one, and not necessarily sports, way of swimming is primarily related. Some experts emphasize that the swimming technique for the adult contingent should be based on modern swimming techniques, since sports swimming methods have significant advantages over original ones, primarily in terms of speed. Many authors argue that most likely adults can be taught to swim on their backs, breaststrokes or on their sides, since when swimming with these methods it is not necessary to exhale into the water. When determining the swimming method, age, individual abilities to master one method (because adults are more capable of mastering one swimming method) are taken into account. However, the final choice of the method is up to the person to master swimming skills, since many people have a coordination tendency to certain movements – in particular, to more efficiently perform movements of the legs with a crawl or breaststroke [10; 15].

At the beginning of our study, young women were offered, using the re-interval method, to fix the technique of at least one swimming method (crawl on the chest or on the back, breaststroke, on the side) in order to master the wellness distance corresponding to the age (the norm of wellness swimming for individuals age from 14 to 50 years is a distance of 1000 m [10; 11]). To overcome the wellness distance, respondents were asked, using elements of various methods of technology, to swim on their sides, crawl on their chest and back, breaststroke on their chest and back with gradual acceleration and at high speed. In the future, in addition to the already mentioned repeated-interval method, repeated, distance, uniform methods were used in the classes.

Having previously familiarized with the level of swimming preparedness, taking into account the level of health, interests and needs of women, as well as adhering to the main stages of planning, a program of recreational swimming was compiled. This program included general physical exercises, special and preparatory exercises, as well as exercises that stimulate aerobic and anaerobic sources of energy production. When compiling the program, we were also guided by the methodology for constructing and conducting training sessions of a health-improving orientation [2; 4; 20]. Wellness training is a standard form of training, in each part of which specific tasks were solved [1; 2; 15]. So, in the process of training ripe loads; constant pedagogical control of health, working capacity, desire to be engaged was provided.

At the beginning and at the end of the study, testing was carried out on the physical development, functional state and physical fitness of subordinates. To analyze the level of physical development, anthropometric data were measured (body length, body weight, chest, waist, hips); the functional state was determined using the Harvard step test and heart rate measurement [6]. Testing of physical fitness was carried out in accordance with State tests and standards for assessing the physical fitness of the population of Ukraine [5]. The obtained quantitative data were processed by methods of mathematical statistics.

Results of the research

During the study, measurements were made of such anthropometric indicators as body length, body weight, girth of the chest, waist, hips. The obtained primary and secondary data are shown in table 1.

Thus, the obtained initial anthropometric data testified to their correspondence to the age of the studied contingent. Having analyzed the primary and secondary indicators of the anthropometric data of table 1, we can state that positive changes have occurred in most indicators under the influence of recreational swimming classes. So, after long sessions of recreational swimming (21 weeks), we have significant differences to a smaller side from the initial data for such indicators as body weight, waist circumference ($P(t)<0,01$), hip circumference ($P(t)<0,001$). The exception was made by such parameters as body length, chest circumference during inhalation and exhalation ($P(t)>0,05$). However, it should be noted that although the changes that have occurred with the indicators of the circumference of the chest on the inhale and exhale are not reliable, but they have a positive tendency.

There has been a tendency towards improvement in the indicators of the functional state of women aged 17–19 years who are engaged in recreational swimming groups (Table 2).

Table 1

Dynamics of indicators of physical development of women aged 17–19 years who are engaged in groups of recreational swimming

No.	Measurement indicators	Primary data	Secondary data	t	P(t)
1.	Body length, cm	167,25±4,92	167,72±4,82	0,70	>0,05
2.	Body weight, kg	61,36±0,91	57,14±1,32	2,65	<0,01
3.	Chest circumference (inhalation), cm	79,75±3,93	77,27±4,15	0,43	>0,05
4.	Chest circumference (exhalation), cm	74,89±4,31	72,94±3,84	0,34	>0,05
5.	Waist circumference, cm	70,76±0,81	65,82±1,63	2,71	<0,01
6.	Thigh circumference, cm	81,81±1,37	73,48±2,53	2,90	<0,001

Table 2

Dynamics of indicators of the functional state of women 17–19 years old who are engaged in groups of recreational swimming

No.	Measurement indicators	Primary data	Secondary data	t	P(t)
1.	Harvard step test, coefficient.	64,47±0,69	68,13±1,63	2,15	<0,01
2.	Heart rate (HR) at rest, beats min^{-1}	87,43±2,76	79,31±2,57	2,15	<0,01
3.	Excursion of the chest, cm	4,86±1,88	4,33±1,31	0,23	>0,05

Table 3

Dynamics of physical preparedness indicators for women aged 17–19 years engaged in the group of recreational swimming

No.	Measurement indicators	Primary data	Secondary data	t	P(t)
1.	Strength (flexion and extension of the arms in an emphasis lying down), number of times	15,37±6,68	20,78±7,18	0,55	>0,05
2.	Strength (raising the torso in gray for 1 min), number of times	38,25±5,86	42,84±7,82	0,47	>0,05
3.	Speed-strength ability (long jump from a place), cm	146,47±3,64	174,36±7,92	3,20	<0,001
4.	Stamina (Cooper 12-minute swimming test), s.	399,8±35,5	593,7±45,5	3,36	<0,001
5.	Dexterity (shuttle run 4x9 m), s	13,12±0,53	10,86±0,59	2,80	<0,01
6.	Flexibility (torso forward from a sitting position), cm	12,37±1,71	18,01±1,42	2,55	<0,01

An important indicator for assessing the functional state of the body and the effectiveness of training is an indicator such as heart rate. It is known that an increase in fitness is accompanied by a decrease in heart rate [1; 12; 14; 15]. In our study, heart rate decreased by 8.12 beats min^{-1} (P(t)<0,01), which convincingly indicates an increase in the fitness of the tested women.

The Harvard step test index values obtained as a result of the initial study were at the border below the average score (64,47±0,69). As can be seen from table 2, under the influence of swimming, there were significant changes in the rates of recovery processes in women after dosed muscular work, they significantly improved (P(t)<0,01) and correspond to the average grade.

Changes in chest excursion indicators, although not reliable (P(t)>0,05), are positive. So, according to the initial data, the chest excursion was at the level of 4,86±1,88 cm, according to the secondary examination – 4,33±1,31 cm.

Testing of physical preparedness was carried out in accordance with State tests and standards for assessing the physical fitness of the population of Ukraine [5]. Analyzing the primary indicators of the physical fitness of the tested women, it can be argued that the physical fitness of the studied population was at a low level. The results of the endurance test (Cooper's 12-minute swimming test) and the indicators of flexion-extension of the arms in a lying emphasis satisfactory. When lifting a torso in gray for one minute, tilting the torso forward from a sitting position, in a long jump from a standstill, in shuttle race it was "unsatisfactory" (Table 3).

After a 21-week training process, there was a noticeable improvement in the physical fitness of the subjects in terms of speed-strength abilities, endurance, dexterity and flexibility. These changes are significant (P(t)<0,01–0,001). The results of tests "flexion and extension of the arms in an emphasis lying down" and "raising the torso in gray in 1 minute" turned out to be unreliable, but positive dynamics can also be seen in the indicators of these tests.

Conclusions / Discussion

Based on the analysis of special scientific and methodological literature, practical work experience and the results of our own research, we revealed a high need for women in physical education and fitness types of physical education, in particular, recreational swimming. An analysis of literary sources shows that existing physical education programs do not fully provide motivational attitudes to a healthy lifestyle, do not involve in mental and physical activity, and do not take into account the peculiarities of changes in the biorhythmics of the female body. In this regard, one of the promising directions in the innovation of physical education of women may be the development and implementation of recreational swimming programs with controlled physical activity.

The study found that the physical development, functional state and physical fitness of women 17–19 years old significantly change during training in the health swimming groups (P(t)<0,01; P(t)<0,001). So, at the initial stage of the study, the physical fitness of women 17–19 years old on almost all indicators was on the verge of «unsatisfactory». Anthropometric indicators corresponded to age; Harvard step test indices were below the average.

Upon completion of the study, it can be stated that after prolonged swimming, an improvement in most of the anthropometric parameters of the studied population (P(t)<0,01–0,001) occurred. Almost all indicators of physical fitness of young women improved (P(t)<0,01–0,001). Recovery processes after dosed muscular work (Harvard step test) and heart rate indicators significantly improved (P(t)<0,01).

Dissemination of the experience of such work answers the question of practice, and the information provided will help teachers, instructors, physical education practitioners, doctors, as well as those who are engaged in their own activities, to use recreational swimming facilities more effectively to improve health and increase physical preparedness.

Prospects for further research include research in the direction of studying the physiological mechanisms of adaptation processes to physical activity during recreational swimming classes and the development of swimming programs for adults, which will take into account not only physiological and functional indicators, but also the characteristics of work.

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Dynamics of indicators of competitive activity of highly qualified wrestlers

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Purpose: *to trace the dynamics of competitive performance indicators of highly qualified wrestlers.*
Material & Methods: *the following methods were used in the study: analysis of scientific and methodological information, generalization of best practices, analysis of protocols and videos of the final fights of highly qualified Greco-Roman style wrestlers at the world championships 2017, 2018, 2019; methods of mathematical statistics. In total, an analysis was made of 81 final duel of athletes (wrestling for first and third places).*
Results: *analysis of the competitive activity of highly qualified wrestlers at the world championships 2017, 2018, 2019 allowed us to identify 11 basic technical actions that are most often used: handspring, handspring with a hand and head grip, tackles with a back belt, back belt, counter-measures in the standing and mat, transfers to the mat, tackles with a twist and a deflection, suplex, pushing over the carpet. It was determined that at the World Championships 2017, 2018, 2019, the most performed technical actions in the stalls are handspring, and in the standing – dumping and pushing an opponent out of the carpet.*
Conclusions: *it was found that during the study period, the effectiveness of attacks in the standing and mat, the effectiveness of the standing and mat have dynamics to improve, which positively affects the entertainment of Greco-Roman wrestling. The average bout time is reduced from 354 seconds at the 2017 World Cup to 273 seconds at the 2019 World Cup. Such a distribution of time shows that the number of fights won ahead of schedule in wrestlers increased.*

Keywords: *competitive activity, indicators, Greco-Roman wrestling, highly qualified athletes.*

Introduction

Every year, competition is intensifying in the struggle for prizes in international competitions in Greco-Roman wrestling. This is due to ever-increasing competition on the basis of introducing the achievements of science and technology into the training process and improving the methodology of training athletes [2; 10].

Analyzing the development trend of wrestling in recent years, most experts agree that for the development of wrestling, including as part of the program of the Olympic Games, efforts must be made to increase the effectiveness of wrestling fights while maintaining a high intensity of wrestling throughout the fight [1; 6].

The level of technical and tactical actions (TTA) of an athlete mainly determines his success in a duel. Scientific and methodological support for the training of highly qualified wrestlers requires, first of all, the selection of the most effective technical and technical specifications and their further improvement. This is due to the fact that the composition and structure of effective TTA are rapidly changing in sports practice. Therefore, for the training of high-class athletes, it is important to inform wrestlers and coaches in a timely manner about the promising areas of wrestling development. At the same time, the analysis of the competitive activity of the leading wrestlers of our time is relevant [4; 5; 9].

Purpose of the study: to trace the dynamics of indicators of competitive activity of highly qualified wrestlers.

Material and Methods of the research

The following methods were used to solve the research problems: analysis of scientific and methodological information, generalization of best practices, analysis of protocols and videos of the final fights (struggle for first and third places) of highly qualified Greco-Roman style wrestlers at the world championships 2017, 2018, 2019. In total, an analysis of 81 final duel of athletes was carried out, the following indicators were recorded in them: fights duration (fights time); all technical actions carried out by wrestlers in fights (the number of technical actions); real attempts (the number of realized attempts to complete the throw); evaluated attempts (number of attacks implemented); the effectiveness of the equipment used in the standing and ground (determined by dividing the number of successful attacks in the number of real attempts to complete the reception and multiplied by 100%); the effectiveness of defense in the standing and ground (determined by dividing the number of reflected attacks by the number of real attempts to complete the reception and multiplied by 100%); the effectiveness of the equipment used in the stance and stalls (evaluated in points: 1, 2, 4, 5 points).

The method of mathematical statistics was used to qualitatively study the results of studies and establish statistical laws.

Results of the research

Based on the analysis of scientific and methodological information and a synthesis of best practices, it was found that successful training of athletes of any level is impossible without careful consideration of the main trends in the development of wrestling, which can be established with sufficient accuracy when analyzing the structural components of the competitive activity of high-class wrestlers [3; 6; 7].

An analysis of the competitive activity of highly qualified wrestlers at the World Championships (World Cups) 2017, 2018, 2019 allowed us to identify 11 main technical actions (TA) that are most often used: roll-overs, flying mare, throws with a back belt, back belt, counter-hold in the standing and ground, takedown, sacrifice throw, suplex, stalling, pushing

Table 1

Analysis of the technical preparedness of highly qualified Greco-Roman style wrestlers at the World Championships

No.	Technical actions, quantity	WC-2017 (23 match)		WC-2018 (29 match)		WC-2019 (29 match)	
		Σ	%	Σ	%	Σ	%
	Ground:						
1.	Roll-overs	3	12,6	9	20,5	17	24,6
2.	Flying mare	1	4,1	2	4,5	11	15,9
3.	Throws with a back belt	1	4,1	8	18,2	4	5,8
4.	Back belt	–	–	1	2,3	1	1,5
5.	Counter-hold	–	–	1	2,3	1	1,5
	Total I on the ground:	5	20,8	23	52,3	35	50,7
	Standing:						
6.	Takedown	2	8,3	3	6,8	8	11,6
7.	Sacrifice throw	1	4,1	4	9,1	1	1,5
8.	Suplex	2	8,3	2	4,5	4	5,8
9.	Stalling e	6	25,1	5	11,4	9	13,0
10.	Pushing behind the carpet	7	29,3	4	9,1	7	10,2
11.	Counter-hold	1	4,1	3	6,8	5	7,2
	Total on the standing:	19	79,2	21	47,7	34	49,3
	Total in standing and ground:	24	100	44	100	69	100

Table 2

Performance indicators of highly qualified Greco-Roman style wrestlers at World Championships

No.	Indicators	WC-2017 (23 match)	WC-2018 (29 match)	WC-2019 (29 match)
1.	Attack efficiency in the standing,%	37	47	59
2.	Attack efficiency in ground,%	42	46	48
3.	The effectiveness of protection in the standing,%	87	91	89
4.	The effectiveness of protection in the ground,%	60	72	61
5.	Performance in the rack, points	2,91	3,00	3,79
6.	Performance on the ground, points	0,96	2,07	2,52
7.	Average fight time, s	354	299	273

behind the carpet (Table 1). These TA can be considered the main in modern Greco-Roman wrestling.

It was established that at all the studied world championships the most performed TA in the stalls are sacrifice throw, and in the stance - various options for stalling and pushing an opponent out of the carpet (Table 1).

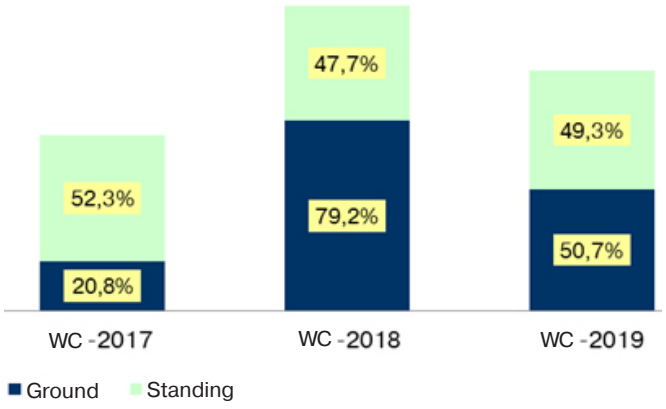

Fig. 1. The dynamics of the ratio of technical actions in the standing and ground at the World Championships (World Cup)

An analysis of competitive activity at the World Championships showed that high-class wrestlers conduct an equal number of TA in the standing and ground, except for the 2017 World Cup, on which more TA in the ground were performed, this is explained by the changes to the rules of the competition (Figure 1).

An analysis of Table 2 made it possible to determine that during the study period, the effectiveness of attacks in the standing and ground, and the effectiveness of standing and ground have a dynamic of improvement, which positively affects the entertainment of Greco-Roman wrestling. The effectiveness of defense in the standing is high: it was 87% at the 2017 World Cup, 91% at the 2018 World Cup and 89% at the 2019 World Cup. The effectiveness of protection in the stalls is average: 60% at the 2017 World Cup, 72% at the 2018 World Cup and 61% at the 2019 World Cup.

The average fight time is reduced from 354 s at the 2017 World Cup to 273 s at the 2019 World Cup. Such a distribution of time indicates that wrestlers increased the number of prematurely won fights and fights became more interesting for the viewer (Figure 2).

The data obtained indicate the importance of technical and tactical preparedness of athletes as a factor determin-

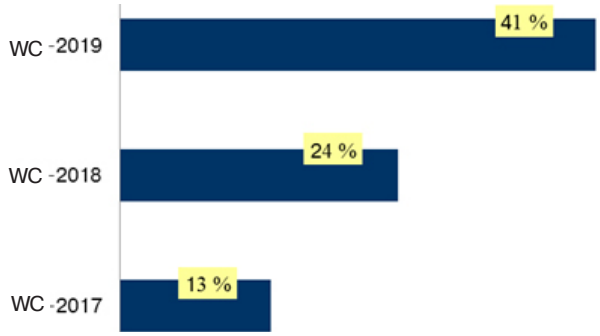

Fig. 2. Dynamics of prematurely won fights at the World Championships (World Cup)

ing success in various types of wrestling. This is also confirmed by the results of studies presented in scientific papers. (Apoiko, P. H., 2015; Tropin, Y. and et. al., 2018; Тьппemann, H., 2016).

Conclusions / Discussion

Analysis of performances at the competitions is of great importance: by analyzing the competitive activity, the effectiveness of the technical and tactical actions of highly qualified Greco-Roman style wrestlers according to the rules of 2018 was determined (Abulkhanov, A.N., Borisov, I.P., 2018), individual tactical and technical skill of highly qualified wrestlers (Ivanyuzhenkov, B.V., Nelyubin, V.V., 2005), the performances of judo athletes of different age groups were tracked (Julio, U. and et. al., 2011). Analysis is also carried out for different types of wrestling: based on the performance of athletes at the 2017 World Cup, a comparative analysis of the strongest and Ukrainian Greco-Roman wrestlers was carried out (Radchenko, Y. and et. al., 2018), similar studies were conducted in freestyle wrestling (Boyko, V.F. et al., 2014) and women's wrestling (Latyshev, N.V. et al., 2019).

It was established that at the World Championships 2017, 2018, 2019, the most performed technical actions in the standing are sacrifice throw, and in the ground – dumping and pushing an opponent out of the carpet.

Over the study period, the effectiveness of attacks in the stance and stalls, the effectiveness of the standing and ground have a dynamic of improvement, which positively affects the entertainment of Greco-Roman wrestling. The average fight time is reduced from 354 seconds at the 2017 World Cup to 273 seconds at the 2019 World Cup. This distribution of time indicates that wrestlers have increased the number of prematurely won fights.

Prospects for further research will be directed to the development of training tasks for Greco-Roman style wrestlers taking into account the requirements of modern competitive activity.

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Effectiveness of physical therapy for autonomic dysfunction in adolescents

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Purpose: *based on the generalization of the results of modern domestic and foreign scientific and methodological literature to develop a physical therapy program for adolescents with autonomic dysfunction.*
Material & Methods: *under our supervision there were 30 children 15–17 years old with a diagnosis of vegetative-vascular dystonia. According to the purpose and objectives of the study, anthropometric methods were used, the condition of the musculoskeletal system was studied using the stoop index and REEDCO posture assessment, the static balancing was determined using the Bondarevsky test, the Kerdo index was calculated, and mathematical statistics methods were used.*
Results: *a physical therapy program was developed, which included kinesiotherapy, elements of psychotherapy and auto-training, post-isometric relaxation. After applying the physical therapy program in adolescents, complaints of headache and dizziness decreased. The dynamics of the assessment of posture and stoop index indicated a significant improvement in all the studied parameters from the cardiovascular system; a decrease in the rate of cardiovascular contractions, an increase in the numbers of systolic blood pressure and the Kerdo index were observed.*
Conclusions: *the physical therapy program was developed taking into account the principles of physical therapy, the effectiveness of the program is confirmed by improving empirical parameters, indicators of the musculoskeletal system, cardiovascular system and quality of life, reduced as a result of autonomic dysfunction.*

Keywords: *physical therapy, adolescents, autonomic dysfunction.*

Introduction

According to WHO, about 80% of the world's population suffer from autonomic dysfunction. Most doctors believe that this diagnosis is a complex of nervous disorders, and some scientists define autonomic dysfunction as a separate diagnosis. As shown by numerous epidemiological studies, vegetative disturbances in the population, starting from puberty, occur in 25–80% of cases [3; 6].

Vascular dystonia occurs due to nervous tension or after acute and chronic infectious diseases, poisoning, vitamin deficiency, nervous breakdowns. Symptoms of vascular dystonia can be persistent or manifest as seizures - the so-called vegetative-vascular paroxysms [2].

Adolescence is an important period of human growth and formation, when a number of morphological and psychological processes arise, develops and ends, and many vital systems of the body become established. In adolescence, there is enhanced muscle growth, their strength increases dramatically; the mass of the brain and spinal cord reaches the level that is determined in an adult, the maturation of the cardiovascular system is almost complete, blood circulation functions reach an optimal level and puberty is stabilized. This age falls on the training period, which is associated with significant loads, including psychoemotional stress. During this period, adolescents increase sensitivity to environmental factors that affect the state of the body. But, on the other hand, the young body responds positively to preventive and therapeutic measures, which makes this activity quite effective [9].

Physical exercises stimulate the creation of a new positive dominant, which, according to the laws of negative induction, suppresses and helps eliminate the pathological stagnant focus in the cerebral cortex. Movements normalize the dynamics of the main nervous processes, their strength, mobility and balance, the regulatory function of the central nervous system and cause positive emotions, which is especially important in the treatment and prevention of autonomic dysfunction [1; 2].

However, in modern scientific and methodological literature there are few studies, and determined the purpose and objectives of our study.

Purpose of the study: based on a synthesis of the results of modern domestic and foreign scientific and methodological literature, develop a physical therapy program for adolescents with autonomic dysfunction.

Material and Methods of the research

The study was conducted on the basis of MI «City Children's Neurological Hospital No. 5». The study was conducted from September to December 2019, under our supervision, there were 30 children 15–17 years old with a diagnosis of vegetative-vascular dystonia.

According to the purpose and objectives of the study, a questionnaire was created, which was built taking into account the object and subject of the study. The questionnaire consisted of 10 questions requiring a positive (yes) or negative answer (no). To assess physical development, anthropometric methods were used according to standardized methods. Height, weight were measured, body mass index (BMI) was determined. The condition of the musculoskeletal system was studied using the Stoop Index and Posture Score (REEDCO Posture Score Sheet). To determine the statistical balancing (SB) – an indicator of the state of the musculoskeletal system, coordination of movements and the stability of the psychological attitude to achieve the best result, a Bondarevsky test was performed. Static balancing is one of the key tests that provides a description of the functional state of many body systems, as well as the interactions between them. The Kerdo Vegetative Index is one of the simplest indicators of the functional state of the autonomic nervous system, in particular, the ratio of the excitability of its sympathetic and parasympathetic departments is estimated.

Results of the research

Using the questionnaire, the following results were

obtained: 78% of respondents noted that they often experience headache, dizziness. When asked about sleep time, only 25.4% of young people observe sleep patterns (7-8 hours), all the rest go to bed "according to their mood". All respondents monitor personal hygiene, but only 11.7% of men use additional hardening agents. In our study, bad habits were not observed among adolescents. 100% of respondents said they do not smoke, do not drink alcohol. As the results of the survey showed, mainly the majority of respondents had insufficient motor activity. Only 19% of respondents attend sports sections several times a month, only one in three noted the presence of regular classes in their daily lives. When collecting anamnesis, adolescents had complaints of headache, dizziness, and weather dependence.

The construction of a kinesiotherapy program was based on a synthesis of scientific, methodological, and specialized literature, as well as data from empirical, clinical, and instrumental examination of subjects. At the beginning of the course of rehabilitation treatment, we had a conversation with the researchers about the need for their knowledgeable and active participation in the rehabilitation process. During the conversation, they explained about the consequences and social significance of the disease, as well as about rehabilitation means to eliminate them, about the quality of life, etc.

To solve this problem, we developed a physical therapy program for adolescents, which included kinesiotherapy, elements of psychotherapy and auto-training, post-isometric relaxation (Table 1).

Table 1
Physical therapy program

Program components	Main group
Stage: outpatient	
Kinesiotherapy	according to the individual program
Muscle relaxation	postisometric relaxation
Psychocorrection	diaphragmatic breathing, self-training
Conversations	during the entire course of therapy

The main means of kinesiotherapy was exercise. As special physical exercises, exercises were used to tone the muscles of the abdominal muscles, dynamic exercises for all muscle groups of the lower extremities, neck and trunk, special breathing exercises, exercises to strengthen the muscles of the trunk.

In the morning, tested persons performed morning muscle relaxation, which consisted of special exercises for tension and relaxation of all muscle groups in the body. Due to the fact that the subjects had low Bondarevsky test values, exercises were prescribed to increase the stability of the vestibular apparatus. The second group of special exercises, which contribute to improving blood supply to the roots of the spinal cord throughout its length, used coordination exercises.

During the work with patients during the classes, discussions were held on the topic "causes of the disease, consequences of the disease, means of prevention" and psychocorrection with the help of diaphragmatic breathing, auto-training according to Johann Schulz's technique.

During the examination, it was important to evaluate posture. In young men, the overall assessment on the REEDCO Posture Score Sheet acquired a value of 65.3±2.34 points during the initial examination. After the treatment program, the indicator acquired a value of 78.2±2.27 points, which indicates an improvement in the indices of the spine in the studied population (Figure 1).

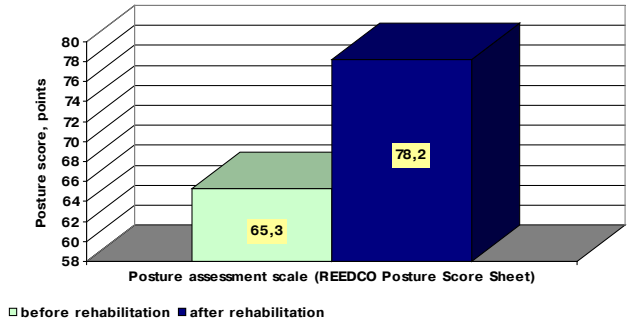

Fig. 1. Dynamics of indicators for assessing posture on the REEDCO scale for adolescents with autonomic dysfunction (n=30)

In the initial study, almost all tested persons had a tendency to stoop (86.28±1.41 points). After applying the physical therapy program, the stoop index indicators approached standard values (Figure 2).

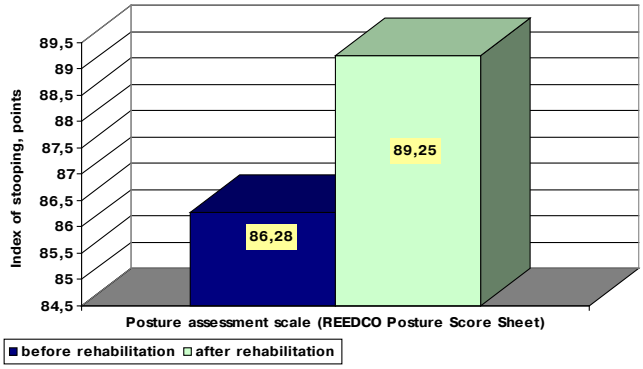

Fig. 2. Dynamics of evaluation of the stoop index of adolescents with autonomic dysfunction (n=30)

Since autonomic disturbances lead to a disorder in coordination, it was important to determine the level of static balancing in the contingent of subjects. At the beginning of the study, the BM index was 15.8±1.8 s. After a second study, there was an improvement in the dynamics of the BM index to 20.4±1.6 s.

When analyzing the dynamics of the indicators of the cardiovascular system, a decrease in heart rate from 14.30±0.26 in 10 s to 11.33±0.19 in 10 s was observed; the SBP indicator increased from 103.66±2.70 mmHg. to 112.25±4.19 mmHg.; the DBP indicator decreased from 74.44±1.18 mmHg. to 68.17±1.17 mmHg.

In the initial calculation of the Kerdo vegetative index, sympathicotonia was observed in 76.7% (23 people) of the subjects, and sympathicotonia became significant in 23.3% (7 people). After the proposed program of physical therapy, due to the decrease and stabilization of heart rate and blood pressure in the adolescents studied by us, the Kerdo index gained significance within the standard values. All of the above confirmed the effectiveness of the developed physical rehabilitation program for adolescents with autonomic dysfunction.

Conclusions / Discussion

The results of the analysis and generalization of the data of the special modern literature have confirmed the great importance of physical therapy in solving problems of comprehensively improving the physical health of children 15-17 years old with autonomic dysfunction [7]. The physical therapy program was developed taking into account the principles of physical therapy, the features of the morpho-functional state,

the functional capabilities of the state of the cardiovascular system, which included kinesiotherapy, elements of psychotherapy and auto-training, muscle relaxation.

The effectiveness of the developed program was confirmed by the improvement of empirical parameters, indicators of the state of the musculoskeletal system, cardiovascular system and quality of life, reduced as a result of autonomic dysfunction.

Prospects for further research are to study the long-term results of using the physical therapy program for adolescents with autonomic dysfunction.

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The reliability of the presented results correspond to authors

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