Theory & Practice
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Interdisciplinary positivism in the development of scientific directions in the field of physical culture and sports

According to Auguste Comte, the founder of sociology, social evolution goes through three stages. At the first, theological stage, natural and social phenomena are explained by the action of supernatural forces, gods and spirits. At this stage of the formation of society, a religious trend of understanding the essence of events and facts is emerging.

The next stage of scientific knowledge of various phenomena is the metaphysical approach, according to which supernatural forces are replaced by abstract entities, principles and ideas. The concept of ontology arises as the doctrine of existence. The general ontological basis that develops the fundamental principles of the universe is philosophy.

The third stage of social development is a positive one, where phenomena are recognized and explained through observation and experiments, the results of which form the basis of scientific laws. At this stage, knowledge is based on facts and evidence that require empirical verification. Each scientific field develops its own methodological apparatus and methodological tools.

From O. Comte's point of view, the transition from one stage to another is inevitable and progressive. Each stage leads to the improvement of public relations, thanks to scientific knowledge and effective management.

The current stage is characterized by moving beyond narrow disciplinarity through the integration of knowledge and research methods from different subject areas in connection with solving complex social problems. Thus, the interconnectedness of various fields of knowledge leads to the emergence of interdisciplinary positivism, conditioned by the need to obtain a complete and objective understanding of phenomena, taking into account the multipolarity of the real world. Many studies are conducted, as a rule, at the junction of scientific directions, therefore, the methodological apparatus is borrowed from the accumulated baggage of the ontology of science. At the same time, interdisciplinary research often uses quantitative methods and other tools for evaluating results inherited from the initial stage of positivism.

Modern sports science, along with other fields, strives to integrate various scientific fields to develop new theoretical concepts and research methods. This is evidenced by the emergence of new concepts, for example, such as the psychophysical state of an athlete, biomechanics, neurophysiology, etc.

In sports science, the positivist idea of the ontology of interdisciplinary positivism is to recognize the reality of the existence of objective physiological, biomechanical, and psychological processes that determine athletic performance and the physical health of those involved, which must be understood. For example, there is a real relationship between the training load and the adaptation of the athlete's body, which can be studied and measured. From the standpoint of materialism, interdisciplinary positivism takes into account the influence of not only the objective characteristics of an athlete, but also neurobiological mechanisms that require the use of interdisciplinary research methods from cognitive neuroscience, psychology, pedagogy, etc. The interpretation of the results should be based on sound scientific criteria, which actualizes the development of expert models for the verifiability of scientific statements and theories. Thus, within the framework of interdisciplinary positivism, there is a transformation of the materialistic view of explaining various phenomena, recognizing the importance of factors of idealistic essence.

To date, sports science has accumulated a large amount of empirical material, as well as methods for quantitative measurement, interpretation of results and hypothesis testing. For example, a wide area of research includes measuring physical parameters, analyzing competition results, evaluating the effectiveness of training programs, the impact of nutrition on athletic performance, and more. At the same time, new technologies are being created: smart simulators, biofeedback systems that make it possible to explore new aspects: the functional state of an athlete, physical qualities (neuroplasticity under the influence of training) or sports analytics (big data analysis).

It is important to emphasize that ontology, as the universal basis of science from the perspective of positivism, should be integrated with new scientific directions, which creates prerequisites for the creation of a single conceptual space for researchers of different specialties. Thus, the synthesis of knowledge of sports science and other scientific disciplines is realized on the basis of the combined formation of a unified methodology of a common conceptual framework.

We invite scientists to publish the results of scientific research aimed at finding and studying the value meanings of physical culture and sports.

Editor-in-Chief of TPPC, Honored Worker of Physical Culture of the Russian Federation

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Theory and Practice of Physical Culture

Contents

Factor structure of the readiness of highly skilled freestyle skiers (mogul)

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Abstract
Objective of the study is to determine the factor structure of elite freestyle skiers' preparedness using the example of the mogul discipline.
Methods and structure of the study. To achieve this goal, the method of factor analysis was used, which was implemented using the IBM SPSS Statistics computer program. The study involved highly qualified freestyle skiers (men), members of the Russian national mogul team (n=36) aged 20-25 years. 9 factors were identified in the structure of the mogulists: special morphology, general morphology, strength, anaerobic abilities, coordination, effectiveness of the cardiovascular system, speed and strength abilities, athletic and technical fitness and technique of downhill skiing.
Results and conclusions. The results of the study revealed that the factorial structure of the training of highly qualified mogulists has a pronounced morphological orientation. The greatest impact on athletic performance is exerted by special and general morphology, including indicators of muscle and fat components, height and body weight. These parameters determine the effectiveness of an athlete's movements on the track and the level of his functional fitness to the extreme conditions of competitive activity. Factors of strength, anaerobic capacity, and coordination also make a significant but less pronounced contribution to performance. The data obtained confirm the need to take into account morphological characteristics when planning a training process aimed at developing optimal ratios of mass, strength and technique in moguls. Thus, the presented factor structure makes it possible to specify the key areas of training for elite freestyle skiers and serves as the basis for improving scientific and methodological support in this sport.

Keywords: factor structure, athletes of the highest sports skills, freestyle, mogul.

Introduction. Modern freestyle skiing, and especially its mogul discipline, is one of the most complex and multi-component sports, combining elements of high coordination, strength, endurance, speed, flexibility, and technical skill [2, 3]. The training of mogul skiers is complex in nature, with results determined by the integration of morphological, functional, coordination, speed-strength and technical qualities [5, 7]. In this regard, one of the pressing scientific tasks is to determine the structure of the relationships between the various components of high-level athletes' training and to identify the leading factors that determine the effectiveness of competitive activity.

In the context of ever-increasing competition in the international arena, as well as the increasing technical requirements for performing jumps and completing the course, knowledge about the factors of athletic training and their impact on athletic performance is becoming particularly important [8].

Despite the existence of a number of studies [5, 8] devoted to the physiological and biomechanical aspects of freestyle training, the structure of the relationships between the components of elite athletes' preparedness in mogul skiing remains insufficiently studied. This limits the possibilities for optimising the training process and developing indi-

vidual programmes for the development of key abilities in athletes.

Objective of the study is to determine the factor structure of elite freestyle skiers' preparedness using the example of the mogul discipline.

Methods and structure of the study. Highly skilled freestyle skiers (men), members of the Russian national mogul skiing team (n=36) aged 20-25, participated in the study.

To determine the factor structure of mogul skiers' preparedness, factor analysis was used, implemented using the IBM SPSS Statistics computer program (version 27) (Analysis → Dimension Reduction → Factor Analysis (principal component method, varimax rotation method)). Each preparedness factor consisted of two indicators, the contributions to the variance of which were summed. The final score for the performance was used as the resulting factor (with which the main preparedness factors were compared) in mogul skiing.

To form the factor structure of elite mogul skiers' preparedness, we used the results of stage and ongoing surveys of athletes as part of the Scientific and Methodological Support activities conducted by specialists from a comprehensive scientific group in Tchaikovsky from October 2024 to February 2025.

The results were determined based on morphological indicators using the method developed by T.F. Abramova with the use of special anthropometric equipment. Strength indicators were measured using the leg dynamometry method implemented in the Biodex isokinetic dynamometer. Anaerobic indicators and cardiovascular system characteristics were assessed on a Monark 894E cycle ergometer using the Wingate test and a Cortex MetaLyzer 3BR2 gas analyser according to the maximum test method with a stepwise increasing load. To assess coordination, the Stabilan 01-02 APK and the jump difficulty coefficient taken from competition protocols were used. Speed and strength indicators were determined using jump tests performed on a Muscle Lab speed endocore. All of the above instrumental methods were applied in accordance with the methodological recommendations of the Analytical Department of the Russian National Teams Sports Training Centre.

The results of sports and technical training and downhill skiing technique were recorded based on the data from the Russian Cup stage protocols.

Results of the study and discussion. A study of the structure of mogul skiers' athletic training identified nine key factors.

The first factor identified in the training structure

Table. Factor structure of freestyle skiers' preparedness in the mogul discipline

Factors	Indicators	Contribution of indicator to variance, %	Total contribution of factor to variance, %
Special morphology	Muscle component	13,9	31,6
	Fat component	17,7	
General morphology	Weight	7,4	27,5
	Height	20,1	
Strength	Maximum leg strength	10,7	13,1
	Flexor-to-extensor ratio	2,4	
Anaerobic capacity	Maximum leg muscle power	7,2	8,8
	Anaerobic threshold leg muscle power	1,6	
Coordination	Coordination readiness index	6,5	6,7
	Jump difficulty coefficient	0,2	
Cardiovascular efficiency	Heart stroke volume index	3,9	5,3
	Heart rate at anaerobic threshold	1,4	
Speed and strength	Maximum push-off power in squat jumps	2,1	4,8
	Maximum push-off power in jumps with no hands	2,7	
Sports and technical skills	Total points for speed	0,5	1,7
	Total points for jumps	1,2	
Downhill skiing technique	Rolling time	0	0,4
	Total points for turns	0,4	
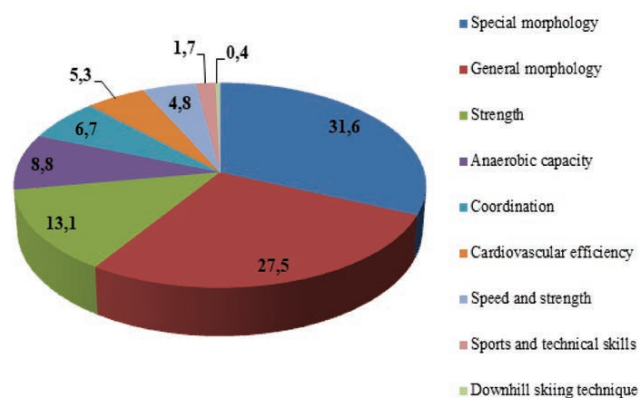
Fig. Factor structure of preparedness of highly qualified mogulists, %

was general morphology, which included athletes' weight and height. The second factor was special morphology, which included indicators of muscle and fat components. The third factor, which assessed strength, included indicators of maximum leg strength and the ratio of flexors to extensors. The fourth factor was speed-strength abilities, with indicators of maximum push-off power in squat jumps and handstand jumps. The fifth factor assessed the athletes' anaerobic capabilities with indicators: maximum leg muscle power and anaerobic threshold power when working with the leg muscles. The sixth factor included indicators characterising the efficiency of the cardiovascular system (stroke volume index, heart rate at the anaerobic threshold). The seventh factor was coordination with indicators: coordination readiness index and jump difficulty coefficient. The eighth factor is downhill skiing technique, with indicators of skiing time and total points for turns. The last, ninth factor is athletic and technical preparedness, characterised by the total points for speed and jumps.

The table and figure show the results of a study of the factor structure of elite mogul skiers' preparedness. It was found that the factor with the greatest influence on athletic performance was special morphology (31.6%). General morphology had a slightly smaller impact – 27.5%. It should be noted that among the indicators of general morphology, height had the most pronounced effect (20.1%). Next in the hierarchy of fitness were the factors of strength and anaerobic capacity, with contributions to the variance of 13.1% and 8.8%, respectively. The influence of the coordination factor was even smaller, at only 6.7%. The cardiovascular system

efficiency factor had an impact of 5.3%, and the speed-strength factor had an impact of 4.8%. The factors with the least influence on sporting results in mogul skiing were sporting and technical preparedness (1.7%) and downhill skiing technique (0.4%).

When analysing the results, it should be noted that the factors with the least influence on athletic performance were athletic and technical training and downhill skiing technique, which scientists [1, 4] in previous studies on other sports identified as key factors. This contradiction can possibly be explained by the fact that the factor analysis method allows us to identify hidden causes affecting the observed variables, which may include the range of variation in each of the variables in a specific sample of athletes [6].

In our case, the difference in the results of athletic and technical training and downhill skiing technique was significantly less than in the results of morphology. At the same time, the final score for a competitive performance in mogul skiing is calculated as follows: 60% of the final score is for turning technique, 20% is for the quality and amplitude of jumps from the jumps, and 20% is for speed of movement down the slope. This multi-component nature of the final assessment in determining the final score could also have influenced our results.

It should also be noted that the contribution of factors to the variance may change if a smaller (or larger) number of factors are used, which may also have a different composition of indicators. Thus, our results should only be studied taking into account the composition of factors we have identified. However, we note that the data obtained indicate that athletes with higher muscle component indicators, height and lower fat component and weight values have an advantage on the mogul course compared to other competitors. In addition, this established fact requires further research, for example, conducting a similar experiment with highly skilled female mogul skiers.

Conclusions. Thus, the results of this study allow us to conclude that the key factors in the preparedness of highly skilled mogul skiers are specialised and general morphology. The results obtained should be taken into account when planning and implementing pedagogical interventions in mogul skiing.

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Structure, content and direction of physical preparation of elite ice hockey players in the annual training macrocycle

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Abstract

Objective of the study is to develop a model for the physical training process of high-level hockey players within a year-long training macrocycle, taking into account the dynamics of the ratio of general and special physical training at different stages of the sports season.

Methods and structure of the study. The empirical basis of the study consisted of training plans, schedules, and working materials from the SKA hockey club's training system. The structure and content of training programmes at various stages of the annual macrocycle were analysed.

To assess the dynamics of physical fitness, the study focused on general and specific endurance as key qualities that directly affect game performance. Monitoring was carried out using instrumental tests conducted both on and off the ice.

The choice of these tests was determined not only by their sensitivity to changes in the athlete's functional state, but also by their practical orientation – they allow us to judge the player's ability to perform technical and tactical actions at a high level of intensity, which is fundamentally more important than, for example, abstract indicators of lower limb muscle strength. We are not so much interested in 'how strong the legs are' as in whether the attacker can run away from the defender and the defender can catch up with the attacker – and in this sense, 'pure' running on the court and specific endurance tests better reflect the actual playing form.

Results and conclusions. An analysis of specialised sources has shown that a hockey player's ability to maintain a high pace of play throughout the match can be considered a key criterion of special endurance. Hockey is characterised by high intensity and the involvement of large muscle groups, which leads to significant energy expenditure. In this context, special endurance can be considered an integral indicator reflecting the player's level of functional readiness. At the same time, it should be emphasised that the study of this indicator does not exclude the importance of other components of physical fitness, but in the conditions of high competitive load of professional hockey, it is necessary to use optimised and applied monitoring methods.

It has been established that indicators of general endurance, which are closely related to the aerobic capacity of the body, tend to decrease during long tournament cycles, especially when there are a large number of away games. This can have an impact on the reduction in the speed of recovery and the overall level of adaptation of players.

At the same time, it was found that general endurance indicators do not show statistically significant differences depending on the players' positions and skill levels. At the same time, specific endurance indicators vary depending on the player's position and show a significant increase with the improvement of the hockey players' athletic skills, which confirms their high sensitivity and practical significance in the process of assessing functional status and planning training impact.

Keywords: *hockey, physical training, general and specific endurance, annual macrocycle, monitoring, high-level hockey players.*

Introduction. The physical fitness of high-level hockey players is considered a multi-component system based on various physical qualities, among which endurance is of particular importance. This component of training becomes critical in the context of high competitive density, large amounts of movement across the rink, and high-intensity shifts and game actions in modern hockey.

According to the definition proposed by V.N. Platonov, 'endurance is understood as the ability to perform an exercise effectively while overcoming developing fatigue' [7]. In turn, V.P. Savin points out that

'endurance (in a broad sense) is a person's ability to resist fatigue while performing work' [8]. These two definitions complement each other and allow endurance to be interpreted as a complex functional ability of the body that ensures the stable performance of a given activity in conditions of increasing fatigue.

At the same time, in the specifics of team sports, and especially in hockey, the concept of special endurance becomes important. According to V.P. Savin's definition, a hockey player's ability to maintain a high pace during a single game segment (40–60 seconds), the entire period (20 minutes), and the match as a whole can be characterised as a manifestation of special endurance. The nature of a hockey player's game is multifaceted, involving frequent acceleration, deceleration, changes of direction, one-on-one battles, technical and tactical actions, which requires the involvement of virtually the entire muscular system [8]. In this regard, special endurance takes on an integral character, as it reflects not only the level of energy supply, but also the effectiveness of the functioning of all physiological systems under the conditions of game load.

With certain reservations, it can be argued that special endurance is an integral physical ability, the indicators of which can serve as an objective basis for the ongoing control and monitoring of the condition of team players. This interpretation is particularly relevant in professional sports, where the training process must be optimised in terms of volume and content, and control must be exercised with minimal distraction from training.

In professional hockey teams, a key factor that significantly influences the training process is the presence of significant morphofunctional differences between players. This is manifested not only in variations in height, body weight and somatotype, but also in the characteristics of bioenergetic support for muscle activity, which determine the predominant energy supply mechanisms for a particular player.

In addition, in professional sports, the technical and tactical characteristics of athletic skill come to the fore, as well as the psychological and personal qualities of the hockey player – the level and quality of decisions made, as well as their implementation, stress resistance, interaction with partners, and the ability to accurately follow coaching instructions in conditions of high competitive and mental stress. All this makes it inappropriate to simply compare the physical fitness indicators of players without taking into account their roles, playing functions, and positions.

Each hockey player is usually included in the team based on their specific individual abilities and to perform specific game tasks. Their training is built around these tasks, and therefore, monitoring their condition should be focused primarily on tracking their own dynamics, rather than comparing them to average standards or other players on the team.

Therefore, despite the fact that this study plans to conduct a comparative analysis by position and skill level, the key methodological guideline remains an individual approach. It provides the most accurate interpretation of the control results, allows for the specifics of the playing role to be taken into account, and gives the coaching staff practical guidelines for individualising training loads and recovery.

In this context, V.I. Koloskov's special endurance test is a convenient tool that combines both a means of control and an effective training effect. Its use does not disrupt the structure and dynamics of the training process, allowing it to be included in micro- and meso-cycles without the need for significant restructuring of training programmes [6]. Thus, the Koloskov test has a dual value: on the one hand, it allows for objective monitoring of the athlete's condition, and on the other, it serves as a powerful stimulus for the development of aerobic and anaerobic capabilities.

Research conducted by N.I. Volkov, A.Yu. Bukatin, S.K. Sarsaniya, M.A. Melikhova, and V.S. Tserkov showed that the characteristics of special endurance in hockey players are determined by the ratio of aerobic and anaerobic capabilities [4]. A.Yu. Bukatin notes the absence of statistically significant differences in the level of aerobic endurance between players of different positions, but finds significant differences in the level of special endurance both between playing roles and in terms of athletic skill level [2]. These results confirm the assumption of the greater practical significance of special endurance as a functional indicator for assessing the readiness of hockey players.

It should be emphasised, however, that A.Yu. Bukatin's study examined the training of the national team, whose structure and training logic may differ significantly from the system used in a professional hockey club [2]. In club hockey, with a busy match schedule, limited recovery time, long flights and a more rigid commitment to the game schedule, the focus of training planning may shift.

Thus, the relevance of this study is determined by the need to:

1. identify the characteristics of general and specific endurance in high-level hockey players in the context of a year-long training macrocycle;

2. determine the possibilities and feasibility of using integrated control tests, such as the V.I. Koloskov test;

3. offer practical recommendations for improving the content, structure and focus of physical training in order to increase endurance indicators as one of the leading components of hockey players' readiness.

Objective of the study is to develop a model for the physical training process of high-level hockey players within a year-long training macrocycle, taking into account the dynamics of the ratio of general and special physical training at different stages of the sports season.

Methods and structure of the study. The empirical basis of the study consisted of training plans, schedules, and working materials from the training system of the SKA professional hockey club. The structure and content of the training programmes at various stages of the annual training macrocycle were analysed, as well as their connection with the functional dynamics of athletes throughout the competitive seasons.

The study was conducted over two seasons: 2023/2024 and 2024/2025. The sample included 62 field players (excluding goalkeepers) who were part of the main and reserve squads. It should be noted that the group was heterogeneous in a number of ways: position (defenders and forwards), age, functional condition (including after injuries), which undoubtedly influenced the interpretation of the results. In this regard, this study allows us to speak more about possible trends that require further study on a larger sample.

Physical fitness was monitored in two main areas: (1) general endurance, reflecting aerobic capacity; (2) special endurance, characterising the ability to maintain intense playing activity [3].

The following diagnostic tools were used:

1. Koloskov's special endurance test, adapted for ice conditions [3];

2. PWC_{170}, used as a means of ongoing monitoring of aerobic capacity [1, 5].

The results of the Koloskov test were not recorded using an electronic timing system, which, of course, introduced an element of error, especially during mass testing (Figure 1). Nevertheless, the method retains its high practical significance due to its simplicity, repeatability, and close connection with the playing activities of hockey players.
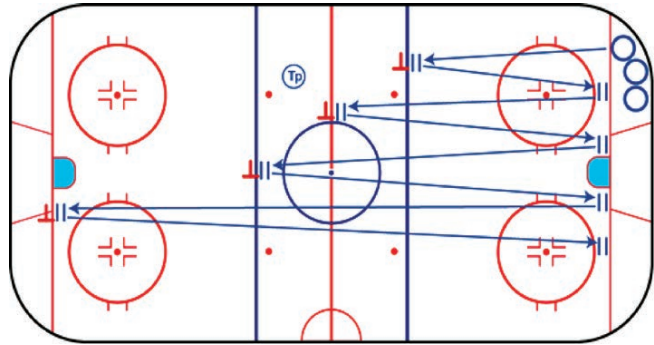
Figure 1. Diagram of the test for assessing special endurance (cited from V.I. Koloskov)

The PWC_{170} test was used in off-ice training sessions on a specialised exercise bike connected to a personalised telemetric heart rate monitoring system, which also allowed for the automatic collection and processing of data on load power and pedalling frequency. The system used ensured accurate power dosage, control of rotation biomechanics, and stable load during group sessions. This made it possible to combine control and training objectives while minimising interference with the main training process.

The choice of these instrumental methods is due to their applied focus and practical value: they allow us to judge not only the physiological capabilities of a player, but also their actual functional readiness to perform specific game tasks [3]. In professional hockey, where each athlete performs a specific tactical function, it is the dynamics of individual indicators that are most informative for the coaching staff.

The testing was conducted within a professional team over two consecutive seasons. Off-season selection led to a partial renewal of the team's roster, so the design of the study should be considered quasi-longitudinal: the dynamics of the indicators were analysed primarily at the level of the team as a whole, rather than the same athletes at all stages of observation. When calculating relative changes (in %), the average values of the first test of each season were taken as the starting point, after which the data from two annual cycles were aggregated and presented as a generalised profile of the dynamics of a professional team of this level.

Results of the study and discussion. Testing to determine indicators characterising special endurance revealed differences between players in different positions. For defenders, the time indicators ranged from 43.5 to 48.9 seconds, with an average value of 45.25 ± 1.42 seconds. For forwards, the range of in-

dicators was narrower, from 41.8 to 44 seconds, reflecting their higher playing speed and movement dynamics, which corresponds to the data from A.Yu. Bukatin's research [2].

The testing was conducted on an ice rink with enlarged attack zones, which could have partially influenced the results compared to the classic test scheme developed by V.I. Koloskov. However, this parameter was not analysed separately in the present study.

Differences in age and skill level were also identified: the best results were shown by hockey players aged 23-28, who belong to the group of high-class hockey players. They outperformed the younger age group (18-22 years) in both types of endurance. In the groups of hockey players aged 28-29 and older, no significant advantages related to skill level were observed.

Based on data from two consecutive annual training cycles of a professional hockey team, a clearly positive trend in special endurance indicators was recorded. Serial testing, conducted once every two weeks from mid-July to March of each season, showed that by the first control point, the average increase for the team was about 5% relative to the seasonal baseline, by the second – 7-8%, and by the fourth–fifth measurement, it reached 9-10%. Thus, during the general and special preparatory stages, there was a phased but fairly rapid increase in performance: over the first 8-10 weeks, the total increase was about 10-10.5% (from 0 to 10.5%).

The positive team trend was combined with pronounced interindividual and group variability, which was already recorded at the first stage of the study: defenders demonstrated a wider range of time indicators, while forwards had a narrower range, reflecting differences in their roles in terms of playing tasks and movement patterns. As the season progressed, all groups showed improvement, but it was uneven: some players with initially lower results showed more significant relative improvement, while leading hockey players with initially high indicators showed moderate improvement. The variation in the rate of improvement remained noticeable, which indicated not a levelling of preparedness, but a shift of the entire distributed sample towards a higher level while maintaining structural differences between roles and skill levels.

During the competitive period, which included the regular championship and subsequent playoffs, the dynamics of special endurance also had a phased character. The regular championship schedule provides for planned breaks of about 7 days, which allows for the construction of extended recovery and correction microcycles. Against the backdrop of such 'windows,' the test indicators stabilised at 11-12% and, in some cases, approached the upper limit of the range (12-12.5%), which indicated that the achieved level was maintained and that it was possible to fine-tune functional readiness. Small decreases (up to 10-11%) occurred mainly during periods with a busy schedule of matches and flights; they are interpreted as manifestations of training and competition fatigue, compensated for in subsequent recovery microcycles. It should also be noted that the nature of the special endurance growth curve remained similar, but the variation range of the indicators in the second year was significantly lower than in the first season. It is evident that the experience gained by the coaching staff in managing load and recovery in the first annual cycle was transferred to the second, which contributed to more grouped values and a reduction in the spread of individual trajectories (Figure 2).
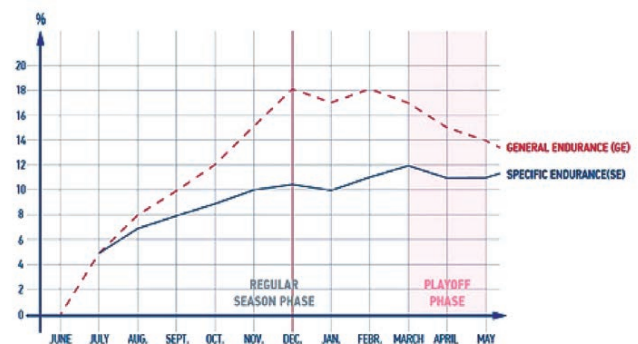
Figure 2. Dynamics of general and specific endurance indicators

The structure of the playoff calendar is fundamentally different: the presence and duration of such breaks in the championship are determined by the outcome of the matches. A series that ends in four matches leaves the team 5-7 days for recovery and targeted training, while a seven-match confrontation virtually eliminates the possibility of full-fledged training, shifting the focus to operational management of workload and recovery. In these conditions, the task of the coaching staff is not so much to further increase special endurance as to maintain the achieved level and prevent its decline against the backdrop of increasing fatigue, microtraumas and the growing emotional tension of knockout games.

Thus, the data obtained indicate not only a marked increase in special endurance by the start of the

competitive period, but also its stable maintenance throughout the regular championship, while maintaining objective differences between playing positions and qualification groups. At the same time, the specifics of the playoffs require a reorientation from developmental to maintenance and recovery modes of operation and increase the importance of ongoing monitoring. This led to a shift in the analytical focus from the values of the increase themselves to a more detailed analysis of the pulse response during exercise and recovery (including PWC_{170} data), which allows us to evaluate not so much the 'speed' of progress on the results scale, but rather the quality of functional shifts and the degree of economisation of the cardiorespiratory system in players of different profiles in the context of a changing competition calendar structure.

Additional information on the nature of adaptation was provided by the results of the PWC_{170} test. In both annual cycles, the initial power level at submaximal heart rate corresponded to the average values for teams in this class, with marked interindividual variability. Over the course of the season, most players showed an increase in mechanical power and a simultaneous decrease in the pulse value per unit of load, reflecting functional economy and improved aerobic endurance. Particularly pronounced positive dynamics in the second year were characteristic of hockey players who continued to participate in the training system throughout both cycles, which allows us to speak not only about the accumulation of coaching experience in load management, but also about the formation of long-term stable adaptation patterns of the cardiorespiratory system. Physical training off and on the ice was organised in accordance with the logic of the five phases of the annual macrocycle and was mainly focused on (Figure 3):

Figure 3. Structure and focus of physical training

1. General preparation stage (2 weeks)

Off the ice: basic athletic training with moderate load (50-75% of 1 – (maximum limit, ML)), exercises for chest and back muscles, quadriceps, glutes, calves. Cyclical aerobic training (running, exercise bike) was also used for 30–45 minutes at a heart rate of 130-150 beats per minute, 4-6 times a week.

On ice: interval shuttle runs, accelerations of varying duration.

2. Special preparatory stage (2 weeks)

Off the ice: increase in intensity (up to 70-80% of 1 ML), addition of plyometric exercises – jumps, push-offs, coordination work.

On the ice: repeated speed segments with short rest intervals; practice of shifts with simulation of game episodes.

3. First competitive period (6 months)

Off the ice: training 4-5 times a week, maintaining strength and power (up to 70-90% of 1 ML), reducing repetitions, increasing intensity if not away, and 2-3 times a week away.

On ice: the load was built up according to the game schedule – reduced or absent on game days; on non-game days – support of special endurance through exercises and inclusion of blocks at the end of the session.

4. Second competitive period (2 months)

Off the ice: supportive strength training, shortened sessions, work on exercise bikes.

On the ice: mainly game practice, tactics training, short sprints.

5. Transition period (4 weeks)

Off the ice: recovery regime, low-intensity work, heart rate recovery, cycling and running, balance and flexibility exercises.

On the ice: light training with elements of play and technique.

This structure allowed for an effective combination of: control and development of aerobic and anaerobic systems, adaptation to the rhythm of play, and individualisation according to role, age and level of preparation.

Conclusions. The results of the study confirmed the high practical value of using V.I. Koloskov and PWC_{170} tests in the training system for high-level hockey players in the context of the professional competition calendar. Both methods are seamlessly integrated into the training process without disrupting its integrity and allow for the rapid monitoring of players' readiness dynamics even under a tight competition schedule.

A steady trend towards improvement in special

endurance indicators has been identified already in the early stages of training, confirming the effectiveness of the developed training process structure. The approach to organising off-ice training, in particular on exercise bikes, deserves special attention: a significant amount of interval training, especially for non-playing players, is performed at high power in the zone of individual anaerobic threshold values and above, up to the level of maximum oxygen consumption. The programme is implemented according to the following scheme: long repetitions of 1 minute (10-12 repetitions) with a subsequent gradual increase in duration to 5 minutes and the number of sets to 6–8 during the training process, which provides a powerful stimulus for the development of aerobic-anaerobic endurance. On game days or when there is a high ice load, this work is dosed with recovery in mind.

It also seems appropriate to modify the special endurance test for defenders by including backward movements, which will increase its relevance to game tasks. The established training structure allows for maintaining a high level of aerobic and anaerobic performance throughout the season, minimising the risk of functional decline.

Taken together, the data confirm the need for individualised monitoring and interventions, especially in professional teams, where each player performs a strictly defined tactical role.

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Psychophysiological compatibility of rhythmic gymnasts

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Abstract

Objective of the study is to identify the features of the psychophysiological compatibility of qualified athletes in rhythmic gymnastics group exercise teams with existing differences in the experience of joint sports activities.

Methods and structure of the study. Two teams of female athletes of rhythmic gymnastics group exercises took part in the scientific work, having differences in the experience of joint sports activities: team No. 1 had no experience of joint sports activities; team No. 2 had performed together for 2 years. To determine the components of psychophysiological compatibility, a battery of tests was used to assess the response time and conduct the object in command mode.

Results and conclusions. It revealed a shorter time for simple visual-motor reaction, reaction time to a moving object, the number of mistakes made in complex visual-motor reaction, and greater efficiency of joint object management for a team with experience in joint actions, which ensures the quality of competitive exercises.

Keywords: gymnasts, rhythmic gymnastics, formation of sports teams, psychophysiological compatibility, criteria.

Introduction. The current stage of development of group exercises in artistic gymnastics is characterised not only by the continuous growth of the technical and artistic skills of each individual athlete, but also, above all, by the complexity of interactions in cooperation with the subject in the creation of a coherent composition by the group to music [2]. In this regard, the quality of perception, assessment and motor response of gymnasts in jointly solving motor tasks is the main factor determining the synchronisation of movements and the effectiveness of competitive activity [3, 5]. However, despite the importance of taking this factor into account in the training of sports reserves in group exercises, at present, in the practice of team formation and diagnosis of gymnasts' readiness to solve joint technical and artistic tasks, there is no objective information about the peculiarities of the manifestation of components of psychophysiological compatibility (CPC).

Objective of the study is to identify the features of the psychophysiological compatibility of qualified athletes in rhythmic gymnastics group exercise teams with existing differences in the experience of joint sports activities.

Methods and structure of the study. Two teams of rhythmic gymnastics group exercise athletes took part in the scientific work, which was conducted at Lesgaft National State University of Physical Education, Sport and Health, St. Petersburg. The first (newly formed) group consisted of six masters of sport in rhythmic gymnastics in individual exercises. A distinctive feature of this team was that the gymnasts had no experience of joint sporting activities. The second group consisted of five athletes (three candidates for master of sport and two masters of sport) who had two years of experience of joint training and competitive activities in a single group exercise team.

The Sigvet-Komanda hardware and software complex [4] was used to assess CPC synchronisation. This complex allowed for group (up to 10 people) diagnosis of CPC components using hand dynamometers with

calibrated springs, allowing for the development of measured force under the control of software.

Participants were asked to complete four tests in sequence:

1. Assessment of simple visual-motor reaction. The task is to assess the reaction time when presented with an expected stimulus. At the same time, the participants' attention was engaged by the task of drawing a line on the monitor screen within a given corridor by varying the force of compression of the hand grips. When the stimulus (ring) appeared, they had to squeeze the expander completely. The reaction time from the appearance of the stimulus to the start of the squeeze was recorded.

2. Assessment of complex visual-motor reaction. The task is to assess the time and accuracy of the response when a stimulus is presented and the response to it (the participant responds in one way to one stimulus and in another way to others). The participants' attention was also engaged by the task of guiding a line on the monitor screen within a specified corridor by varying the compression force of the hand grips. When a stimulus (ring) appears above or below the corridor, the expander must be fully compressed or relaxed. The reaction time and number of incorrect reactions were recorded.

3. Assessment of the reaction to a moving object. The task is to react as accurately as possible to the intersection of one line with another. Participants see one line moving towards a stationary line. When the lines intersect, the expander must be squeezed. Reaction time and the number of accurate, delayed and premature reactions were recorded.

4. Assessment of the effectiveness of joint 'guidance' of an object. Participants are asked to copy the movement of a line drawn by a computer on the screen by varying the amount of force they apply to the expander. During the trial attempts, the individual results of each participant were displayed on the screen. During the control task, the result of the joint effort was displayed on the screen. The individual contribution of each athlete to the test was not displayed.

The following formula was used to assess the level of psychophysiological compatibility (y) of the teams: , where A, B, C, D, F are the results of the correlation effect of the specific contribution with the model value of the diagram of each participant. The maximum ratio of the diagrams tested with the model diagram, determined as the best CPC value [6], was taken as '1'.

Unlike traditional methods of testing simple and complex visual-motor reactions, the author's methodology involved background dosed pressing with tracking of the developed effort to engage attention in performing the motor action.

Before starting the test, the researcher explained the task to the participants, gave instructions on how to perform the task, and answered any questions they had. Each group of gymnasts was given 10 trial attempts to perform each of the tests. If the group did not have enough attempts, additional ones were provided. After the trial attempts, 30 attempts were given to perform the actual test task.

All the results obtained were subjected to mathematical and statistical analysis, which included checking the data for normal distribution using the Shapiro-Wilk criterion and the t-test or Mann-Whitney U-test for paired teams [1]. The significance level was set at $\alpha=0.05$. The data were analysed using the R programming language.

Results of the study and discussion. During the assessment of visual-motor reaction (Table 1), data was obtained indicating the influence of the athletes' joint activity experience on the effectiveness of test task performance.

In the indicators of simple visual-motor reaction, a statistically significant ($p<0.05$) difference in the reaction time of athletes was recorded in favour of the team that had been performing together for two years.

Analysis of the results of testing complex visual-motor reactions showed no statistically significant differ-

Table 1. Results of the assessment of the visual-motor reaction of athletes in rhythmic gymnastics group exercise teams with different levels of experience in joint sports activities

Focus of test tasks	Team 1 (n=6)	Team 2 (n=5)	W	p
Простая зрительно-моторная реакция (мс)	513±30	472±44	7,5	0,047*
Сложная зрительно-моторная реакция (мс)	563±21	577±47	36,0	0,414
Сложная зрительно-моторная реакция (количество ошибок)	2,8±1,7	0,8±0,8	0,0	0,048*
Реакция на движущийся объект (мс)	105±82	14±35	0,0	0,031*

Note: M±m – mean ± standard deviation; W – Wilcoxon criterion values; * – p<0.05; team 1 – athletes had no experience of joint sporting activities; team 2 – athletes had been competing together for two years.

Table 2. Indicators of the effectiveness of joint management of the object by athletes of rhythmic gymnastics group exercise teams with differences in experience of joint sports activities (u.e.)

Participant No.	team 1 (n=6)	team 2 (n=5)
A	0,585	0,746
B	0,184	0,728
C	0,684	0,456
D	0,483	0,841
E	0,231	0,571
F	0,502	
Overall indicator of psychophysiological compatibility	0,428	0,668

Note: Team 1 – athletes had no experience of playing together; Team 2 – athletes had played together for two years.

ences in reaction time, although group 1 showed greater dispersion than group 2. However, significant differences (p<0.05) were found in the number of errors made.

The assessment of the reaction to a moving object showed that both groups of subjects had delayed reactions and revealed a longer reaction time (p<0.05) in team 1, which had no experience of joint sports activities in group rhythmic gymnastics exercises. In addition, group 1 showed greater dispersion compared to group 2.

Considering that synchronisation of common tasks is specific to motor activity in group rhythmic gymnastics exercises, the effectiveness of joint object handling was assessed (Table 2), which revealed a statistically significant difference (p<0.05) between the teams.

Analysis of the individual contributions of the participants showed that in the newly formed group of group exercise athletes, there was moderate (50%), low (16.7%) and insignificant (33.3%) positive correlation significance. In the group of experienced athletes, there was a high (60%), moderate (20%) and low (20%) positive correlation significance. The final CPC score of the tested gymnasts showed that the group with extensive experience in solving similar motor tasks performed the test task 36% more effectively.

It was assumed that in the synchronisation of movements in the newly created team of individual exercises, athletes would experience greater difficulties in movements requiring quick assessment of the situation and decision-making. Correlation analysis of the influence of CPC indicators on the quality of group competitive rhythmic gymnastics exercises confirmed this assumption: the number of errors made by gymnasts was inversely correlated with the results of the monitoring (r=-0.9).

Conclusions. The study revealed differences in the components of psychophysiological compatibility between athletes in the newly formed and experienced rhythmic gymnastics groups. The influence of these components on the quality of joint motor task performance and the need to take them into account when forming a team were established. The selected test tasks in the diagnosis of psychophysiological compatibility showed the informative value of their use in assessing the team's readiness to master and perform competitive group exercises in rhythmic gymnastics.

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Criteria for assessing children's abilities when selecting them for hockey

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Abstract

Objective of the study is to develop and test a set of criteria for assessing children's abilities, supplementing existing standards to improve the effectiveness of individual selection at the initial stage of training.

Methods and structure of the study. The work used questionnaires, anthropometric measurements, testing of general and special physical fitness, functional testing, analysis of neurodynamic parameters, pedagogical observation and processing of statistics of gaming activity. The study included 120 8-year-old children who were trained at the sports school of the Olympic reserve "Spartakovets" in 2021-2024.

Results and conclusions. The use of the proposed criteria increased the percentage of transfer to the next stage from 71.5% to 97.9%, and the assignment of sports grades to 93.6%. The practical significance of the work lies in increasing the objectivity and accuracy of the selection, ensuring the individualization of training and the formation of an optimal trajectory for the development of young hockey players. The developed criteria base for identifying the abilities of 8-year-olds in the sport of hockey, complementing the system of physical fitness standards of the Federal Standard, makes it possible to increase the effectiveness of the individual selection procedure at the initial stage of sports training.

Keywords: *criteria base, children, hockey, sports selection, initial stage of training.*

Introduction. In the current context of youth hockey development in Russia, special requirements are imposed on the identification of talented athletes and the system for selecting them at the initial stage of sports training. The importance of the physical fitness level of 8-year-old children is reflected in the Federal Standard for Sports Training in Hockey[1].

As can be seen from Table 1, standards measured in precise units (metres and seconds) only take into account the physical fitness of athletes and correspond to the principle of necessity. However, they do not take into account the child's orientation in sports activities, their interest in playing hockey, the manifestation of independence and emotional-volitional quali-

ties, self-organisation, knowledge, motivation for their sports development, genetic abilities and anthropometric data. The activities of a coach-teacher in predicting and identifying the hockey abilities of 8-year-old children, when using only the criterion of physical development, fall within the realm of foresight, the accuracy of which determines the effectiveness of a hockey player's training trajectory [7].

A 20-year retrospective analysis was conducted to investigate the relationship between biological maturation and success in junior and adult ice hockey among men in Sweden [10]. The study used anthropometric data from 4,787 players. The results showed that players who matured earlier had an advantage in achieving success at the junior level (U16), while later maturation was more favourable for achieving success at the adult level (entering the NHL). In the

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course of the work, an attempt was made to create a multidimensional system for assessing talent among adolescents involved in ice hockey, including physical and psychological tests [9]. However, it was only possible to create it for girls. For boys, further development of more sensitive and specific tests is required. When describing the process of orienting children in sports, we agree with the position of V.G. Nikitushkin, who defines it as a type of social orientation aimed at providing organised assistance to children in choosing a sport, taking into account their individual abilities, inclinations and interests, with the aim of determining the type of sport that is suitable for the child. The goal of early sports orientation is to predict and identify the abilities of 8-year-old children for a specific sport [5].

According to L.I. Lubysheva, children's sporting orientation is understood as an integral personal characteristic that determines a child's selective, conscious, emotional, value-based and active attitude towards a particular sport [3]. V.K. Balsevich, studying the problem of sports orientation, determined that identifying children's predisposition to a particular sport can be achieved through long-term monitoring, and the basis of the methodology should be targeted work with children aged 8 years [1].

A number of modern scientists have identified four groups of factors for identifying children's aptitude for a particular sport: anthropometric, physiological, psychological and sociological. Each of these groups contains indicators that can be predictive in the search for gifted athletes [8].

Based on an analysis of the essence of the concept of sports orientation, we define the identification of the aptitude of 8-year-old children for a particular sport at the initial stage of sports training as targeted work to identify the level of interest, awareness, and desire to achieve set goals; level of special skills and abilities, motor experience; level of activity and independence; level of trainability in the form of physical activity specific to the chosen sport; level of anthropometric indicators.

Objective of the study is to develop and test a set of criteria for assessing children's abilities, supplementing existing standards to improve the effectiveness of individual selection at the initial stage of training.

Methods and structure of the study. Questionnaire survey; measurement of anthropometric data, functional testing, collection and analysis of statistical data; pedagogical observation; testing of general and special physical and technical fitness of 8-year-old

Table 1. Standards for general physical and special physical training for enrolment and transfer to the initial training stage in the sport of hockey

No.	Exercise	Unit of measurement	Standard	
			Boys	**Girls**
1. General physical fitness standards				
1	20 m run	s	No more than	
			4,5	5,3
2	Standing long jump with a push-off with both feet	cm	No less than	
			135	125
3	Arm bends and extensions in a push-up position on the floor	Number of times	No less than	
			15	10
2. Special physical training standards				
4	20 m skating race	s	No more than	
			4,8	5,5
5	6×9 m shuttle skating race	s	No more than	
			17,0	18,5
6	20 m backward skating race	s	No more than	
			6,8	7,4
7	Slalom skating race without a puck	s	No more than	
			13,5	14,5
8	Slalom skating race with a puck	s	No more than	
			15,5	17,5

children (n=120) attending the Spartakovets Olympic Reserve Sports School for 3 years (2021-2024). Expected result: an increase in the percentage of individuals in the initial training group who progress to the training stage from the baseline value of 71.5% to 97.55%, and the awarding of youth sports ranks to 93.5%.

Results of the study and discussion. One way to solve the problem of identifying the aptitude of 8-year-old children for the sport of hockey is to create a sports and games environment at the hockey school that allows for the implementation of methods (verbal, visual, practical) and technologies (methods, means and control systems) of sports training through physical education and sports events, including regular (once every three months) tournaments with simplified rules and comprehensive monitoring of the physical, psychological and functional abilities and anthropometric data of athletes.

The minimum requirements for the implementation of the project are: an automated service http://individual-championship.ra-first.ru for determining the line-ups for each match [6]; a system for monitoring neurodynamic indicators ; an automatic timing system

'Start-Finish'; equipment (goals measuring 130*90 cm; safe fencing (boards), whistle, stopwatch, information board; scales; height gauge; hand dynamometer; teaching materials (tables, visual aids, rules); monitoring of physical abilities [2, 6]; psychological testing [4].

The result of the project is a sports selection system based on criteria for identifying the hockey abilities of 8-year-old children, presented in Table 1. At the initial stage of our research, 47 athletes out of 120 enrolled in the institution were selected based on additional criteria for identifying the aptitude of 8-year-old children for hockey.

As a result of completing a three-year sports training programme, at the summary stage of the study, 46 children selected on the basis of additional criteria successfully met the standards for transfer to the training stage (sports specialisation stage), which corresponds to 97.9% of their number, and 44 athletes were awarded the III junior sports category – 93.6%. Of the group of athletes selected solely on the basis of physical fitness, only three were transferred to the training stage, and one was awarded a category. This trend confirms the validity of the criteria and levels we

Table 2. Additional criteria for identifying the aptitude of 8-year-old children for the sport of hockey

Criterion	Parameter
Motivational	Interest in playing hockey. Positive attitude towards hockey. Awareness of oneself as a participant in hockey.
Emotional-volitional	Willpower in problem solving (ability to sustain effort, prolonged physical activity, endurance, self-control in game situations). Emotional responsiveness to participation and desire to play.
Evaluative-behavioural	Ability to navigate various game situations. Active and independent play. Awareness of one's own active role in the game. Ability to work in a team.
Statistical data	The difference between goals scored (GS) and goals conceded (GC) in all micro-matches (GM) (GM = GS - GC). Points earned by a player with teams (TP) based on the results of all micro-matches (win - 2 points; draw – 1 point; defeat – 0 points), is determined as the sum of team points with the player's participation. TP max – the maximum number of points in the tournament. The player's personal rating (R) (R=TP+((GS-GC)/(GS+GC)), rounded to the nearest whole number.
Anthropometric indicators	Body mass index (BMI) BMI = Weight, kg/Height, m² Height, cm Lung capacity (difference in chest measurement between inhalation and exhalation), cm
Neurodynamic indicators	Simple visual-motor coordination (SVMC, ms) Advanced visual-motor coordination (AVMC, ms) Competitive visual-motor coordination (CVMC, ms) Decision-making speed (DM, ms) DM = AVMC - SVMC Change in VMC in a competitive environment (ΔVMC, %). ΔVMC = (CVMC - AVMC)/AVMC*100 (%), rounded to the nearest whole number

have established for identifying the aptitude of 8-year-old children for the sport of hockey.

Conclusions. The developed criteria for identifying the aptitude of 8-year-old children for the sport of hockey, which complements the physical training standards of the Federal Standard, allows for improving the effectiveness of the individual selection procedure at the initial stage of sports training. Testing of the criteria (including motivational, emotional-volitional, evaluative-behavioural, statistical, anthropometric and neurodynamic parameters) within the framework of the sports and games environment project showed an increase in the percentage of children moving on to the next stage from 71.5% to 97.9% and the awarding of sports ranks to 93.6%. This ensures the individualisation of training, the prediction of the trajectory of sporting activity and the optimisation of the development of young hockey players.

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Competence-Oriented Technology for Long-Term Athletic Development of Young Ice Hockey Players

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Abstract

Objective of the study is to theoretically substantiate and practically develop a competence-based technology for the long-term sports training of young ice hockey players aged 7–17, ensuring the alignment of goals, content, methods, and performance criteria within the system of long-term athletic development.

Methods and structure of the study. The research relies on systemic, activity-based, competence-based, and synergetic methodological approaches. Theoretical methods included analysis, modeling, structural-functional and comparative analysis. Empirical methods comprised pedagogical observation, testing, surveys, and experimental design (ascertaining, formative, and local stages). Instrumental methods included heart rate monitoring, electromyography, heart rate variability analysis, psychophysiological testing, and video analysis of competitive activity. The study involved approximately 2,420 male ice hockey players aged 7–17 and over 50 coaches representing sports schools and club systems implementing the National Ice Hockey Training Program. The experimental work was carried out between 2010 and 2025.

Results and conclusions. For the first time, a competence-based technology for the training of young ice hockey players has been theoretically substantiated and developed, including target, content, procedural, and evaluation modules. The "competence architecture" was identified, reflecting the systemic interrelation of physical, technical, tactical, cognitive, and personal-regulatory components of athlete readiness. A system of criteria and indicators for competence assessment was developed, ensuring pedagogical feedback and manageability of the long-term process. Experimental data confirmed that the implementation of the competence-based technology increases integrative readiness, improves competitive performance, decision-making speed, stability, and teamwork effectiveness among young hockey players. The competence-based training technology for young hockey players serves as an effective tool for integrating training, competitive, educational, and developmental processes into a unified system. Its implementation ensures individualization, continuity, and manageability of long-term sports development while fostering athletes' ability to perform effectively in dynamic and uncertain competitive environments.

Keywords: *competence-based approach, ice hockey, youth athletes, long-term athlete development, sports training, pedagogical diagnostics, competence architecture.*

Introduction. The current Strategy for the Development of Physical Culture and Sports in the Russian Federation until 2030 identifies a human-centered orientation as a key national value, emphasizing that the development of physical culture and sports should primarily serve the purposes of health preservation, active longevity, and the holistic well-being of citizens [1]. In this context, sports training is viewed not only as a means to achieve competitive success but also as a process of developing competencies that support the athlete's sustainable personal and professional self-realization.

A particularly important role is assigned to youth sports, which, according to the Federal Law No. 329-FZ "On Physical Culture and Sports in the Russian Federation" (as amended on November 28, 2025), is defined as a part of sport aimed at the physical education and training of individuals under the age of eight-

een and the formation of the athletic reserve (Article 2, Paragraph 3.1-1) [2]. This conceptual position is further elaborated in the Concept for the Development of Youth Sports in the Russian Federation until 2030, which stresses the need for scientifically grounded training technologies ensuring continuity and individualization within the long-term athletic development system [3].

Contemporary youth ice hockey faces a complex set of challenges, including early specialization, professionalization, commercialization, and the increasing variability and intensity of the competitive environment. Empirical and theoretical studies show that the effectiveness of long-term sports training depends not only on the improvement of physical and technical capacities but also on the formation of cognitive, regulatory, and communicative competencies, which determine an athlete's ability to act effectively under uncertainty and pressure [4; 5].

International models of athlete development, such as the Long-Term Athlete Development (LTAD) framework (I. Balyi, J. Way, & C. Higgs, 2013), exemplify a shift from prescriptive, norm-based planning to competence-oriented paradigms that emphasize adaptability, decision-making, and contextual performance [6; 7]. In Russia, similar principles are incorporated into the National Ice Hockey Player Development Program, which integrates training, competition, education, and upbringing into a unified developmental system. However, despite its structural and methodological advances, the program still lacks a fully operationalized competence model, leaving a methodological gap between program goals and their practical implementation.

The traditional program-normative model of sports training ensured systematization and continuity of the multi-year preparation process but largely neglected the integrative dynamics of competence formation as a systemic quality of athletic readiness [8]. As noted by V. G. Nikitushkin (2010) and P. V. Kvashuk (2022), excessive reliance on normative testing and quantitative evaluation insufficiently reflects the contextual variability and adaptability of real sports performance, thus necessitating a competence-based methodological revision [9; 10].

The theoretical foundations for this revision, who define competence as the integrated ability of an individual to act effectively by mobilizing knowledge, skills, experience, and value orientations. In sports science, these ideas resonate with nonlinear peda-

gogy and ecological dynamics, which conceptualize learning as a process of self-organization within the "athlete–environment–task" system [11].

Within the specific context of ice hockey, a complex, high-intensity, and team-based sport, the implementation of a competence-oriented training approach becomes crucial. It allows the preparation process to be viewed not as a linear sequence of workloads but as an integrated system of competence formation, fostering adaptability, stability, and effectiveness in dynamic competitive environments.

Thus, the scientific problem of this study lies in the need to theoretically substantiate and technologically design a competence-based model of long-term sports training for young ice hockey players, ensuring the alignment of goals, content, tools, and performance criteria within a unified pedagogical framework.

Objective of the study is to theoretically substantiate and practically develop a competence-based technology for the long-term sports training of young ice hockey players aged 7–17, ensuring the alignment of goals, content, methods, and performance criteria within the system of long-term athletic development.

Methods and structure of the study. The research was based on a set of complementary theoretical and empirical methods consistent with the objectives and logic of a multi-year pedagogical experiment.

Within the framework of theoretical methods, analysis, systematization, and synthesis of scientific and regulatory-methodological literature were conducted on the issues of sports training theory and methodology, the competence-based approach, and youth sports. The methods of modeling, structural-functional analysis, and comparative research were applied, which made it possible to construct a conceptual model of the competence-oriented training technology for young ice hockey players.

Empirical methods included pedagogical observations, testing, questionnaires, and a formative pedagogical experiment aimed at testing the developed technology. The assessment of physical, technical, tactical, and cognitive readiness was carried out using expert evaluation, video analysis, and pedagogical testing adapted to the athletes' age and stage of long-term development.

Instrumental and diagnostic methods involved modern tools of pedagogical diagnostics: heart rate

monitoring (Polar Team Pro), heart rate variability analysis, electroneuromyography, and psychophysiological tests (Schulte tables, sensorimotor reaction tests). In addition, video analysis of competitive performance was used to evaluate the biomechanical and tactical structure of game episodes.

Statistical methods included the calculation of mean and relative values, correlation and factor analyses, and significance testing (Student's t-test, Mann–Whitney U-test). Data processing was performed using IBM SPSS Statistics 25.0 and Microsoft Excel software packages.

The study was carried out from 2010 to 2025 at hockey schools and academies affiliated with professional clubs implementing the National Ice Hockey Player Development Program. The research involved approximately 2,000 young hockey players aged 7–17 and over 50 coaches. The experimental work consisted of three stages–ascertaining, formative, and local–corresponding to the structure of the long-term athletic development process.

Results of the study and discussion. At this stage of the research, interim results have been obtained concerning the theoretical substantiation and design of a competence-oriented technology for the long-term sports training of young ice hockey players.

The analysis of scientific literature, regulatory documents, and program materials revealed contradictions between the program-normative logic of training organization and the actual demands of competitive activity. Current standards tend to regulate training load parameters and performance indicators rather than promote the development of integrative competencies that ensure the stability and adaptability of athletes' behavior during play.

The conducted theoretical and methodological analysis made it possible to substantiate the structure of competence in young hockey players as a system of interrelated components – physical, technical, tactical, cognitive, and personal-regulatory. Based on this structure, an architecture of competencies was designed, reflecting their hierarchy, sequence of formation, and relationship with the stages of long-term athletic development (from initial training to athletic mastery).

A conceptual model of competence-oriented training technology was developed, comprising four key modules: (1) target module – defines strategic orientations and the system of target competencies; (2) content module – reveals the interconnection of training means, methods, and objectives across the components of competence; (3) procedural module – describes the pedagogical mechanisms for forming competencies within training and competitive activities; (4) evaluation module – establishes a system of criteria and indicators of readiness that provide pedagogical feedback and enable the adjustment of training content.

Diagnostic design frameworks were created, including a system of competence criteria and indicators, which made it possible to outline directions for subsequent empirical testing of the technology's effectiveness. The conducted observations and local experimental studies confirmed the feasibility of operationalizing competencies through pedagogically measurable indicators – in particular, measures of the variability of game actions, attentional stability, decision-making speed, and the effectiveness of team interaction.

At the next stage, a formative experiment is planned to test the developed technology in the training process in order to assess its impact on the dynamics of competence development and the competitive performance of young ice hockey players.

Conclusions. At this stage of the study, the methodological principles for designing a competence-oriented technology for the long-term sports training of young ice hockey players have been theoretically substantiated, integrating training, competitive, educational, and developmental components.

A conceptual model of the technology has been developed, comprising four interrelated modules – target, content, procedural, and evaluation – ensuring the systemic integrity and manageability of the competence formation process throughout long-term athletic development.

The architecture of competencies for young hockey players has been defined as a hierarchical system combining physical, technical, tactical, cognitive, and personal-regulatory components, interconnected with the stages of multi-year sports preparation.

Project foundations for pedagogical diagnostics have been established, including a system of criteria and indicators enabling the operationalization of competencies and providing a basis for the subsequent empirical validation of the proposed technology.

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Mathematical model for predicting maximum oxygen consumption by football players

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Abstract

Objective of the study is to develop a mathematical model for predicting the maximum oxygen consumption (MOC) of football players aged 15-17 based on anthropometric and functional indicators.

Methods and structure of the study. To build a prognostic model, a set of anthropometric indicators (body length and weight, thickness of skin and fat folds, body composition), heart rate variability parameters (HR, SI, TP, HF, LF, IC, PARS), as well as (systolic and diastolic blood pressure) were preliminarily determined. The MOC was measured by the direct method when performing a maximum load test using a gas analyzer. Five machine learning algorithms have been tested. The developed mathematical model based on linear regression makes it possible to predict the MOC of football players with a fairly high degree of accuracy.

Results and conclusions. During development, five different machine learning algorithms were tested to predict MOC in football players based on a set of anthropometric and functional indicators, and a comparative analysis of the algorithms was performed. A mathematical model based on the use of a linear regression algorithm allows the maximum oxygen consumption of football players to be predicted with high accuracy (R^2=0.78; MAE=3.1 ml/kg/min), which meets the criteria for prediction in sports physiology and can be used for practical application in the training process.

Keywords: *football, mathematical model, machine learning, sports training, anthropometric indicators.*

Introduction. It is well known that maximum oxygen consumption (MOC) is an integral indicator of aerobic performance and one of the most important criteria for assessing the effectiveness of sports training [1-3].

Direct measurement of MOC using gasometry while performing a stepwise increasing load on a treadmill or bicycle ergometer is considered the classic method for assessing aerobic capacity. However, this method requires specialised laboratory equipment, qualified personnel, and considerable time. Given the busy competition schedule and the need for regular monitoring of the functional status of a large number of athletes, direct MOC measurements become difficult to perform. This determines the relevance of developing

valid and accessible methods for indirect assessment of the aerobic performance of football players.

Existing approaches to MOC prediction are based on regression models using anthropometric indicators (age, body weight) and resting heart rate [4, 9], the ratio of maximum HR to resting HR [4, 5], and the results of field tests – 20-metre shuttle run and bleep test [6-8, 10]. Specific equations have been developed for footballers of different skill levels based on the time to exhaustion in the modified Heck protocol [8] and speed indicators [5, 6, 9, 10].

Studies have shown that MOC values vary depending on playing position, age and athletic skill level: field players (especially midfielders) have higher values than goalkeepers, and highly skilled athletes have

higher values than less trained athletes [5, 6]. At the same time, most existing models are characterised by a limited set of variables, insufficient prediction accuracy, and a lack of comprehensive consideration of anthropometric and functional parameters.

Objective of the study is to develop a mathematical model for predicting the maximum oxygen consumption (MOC) of football players aged 15-17 based on anthropometric and functional indicators.

Methods and structure of the study. Forty-one footballers aged 15-17 took part in the scientific study, which was conducted in two stages.

In the first stage, anthropometric measurements of body length and weight were taken, and body mass index (BMI) was calculated. Using calipers, the thickness of skin-fat folds was determined at seven standard points, followed by calculation of body composition (in particular, the percentage of muscle and fat mass).

Heart rate variability was measured at rest. The following indicators were recorded: heart rate (HR), stress index (SI), total power spectrum (TP), high-frequency (HF) and low-frequency (LF) components, centralisation index (IC) and regulatory activity index (PARS). Systolic and diastolic blood pressure were measured using the Korotkov auscultatory method. MOC was measured directly during a maximal exercise test using a gas analyser.

In the second stage, a correlation analysis was performed to identify relationships between predictors and the target variable. Five machine learning methods were used to predict VO_2max: linear regression (a basic model for estimating linear relationships), Ridge regression with L2 regularisation (resistant to multicollinearity of features), Lasso regression with L1 regularisation (with automatic selection of the most significant predictors), Random Forest (an ensemble of decision trees for modelling nonlinear interactions), and Gradient Boosting (sequential tree construction to maximise prediction accuracy). The quality of the models was evaluated using three metrics: the coefficient of determination R^2 (proportion of explained variance, target value >0.90), root mean square error RMSE (average deviation in ml/kg/min, target value <2.0) and mean absolute error MAE (outlier-resistant metric, target value <1.5). Validation was performed using k-fold cross-validation with the data divided into training (80%) and test (20%) samples.

Results of the study and discussion. During the study, a comparative analysis of algorithms was conducted. The results of testing five machine learning algorithms for MOC prediction are presented in the table.

During the research, five different machine learning algorithms were tested to predict MOC in football players based on a set of anthropometric and functional indicators. The linear regression model demonstrated the best predictive characteristics among all the algorithms tested. On the training sample, the coefficient of determination was $R^2 = 0.92$, which indicates the model's high ability to explain data variability.

On the test sample, the model showed $R^2 = 0.78$, which means that 78% of the variance in maximum oxygen consumption is explained by the selected predictors. The root mean square error (RMSE) was 4.2 ml/kg/min, and the mean absolute error (MAE) was 3.1 ml/kg/min. Regularised linear models showed results close to those of basic linear regression. The Lasso model showed $R^2 = 0.90$ on the training sample and $R^2 = 0.76$ on the test sample, with RMSE = 4.5 ml/kg/min and MAE = 3.3 ml/kg/min.

The Ridge model showed slightly lower results: $R^2 = 0.76$ on training and $R^2 = 0.72$ on testing, with RMSE = 4.9 ml/kg/min and MAE = 3.7 ml/kg/min. Ensemble machine learning methods demonstrated less impressive results compared to linear models.

The Random Forest model showed $R^2 = 0.75$ on the training sample and $R^2 = 0.73$ on the test sample, with RMSE = 4.8 ml/kg/min and MAE = 3.6 ml/kg/min.

Table. Results of testing machine learning algorithms

Model	R^2 (Train)	R^2 (Test)	RMSE (Test), ml/kg/min	MAE (Test), ml/kg/min	Rank
Linear Regression	0,92	0,78	4,2	3,1	1
Lasso	0,90	0,76	4,5	3,3	2
Random Forest	0,75	0,73	4,8	3,6	3
Ridge	0,76	0,72	4,9	3,7	4
Gradient Boosting	0,74	0,71	5,0	3,8	5

Gradient Boosting showed the most modest results among all tested models: $R^2 = 0.74$ on training and $R^2 = 0.71$ on testing, with RMSE = 5.0 ml/kg/min and MAE = 3.8 ml/kg/min.

The difference between the training and test sample scores for the best model (linear regression) was 0.14, indicating moderate overfitting and good generalisation ability of the model. With a typical MOC range of 50-65 ml/kg/min for well-trained footballers, the average absolute error of 3.1 ml/kg/min is approximately 5-6% of the measured value, which is an acceptable level of accuracy for practical application in sport. The superiority of linear models over complex nonlinear algorithms indicates the predominantly linear nature of the relationships between the selected predictors and the target variable.

To predict maximum oxygen consumption (VO_2max) values, an automated system has been developed in the Python programming language, implementing a comprehensive approach to the processing and analysis of athlete data. The method includes several key stages: preliminary data processing with missing values filled in with median values from the training set, feature standardisation using a pre-trained scalers, and the application of an optimal machine learning model to generate predictions.

Conclusions. 1. The developed mathematical model, based on the use of a linear regression algorithm, allows predicting the maximum oxygen consumption of football players with high accuracy (R^2=0.78; MAE=3.1 ml/kg/min), which meets the criteria for prediction in sports physiology and can be used for practical application in the training process.

2. The superiority of linear regression over complex ensemble methods (Random Forest, Gradient Boosting) indicates the predominantly linear nature of the relationships between the selected anthropometric and functional indicators and MOC in football players.

3. A comprehensive approach that includes anthropometric and functional indicators in combination with machine learning methods provides reliable prediction of aerobic performance and can be used to monitor the functional state of athletes and subsequently optimise the training process.

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Monitoring haemodynamic adaptation in athletes involved in cyclic sports

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Abstract

Objective of the study is to substantiate the results of monitoring long-term haemodynamic adaptation in athletes involved in cyclic sports for the purpose of planning and/or correcting the training process.

Methods and structure of the study. To substantiate the patterns of long-term haemodynamic adaptation of athletes to natural growth and development in combination with increasing physical loads during long-term training, haemodynamic monitoring was performed in an orthostatic test (AOT) in successful female cross-country skiers (n=310), biathletes (n=23), male cross-country skiers (n=533), biathletes (n=33) aged 9-18 who took leading places in cross-country skiing competitions at the regional level in the Russian Federation (1st-6th place), and highly qualified athletes aged 19-35 who participated in the Russian Championships. The sample of successful athletes included 4 Honoured Masters of Sport of Russia, 8 International Class Masters of Sport and 213 Masters of Sport.

Results and conclusions. The study of age-related patterns of long-term haemodynamic adaptation in successful male and female cross-country skiers and the subsequent statistical processing of the data obtained made it possible to determine the model indicators for athletes in cyclic sports based on the most informative haemodynamic parameters. The developed algorithm for interpreting the results of pedagogical control of long-term haemodynamic adaptation of athletes provides for the rational management of training loads with the aim of forming the necessary and sufficient level of haemodynamic adaptation.

Keywords: athletes in cyclic sports, long-term haemodynamic adaptation, monitoring, orthostatic test indicators.

Introduction. Long-term haemodynamic adaptation in athletes participating in cyclic sports is the gradual formation of physiological changes in subordinate body systems (cardiovascular, circulatory and neurohumoral regulation) in the ontogenesis of athletes as a result of prolonged and repeated mobilisation of the functional system in appropriate training and competitive activities with a predominance of aerobic exercise.

Long-term haemodynamic adaptation provides an increase in physical performance mainly due to the expansion of the capabilities of the cardiovascular system. Despite the fact that issues related to determining the volumetric parameters of the heart have been addressed in sports medicine for over 100 years

[3], the real possibility of controlling stroke volume and end-diastolic volume of the heart in pedagogical research appeared after the improvement of the non-invasive method of impedance cardiography [1].

Objective of the study is to substantiate the results of monitoring long-term haemodynamic adaptation in athletes involved in cyclic sports for the purpose of planning and/or correcting the training process.

Methods and structure of the study. To substantiate the patterns of long-term haemodynamic adaptation of athletes to natural growth and development in combination with increasing physical loads during long-term training, haemodynamic monitoring was performed in an orthostatic test (AOT) in success-

ful female cross-country skiers (n=310), biathletes (n=23), male cross-country skiers (n=533), biathletes (n=33) aged 9-18 who took leading places in cross-country skiing competitions at the regional level in the Russian Federation (1st-6th place), and highly qualified athletes aged 19-35 who participated in the Russian Championships. The sample of successful athletes included 4 Honoured Masters of Sport of Russia, 8 International Class Masters of Sport and 213 Masters of Sport.

During haemodynamic monitoring in active orthostatic testing, indicators such as heart rate (HR, beats per minute), end-diastolic index (EDI, ml/m2), systolic blood pressure (SBP, mm Hg) in the supine and standing positions, as well as ΔHRAOT as a change in HR in AOT. Statistical analysis of the data was performed using Excel software (Microsoft Office 2016).

Results of the study and discussion. The study of age-related patterns of long-term haemodynamic adaptation in successful male and female cross-country skiers [1, 2] and subsequent statistical processing of the data obtained made it possible to determine the model indicators for athletes in cyclic sports based on the most informative haemodynamic parameters (Table 1).

The algorithm for interpreting the results of haemodynamic monitoring in stage control (Figure 1) is based on comparing the key haemodynamic criterion – the athlete's EDI – with age-related model indicators (Table 1), referred to in the figure as 'norms'.

If the athlete's level of haemodynamic adaptation according to EDI in both lying and standing positions corresponds to or exceeds the model indicators, the training process does not require correction to ensure the necessary cardio resource (Figure 1).

If EDIlying is normal and EDIstanding is below normal, then the heart has potentially reached normal age-related parameters, but in an upright position, the body experiences a physiologically suboptimal state that requires monitoring of the body's response to AOT in terms of HR and SBP (see figure). The most common cause of this condition (Table 2) is maladaptation to the upright position. In adolescent athletes during a period of intensive growth, this condition must be waited out, devoting more time to aerobic training, reducing the total intensity of physical activity by choosing 'gentle' training routes, using general development exercises with a large number of inclines, stretching exercises and simple acrobatic exercises.

If ΔHR in the active orthostatic test is excessive, but fatigue of the athlete is excluded, then it is necessary to monitor changes in blood pressure in the orthostatic test. Possible causes of a decrease in SBP during verticalisation include hereditary varicose veins that have not yet manifested themselves in a young body or blood pooling in the veins of the lower extremities: excessive stretching of the peripheral veins of the legs leads to a redistribution of blood in the body.

For athletes with low EDI values, the generally accepted recommended method for increasing heart volume is prolonged aerobic training. Taking into account the age characteristics of athletes, training methods aimed at increasing aerobic capacity and, first of all, increasing heart volume can be classified according to the stages of sports training.

The main means of developing endurance in children is walking, a combination of walking and running. In addition, activities that contribute to cardiac hypertrophy include both work processes (agricultural and repair work, courier work without the use of personal mobility aids, housework) and active leisure activities (dancing, walking, excursions). The above methods of increasing heart volume can be classified as non-training activities. For trained athletes (at the stage of improving their athletic skills), the interval method is considered to be the most effective in increasing heart volume.

Table 1. Age-related model indicators of the haemodynamic status of ski racers

Age, years	9 -10	11-12	13	14	15	16	17	18	19	20-23	23+
Haemoparameters	Males										
HRlying down, bpm	63	60	58	56	56	51	48	51	51	49	46
ΔHRAOT, bpm	9	16	13	14	14	13	14	13	13	8	10
EDIlying, ml/m²	83	91	98	102	104	110	114	111	111	111	115
EDIstanding, ml/m²	77	74	81	81	84	88	92	87	93	94	100
	Females										
HRlying down, bpm	63	61	58	54	54	52	53	51	50	45	45
ΔHRAOT, bpm	5-10	14	13	11	17	14	14	17	14	15	10
EDIlying, ml/m²	91	91	97	100	102	104	105	105	108	108	106
EDIstanding, ml/m²	78	78	85	85	87	86	88	93	96	93	92

Table 2. Correction of haemodynamic status in athletes with normal EDIlying and low EDIstanding

Probable cause	Nature of the condition and methods of correction
(1) Failure to adapt to an upright position	The body perceives the vertical position as physiologically energy-intensive and, in an effort to ensure a comfortable position, forces you to sit or lie down. Important: find time to adapt, eliminating vascular problems (4)
(2) Adolescence with rapid growth	The natural lag in the adaptation of the heart and blood vessels to bone growth requires 3-4 months to normalise the condition after a growth spurt, given the nature of the cause (1)
(3) Overwork	The accumulation of fatigue requires adequate recovery to prevent overtraining
(4) Vascular problems	The manifestation of signs of vascular disease (varicose veins and excessive stretching of peripheral veins) requires health-preserving correction

Control of haemodynamic adaptation has been used in the scientific and methodological support of athletes of the Sverdlovsk Oblast Ski Racing Federation since 2017. The criterion for the effectiveness of the training process under the control of haemodynamic status and scientifically -based sports selection is the sports results of the Sverdlovsk Oblast national ski racing team, which won convincing victories at the Russian Student Spartakiad in 2022 and the Russian Junior Student Spartakiad in 2023.
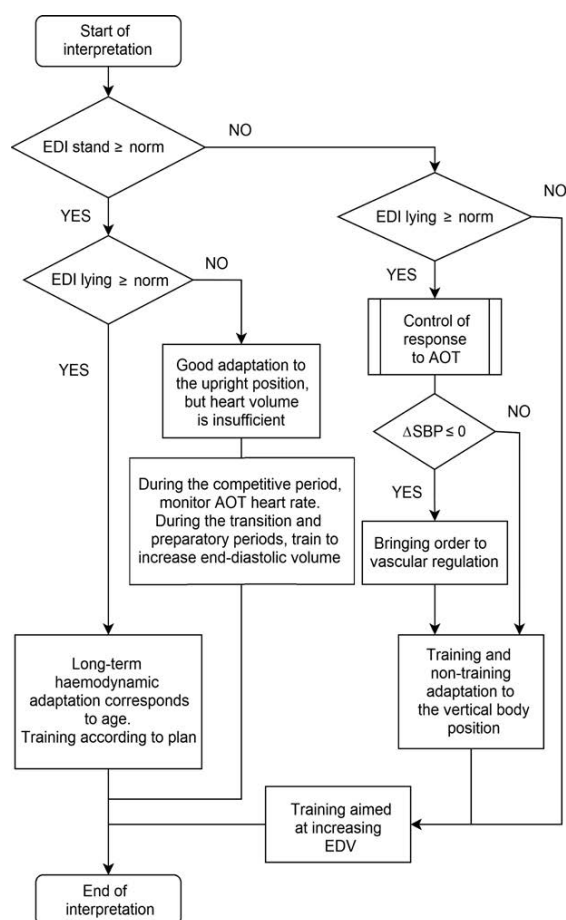
Fig. 1. Algorithm for interpreting haemodynamic monitoring results in stage-by-stage monitoring of athletes in cyclic sports

Conclusions. Haemodynamic monitoring is an important tool in the training of cross-country skiers, and it is appropriate for use in stage control at all stages of sports training. The developed algorithm for interpreting the results of pedagogical control of long-term haemodynamic adaptation of athletes provides for the rational management of training loads with the aim of forming the necessary and sufficient level of haemodynamic adaptation based on the analysis of the athlete's end-diastolic index in a standing position, considered in comparison with the EDIlying down and the appropriate norms for these indicators for cyclic sports, taking into account the athlete's gender and age.

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Assessment of daily dynamics of postural control in badminton players

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Abstract
Objective of the study is to evaluate the daily dynamics of postural control in badminton athletes.
Methods and structure of the study. 16 badminton athletes aged 18 to 22 years old, with a level of sportsmanship ranging from candidate for Master of Sports to Master of Sports of the Russian Federation, were examined. Postural stability was assessed in athletes using a biofeedback stability platform in the morning (07:00-08:00), afternoon (12:00-13:00) and evening (18:00-19:00) on a day of complete rest.
Results and conclusions. Postural control in athletes demonstrates high individual stability throughout the day. The key factor that significantly affects the quality of the balance function is the presence of visual afferentation. The daily dynamics is most pronounced for the lateral displacement of the pressure center: the morning trend of a shift to the right is replaced by a shift to the left in the afternoon and evens out by the evening. Proprioceptive-vestibular mechanisms work in concert during the day (especially in the absence of vision), while the role of visual control increases during the daytime and evening.

Keywords: *badminton players, daily dynamics, postural control, balance, stabilisation platform.*

Introduction. Postural stability, or the ability to maintain balance in various static and dynamic conditions, is a key factor in achieving high athletic performance. In sports that require quick decision-making and manoeuvrability, such as badminton, the accuracy and stability of postural control significantly affect the effectiveness of movements and coordination when changing direction.

It is known that many physiological processes in the human body, including neuromuscular function, are subject to daily fluctuations associated with circadian rhythms [3]. These rhythms, regulated by the body's 'internal clock,' affect hormonal regulation, body temperature, alertness, and other factors that can influence athletic performance. In particular, studies show that strength, power, and reaction speed can peak in the afternoon [4].

Factors affecting postural stability, including the influence of age, gender, fitness level, as well as external conditions and physical activity, are currently being actively studied [1]. However, despite exten-sive scientific research, the daily dynamics of postural control in athletes throughout the day remain relatively understudied. Existing studies mainly focus on the influence of the time of day on postural control in elderly people and patients with neurological disorders, where daily fluctuations may be more pronounced and associated with pathological processes [2]. Understanding daily fluctuations in postural stability may be of considerable interest for optimising the training process and developing individual rehabilitation programmes.

Objective of the study is to evaluate the daily dynamics of postural control in badminton athletes.

Methods and structure of the study. The scientific work was carried out at the Research Institute of Physical Culture and Sport 'Volga Region State University of Physical Culture, Sport and Tourism' (Kazan) in the morning (07:00-08:00), afternoon (12:00-13:00) and evening (18:00-19:00) on a day when the athletes were completely rested. Sixteen athletes aged 18 to 22 who play badminton and have a level

of athletic skill ranging from candidate for master of sports to master of sports of the Russian Federation were examined.

Postural stability was assessed using the Stabilan-01 closed joint-stock company special design bureau 'Rhythm' (Taganrog) Romberg test with eyes open and closed: MOX (mm) – average displacement of the centre of pressure (COP) projection in the frontal plane (X-axis); MOY (mm) – average displacement of the COP projection in the sagittal plane (Y-axis); QBF, % – quality of balance function, assesses how minimal the speed of oscillation of the centre of pressure is while maintaining an upright posture. Statistical data processing was performed using SPSS 20 software. Correlation analysis was performed using the Brave-Pearson or Spearman method (depending on the nature of the distribution of values in the sample).

Results of the study and discussion. The balance function quality indicator recorded in the morning during the open-eye test has a strong correlation with the results obtained in the evening (r=0.846, p<0.001). This suggests that subjects who demonstrated good postural control in the morning also had high postural control in the evening. This is consistent with studies showing that postural stability in trained individuals can be relatively resistant to fatigue factors [1].

A correlation was found between the indicators of balance function quality in the morning with eyes open and closed (r=0.629, p=0.028), indicating that the balance function quality of a particular person in the morning remains relatively stable despite the absence of visual control. At the same time, during the day and in the evening, the correlations between the results with eyes open and closed are not statistically significant, which, apparently, indicates a greater involvement of visual control during the day and in the evening. The closest correlation with eyes closed is observed between daytime and evening indicators (r=0.788, p=0.002). This correlation is high and indicates the consistency of the proprioceptive and vestibular systems throughout the day.
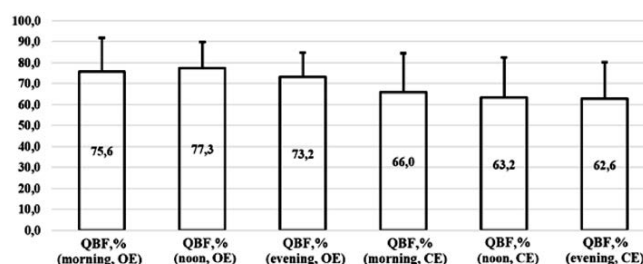
Fig. Changes in QBF indicators in subjects throughout the day in tests with eyes open (OE) and eyes closed (CE)

Comparisons of stabilographic indicators throughout the day showed that the main factor affecting the quality of balance function in athletes is the presence or absence of visual control (see figure). A significant deterioration in QBF occurs when the eyes are closed. The time of day (morning, afternoon, evening) did not show a statistically significant effect on QBF in this group of subjects. All observed trends towards a decrease in indicators towards the evening were statistically insignificant.

Statistically significant changes were observed in the indicator of pressure centre displacement in the sagittal plane, recorded with eyes open, which differed between daytime and evening.

Thus, in the morning, the subjects showed a tendency to shift their body weight to the right, which was expressed in a positive value of the average pressure centre displacement (+3.87 mm), and in the afternoon, under similar conditions, the standing pattern changed to the opposite: there was a statistically significant shift in body weight to the left, as evidenced by the negative value of the average shift (-3.89 mm, p<0.001 when compared to morning values). As shown in the table, in the evening, the asymmetry of the postural strategy for maintaining an upright posture was practically eliminated, which was expressed in a relatively average position of the centre of pressure (-0.66 mm, p<0.01 when compared with the morning values).

It should be noted that there are significant individual differences, expressed in a large spread of data, as evidenced by the significant difference between the minimum and maximum values of the indicators.

Table. Dynamics of pressure centre displacement in athletes throughout the day

Frontal component of COP displacement		Minimum	Maximum	Average	Root mean square deviation
MO(x), mm	Morn.	-7,25	18,37	3,8717	6,64978
	Noon	-20,17	4,32	-3,8925	6,51313
	Even.	-11,61	3,66	-,6592	4,42893

The data obtained suggest that the daily dynamics of the centre of pressure shift are likely related to circadian rhythms that affect the tone of postural control muscles.

Morning right-sided asymmetry may reflect the predominance of activity in the left hemisphere of the brain, which controls the right side of the body, corresponding to the period of activation of cognitive functions after waking up.

During the day, with an increase in the load on the musculoskeletal system and, possibly, compensatory mechanisms, the body mass vector shifts to the left, reflecting fatigue on the right side and a redistribution of muscle activity. By evening, with the onset of fatigue and a decrease in overall activity, the asymmetry decreases, possibly due to a general decrease in postural muscle tone and the levelling of interhemispheric differences.

Conclusions. The stabilographic indicator of balance function quality demonstrates high individual stability and remains virtually unchanged throughout the day. The main factor significantly affecting balance function quality is the presence or absence of visual afferentation. In all time slices, a statistically significant deterioration in balance function quality was observed with closed eyes.

The most pronounced daily dynamics were observed in the pattern of body weight distribution (lateral shift of the centre of pressure): in the morning, the subjects tended to shift their body weight to the right, which was statistically significantly replaced by a shift to the left in the afternoon, and by evening the asymmetry was levelled out.

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Methodology for teaching combat techniques to students of educational organisations of the ministry of internal affairs of Russia

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Abstract
Objective of the study is to substantiate the scientific and methodological aspects of training Russian Ministry of Internal Affairs cadets in the tactics of using physical force and combat techniques in conditions close to operational and service activities.
Methods and structure of the study. The bibliometrics method was used to analyze scientific and methodological literature; a retrospective analysis of experience and methods of forming combat techniques of wrestling, as well as the study of normative legal acts and teaching aids; synthesis of the information obtained to improve existing methods of teaching tactics of using physical force and combat techniques by police officers.
Results and conclusions. The authors consider the main scientific and methodological aspects of teaching tactics for the use of physical force and combat techniques by police officers in conditions close to operational activities. The leading pedagogical condition for training is the inclusion in the learning process of not only mastering the technical basics of combat techniques, but also tactical ones, which makes it possible to build the process of mastering educational material in a practice-oriented manner and, accordingly, more effectively.

Keywords: cadets, Russian Ministry of Internal Affairs, combat techniques, combat readiness conditions.

Introduction. When performing law enforcement duties, police officers often encounter resistance from offenders. In situations where non-violent methods are ineffective, police officers are forced to use physical force, special equipment and firearms. The use of force requires police officers to be specially prepared for action in these conditions. The structure of this preparedness is not limited to the motor (physical) component. It is also based on theoretical, intellectual and psychological training [1]. Taken together, these types of training form the foundation of police officers' tactical preparedness.

A number of researchers note that, despite a satisfactory level of development of professionally important physical qualities and confident mastery of combat techniques during training, police officers are often unable to resist criminals and lose to them in confrontation during the forceful detention of offend-

ers [3, 4, 5]. One of the main reasons for this situation, according to physical training specialists, is the low level of tactical preparedness [1].

Objective of the study is to substantiate the scientific and methodological aspects of training Russian Ministry of Internal Affairs cadets in the tactics of using physical force and combat techniques in conditions close to operational and service activities.

Methods and structure of the study. To determine the extent to which the problem has been studied using bibliometric methods, an analysis of scientific and methodological literature was conducted, which made it possible to establish the subject of the study; a retrospective analysis of the experience and methods of developing combat techniques, as well as a study of regulatory and legal acts and teaching and methodological aids, made it possible to identify the key research problem, which is the insufficient devel-

opment of scientific and methodological aspects of training in the tactics of the use of physical force and combat techniques by police officers in conditions close to operational and service activities; synthesis of the information obtained to improve existing methods of training police officers in the tactics of using physical force and combat techniques.

Results of the study and discussion. The established fact that there is no step-by-step training methodology or tactics for police officers to use physical force and combat techniques in conditions close to operational and service activities (in line with the general pedagogical principle of 'from simple to complex') is one of the problems of effective training for cadets at educational institutions of the Russian Ministry of Internal Affairs.

As part of the solution to this problem, the inclusion of a special educational module 'Tactics of applying combat techniques' is a necessary step towards overcoming the problem identified in the study, since this module provides a model for the lawful use of physical force, special means and firearms by police officers [2].

The main objective of tactical training in this module is to develop tactical readiness for the effective and lawful use of physical force, including combat techniques, special equipment and firearms. Achieving this goal involves solving a wide range of tasks. These tasks are closely related to such components of readiness as theoretical, intellectual, physical (motor) and psychological readiness. By shifting the emphasis in setting training tasks in one direction or another, we can purposefully influence all aspects of the trainees' readiness.

Training cadets of educational organisations of the Russian Ministry of Internal Affairs in the tactics of applying combat techniques within the framework of the specified module involves a combination of various methods and means that take into account the target component (the goal of training, conditions and factors of implementation, etc.), the specifics of the subject area of operational and service activities, and available educational resources. Accordingly, from the very first classes, students are tasked with studying the conditions and identifying the factors that allow them to recreate the situation of an operational service environment and build the most effective model of physical force application for it, as well as determine and use the most rational means and methods when practising practical skills.

As a result of tactical training, the following should be developed:

1. Knowledge of methods and tactics for the use of force to prevent offences, detain and escort offenders in the course of performing official duties, as determined by the qualification requirements for special professional training established by the Ministry of Internal Affairs of the Russian Federation; the procedure and tactics for the use of physical force, special means and firearms when detaining offenders, including in conditions of extreme necessity and necessary self-defence.

2. The ability to carry out actions to forcibly suppress offences, detain and escort offenders in the course of performing official duties; assess threats to personal safety, identify their sources, make decisions on their minimisation or neutralisation; detain and transport offenders in complex operational situations; use physical force, special means and firearms when detaining and transporting offenders, including in cases of extreme necessity and necessary self-defence.

3. Skills in the use of force to suppress offences, detain and escort offenders in the course of performing official duties, techniques for the safe and effective detention of criminals using physical force, special means and firearms.

To clarify the above, it seems logical to note that within the framework of a single training session on the topic of 'Tactics for the use of combat techniques', for example, such training issues as 'Improving pain techniques on the arm' and 'Solving problems related to suppressing resistance to a police officer' are considered. While the first topic is covered through sports training, the second one is covered by using tactical schemes based on the skills learned in pairs with an assistant. The idea is to solve several tactical problems using hand pain techniques depending on the nature and degree of resistance of the assistant to the simulated police officer.

During the testing of the author's course on the module 'Tactics of applying combat wrestling techniques,' the most effective methods of organising participants during classes were found to be group and shift methods, while less effective methods were found to be flow and individual methods.

A prerequisite and leading methodological recommendation for mastering the module is the inclusion of various methodological techniques aimed at complicating the tasks (performing training tasks

after physical exertion, using distracting factors: actions of third parties, insufficient lighting, loud and sharp sounds, ice, etc.) in confined spaces (stairwell, room, corridor, etc.), sudden changes in task conditions, etc.), which increases the effectiveness of tactical training.

The training of cadets at educational institutions of the Russian Ministry of Internal Affairs in the tactics of applying combat techniques includes the following traditional stages: initial (introductory), in-depth training and improvement.

It should be noted that at the improvement stage, the effectiveness of tactical training in the use of combat techniques in conditions simulating an operational service situation during training sessions can only be ensured by including the following components in the educational process:

1) creation of a quasi-professional educational environment (operational conditions) in training sessions;

2) design of local training and tactical tasks (corresponding to real situations) for the detention of offenders;

3) developing training and methodological materials to support the educational process, focused on the professional activities of police officers.

Taking into account all of the above components within the framework of tactical training for cadets at educational institutions of the Russian Ministry of Internal Affairs, it seems possible to form a sustainable skill in the application of combat techniques in operational service conditions.

Conclusions. The effectiveness of training cadets at educational institutions of the Russian Ministry of Internal Affairs in combat tactics depends on the introduction of an additional educational module into the physical training programme 'Tactics of Combat Techniques' on tactical training, which combines various methods and means that take into account the target component, the specifics of the subject area of operational and service activities, and available educational resources.

It should be noted that expanding the content of educational programmes for training law enforcement officers in physical training disciplines with the proposed module 'Tactics of Combat Techniques' entails additional tasks at the level of the educational institution:

– improving the criteria for assessing the readiness of law enforcement officers to act in situations involving the use of physical force, special means and firearms;

– improving the qualifications of teaching staff conducting classes in the system of professional service and physical training;

– increasing the responsibility of training group leaders for the physical training of their units;

– providing methodological support for the training section 'Tactics of Combat Techniques.'

Solving these tasks broadens the scope of the research and gives a clear idea of its future directions.

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Analysis of the physical fitness of civil aviation pilots based on heart rate variability research

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Abstract

Objective of the study is to analyse the physical condition of civil aviation pilots and develop an optimal physical training programme aimed at improving flight safety.

Methods and structure of the study. The analysis of the most informative indicators of heart rate variability was carried out to assess the functional state of pilots, including time domain metrics such as: SDNN – Standard Deviation of NN intervals (average value of variability in milliseconds and reflecting heart rate variability over a certain time), RMSSD – Root Mean Square of Successive Differences (metric showing activity of the parasympathetic nervous system and reflecting changes in the duration of intervals between heartbeats), frequency domain: LF/HF – Low Frequency/High Frequency and specific Russian indices: Bayevsky index (stress index of regulatory systems), IARS (indicator of adaptation of regulatory systems).

Results and conclusions. The scientific work was carried out using the Varicard 3.0 system. 42 active civil aviation pilots of the Russian Federation aged 25 to 40 years participated in it, randomly assigned to experimental (n=21) and control (n=21) groups. The experimental group used a developed physical training program lasting 2 months, after which a significant improvement in heart rate variability was revealed. The control group showed no significant changes in the same indicators. As a result of the research, a universal method for identifying the physical condition of pilots and a structured training program for improving physical condition in order to increase flight safety were developed.

Keywords: physical training, pilots, civil aviation, heart rate, stress factors, analysis.

Introduction. The work of civil aviation pilots is associated with high levels of stress, which has a significant impact on the functional state of the pilot's body and, as a result, on flight safety. Stress factors for pilots include increased psycho-emotional and physical stress, long flights, hypoxia and vibration, which affect the cardiovascular system.

In recent years, heart rate variability analysis has been actively used in aviation medicine as an objective, non-invasive method for assessing the state of regulatory systems [1, 2]. A number of studies have found that heart rate variability (HRV) indicators reflect the body's ability to adapt to stress and directly correlate with the psychophysiological stability of pilots [5, 6, 8]. An analysis of international practice shows that approaches to HRV analysis vary around the world, as do methods for optimising vegetative regulation in pilots, leading to a lack of uniform standards [3, 7]. This significantly complicates the development of scientifically based programmes for the prevention of occupational stress.

Objective of the study is to analyse the physical condition of civil aviation pilots and develop an optimal physical training programme aimed at improving flight safety.

Methods and structure of the study. The scientific work was carried out by randomly dividing the subjects into two groups. The participants in the study were 42 active civil aviation pilots in the Russian Federation aged between 25 and 40 (23 men and 19 women), selected by random sampling from pilots working for four major airlines and meeting the following criteria: no chronic diseases of the cardiovascular and respiratory systems, no pronounced psycho-emo-

tional disorders (<11 points on the HADS scale), low to moderate physical fitness (no regular intensive training more than 3 times a week), and at least 2 years of experience as a pilot.

The criteria for exclusion from the study were: taking medications that affect the autonomic nervous system, acute respiratory diseases, refusal to participate in the study, alcohol consumption within 48 hours prior to testing. The basic characteristics of the study participants are shown in Table 1.

In the first stage, pilots were surveyed to conduct a detailed analysis of their lifestyle characteristics. The IPAQ physical activity questionnaire was used. HRV indicators were also recorded using the Varicard 3.0 software and hardware complex [4] under the following conditions: in the morning (9:00-11:00), on an empty stomach or 2 hours after a light breakfast, in a sitting position after a 10-minute rest, in a room with a temperature of 20-22°C, with a recording duration of 5 minutes.

The following parameters were evaluated: time indicators (SDNN, pNN50); frequency indicator LF/HF ratio; Russian indices (stress index SI and IARS; functional tests (Stange test, Genchi test).

Over the course of eight weeks, the experimental group followed a structured physical training programme with a progressive increase in load every two weeks, including:

Aerobic exercise (5 days a week):
Weeks 1-2: walk 2 km in 25-30 minutes;
Weeks 3-4: walk 2.5 km in 25-30 minutes;
Weeks 5-8: walk/jog 3 km in 25-30 minutes.
Strength training (3 times a week):
Squats: 3 8–12 reps;
Plank: 3 30–60 seconds;
Push-ups: 3 6–10 reps.
Lifestyle recommendations: 7-8 hours of sleep; no caffeine after 4 p.m.; active recovery days involving walking.

The control group also received recommendations, but these did not constitute a structured programme.

Compliance with the programme by the experimental group was monitored through daily electronic training diaries, the use of a fitness tracker and an assessment of training regularity: high (>80% of training sessions), medium (60-80%), low (<60%).

Results of the study and discussion. For the purposes of the study, an analysis of international experience was conducted in its early stages, which revealed the most reliable metrics used in China, Europe, and the United States [6].

The main HRV indicators and their significance for pilot monitoring are shown in Table 2.

The baseline HRV indicators in the study groups are shown in Table 3.

Table 1. Basic characteristics of study participants

Indicator	Experimental group (n=21)	Control group (n=21)	P-value
Age, years	32,4±4,8	33,1±5,2	0,652
Sex (M/F)	12/9	11/10	0,754
BMI, kg/m²	24,8±2,3	25,2±2,7	0,586
Work experience, years	7,2±3,4	6,8±2,9	0,684
Flying time per month (hours)	78,3±12,6	81,2±14,1	0,469

Table 2. Key HRV indicators and their significance for pilot monitoring

HRV indicator	Physiological significance	Typical values (resting)	Comments specific to pilots
SDNN (ms)	Total HRV; reflects the influence of the sympathetic and parasympathetic divisions of the ANS (autonomic nervous system)	30-69 (short-term 5-minute norm)	Pilots often have values at the lower limit of normal (~40-50 ms) due to occupational stress
RMSSD (ms)	Short-term interbeat variability; predominantly vagal tone	~20-50 ms	Reduced under conditions of functional stress (e.g., ~24 ms when flying on a simulator)
LF/HF Ratio	Balance of sympathetic and parasympathetic regulation	~1,5 (in young adults); >2.5 often indicates tension	Pilots often show elevated values under workload (up to ~5.7 during complex manoeuvres)

In the experimental group, 18 participants (85.7%) demonstrated high interest (>80% of training sessions), and 3 participants (14.3%) demonstrated moderate interest (60-80%). One participant from the experimental group was excluded from the study due to acute illness in the sixth week of the programme. Therefore, the analysis was performed according to the 'as intended' protocol for n=20 in the experimental group and n=21 in the control group.

In the experimental group, significant improvements in most HRV indicators were observed compared to the baseline data (Table 4).

Intergroup comparisons based on the study results revealed a pronounced effect across all indicators: SDNN: $p<0.001$, Cohen's d=1.12; stress index: $p=0.002$, Cohen's d=0.87; resting heart rate: $p<0.001$, Cohen's d=1.18.

The study also revealed a correlation between the results obtained and the initial level of fitness. Participants with lower SDNN scores (<45 ms, n=8) showed the greatest increase – 9.2±2.4 ms versus 4.1±1.7 ms in participants with SDNN >45 ms (p=0.002).

Conclusions. As a result of the study, a universal method for assessing the physical condition of pilots and a structured training programme for improving physical condition with the aim of increasing flight safety were developed. It was found that SDNN, RMSSD and stress index are objective markers for determining the condition of pilots.

The study showed that active pilots demonstrate signs of functional stress in regulatory systems: SDNN at the lower limit of normal (47.0±6.0 ms) and an elevated stress index (131.0±39.5 u.e.). An eight-week physical training programme resulted in significant improvements: a 13.3% increase in SDNN (Cohen's d=0.98) and a 16.1% decrease in the stress index (Cohen's d=0.59). The results of the study indicate the need to integrate such programmes into the professional training system for civil aviation pilots in order to improve flight safety.

Table 3. Baseline HRV parameters in the study groups

Indicator	Experimental group (n=21)	Control group (n=21)	P-value
SDNN (ms)	47,2±6,1	46,8±5,9	0,835
RMSSD (ms)	31,4±7,8	30,9±7,2	0,836
pNN50 (%)	12,6±5,4	13,1±5,8	0,772
LF/HF ratio	2,8±0,9	2,9±1,1	0,725
Stress index (SI)	129,3±37,8	132,7±41,2	0,774
Resting heart rate (bpm)	79,6±6,2	80,4±6,8	0,686
Inhalation breath hold (s)	49,7±5,8	48,9±6,2	0,672
Exhalation breath hold (s)	32,8±6,7	33,4±7,1	0,774

Table 4. Dynamics of HRV indicators after 8 weeks of research

Indicator	Group	Before	After	Δ	P-value*	Cohen's d
SDNN (ms)	Exp.	47,2±6,1	53,5±7,2	+6,3	<0,001	0,98
	Contr.	46,8±5,9	46,2±6,1	-0,6	0,672	0,10
Stress index (SI)	Exp.	129,3±37,8	108,5±33,6	-20,8	0,003	0,59
	Contr.	132,7±41,2	135,4±39,7	+2,7	0,753	0,07
Resting heart rate (bpm)	Exp.	79,6±6,2	73,4±5,7	-6,2	0,002	1,05
	Contr.	80,4±6,8	80,1±6,5	-0,3	0,865	0,05
Inhalation breath hold (s)	Exp.	49,7±5,8	56,2±6,1	+6,5	<0,001	1,10
	Contr.	48,9±6,2	49,4±6,0	+0,5	0,743	0,08
RMSSD (ms)	Exp.	31,4±7,8	36,8±8,2	+5,4	0,008	0,68
	Contr.	30,9±7,2	30,2±7,4	-0,7	0,694	0,10

*with Bonferroni correction (α=0,01)

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Dynamics and status of physical development and physical fitness of students at the agricultural university

UDC 796.012.

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Abstract

Objective of the study is to identify the dynamics and state of physical development and physical fitness of students at an agricultural university (Krasnoyarsk) from the 1st to the 3rd year, to determine the problems and prospects of the processed results based on the factual material obtained, to develop appropriate methodological adjustments, and to recommend them for use in physical education for students at the university.

Methods and structure of the study. The study was conducted between 2024 and 2025 at the educational base of Krasnoyarsk State Agrarian University. First- to third-year male students of the Krasnoyarsk Agrarian University took part in the experiment. The sample size was 180 people, 60 students in each year (1st to 3rd years). The groups of students were formed by random selection for analysis. The following research methods were selected to compile the factual material: analysis of scientific and educational literature, questionnaires, surveys, interviews, systematisation, abstraction, modelling, pedagogical observations, expert assessment, physical fitness testing, physical development measurements, mathematical statistics, etc. During the research period, more than 1,080 physical fitness tests and 900 physical development measurements were conducted. All this contributed to the collection of comprehensive factual material on students and the resolution of the scientific tasks set.

Results and conclusions. The analysis of the dynamics and status of physical development and physical fitness showed the following statistical results: the physical development of students at the agricultural university (height, body weight, and hand dynamometry) decreased on average by (-9.1%) ($p < 0.05$) from the first to the third year; the resting heart rate while sitting decreased by an average of -12.8% ($p < 0.05$); physical fitness (pull-ups on a high bar, standing long jump, sit-ups per minute, 3000-metre run, 100-metre run, forward bend from a standing position) increased by an average of 2.0% ($p < 0.05$). The final statistical results presented show that during their studies at the university, students (young men) of the agricultural university experienced a 9.1% decrease in physical development, a 12.8% improvement in heart rate ($p < 0.05$) and a slight increase in physical fitness of 2.0%. All this, in general, indicates the need to make adjustments to the physical education programme for students at the agricultural university.

Keywords: students, dynamics, physical development, physical fitness, agricultural university.

Introduction. Physical education of students is an important component and basis for the readiness of young people for active and productive professional activity. As theoretical and statistical analysis of physical education practices shows, young people's motivation and interest in physical education and sports is significantly declining. All this leads to a decrease in the indicators of physical development and physical fitness of students in higher education institutions. The number of students with health groups 2 and 3 is increasing, and their percentage reaches more than 75% of the total number of students in higher education institutions in the country. The aim of this work was to identify the initial state of physical development and physical fitness of students (young men) in the Siberian region using the example of Krasnoyarsk State Agrarian University and to develop proactive organisational and methodological measures.

Objective of the study is to identify the dynamics and state of physical development and physical fitness of students at an agricultural university (Krasnoyarsk) from the 1st to the 3rd year, to determine

the problems and prospects of the processed results based on the factual material obtained, to develop appropriate methodological adjustments, and to recommend them for use in physical education for students at the university.

Methods and structure of the study. The study was conducted between 2024 and 2025 at the educational base of Krasnoyarsk State Agrarian University. First- to third-year male students of the Krasnoyarsk Agrarian University took part in the experiment. The sample size was 180 people, 60 students in each year (1st to 3rd years). The groups of students were formed by random selection for analysis. The following research methods were selected to compile the factual material: analysis of scientific and educational literature, questionnaires, surveys, interviews, systematisation, abstraction, modelling, pedagogical observations, expert assessment, physical fitness testing, physical development measurements, mathematical statistics, etc. During the research period, more than 1,080 physical fitness tests and 900 physical development measurements were conducted. All this contributed to the collection of comprehensive factual material on students and the resolution of the scientific tasks set.

Results of the study and discussion. At the preliminary stage of the work, a theoretical and statistical analysis was carried out at Krasnoyarsk State Agrarian University between 2022 and 2025 on the physical development and physical fitness of first- to third-year male students. The sample consisted of 180 people, with 60 students in each year group.

The average age of students (± б) was 18±1 years for the 1st year, 19.1±0.5 years for the 2nd year, and 20.0±0.7 years for the 3rd year. The statistical collection of factual material contributed to the formation of analytical table 1, which presents in detail the numerical data characterising the current state of physical development and physical fitness of students (young men) using the example of Krasnoyarsk State Agrarian University.

Analysing the statistical data as a whole, it can be stated that by the third year, male students show a decline in physical development (height, body weight and hand grip strength), especially in body weight and left hand grip strength. in physical fitness, a significant decrease is observed in spinal mobility and in the 3000-metre run; speed and strength indicators (standing long jump) also decrease. The statistical data on the physical development and fitness of students (young men) at the agricultural university require necessary adjustments to the content of physical education programmes for young people in the country's universities.

Conclusions. An analysis of the physical development and physical fitness of male students in their first to third years of study in the Siberian region, using Krasnoyarsk State Agrarian University as an example, showed that male students' physical development and physical fitness indicators decline upon completion of their university studies. All this allows us to conclude that there is a need to adjust the content of physical education programmes for students in the country's universities; to develop and implement new software

Table 1 – Dynamics of physical development and physical fitness indicators of male students in years 1–3 at an agricultural university.

Physical development and fitness indicators	Year of education, $\bar{X} \pm б$			Increase in %	P
	1	2	3		
Height, cm	176,6±5,4	174,9±5,9	173,8±4,2	-1,6%	>0,05
Body weight, kg	80,1±10,3	76,7±8,6	73,4±6,1	-8,4%	<0,05
Heart rate, at rest while sitting, beats per minute	78,3±12,7	75,3±7,3	68,3±5,9	-12,8%	<0,05
Pull-ups on a high bar, number of repetitions	7,8±2,9	8,4±2,4	8,7±2,4	11,5%	<0,05
Standing long jump, cm	217,2±12,2	211,1±11,8	212,1±14,9	-2,4%	>0,05
Sit-ups per minute, number of repetitions	32,7±5,6	33,7±5,6	33,1±3,9	1,2%	>0,05
3000 m run, min/sec	15.20±2.04	15.08±1.30	16.16±1.38	-6,3%	<0,05
100 m run, sec	15,3±1,1	14,6±0,7	14,4±1,4	5,9%	<0,05
Forward bend from standing position, cm	3,0±1,1	3,7±2,4	1,9±0,7	-36,7%	<0,05
Hand grip strength, kg:					p<0,05
Right hand:	33,7±4,4	33,1±5,4	32,4±4,4	-3,9%	
Left hand:	32,4±6,9	30,2±6,1	28,1±5,6	-13,3%	

technologies and approaches aimed at improving the physical fitness and motivation of young people to participate in systematic physical culture and sports activities.

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Discipline-specific cognitive differences in esports: DOTA 2 and Counter-Strike 2

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Abstract

This study presents the results of an analysis of cognitive differences between players of two popular esports disciplines from different genres — DOTA 2 (battle arena) and Counter-Strike 2 (CS2, team shooter). A group of 37 participants (Counter-Strike 2 players, n=15; DOTA 2 players, n=12; control group, n=10) was conducted using three specialized digital trainers for assessing reaction time, visual memory, and attention concentration. The results demonstrate statistically significant discipline-specific differences: DOTA 2 players outperform CS2 players in accuracy (d=-2.078), number of targets hit (d=-1.495), and have advantage in reaction time (d=1.059). Both esports groups significantly outperformed the control group in most cognitive measures. The study confirms the applicability of the discipline-specific approach in sports science and validates the use of digital trainers for objective assessment of cognitive abilities.

Keywords: *esports, cognitive abilities, DOTA 2, Counter-Strike 2, discipline-specific differences, digital trainers.*

Introduction. Esports places specific demands on athletes' cognitive functions, including reaction time, movement accuracy, visual memory, and ability to maintain attention and concentration. These requirements have been extensively documented, including recent meta-analyses [1,2], and position esports as a promising platform for cognitive training. Accumulating evidence highlights that expert esports players consistently outperform amateurs, especially in spatial cognition and bottom-up attentional processes.

Recent investigations have demonstrated that action video games can significantly enhance cognitive processing speed across various tasks [3]. A comprehensive meta-analysis has shown that experienced video game players consistently react 11% faster than non-players across diverse cognitive tasks without sacrificing accuracy. This speed enhancement generalizes well beyond gaming contexts and has been replicated through training studies establishing causality.

For traditional sports disciplines, substantial research has been conducted confirming cognitive specificity. Athletes in "interceptive sports" (tennis, baseball) demonstrate better object recognition accuracy, reaction time, and contrast sensitivity, while athletes in "strategic sports" (football, basketball) show enhanced spatial working memory [4]. Similarly, athletes in sports with horizontal attention distribution (hockey) demonstrate greater horizontal attention breadth compared to sports requiring vertical attention (volleyball) [5].

Scientific research in esports disciplines start to focus on differential analysis between disciplines. This study [6] shows that fighting game esports players outperformed Rhythm esports players on a sustained attention, while Rhythm esports players did better on motor timing.

Furthermore, discipline-specific research has revealed distinct cognitive profiles of the first-person shooter (FPS) and (MOBA) players [7]. According to the study, FPS players excel in sustained attention, reaction time, and inhibition.

Given these emerging insights, there is a growing need to systematically investigate cognitive variation among esports players across game genres. Deepening our understanding of these differences will enable the development of more targeted training protocols

and innovative strategies for leveraging esports to enhance specific cognitive domains.

Research objective — to identify discipline-specific cognitive differences between DOTA 2 and Counter-Strike 2 players using validated digital trainers.

Materials and methods

Sample

Thirty-seven males aged 18-25 years participated in the study:

- Counter-Strike 2 players: n=15 (age 20.8 ± 1.9 years)
- DOTA 2 players: n=12 (age 21.4 ± 2.3 years)
- Non-players (control group): n=10 (age 21.7 ± 2.0 years)

Inclusion criteria for esports athletes: active gaming activity for at least 400 hours in the selected discipline, participation in amateur or semi-professional tournaments. Average MMR rating in DOTA 2 was 6000, in Counter-Strike 2 — 2500. Exclusion criteria: presence of neurological diseases, uncorrected vision disorders.

Instrumentation. The validation of digital cognitive assessment tools has become increasingly important in sports science. Recent studies have confirmed that digital trainers show high reliability and validity for cognitive assessment, with intraclass correlations ranging from 0.59 to 0.83 between self-administered and researcher-administered sessions [8].

In the context of developing digital technologies in sports, there is an increasing need for validated instruments for assessing cognitive abilities. The Click-Storm platform represents an innovative system of digital trainers specifically designed for measuring and developing cognitive abilities [9].

Three specialized trainers were used:

1. Reaction Trainer — determines reaction time and ability to accurately hit targets within 60 seconds. Parameters: accuracy (%), number of targets hit, reaction time (ms). Validity confirmed by correlation with tapping test (rs=0.898, p<0.05) [10]. Accuracy means how close to the center of the target the hit was done.

This trainer incorporates principles similar to validated reaction time assessment tools that have demonstrated strong psychometric properties in clinical and research settings.

2. Wards (Visual Memory Trainer) — trains visual and working memory. Measure: total score (higher is better). Validity confirmed by correlation with Borg RPE scale (rs=0.859, p<0.05) [11]. The design follows established principles of visuospatial memory assessment, incorporating adaptive difficulty adjustment based on performance.

3. Schulte (Attention Concentration Trainer) — accelerated version of trainer based on Schulte tables, trains attention concentration. Measure: total score (higher is better). This trainer adapts the classic Schulte table methodology to digital format, employing randomized number positions to minimize learning effects while maintaining construct validity [12,13].

According to previous studies, the platform's trainers showed high correlation with traditional psychodiagnostic methods [14,15,16]. The instrumentation was verified from recent validation studies confirming the reliability of digital cognitive assessments [10,11,14,15,16], as well as through integration of the extensively validated Schulte trainer [12,13].

Modern research emphasizes the importance of technical preparedness in computer sports, including both technique in the digital environment and the athlete's own technique. Analysis of strategy and tactics shows their key role in the sports training system of various esports disciplines.

The total assessment duration of 10-15 minutes optimizes participant engagement while minimizing fatigue effects that could confound results.

The obtained results convincingly demonstrate the high validity of Click-Storm platform digital trainers. The trainers' ability to differentiate groups with different cognitive demands confirms their suitability for objective assessment of psychophysiological parameters.

The highest discriminative ability was found for the Reaction trainer (accuracy and number of targets) and "Schulte", which is consistent with theoretical representations of the key role of these cognitive functions in esports.
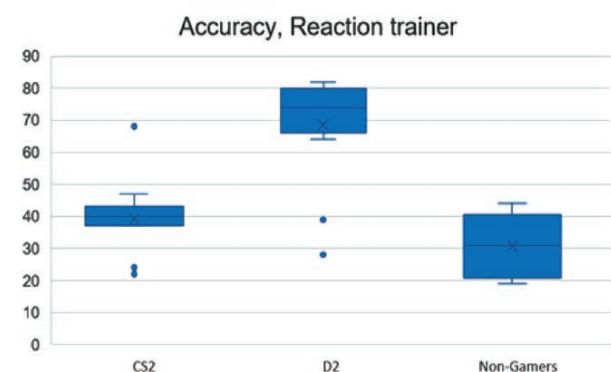

Figure 1. Box-plots for Accuracy, Reaction trainer for Counter-Strike 2 (CS2), DOTA 2 (D2), and Non-Gamers.
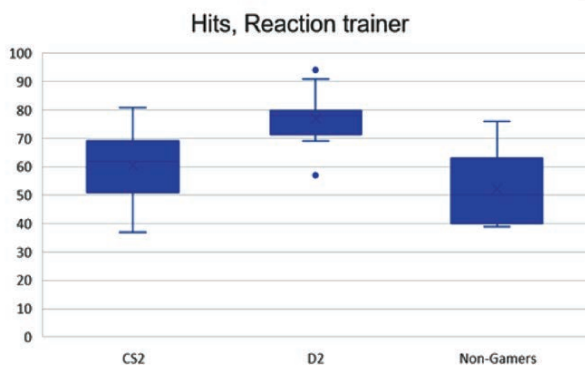
Figure 2. Box-plots for Hits, Reaction trainer for Counter-Strike 2 (CS2), DOTA 2 (D2), and Non-Gamers.
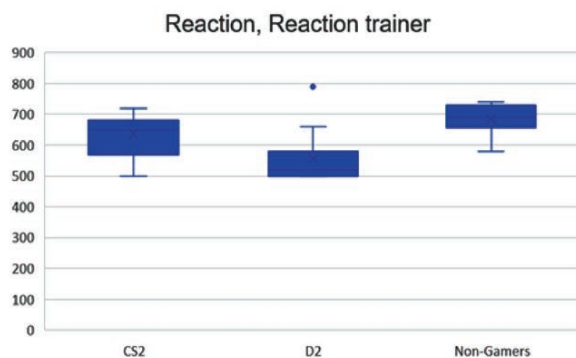

Figure 3. Box-plots for Reaction in ms, lower is better. Reaction trainer for Counter-Strike 2 (CS2), DOTA 2 (D2), and Non-Gamers.
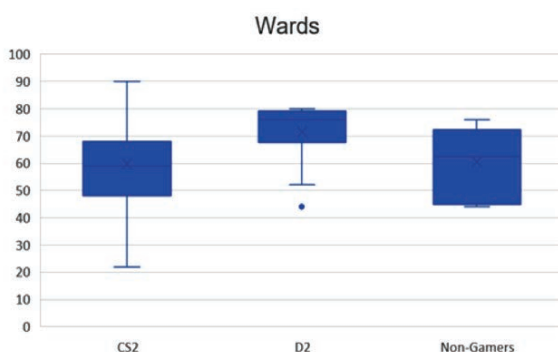

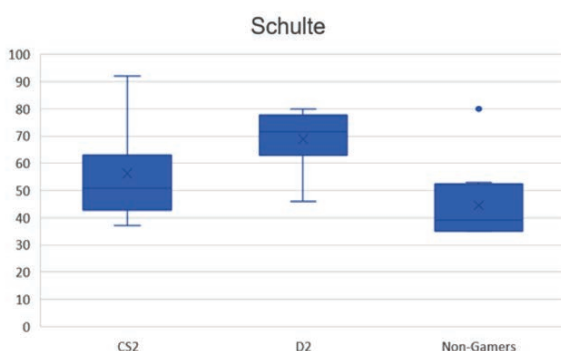*Figure 4. Box-plots for Wards, scores for Counter-Strike 2 (CS2), DOTA 2 (D2), and Non-Gamers.*

Figure 5. Box-plots for Wards, scores for Counter-Strike 2 (CS2), DOTA 2 (D2), and Non-Gamers.

Research procedure. Testing was conducted under standardized conditions in the esports auditorium of Tomsk State University. Each participant completed three attempts on each trainer with a 2-minute rest interval. The best results from three attempts were used for analysis, which corresponds to standard practice for assessing maximum performance in cognitive ability research.

Statistical analysis. Statistical data processing was performed using Python programming language (SciPy, NumPy, Pandas libraries). The following methods were applied:

• Descriptive statistics (M, SD, median, range)

• Kruskal-Wallis test for analyzing differences between three groups

• Mann-Whitney test for pairwise comparisons with Holm correction for multiple comparisons

• Cohen's d effect size calculation

• Cliff's delta for assessing directionality and magnitude of differences

The level of statistical significance was set at $p < 0.05$. Effect sizes were interpreted according to Cohen's criteria: small (d = 0.2), medium (d = 0.5), large (d = 0.8).

The choice of non-parametric statistical tests (Kruskal-Wallis and Mann-Whitney U) was made based on recent recommendations for esports cognitive research, which frequently involves non-normal data distributions and small sample size. These tests are robust to outliers and do not assume normal distribution, making them particularly suitable for cognitive performance data that often exhibits skewness.

Results

Descriptive statistics

Table 1 presents descriptive statistics for all measured indicators across the three participant groups.

Overall analysis of group differences

Kruskal-Wallis test results showed statistically significant differences between the three groups on four of five indicators:

• Accuracy: H = 16.918, p < 0.001 — highly significant differences

• Targets Hit: H = 16.446, p < 0.001 — highly significant differences

• Reaction Time: H = 13.532, p = 0.001 — significant differences

• Schulte: H = 12.245, p = 0.002 — significant differences

• Wards: H = 4.827, p = 0.089 — differences did not reach significance level

Table 1. Descriptive statistics of trainer indicators by groups

Group	Indicator	N	M	SD	Median	Min	Max
CS2	Accuracy	15	39.20	11.08	40.0	22	68
CS2	Targets Hit	15	60.47	12.16	62.0	37	81
CS2	Reaction (ms)	15	637.33	67.03	650.0	500	720
CS2	Wards	15	59.73	17.46	59.0	22	90
CS2	Schulte	15	56.13	16.14	51.0	37	92
DOTA2	Accuracy	12	68.50	17.20	74.0	28	82
DOTA2	Targets Hit	12	77.08	9.61	78.0	57	94
DOTA2	Reaction (ms)	12	555.92	87.85	520.0	500	790
DOTA2	Wards	12	71.50	11.81	76.0	44	80
DOTA2	Schulte	12	69.00	11.12	71.5	46	80
Non-players	Accuracy	10	30.80	9.82	31.0	19	44
Non-players	Targets Hit	10	52.30	12.94	50.0	39	76
Non-players	Reaction (ms)	10	684.00	56.21	690.0	580	740
Non-players	Wards	10	60.70	12.89	62.5	44	76
Non-players	Schulte	10	44.60	14.14	39.0	35	80

Table 2. Results of pairwise comparisons (Mann-Whitney test with Holm correction)

Indicator	Comparison	U	p (corrected)	Cohen's d	Interpretation
Accuracy					
	CS2 vs DOTA2	21.5	0.002*	-2.078	DOTA2 significantly higher
	CS2 vs Non-players	108.0	0.071	0.792	Non-significant differences
	DOTA2 vs Non-players	111.0	0.003*	2.626	DOTA2 significantly higher
Targets Hit					
	CS2 vs DOTA2	23.5	0.003*	-1.495	DOTA2 significantly higher
	CS2 vs Non-players	101.0	0.157	0.655	Non-significant differences
	DOTA2 vs Non-players	113.0	0.002*	2.206	DOTA2 significantly higher
Reaction Time					
	CS2 vs DOTA2	143.5	0.019*	1.059	CS2 significantly slower
	CS2 vs Non-players	36.0	0.032*	-0.741	CS2 significantly faster
	DOTA2 vs Non-players	13.5	0.007*	-1.701	DOTA2 significantly faster
Wards					
	CS2 vs DOTA2	55.0	0.184	0.773	Non-significant differences
	CS2 vs Non-players	73.5	0.956	0.061	Non-significant differences
	DOTA2 vs Non-players	92.5	0.103	0.878	Non-significant differences
Schulte					
	CS2 vs DOTA2	44.5	0.028*	-0.909	DOTA2 significantly higher
	CS2 vs Non-players	116.5	0.045*	0.750	CS2 significantly higher
	DOTA2 vs Non-players	105.0	0.010*	1.941	DOTA2 significantly higher

Pairwise group comparisons

*p < 0.05

Effect size analysis

Cohen's d effect sizes revealed the following patterns:

Very large effects (d > 1.5):
- DOTA2 vs Non-players on accuracy: d = 2.626
- DOTA2 vs Non-players on targets: d = 2.206
- CS2 vs DOTA2 on accuracy: d = -2.078

・ DOTA2 vs Non-players on reaction time: d = -1.701

・ DOTA2 vs Non-players on Schulte: d = 1.941

Large effects (0.8 < d ≤ 1.5):

・ CS2 vs DOTA2 on targets: d = -1.495

・ CS2 vs DOTA2 on reaction time: d = 1.059

・ CS2 vs DOTA2 on Schulte: d = -0.909

Discussion

Specificity of cognitive demands in esports disciplines

The study results revealed substantial differences in the cognitive profiles of Counter-Strike 2 and DOTA 2 players, confirming the hypothesis of specificity of cognitive demands across different esports disciplines. These findings align with recent meta-analytic evidence demonstrating that esports experts possess superior cognitive abilities compared to amateurs, particularly in spatial cognition and attention domains.

DOTA 2 players demonstrated superiority in:

・ Task execution accuracy (d = -2.078)

・ Number of targets hit (d = -1.495)

・ Attention concentration (Schulte test, d = -0.909)

・ Reaction speed (d = 1.059)

These results reflect the specificity of DOTA 2 gameplay, which requires high precision clicking on small objects on the map and sustained attention concentration throughout matches lasting 30-60 minutes [17]. This pattern is consistent with research demonstrating that strategy games like DOTA 2 are associated with enhanced decision-making abilities, particularly in tasks requiring ambiguous decision-making similar to real-life situations.

The observed pattern aligns with theoretical frameworks suggesting that different game genres impose distinct cognitive demands on players. MOBA games such as DOTA 2 require sustained strategic thinking, precise motor control, and complex decision-making under uncertainty. These cognitive processes encompass working memory, executive attention, spatial information processing, and the ability to rapidly switch between tasks.

It is important to note that participants from both groups (DOTA 2 and CS2 players) are not professional esports athletes and do not regularly participate in high-level tournaments. This limitation indicates the necessity for further investigation of cognitive profiles among elite players competing at the international level.

Professional esports athletes participating in top-tier tournaments may demonstrate more pronounced differences in cognitive abilities as a consequence of intensive training regimens and specialized preparation. Research involving this population would provide a more comprehensive understanding of how genre-specific gaming influences cognitive function development.

Esports enthusiasts' superiority over control group

The combined group of esports enthusiasts significantly outperformed the control group in most indicators with large effect sizes:

・ Accuracy: d = 1.18, p = 0.004

・ Targets Hit: d = 1.15, p = 0.007

・ Reaction Time: d = -1.04, p = 0.004

・ Schulte Test: d = 1.15, p = 0.003

These findings are consistent with large-scale meta-analytic evidence showing that esports experts demonstrate superior cognitive abilities with small to medium effect sizes (Hedges' g = 0.373) compared to amateurs [1]. The absence of significant differences on the "Wards" test may be explained by the specificity of the measured cognitive function or requires further investigation.

Theoretical foundation for differences

1. DOTA 2 as a model of strategic cognitive training:

・ Long matches (up to 40-60 minutes) require attention and multitasking concentration.

・ Character development planning and event prediction stimulate working memory and strategic thinking.

・ Precise motor coordination (micromanagement, last hit) develops motor accuracy and cognitive control.

2. Counter-Strike 2 as a model of reactive cognitive training:

・ Dynamic situations and short game rounds create extreme time pressure.

・ Success depends on the ability to instantly analyze visual stimuli and produce motor responses in fractions of a second.

・ The game develops attention, information processing speed, and adaptability.

This theoretical framework is supported by neuroimaging studies demonstrating that different types of video game experience produce distinct patterns of brain activation and structural changes. Action video games like Counter-Strike have been associated with enhanced processing speed and attention networks, while strategy games like DOTA 2 are linked to improvements in executive control and working memory systems [20].

Practical significance of results

The identified patterns have important practical significance for:

1. Athletic selection — possibility of identifying individual cognitive profiles for optimal choice of esports discipline.

2. Training process — development of specialized cognitive preparation programs considering discipline specificity.

3. Athlete condition monitoring — objective assessment of competition readiness and fatigue control.

The validation of digital cognitive assessment tools also has broader implications for sports science. The demonstrated reliability and validity of the Click-Storm platform suggests potential applications in traditional sports for cognitive screening and monitoring, as well as in clinical settings for cognitive rehabilitation.

These findings also pave the way for future research into how esports gamers can serve as a mental fitness tool [21], potentially enhancing cognitive abilities and academic performance among university students, and also athletes as it was preliminary shown in [22, 23].

Conclusion. The study confirmed discipline-specific cognitive differences between DOTA 2 and Counter-Strike 2 players. DOTA 2 develops strategic thinking, concentration, and motor accuracy, and ability to act under strict time pressure conditions. The obtained data expand the scientific-methodological base of sports psychology and esports, providing validated instrumentation for cognitive ability research.

The Click-Storm platform digital trainers demonstrated high construct validity and can be used as scientific and practical instruments for objective assessment of cognitive abilities in sports science. The study results open perspectives for developing specialized cognitive preparation programs for esports athletes and applying the discipline-specific approach in sports practice.

Furthermore, this research contributes to the broader understanding of cognitive plasticity and expertise development in digital environments. The observed discipline-specific cognitive profiles provide evidence for the transfer of skills between gaming contexts and potentially other domains requiring similar cognitive abilities, supporting the use of esports as both a research model for cognitive expertise and a potential tool for cognitive training interventions.

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Analysis of popular types of gto standards among middle-aged people

UDC 796

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Abstract

Objective of the study is to analyze the most popular types of GTO tests among middle-aged people and develop recommendations for optimizing the process of preparing and passing standards.

Methods and structure of the study. The analysis of scientific and methodological literature, the analysis of data on the fulfillment of the state requirements of the GTO for 2023 in the subjects of the Russian Federation based on the statistical reports of the GTO for 2023, as well as methods of mathematical statistics.

The article is based on the results of the implementation of the state task 'Improving the GTO based on the results of an expert-analytical analysis of the implementation of the GTO in the Russian Federation.'

Results and conclusions. In 2023, the total number of middle-aged people participating in GTO tests decreased by 9.3%. At the same time, there was an increase in female participants by 18.4% and a decrease in male participants by 6.6%, respectively.

An analysis of the popularity of test types among people aged 45 to 59 (XIII-XV levels) participating in the implementation of state GTO requirements in 2023 gave an idea of which types of tests are most in demand and accessible for this age group, as well as identified problem areas and developed recommendations for optimising the process of preparation and passing the standards.

The implementation of these recommendations will increase the accessibility and attractiveness of the GTO complex, increase the number of participants and ultimately strengthen the health of the nation.

Keywords: physical culture and sports, GTO, average age, public health, health promotion.

Introduction. Physical culture and sport play a key role in the state's social policy, providing opportunities for citizens to develop their talents, pursue their interests and improve their health1. It is an important tool for enhancing human potential and improving the quality of life of Russians [1].

However, in the socio-psychological context of physical education, one of the main problems is the lack of personal interest among middle-aged people in training for and passing the GTO standards. The lack of deep positive motivation to participate in GTO activities may lead to its values not being accepted by the population. It should be noted that professional self-realisation is directly related to active and regular participation in physical culture and sports [2].

Objective of the study is to analyze the most popular types of GTO tests among middle-aged people and develop recommendations for optimizing the process of preparing and passing standards.

Methods and structure of the study. The analysis of scientific and methodological literature, the analysis of data on the fulfillment of the state requirements of the GTO for 2023 in the subjects of the Russian Federation based on the statistical reports of the GTO for 2023, as well as methods of mathematical statistics.

¹Order of the Ministry of Sport of the Russian Federation No. 117 of 22 February 2023 'On the Approval of State Requirements for the All-Russian Physical Culture and Sports Complex "Ready for Labour and Defence" (GTO)' URL: https://www.garant.ru/products/ipo/prime/doc/406525773 (data of access 03.09.2025).

The article is based on the results of the implementation of the state task 'Improving the GTO based on the results of an expert-analytical analysis of the implementation of the GTO in the Russian Federation.'

Results of the study and discussion. The total number of middle-aged participants selected for 2023 (XIII-XV stages) was 53,773, with women accounting for 21% of the total (Figure 1). This figure represents a 9.3% decrease compared to 2022.
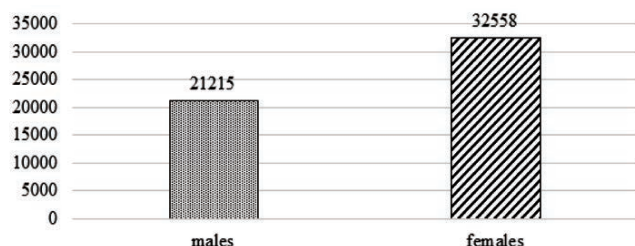

Fig. 1. Number of test participants by gender for 2023

It should be noted that in order to assess different physical qualities, the mandatory test programme and optional tests include a varying number of control exercises, ranging from one (flexibility tests) to twenty (endurance tests).

In 2023, due to the wide variety of test exercises offered, there has been a redistribution of the most popular types of tests for both males and females.
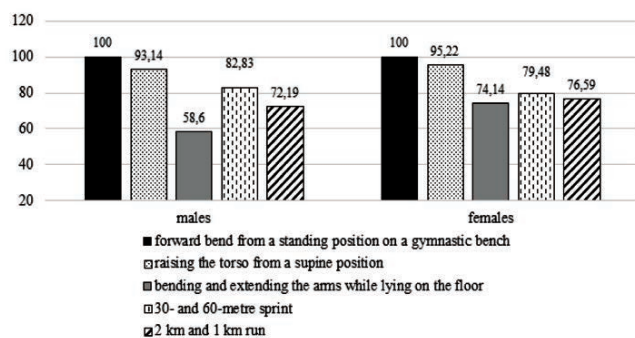

Fig. 2. Most popular types of tests among males and females aged 45–49 (%)

An analysis of the popularity of mandatory tests among men aged 45-49 (level 13) revealed the following. The forward bend from a standing position on a gymnastic bench took the lead with 100%. The 1000 m run test was equally popular among men in this age group (72.19%). The push-up test was the third most

popular (58.6%), followed by pull-ups on a high bar (28.93%). Few chose the pull-up test on a low bar (3.12%) and the 16 kg kettlebell snatch test (9.4%). The 5 km cross-country skiing test (1.41%) and the 3 km cross-country running test (1.38%) were also not very popular in 2023 (Figure 2).

Popular mandatory tests among women aged 45-49: forward bend from a standing position on a gymnastic bench (100%); 1000 m run (76.59%), as well as push-ups and sit-ups on the floor (74.17%). In 2023, women showed the least activity in the 2 km cross-country skiing test (1.45%) and the 2 km cross-country running test (1.32%).

In the optional tests for men aged 45-49, preferences were distributed as follows. The absolute leader was the test of lifting the torso from a supine position (93.11%). The 50 m swimming test was chosen by 15.49% of men. The 60 m running test became more popular in 2023 (82.83%). Approximately one in three men aged 45-49 preferred shooting from a seated position with support (20.96%) or shooting with an air rifle or electronic weapon (20.2%) as their test of choice. The least popular test in 2023 was the hiking trip with a test of hiking skills (1.53%).

In the tests of choice, women aged 45-49 most often chose the sit-up test (95.22%). Only 15.7% chose the 50 m swimming test in 2023 (a similar trend was observed among men in this test). The 60 m run was quite popular in 2023 (79.48%). A test such as air rifle shooting remains quite popular (20.79%) and consistently ranks third in the rating of the most popular types of tests. The hiking test, which tests hiking skills, was the least popular (2.73%).

An analysis of the popularity of mandatory tests among men in the 50-54 age group (Figure 3) revealed that the two most popular tests are the forward bend from a standing position on a gymnastic bench (100%) and arm bends and extensions in a push-up position on the floor (63.67%). The pull-up test on a high bar remains moderately popular (23.86%). The 1000 m run test in 2023 was of interest to 67.03% of the test subjects, while the 2000 m run test in the same year attracted significantly less interest (25.69%). As in previous stages, low activity was noted in tests such as the 16 kg kettlebell snatch (8.2%); pull-ups from a lying position on a low bar (3.63%), as well as tests added to the list of mandatory tests in 2023: 3 km Nordic walking (4.95%); 5 km cross-country skiing (1.39%) and 3 km cross-country running (0.95%).
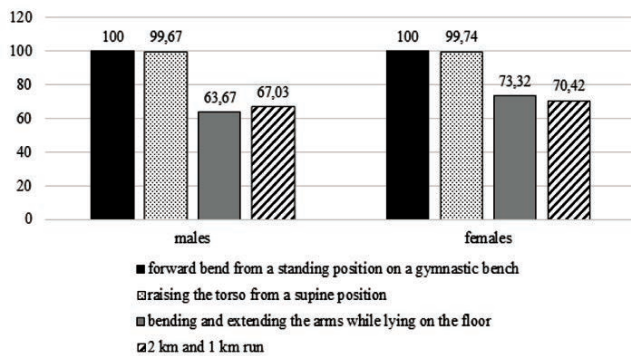
Fig. 3. Most popular types of tests among men and women of level XIV in 2023 (aged 50–54) (%)

An analysis of the popularity of mandatory tests among women aged 50-54 (level 14) found that tests such as forward bend from a standing position on a gymnastic bench and arm flexion and extension in a push-up position on the floor were among the most popular (100% and 73.32%, respectively). The 1000 m run test was also highly popular (70.42%). The pull-up test from a lying position on a low bar remained moderately popular (26.74%), while the 2 km run test was 21.92%. Tests such as the 3 km Nordic walking (5.54%), 2 km cross-country skiing (1.38%) and 2 km cross-country running (0.83%) were not very popular in 2023.

In the selection tests for men at this level, the test of lifting the torso from a supine position traditionally attracted the most interest (99.67%). The 50 m swimming test (32.3%) and the air rifle shooting test (26.44%) proved to be quite popular. The average level of popularity among men aged 50-54 was recorded in the following tests: shooting from a sitting position with elbow support (34.39%). The test that became unpopular in 2023, as it was for men in the previous age group, was the hiking trip with a test of hiking skills, which was chosen by 3.18% of the test subjects.
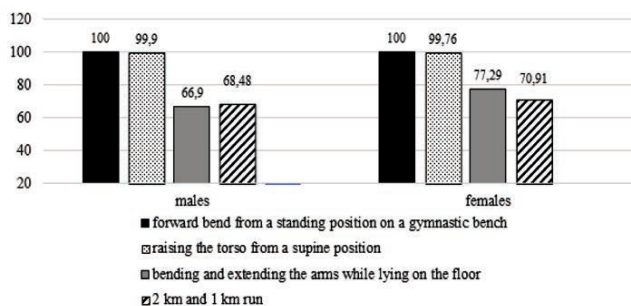

Fig. 4. Most popular types of tests among men and women of stage XV in 2023 (aged 55–59) (%)

Among the tests chosen by women aged 50-54, the following tests enjoyed consistently high interest lifting the torso from a supine position (99.74%); 50 m swimming skills (33.9%), as well as air rifle shooting (26.85%) or shooting from a seated position with support (31.21%). The least popular test was the hiking trip with a test of hiking skills (4.28%).

For males aged 55-59, which corresponds to level 15, the most popular of the mandatory tests was the forward bend test from a standing position on a gymnastic bench (100%) (Figure 4).

The second most popular test was the push-up test (66.9%), followed by the 1000 m run (68.42%). Interest remained relatively stable in the high bar pull-up test (20.59%) and the 16 kg kettlebell lift (7.85%). and the 16 kg kettlebell lift (7.85%). At the same time, the 2000 m run, which was added to the list of mandatory tests, proved to be quite popular in 2023 (24.4%). The lowest activity in 2023 was recorded for tests such as the 5 km cross-country skiing (1.46%) and the 3 km cross-country running (0.67%).

For women in the same age group of 55-59, the most frequently performed mandatory test was the forward bend from a standing position on a gymnastic bench (100%). The 1000 m run was performed by 77.29%. Tests such as push-ups on the floor attracted consistently high interest (77.29%), and the pull-up test on a low 90 cm bar was also quite popular (22.74%). Low activity in 2023 was recorded in the 3 km Nordic walking (8.89%), 2 km cross-country running (1.2%) and 2 km cross-country skiing (1.18%) tests.

When analysing the activity of men aged 55-59 in the test trials, the most popular tests were traditionally those such as lifting the torso from a supine position (99.9%); 50 m swimming (31.66%) and air rifle shooting (30.68%) or shooting from a sitting position with elbow support (31.28%). The least popular choice in 2023 was a hiking trip with a test of hiking skills (3.24%).

The popularity of the tests among women aged 55-59 was distributed as follows. The most popular tests were sit-ups from a supine position (99.76%); 50 m swimming skills (36.02%), and air rifle shooting (29.13%). The least popular was a hiking trip with a test of hiking skills (4.43%).

Conclusions. In 2023, the total number of middle-aged people participating in GTO tests decreased by 9.3%. At the same time, there was an increase in female participants by 18.4% and a decrease in male participants by 6.6%, respectively.

An analysis of the popularity of test types among the population aged 45 to 59 (XIII-XV levels) participating in the implementation of state GTO requirements in 2023 gave an idea of which types of tests are most in demand and accessible for this age group, as well as allowed to identify problem areas and develop recommendations for optimising the process of preparation and passing the standards.

Thus, the analysis of popular types of tests in this age category made it possible to develop a number of recommendations for optimising the process of preparing for and passing GTO standards:

1. creation of accessible and understandable brochures, videos, and infographics dedicated to each type of test, the specifics of preparation and evaluation criteria, and dissemination of information through municipal portals and social networks;

2. Organising seminars, master classes, and open training sessions with experienced instructors and athletes to demonstrate exercise techniques, share experiences, and motivate participants.

3. Providing advice and recommendations based on the individual age characteristics and physical fitness level of each participant.

4. Organising team competitions and events aimed at promoting GTO in the local community, creating a spirit of competition and mutual support;

5. Developing training recommendations that take into account gender-specific characteristics of the body and selecting appropriate exercises;

6. Developing programmes and events for enterprises and organisations aimed at involving employees in training and passing GTO standards.

The implementation of these recommendations will increase the accessibility and attractiveness of the GTO complex, increase the number of participants and ultimately strengthen the health of the nation.

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Activities of municipal sports schools and olympic reserve schools in large cities of Russia (for 2024)

UDC 796.077.5

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Abstract

Objective of the study is a comprehensive assessment and comparison of the development indicators of basic Olympic sports of sports schools and sports schools of the Olympic Reserve of the city of Ekaterinburg in comparison with cities with a population of one million in 2024 to identify best practices and problem areas.

Methods and structure of the study. The study was based on data from the official statistical reporting on the 5-FC form for 2024, provided by sports schools in nine million-plus cities. Methods of comparative, structural and statistical analysis were used. Quantitative and qualitative indicators are analyzed, including the network of institutions, the number of students, financial support and results of sports training. The leading cities in each of the areas have been identified, as well as key factors affecting the effectiveness of sports reserve training.

Results and conclusions. A comparative analysis of the development of basic Olympic sports in Ekaterinburg and cities with millions of residents revealed a significant differentiation in the development of the sports training system in the largest cities of Russia. The findings suggest that there is no universal model of success. The effectiveness of training a sports reserve depends on a number of factors: financial security, historically established sports specializations in the region, and management effectiveness. To even out the situation and increase the overall competitiveness of Russian sports, it is advisable to exchange best practices between regions and develop targeted measures to support lagging areas.

Keywords: major cities of Russia, sports schools, Olympic reserve schools, comprehensive assessment, sports training.

Introduction. The sports reserve training system is the foundation of Russian sport's achievements on the international stage. Municipal sports schools (SS) and Olympic reserve sports schools (SSOR) play a key role in this process, ensuring mass participation and the selection of promising athletes. Given the uneven socio-economic development of Russia's regions, a comparative analysis of the activities of such institutions in the largest urban agglomerations – cities with a population of over one million – is relevant.

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tions in the largest urban agglomerations – cities with a population of over one million – seems relevant[1], [2].

Objective of the study is a comprehensive assessment and comparison of the development indicators of basic Olympic sports of sports schools and sports schools of the Olympic Reserve of the city of Ekaterinburg in comparison with cities with a population of one million in 2024 to identify best practices and problem areas.

Methods and structure of the study. The study was based on official statistical reports (Form 5-FK) for 2024 provided by sports schools in nine cities with populations exceeding one million: Volgograd, Voronezh, Ekaterinburg, Krasnoyarsk, Nizhny Novgorod,

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[1] Strategy for the Development of Physical Culture and Sport in the Russian Federation for the Period until 2030. Decree of the Government of the Russian Federation No. 3081-r of 24 November 2020.
[2] Federal Law No. 329-FZ of 4 December 2007 'On Physical Culture and Sport in the Russian Federation'.
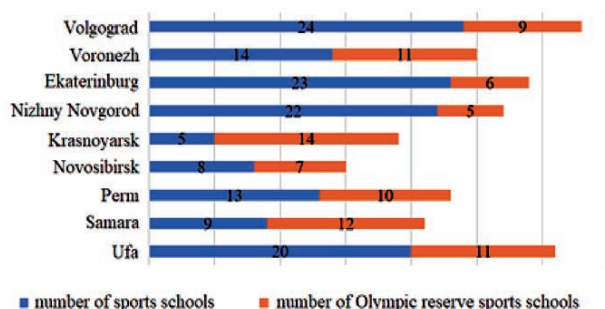
Fig. 1. Number of sports facilities
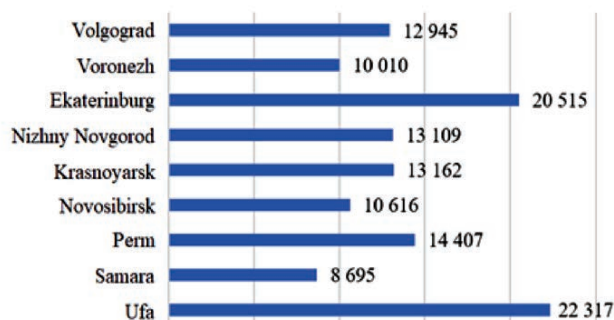
Fig. 2. Number of persons employed at the expense of the budget, persons

Novosibirsk, Perm, Samara, and Ufa. Comparative, structural and statistical analysis methods were used[1].

Quantitative and qualitative indicators were analysed, including the network of institutions, the number of participants, financial support and the results of sports training. Leading cities in each area were identified, and key factors influencing the effectiveness of sports reserve training were determined [3].

Results of the study and discussion.

[1] Federal statistical observation form No. 5-FK 'Information on physical culture and sports' for 2024.

1. **Network of institutions and number of participants.**

Overall, the largest number of sports schools (SS and SSOR) is recorded in Volgograd. Ufa, Ekaterinburg, Nizhny Novgorod and Voronezh are slightly behind. The smallest number of institutions is in Samara, Krasnoyarsk and Novosibirsk.

The highest coverage of athletes in selected sports funded by budgetary resources was observed in Ufa and Ekaterinburg. The lowest coverage was observed in Samara, where this indicator is almost three times
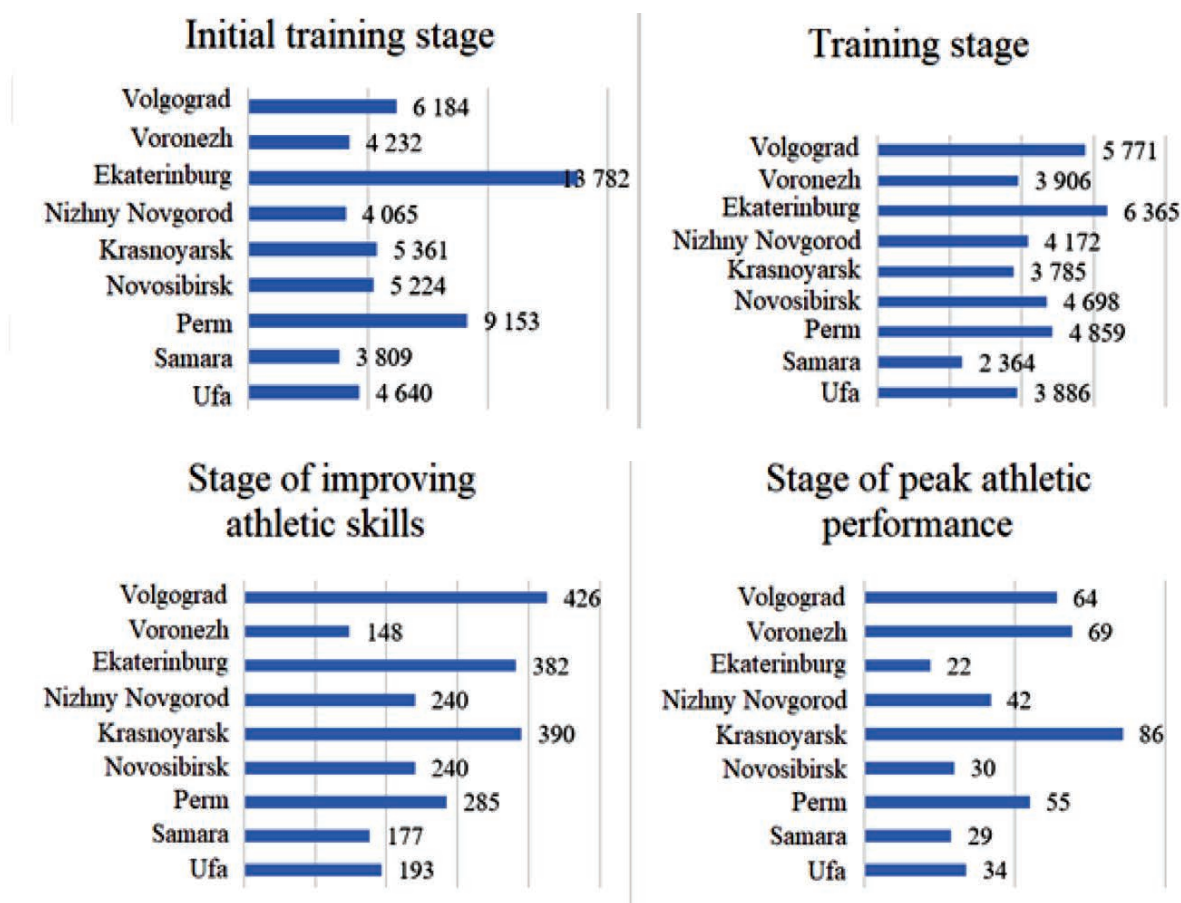
Fig. 3-6. Number of students at various stages of training in the sport of football, persons

lower than in Ekaterinburg. Ekaterinburg is also the leader in terms of the number of people participating on a paid basis.

By age group: Ekaterinburg leads in terms of the number of children at the initial training and educational training stages (5-18 years old). Volgograd and Krasnoyarsk demonstrate the best results at the stages of improving sports skills and higher sports skills, with both cities showing the maximum number of students at the stage of improving sports skills in the sport of football.

The least variety of selected sports (18 out of 27 analysed) is observed in Samara.

2**. Sports training results.** In terms of the total number of categories awarded (junior, III, II, I), Ekaterinburg is the absolute leader (thanks to its results in basketball, biathlon, volleyball, cross-country skiing, shooting, and gymnastics).

Fig. 7. Total number of ranks awarded in 2024, persons

Ekaterinburg and Volgograd are leaders in terms of awarding sports titles and ranks (candidate for master of sports, master of sports, master of sports of Russia of international class), which is primarily due to successes in swimming in Ekaterinburg and successes in judo in Volgograd.

Ekaterinburg and Nizhny Novgorod are leaders in terms of the number of candidates for the Russian national teams. Ekaterinburg leads in junior and senior teams (athletics, rock climbing, figure skating), while

Fig. 8. Number of medals won at All-Russian competitions, pcs.

Nizhny Novgorod leads in youth and senior teams (cross-country skiing, sailing and diving).

According to the results of all-Russian competitions, athletes from Ekaterinburg and Voronezh won the most medals (championships, championships and Russian Cups). The key sports were figure skating, athletics, synchronised swimming and wrestling.

Athletes from Krasnoyarsk have achieved the greatest success in international competitions, mainly in athletics and wrestling.

3. Financial support. Data is provided on the total amount of funds received from the founder, the executive authority of the Russian Federation in the field of physical culture and sports, education authorities at all levels, municipal authorities and extrabudgetary sources, spent in cities with a population of over one million [2]. Krasnoyarsk and Ekaterinburg are the leaders in terms of the total expenditure of sports schools and Olympic Reserve sports schools for all cultivated sports. Ekaterinburg and Novosibirsk demonstrate the highest indicators in terms of income-generating activities, which testifies to the effectiveness of additional financing mechanisms.

Fig. 9. Financial activities (expenses), thousand roubles

Conclusions. A comparative analysis of the development of core Olympic sports in Ekaterinburg and other cities with a population of over one million revealed significant differences in the development of sports training systems in Russia's largest cities.

Ekaterinburg demonstrates balanced development of basic Olympic sports in most indicators: it leads in terms of coverage of participants (including paid services), the number of ranks and titles awarded, training of national team members, and medalists at all-Russian competitions. Krasnoyarsk shows outstanding results in training high-class athletes, leading in terms of success on the international arena. Samara lags behind other cities with a population of over one million

in most of the indicators analysed. The data obtained indicate that there is no universal model for success. The effectiveness of training the next generation of athletes depends on a bunch of factors: financial security, the region's historical sports specialisations, and how well it's managed [1]. To even things out and make Russian sports more competitive overall, it makes sense for regions to share best practices and come up with targeted ways to support areas that are falling behind.

The results of the data obtained can be used:

– by heads of physical culture and sports management bodies at both the federal and municipal levels to find effective solutions and implement them in their work to increase competitiveness and productivity, as well as to develop targeted management decisions.

– directors of sports schools and Olympic reserve sports schools to assess their own position in a competitive environment and borrow successful experiences from colleagues in other regions.

– researchers to conduct more in-depth industry research.

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Research of the technique of percussion massage in the training day of high-qualified rowers of academists

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Introduction. The purpose of the study is to investigate the effect of a short-term percussion massage session on anaerobic power and external respiration parameters in qualified academic rowers. The study revealed that there was a statistically significant increase in anaerobic performance and total work performed after the percussion massage session.

Objective of the study is to investigate the effect of a short-term percussion massage session on anaerobic power and external respiration parameters in qualified rowers.

Methods and structure of the study. Academic rowing is one of the most physically demanding cyclic sports, which places high demands on both the aerobic and anaerobic energy systems of the athlete's body. Therefore, finding effective and accessible methods to improve performance and accelerate recovery processes is a priority in the training of high-class rowers. In recent years, percussion (vibration) massage, implemented using specialized devices, has gained widespread use in sports practice [1].

The study involved 12 male athletes specializing in rowing. The participants ranged in age from 18 to 22 years old. The athletes' athletic qualifications ranged from II adult category to master of sports. All the athletes were in the preparatory phase of their annual training cycle and had no injuries or medical contraindications. The total duration of the percussion massage session was 2 minutes and 15 seconds. The protocol included sequential exposure to the muscles of the back (60 seconds), neck (15 seconds), and arms (15 seconds each). The choice of these muscle groups was based on their active participation in the stroke phase.

Results of the study and discussion. The data obtained clearly demonstrate the improvement of almost all key power characteristics after massage effect. After the percussion massage session, there was a statistically significant increase in anaerobic performance indicators: peak power (by 4.80%, $p=0.03$), relative peak power (by 3.20%, $p=0.04$), relative average power (by 4.23%, $p=0.04$), and total work performed (by 5.20%, $p=0.03$). The time to reach peak power and gas exchange indicators did not show significant changes. Improved strength performance may be associated with neuromuscular activation, improved local blood flow, and reduced muscle stiffness.

It should be noted that this study has a certain limitation due to the absence of a control group. The positive changes observed may be partially due to the learning effect when the test is repeated. To more accurately assess the isolated effect of massage, future studies should include a control group that performs the test under identical conditions without percussion massage.

Conclusions. A short-term session of percussion massage is an effective means to increase anaerobic power and performance in rowers, which can be used as an element of warm-up or pre-start preparation.

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Involvement of the working-age population in physical culture and sports activities

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Abstract

Objective of the study is to study the effectiveness of the digital portal mosgorsport.ru as part of attracting the able-bodied population to systematic physical culture and sports in Moscow, identify problem areas and factors that reduce citizens' interest in using the portal's services based on an expert survey.

Methods and structure of the study. Employees of the "Mosgorsport" were involved in the study: managers, instructors, methodologists and trainers. At the first stage, the analysis of annual statistical data on the activities of district administrations for the development of mass sports in Moscow was carried out. At the second stage, an expert assessment of the effectiveness of the digital portal was conducted. mosgorsport.ru (hereinafter referred to as the portal).

Results and conclusions. The formed information and digital space (portal mosgorsport.ru), focused on the development of mass sports and the implementation of the GTO complex in Moscow, increased the interest of Muscovites in Mosgorsport events, which resulted in a 20% increase in the number of unique visitors per day (from one id). The annual increase in Moscow residents participating in mass sports events amounted to 70.7%. On average, the number of places of study increased by 10.1%, the number of created groups increased by 3.8%, the number of residents of Moscow, which completed tests on the signs of the GTO complex, increased by 11.5%. At the same time, a number of factors have been identified that negatively affect the involvement of the able-bodied population in physical culture and sports activities (hereinafter referred to as FCS) at the place of residence, among them: the complexity of the interface of the digital portal mosgorsport.ru for older people, the lack of interconnection of the portal with the Unified Medical Information and Analytical System (UMIAS), confirming the absence of restrictions on physical culture, restrictions on the choice of sports facilities and class time, overcrowding of a number of sports groups.

Keywords: physical culture and sport, digital services, public engagement, local sporting events.

Introduction. The working-age population aged 16 to 65 is a strategically important resource for Russia, on which the country's socio-economic development depends [1, 2, 4]. According to Rosstat data, the working-age population at the end of 2024 was 84.7 million people (43.6 million (51.5%) men and 41.1 million (48.5%) women). The projected decline in the working-age population by 2030 and the decrease in its social and economic activity significantly complicate the achievement of the socially important public indicators set by the President of the Russian Federation: maintaining a high level of working capacity and physical activity among the population, which can only be achieved by preserving and maintaining a high level of health for each individual citizen of our country (Decree 'On the National Development Goals of the Russian Federation for the Period up to 2030 and the Prospect for 2036' (No. 309 of 07.05.2024). Measures aimed at involving the working-age population in physical culture

and sports activities are particularly relevant in the current situation [3, 5, 6].

One such effective mechanism aimed at improving the efficiency of access for the population of Moscow to sports facilities and various types of FCS activities is the digital portal mosgorsport.ru. The portal is focused on the development of mass sports and the implementation of the GTO complex in Moscow, providing the population with information about ongoing social (budget) physical culture and sports projects aimed at improving health, increasing physical activity and the overall level of physical fitness of all categories of citizens.

Objective of the study is to study the effectiveness of the digital portal mosgorsport.ru as part of attracting the able-bodied population to systematic physical culture and sports in Moscow, identify problem areas and factors that reduce citizens' interest in using the portal's services based on an expert survey.

Methods and structure of the study. The first stage involved analysing annual statistical data from the Mosgorsport information portal, which contains information on the results of promoting physical cul-

ture and mass sports in Moscow, coordinating and implementing the GTO, and quantitative indicators of the involvement of citizens of different ages in the physical culture and sports system.

At the second stage, an expert assessment of the effectiveness of the digital portal mosgorsport.ru was carried out. Employees of Mosgorsport took part in the study: managers, instructors, methodologists, and coaches (n=10) [7].

Results of the study and discussion. The structure of Mosgorsport clearly demonstrates the diversity of forms of organisation and implementation of physical culture, health and mass sports activities in residential areas, covering all administrative districts and areas of Moscow (Fig. 1).

The popularity of the portal was assessed by the number of visits to the site. In 2024, the average daily number of visits to the site exceeded 350,000 unique visitors (from a single ID). The functioning Mosgorsport portal and its mobile application allow the population to obtain all information about the place, time, conditions of training sessions and physical education and sports events, choose a sport and
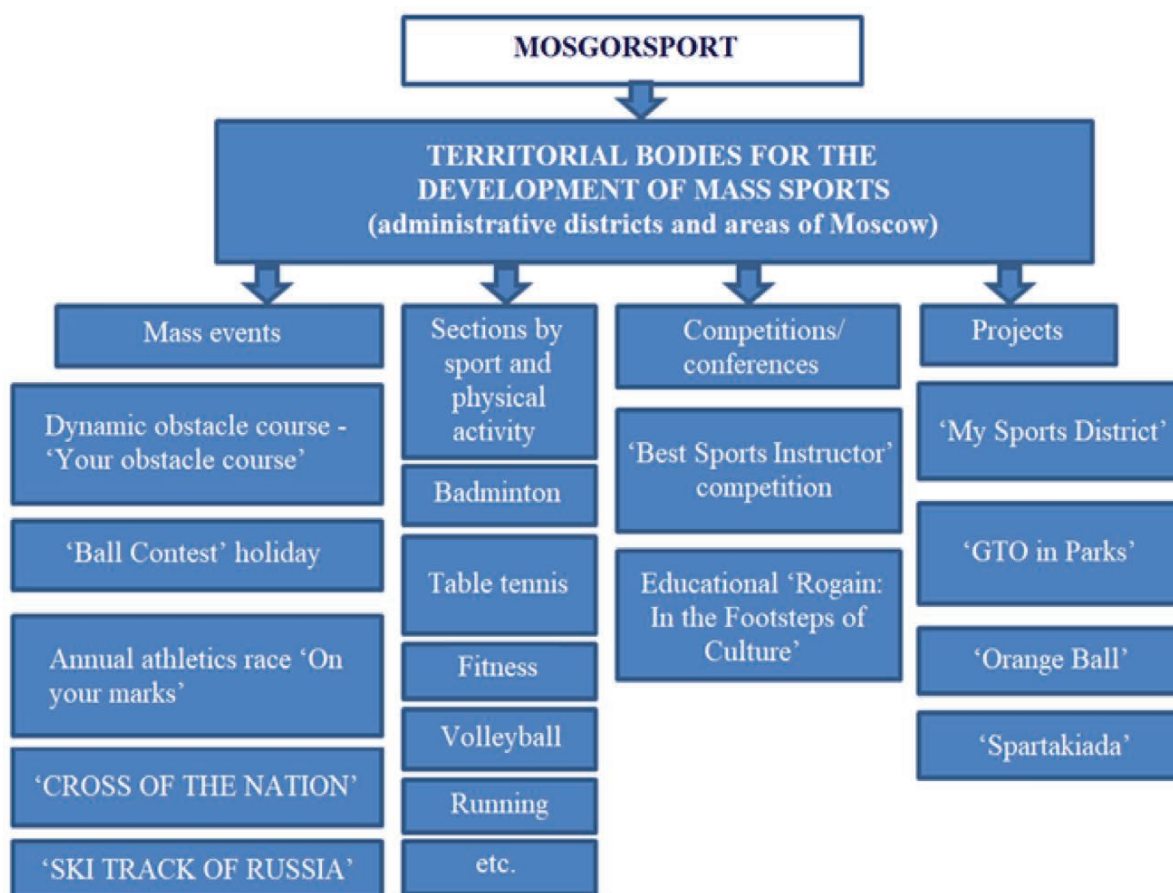

Fig. 1. Structure of physical culture and mass sports activities at Mosgorsport

Table. Expert assessment of factors reducing the effectiveness of adult participation in physical education and sports activities (n=10)

Assess-ment scale	Level of significance	Reasons preventing more active use of physical culture and health services provided on a budgetary basis by Mosgorsport									
		Factor, expert, assessment (degree of significance)									
5	very significant	Inconvenient class times, limited to two hours per week									
		1	2	3	4	5	6	7	8	9	10
		4,8	4,9	4,9	4,9	4,9	4,9	4,8	4,9	4,9	4,8
4	more significant than less	Difficulties associated with the inconvenient process of registering at the section and obtaining a medical certificate (lack of connection with UMIAS)									
		4,3	4,2	4,1	4,2	4,3	4,2	4,4	4,4	4,3	4,4
3	less significant than more	Overcrowding of a large number of sports groups and the inability to enrol in them									
		3,0	2,8	2,9	2,8	2,9	2,9	2,9	2,8	2,8	2,9
2	not very significant	Inconvenience of access to infrastructure and portal interface									
		2,2	2,1	2,1	2,2	2,3	2,2	2,2	2,1	2,1	2,1
1	not significant	Dismissals from groups for missing classes									
		1,2	1,2	1,3	1,2	1,1	1,4	1,3	1,3	1,4	1,3

type of physical activity, register online for a section or free classes based on their preferences, access online events and multimedia resources, and choose a coach.

The publicly available statistical information published on the portal allows Mosgorsport's activities to be assessed in terms of quantitative indicators such as: the number of training sessions per year (300,000); the number of coaches and sports instructors involved in the implementation of projects (500 people); the number of mass sports (70), the number of sections for mass sports (9,647) (Fig. 2).

Qualitative growth indicators include: a 3.8% increase in the number of budget places in sports sections compared to 2023 and a 75.6% increase compared to 2022; a 14.9% increase in the number of GTO badges compared to 2023 and a 24.1% increase compared to 2022 (Fig. 2).
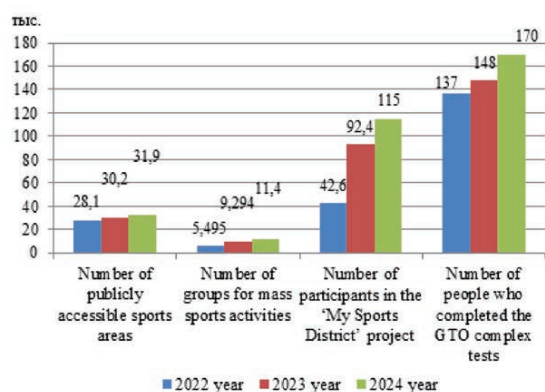

Fig. 2. Number of people involved in Mosgorsport projects

The data obtained demonstrates the effectiveness of the mosgorsport.ru digital portal in encouraging the working-age population to engage in regular physical education and sports activities in their place of residence, by synchronising the activities of local mass sports development authorities and optimising the processes of monitoring attendance and recording demand for training facilities, as well as drawing up schedules for sports facilities.

The second stage involved an expert survey to determine the effectiveness of the portal, in which the heads of regional mass sports development departments, coaches and sports instructors took part. Participants in the expert survey filled out a specially designed questionnaire containing a list of questions about the reasons that make it difficult for Muscovites to use physical education and health services on a budget basis. A significance scale from 1 to 5 was used for the assessment, and the degree of agreement was correlated with Kendall's concordance coefficient (0.96). Experts were also asked to make suggestions on how to improve the effectiveness of the digital portal (Table).

An analysis of the expert opinions received showed that the main reasons reducing the effectiveness of physical education and health services provided on a budgetary basis through the digital portal mosgorsport.ru are:

- the time allocated for mass sports activities is distributed on a residual basis, with the most convenient times being given to sports training in Specialised Children's and Youth Schools of the Olympic Reserve

and children's and youth sports schools, as well as commercial groups;

- the lack of synchronisation with UMIAS and the need to submit documents in person (application, copy of passport, copy of SNILS, medical certificate form 073/u, 083/5-89, 514n) to the district office for the development of mass sports complicates registration in a group for selected sports and physical activities;

- the mismatch between the population's demand for FCS and the list of sports and physical activities offered, which leads to an uneven distribution of residents across sports sections, overcrowded groups and the inability to enrol in them.

It should be noted that the opinion of experts regarding 'access to the infrastructure and interface of the portal' indicates that the digital portal itself is quite effective and accessible for use by all segments of the population.

Conclusions. An analysis of the work of the digital portal mosgorsport.ru in attracting the working-age population to regular physical culture and sports activities in their place of residence made it possible to assess its effectiveness and impact on improving physical culture and sports in the place of residence, ensuring positive dynamics in increasing the number of people participating in physical culture and sports in courtyards and parks, which are public sports areas located near their place of residence, which is reflected in the following indicators:

- an increase in the number of participants (annual growth of up to 70% since the launch of the portal); an increase in the number of training locations (by 10.1%); an increase in the number of training groups created (by 3.8%); an increase in the number of people who successfully passed the GTO tests (by 11.5%);

- the digital transformation of the FCS for Moscow residents contributed to the rational use of the city's sports infrastructure, the structuring of the activities of physical culture and sports clubs in their localities, and the improvement of mechanisms for informing citizens about various areas of FCS provision and physical culture and sports events held at the municipal and city-wide levels;

- A number of factors that negatively affect the involvement of the working-age population in FCS at their place of residence have been identified and taken into account in the development of further work on the regulation of physical culture and health, physical recreation and sports activities will contribute to the achievement of national goals to increase the proportion of citizens who regularly engage in physical culture and sports.

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Improving the effectiveness of the educational process in physical education of students using balancing platforms

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Abstract

Objective of the study is to increase the effectiveness of physical education electives by introducing the training functionality of BOSU universal balancing platforms into the educational process.

Methods and structure of the study. Sports and pedagogical testing of the physical and technical conditions of 56 female students aged 18 to 20 was carried out, factors of the effectiveness of the educational process in physical education were identified, teachers were interviewed, followed by a pedagogical experiment using BOSU balancing platforms.

Results and conclusions. The effectiveness of the developed training complexes using balancing platforms is proved by the results of a pedagogical experiment. The achievements of all control tests significantly improved ($p<0.05$), the largest increase in indicators was shown in the balance test. The number of female students who completed the technical test for the highest score increased by 30.7%. Exercises on a balancing platform can be considered as a universal training tool aimed at solving the complex tasks of physical education of students of managerial specialties.

Keywords: educational process, students, fitness, balancing platform, efficiency.

Introduction. One of the most popular forms of physical education and sport is fitness. Every year, fitness technologies are increasingly integrated into the teaching and training process of physical education in universities [2]. Currently, training using BOSU balance platforms is rapidly gaining popularity as an effective and multifunctional means of physical activity for students [5].

The BOSU balance platform is a special piece of sports equipment consisting of a flat disc of a rounded or polygonal shape, with protrusions on its surface that serve to massage the feet [4]. The non-slip surface ensures safety and load control, contributing to the development of postural balance [1].

Training with balance platforms strengthens the deep muscles of the torso, improves coordination of movements and the functioning of the vestibular apparatus, contributes to improved posture, strengthens the musculoskeletal system, and increases strength endurance, mood, and overall well-being [3]. It is be-lieved that the use of balance platforms in physical education has a comprehensive effect on students' preparedness, contributes to increased interest in classes, improved health, successful completion of tests, and the development of stress resistance [6].

Objective of the study is to increase the effectiveness of physical education electives by introducing the training functionality of BOSU universal balancing platforms into the educational process.

Methods and structure of the study. The research programme included a six-month pedagogical experiment involving 56 second-year female students aged 18-20 from the North-West Institute of Management.

The first stage of the study involved sports and educational testing to determine the physical and technical condition of the students, identify factors affecting the effectiveness of the physical education process, and conduct a survey of teachers. The level of technical preparedness in the 'Fitness' section was deter-

Table 1. Ranking structure of negative impact factors

Ranking (significance) (%)	Factors	Ranking indicator
1	Poor ability to restructure motor actions	32
2	Low precision of movements	24
3	Low level of static and dynamic stability	20
4	Weak muscle corset	16
5	Low level of strength endurance	8

mined using a comprehensive sports and technical training (STT) test, which consisted of performing a strength combination of 64 counts and was evaluated on a 10-point scale.

The following control tests were used to assess physical fitness: maintaining a standing position on one leg on a balancing platform, static support lying on the forearms, lifting the torso from a lying position to a sitting position, squats in 60 seconds.

In the second stage, training complexes using balancing platforms were developed and included in the training process in the 'Fitness' section.

In the third stage, physical and technical fitness were reassessed, and the results of the experiment were summarised.

Results of the study and discussion. The results of technical readiness testing prior to the experiment showed that only 25.6% of female students scored 10 points on the STT test, 35.3% scored 8 points, and the rest scored low marks.

A survey of the teaching staff of the Department of Physical Education and Sports at the North-West Institute of Management revealed factors that had a negative impact on the STT test results.

Based on the identified factors, training complexes of exercises were developed to develop a sense of balance on limited and unstable support, improve the interaction of superficial and deep muscles, and develop strength endurance using balancing platforms. All exercises were performed without shoes at a slow pace in various modes involving a large number of muscle groups. The complex consisted of 10 exercises with 10-15 repetitions. Two to three stages were performed depending on the students' level of prepa-

ration. The rest period between exercises was 15-20 seconds, and between sets was 1-1.5 minutes.

The dynamics of the students' physical fitness results before and after the experiment were studied.

The results of control tests to determine the level of physical fitness of female students have significantly improved (p<0.05). The greatest increase in results was shown in the balance test, which assesses spatial orientation, vestibular stability, and balance. The time spent standing on the right leg increased by 75%, and on the left leg by 110.2%. The number of female students who achieved the highest score in the strength test increased by 30.7%.

Conclusions. The use of training complexes with balancing platforms helps improve spatial orientation and develop deep core muscles, which leads to better results in the technical test in the 'Fitness' section. Exercises on a balance platform can be considered a universal training tool aimed at comprehensively addressing the physical education needs of students majoring in management.

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Table 2. Dynamics of fitness test results

Control tests		Before	After	p
Standing on one leg on a balance platform, s	right	35,6±11,7	62,3±7,6	<0,05
	left	26,4±9,3	55,5±8,2	<0,05
Squats in 60 seconds, number of times		40,6±5,1	51,3±4,4	<0,05
Static forearm support, s		90,8± 22,5	128,4±10,3	<0,05
Lifting the torso from a lying position to a sitting position, number of times		35,2±7,2	44,1±5,3	<0,05

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Comparative assessment of psychophysical fitness indicators of contemporary students of an economic university with GTO standards

UDC 796.03

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Abstract

Objective of the study is to assess the compliance of the psychophysical fitness indicators of modern female students of an economic university with the GTO standards.

Methods and structure of the study. An assessment of the psychophysical fitness of 40 first-year female students at the Plekhanov Russian University of Economics was conducted. The results of the students' physical fitness are presented in terms of indicators of coordination, speed and strength, flexibility and joint mobility. Based on the indicators of coordination development, the following conclusions can be made: in the test of the ability to maintain dynamic balance (Romberg test), the students' results correspond to an unsatisfactory level.

Results and conclusions. Analysis of the indicators characterising the ability to maintain dynamic balance also indicates only a satisfactory level of this ability. The data obtained allow us to conclude that the students have reduced vestibular function, which can cause symptoms such as dizziness, balance disorders, nausea and even a tendency to fall, leading to a risk of injury.

After analysing the indicators reflecting the mental state of the females, it can also be concluded that the students show signs of tension and low mental activation.

Keywords: *psychophysical fitness, physical fitness, mental states, artistic and aesthetic needs, female students, economic university.*

Introduction. One of the criteria for students' readiness for educational and creative activities is their psychophysical preparedness (physical and psychological), which includes the development of physical qualities that are important for professional activity and the formation of mental processes and personality states [3].

Objective of the study is to assess the compliance of the psychophysical fitness indicators of modern female students of an economic university with the GTO standards.

Methods and structure of the study. An assessment of the psychophysical preparedness of 40 first-year female students at the Plekhanov Russian University of Economics was conducted. Table 1 presents the results of the students' physical preparedness in terms of the development of coordination abilities, speed and strength abilities, and flexibility and mobility in the joints. Based on the indicators of coordination abilities, the following conclusions can be drawn: in the test of the ability to maintain dynamic balance (Romberg test), the students' results correspond to an unsatisfactory level.

Results of the study and discussion. Analysis of indicators characterising the ability to maintain dynamic balance also shows only a satisfactory level of this ability. The data obtained allow us to conclude that female students have reduced vestibular function, which can cause symptoms such as dizziness, balance disorders, nausea and even a tendency to fall, leading to the risk of injury.

In terms of speed and strength abilities, the results do not meet any of the GTO standards, which indicates reduced muscle power in the shoulder girdle.

The tests for functional joint mobility correspond to 5.7 points, which is 60% of the physiological norm.

According to the flexibility test ('Forward bend from a standing position on a gymnastic bench'), the results correspond to the bronze mark (Table 1).

Table 2 presents the results of the assessment of mental states such as 'mental activation,' 'interest,' 'emotional tone,' 'tension,' and 'comfort' (authors N.A. Kurgan, T.A. Nemchin, 1990) [4, 5].

Absolute mean group values were converted into levels of severity for each mental state, corresponding to high, medium and low.

Mental activation is a state of the nervous system that characterises its level of arousal and reactivity, affecting the intensity of mental processes, the speed of psychomotor reactions, movement tempo, and behavioural energy, corresponds to a low level, manifested in inhibited reactions, slowness, lethargy of cognitive processes, and passivity of activity (Table 2).

According to indicators of interest as an emotional state that arises when a person feels an inner need to learn, know or understand something new, we have identified an average level (Table 2), which allows us to conclude that students are moderately interested in learning about the essential properties of objects or phenomena that constitute their essence.

Analysis of the data allows us to characterise the level of emotional tone, which forms the basis for successful adaptation to the changing conditions of the social environment that regulates the feeling of psychosomatic well-being, as average (Table 2).

On the mental stress scale, we identified a high level, which is characterised by a state of increased emotional and mental stress, an increase in the processes of excitation of the central and peripheral nervous systems, arising in response to stressful or negative situations, which leads to a complex disruption of cognitive processes.

Table 2 presents the results of female students on the 'Mental Comfort' scale as a state of inner well-being in which a person effectively adapts to the environment and circumstances without losing their 'self' and without forgetting their own needs. The mental comfort of students in an educational environment is a subjective state of satisfaction, which consists of a combination of positive emotional experiences and mental states, formed under the influence of socio-psychological factors that contribute to an increased

Table 1. Analysis of female students' physical fitness indicators at the initial stage of the pedagogical experiment, X±σ

Indicator	Females (n=40)	GTO physical fitness standards Level 7 (women)	p
Coordination skills			
Ability to maintain static balance (Romberg test, s)	14,3±2,2	>15 s – good 15 s – satisf. <15 s – unsatisf.	>0,05
Ability to maintain dynamic balance ('Turns on a gymnastic bench', s)	13,9±2,0	< 11 – excellent 11,1 - 12,5 - good 12,6-14,5 – satisf. >14,5 - unsatisf.	
Rhythmic ability ('Reproduction of a given jumping rhythm', s)	7,9±1,8		
Ability to coordinate motor actions ('Stepping over a gymnastic stick', s)	22,6±4,4		
Speed and strength abilities			
Bending and extending the arms, in a lying position, number of times	6,4±1,2	8 - bronze 12 - silver 17 - gold	
Flexibility and mobility in the joints			
Forward bend from a standing position on a gymnastic bench, cm	8,4±2,0	+ 7- bronze +9 - silver +16 - gold	
FMS functional assessment tests, total score:	5,7±1,5	0-9 points	U
Shoulder girdle mobility, points	1,8±0,6	0-3 points	
Straight leg raise, points	2,0±0,4	0-3 points	>0,05
Rotational stability, points	1,9±0,5	0-3 points	

Table 2. Assessments of mental states according to the methodology of N.A. Kurgan, T.A. Nemchin at the ascertaining stage of the pedagogical experiment

Mental states	Female students (n=40)	Level of severity	Wilcoxon criterion (U)
Mental activation	17,4±3,3	Low	>0,05
Interest	14,8±2,9	Medium	
Emotional tone	15,5±3,6	Medium	
Tension	8,7±3,0	High	
Comfort	15,1±2,7	Medium	

interest in mastering professional activities [1, 2]. Analysis of the data obtained allows us to conclude that the average level of comfort among female students is moderate.

Thus, analysis of the mental states of first-year female students indicates a low level of psychological activation and high tension, which may be associated with the novelty of academic activity, as these are first-year students. The other mental states correspond to the average level.

The assessment of aesthetic education as a set of qualities that reflect a person's aesthetic attitude to art, life, behaviour, people and social relations, nature and work was carried out using the method 'Formation of artistic and aesthetic needs' (V.S. Avanesova). The results are presented in Figure 1.
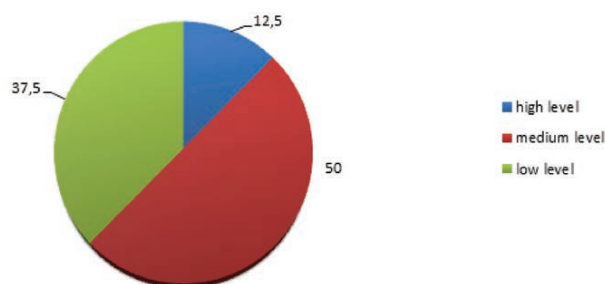

Fig. 1. Ratio of artistic and aesthetic needs among first-year female students, %

Based on the data obtained, it can be concluded that only 12.5% of female students have a high level of aesthetic education, 50% have an average level, and 37.5% have a low level, which indicates that artistic and aesthetic needs have not been formed as a source of activity that motivates self-actualisation, creative self-expression, emotional perception, cognition and evaluation of works of art, and the pursuit of beauty and aesthetics in the perception of the surrounding world.

Conclusions. Thus, summarising the results of the ascertaining stage of the pedagogical experiment on assessing the development of coordination abilities

and flexibility, it can be concluded that the students have rather low indicators. Analysing the indicators reflecting the mental state of the females, it can also be concluded that the students show signs of tension and low mental activation. According to the assessment of aesthetic education, almost half of the respondents have a low level of artistic and aesthetic needs.

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Optimisation of initial swimming training of students based on the identification of individual predisposition to certain sports methods of swimming

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Abstract

Objective of the study is to develop and prove a methodology in which taking into account the individual characteristics of the student's characteristics and assessing the students' predisposition to a certain swimming style will impressively reduce the time of mastering the general swimming skill.

Methods and structure of the study. Included a 5-week pedagogical experiment with the participation of 36 students divided into control (CG) and experimental (EG) groups. In the experimental group, the swimming style was appointed individually on the basis of diagnostics using a special set of exercises.

Results of the study and discussion. The study showed a statistically significant superiority of EG. The indicator of successful development of the distance of 25 metres in the EG was 1.9 times higher than in the KG; the EG test subjects had a higher technique of performing basic swimming skills. A differentiated approach to primary swimming training, based on early detection of individual predisposition, has proven to be effective, allowing to optimise time costs and improve the quality of the formation of sustainable motor skills in students.

Keywords: *students, swimming, individual training, motor skills, swimming methods, university swimming.*

Introduction. Swimming is a certain life-supporting skill that allows any person who has acquired it to move through the aquatic environment independently due to a certain set of motor actions [3]. The "Swimming for All" program is one of the solutions for safety and physical education on the water. In the educational context, swimming is an educational discipline that studies the patterns of interaction of the human body with the aquatic environment. Being the most important component of the physical education system, it is included in the physical culture programs of higher education institutions. The analysis of swimming curricula, which in universities, testifies to the superiority of the parallel-sequential teaching methodology. The essence of this approach is the initial development of two kinematically similar ways of swimming: crawling on the chest and crawling on the back. After visually acceptable execution of sets of these motor actions, in some cases a second group of swimming methods is added: brace and butterfly [6]. It is important to note that at a low level, the individual characteristics of students, their motivational sphere, anatomical and anthropometric predispositions to certain types of motor pattern are taken into account [1]. This very strict sequence for everyone contradicts modern educational practice, where the main emphasis is on a personalised approach to teaching students [4]. The established practice involves the student's adaptation to existing methodological approaches. In accordance with modern pedagogical concepts, it is the teacher who should adapt the program to the student's capabilities, and not vice versa [2]. In case of insufficient hours of elective discipline "Swimming" at the university and the lack of necessary experience among physical education teachers leads to incorrect study of the set of motor actions for a certain method of swimming [7].

Objective of the study is to develop and prove a methodology in which taking into account the individual characteristics of the student's characteristics and assessing the students' predisposition to a certain swimming style will impressively reduce the time of mastering the general swimming skill.

Methods and structure of the study. This technique is based on the analysis of key parameters: symmetry or asymmetry in the work of arms and legs, tendency to cyclic or acyclic movements, as well as the convenience of certain positions of the body in water [5]. The study was conducted on the basis of the sports and recreation complex "SK "Polytehnik" in the 25-metre swimming pool of the city of Perm. The pedagogical experiment was attended by 36 students of 1-2 courses who do not know sports swimming methods, but demonstrate psychological readiness to stay in the aquatic environment (absence of water, ability to perform tasks on the shallow part of the pool). The depth of the pool varied from 120 to 180 cm. Based on the results of the input testing, which included a set of specialised exercises ("Full immersion", "Heel pushes", "Sliding", "Underwater engine"), a chaotic sample of subjects was carried out with the formation of two groups: control (CG) and experimental (EG), 18 people each. The 5-week pedagogical experiment included 10 classes (2 times a week) lasting 45 minutes each. CG mastered swimming according to the traditional parallel-sequential technique. In the EG, the author's methodology was used, where there was a differentiated assignment of the method of swimming for each student on the basis of the identified predisposition.

After the assessment of initial swimming fitness, CG and EG were formed to continue the study.

Results of the study and discussion. A certain set of exercises on the shallow part of the pool was proposed for the entrance control of students. The "Full Immersion" exercise is the first tool for assessing the buoyancy of students' bodies. When per-forming the task several times, the teacher not only objectively evaluates the possibilities of holding on the water, but also the possibilities of immersion by exhaling air into the water. Next, you can understand which of the students will be able to perform pushing or wave-like movements with the body with subsequent immersion under water much faster than the rest. The exercise "Heel pushes" serves as an objective definition to assess the predisposition of students to "symmetrical" swimming styles. Repeated repetition allows you to distinguish random chaotic movements from the true tendency to the brasse technique. It is critically important for choosing the direction of style training at the initial stage. The "Sliding" exercise makes it possible to understand the basic capabilities of students to maintain a long (s) and long (m) extended body position on the water. The "Underwater Engine" exercise provides teachers with valuable information about human natural motor skills.

The criteria for the effectiveness of training at the end of the experiment were:

1. Technique of performing basic swimming skills: quality of exhalation into the water, horizontal position of the body when sliding, technique of leg work.

2. The ability to swim a distance of 25 metres (pool length) in a learned sports way without gross technical errors that violate the overall coordination of movements.

3. Time standard at a distance of 25 metres (for those who were able to overcome the distance).

The results of the final testing of the pedagogical experiment are presented in Table 1.

Qualitative analysis of swimming technique revealed significant differences. In the CG, students had significant stiffness and awkwardness of movements, breathing rhythm disturbances and low efficiency of rowing movements. In the EG, the motor actions were coordinated. In students who showed a tendency to breaststroke, the kick was performed

Table 1. Comparative results of control testing in CG and EG after a pedagogical experiment.

Evaluation criterion	Control group	Experimental group	Statistical significance
The number of students who swam 25 metres in any sports way	9 people (50,0 %)	16 people (88.9%)	$p < 0.01$
*Average time at a distance of 25 metres, having fulfilled the standard	$37,8 \pm 5,2$ c	$29,4 \pm 3,8$ c	$p < 0.05$
Average score for basic skills technique (on a 5-point scale)	$3,1 \pm 0,7$	$4,3 \pm 0,5$	$p < 0.01$

*Note - time was taken into account for those students who successfully covered the distance of 25 metres

more correctly. Those who trained in chest crawling had a noticeable better rotation of the body and effective rowing. The obtained data convincingly testify in favour of the hypothesis put forward. The statistically significant superiority of the experimental group in all evaluated parameters ($p < 0.05$ and $p < 0.01$) states that early detection of predisposition to swimming style and building the educational process on this basis is an effective tool for primary education. The proposed differentiated methodology eliminates the key disadvantage of the traditional approach - its uniformity.

Conclusions. The effectiveness of the differentiated approach to initial swimming training has been confirmed. EG students, who were assigned a specific swimming style based on individual characteristics, showed: 1.9 times higher rate of successful development of the distance of 25 metres compared to the control distance; statistically significant improvement in the technique of swimming elements; high coordination and naturalness of movements;

The developed set of four specialised exercises has proven its practical value for identifying a natural predisposition to certain modes of swimming.

A significant advantage of the personalised methodology has been established. Training taking into account individual characteristics allowed to reduce the time of mastering the basic swimming skill;

The practical significance of the results lies in the possibility of integrating the developed methodology into the educational process of higher education institutions.

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External respiration function in adolescents with childhood cerebral palsy who do and do not participate in sports

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Abstract

Objective of the study is to identify the features of the manifestation of the function of external respiration in adolescents with cerebral palsy, engaged and not engaged in sports.

Methods and structure of the study. 24 adolescents with cerebral palsy (diagnosis: spastic diplegia, preserved intellect) participated in the scientific study. The group of athletes consisted of 12 sledge hockey players from the Krylia Sovetov and Spartak teams (Moscow) aged 12-14, and the group of non-athletes consisted of 12 students from Boarding School No. 17 (Moscow) aged 12-14. The study was conducted in April and May 2025.

To assess the level of external respiration function in adolescents with cerebral palsy who do and do not participate in sports, the following indicators were studied: vital capacity (VC), peak expiratory flow rate (PEFR), respiratory rate per minute (RR), Stange test, and Genchi test.

Results and conclusions. A comparison of respiratory function indicators of adolescents with cerebral palsy who are engaged and not engaged in sports allowed us to assess their current parameters of pulmonary function, to substantiate the importance of new data in terms of increasing the rehabilitation potential of adolescents with cerebral palsy through systematic and targeted sports training. The experimental data obtained open up a new perspective on the resource possibilities of regular and purposeful adaptive sports activities in terms of increasing the level of functional capabilities of adolescents with cerebral palsy and confirm the need to include specially developed blocks of breathing exercises in the methodology of comprehensive rehabilitation of children with musculoskeletal system disorders.

Keywords: adolescents, cerebral palsy, vital capacity, respiratory function, Stange and Genchi tests.

Introduction. One of the most common causes of disability in childhood is cerebral palsy. This is a serious brain disorder that manifests itself in various mental and motor impairments with a leading motor defect [1, 4, 6].

Against the background of motor function disorders characteristic of this pathology, respiratory function is impaired, leading to a decrease in oxygen supply to tissues, especially nerve and muscle fibres. Breathing problems in people with cerebral palsy are caused by a combination of factors: limited mobility, changes in muscle tone and coordination of the respiratory muscles, and immaturity of the respiratory system [3, 4, 5, 7]. This manifests itself in shallow breathing, a predominance of the clavicular type, short inhalation and weak exhalation. As a result, during conversation, the child quickly exhausts their air supply, cannot finish a sentence and may even breathe while pronouncing sounds. In cerebral palsy, weak, shallow breathing, poor synchronisation of movements with breathing, and speech defects are interrelated problems. According to D.O. Khryokin and E.V. Kazakova, proper breathing is necessary not only for the respiratory system, but also for the circulatory system. Therefore, when the respiratory system is impaired in children with cerebral palsy, the functioning of the entire body is disrupted. At the same time, improved breathing contributes to increased physical endurance, normalisation of metabolism, and speech recovery [4].

Despite a significant number of studies devoted to the clinical presentation and adaptation of individuals with cerebral palsy, a range of issues concerning the objective assessment of overall functional status and, in particular, the regulatory and adaptive capabilities of the respiratory system remain insufficiently studied.

In this regard, a study was conducted on the charac-

teristics of external respiratory function in adolescents with cerebral palsy who do and do not participate in sports.

Objective of the study is to identify the features of the manifestation of the function of external respiration in adolescents with cerebral palsy, engaged and not engaged in sports.

Methods and structure of the study. 24 adolescents with cerebral palsy (diagnosis: spastic diplegia, preserved intellect) participated in the scientific study. The group of athletes consisted of 12 sledge hockey players from the Krylia Sovetov and Spartak teams (Moscow) aged 12-14, and the group of non-athletes consisted of 12 students from Boarding School No. 17 (Moscow) aged 12-14. The study was conducted in April and May 2025. To assess the level of external respiration function in adolescents with cerebral palsy who do and do not participate in sports, the following indicators were studied: vital capacity (VC), peak expiratory flow rate (PEFR), respiratory rate per minute (RRPM), Stange test, and Genchi test.

Results of the study and discussion. The study yielded the following results (Table).

As is well known, VC is an important indicator of physiological capacity, depending on physical development, constitution and fitness, and athletes have on average 500–1000 cm^3 more than untrained people (the degree of increase depends on the type of sport, training methods and duration) [2, 5]. In individuals with cerebral palsy, VC indicators are significantly lower than in their relatively healthy peers.

Our study found that VC in athletes with cerebral palsy is close to normal for healthy individuals and 38.33% higher than in non-athletes with cerebral palsy. This fact is a serious argument for understanding the qualitative improvement in rehabilitation potential in children and adolescents with cerebral palsy.

Due to disturbances in the tone and contractility of the auxiliary respiratory muscles, individuals with cerebral palsy typically experience significant, uneven difficulty in exhaling as quickly as possible from the beginning to the end of the movement. Therefore, their peak expiratory flow rate (PEFR), which mainly characterises the speed and strength of the expiratory muscles involved in forced active exhalation, is lower than that of their healthy peers. At the same time, higher PEFR values in athletes indicate a better quality of the respiratory tract and a lower incidence of respiratory diseases. In our study, this indicator was 13.31% higher in athletes with cerebral palsy compared to non-athletes.

Respiratory dysfunction in children and adolescents with cerebral palsy has a complex pathogenesis associated with limited mobility of the respiratory muscles, changes in muscle tone, impaired intermuscular coordination, and delayed functional maturation of the respiratory system. It is known that trained individuals have a more economical breathing pattern at rest [2, 4]. The RRPM indicator allows the condition of the bronchopulmonary system to be characterised and indirectly assesses the condition of the heart and blood vessels.

Table. Indicators of external respiration function in adolescents with cerebral palsy who participate and do not participate in sports

Test indicators	Stat. indicators	Group of respondents		Δ %
		non-athletes	athletes	
VC, l	X	2,14	3,47	*38,33*
	±m	0,29	0,20	
	σ	0,65	0,44	
RRPM, number/ minute	X	35,87	28,65	*20,13*
	±m	4,83	4,02	
	σ	9,24	8,78	
PEFR, l/s	X	2,93	3,32	*13,31*
	±m	0,14	0,21	
	σ	0,42	0,53	
Stange test, s	X	33,32	48,00	*30,58*
	±m	4,76	16,55	
	σ	14,27	37,01	
Genchi test, s	X	19,40	24,82	*21,84*
	±m	8,82	3,10	
	σ	19,72	9,31	
Genchi test, s	X	19,40	24,82	*21,84*
	±m	8,82	3,10	
	σ	19,72	9,31	

In our study, the RRPM in adolescents with cerebral palsy who do not participate in sports was 20.13% lower than in their peers who play sledge hockey. Based on the results of this test, it can be concluded that athletes with cerebral palsy breathe more deeply, which means that the greater the volume of respiratory muscles involved in this work, the more oxygen enters the lungs and the more carbon dioxide is removed, respiratory function is performed economically with a high-quality supply of oxygen to the body, and therefore more efficiently.

Using the Stange test, we identified the resistance of adolescents with cerebral palsy to oxygen deficiency. As is well known, the longer the breath-holding time, the greater the ability of the cardiovascular and respiratory systems to remove carbon dioxide from the body [4]. The resistance of adolescents with cerebral palsy to oxygen deficiency is low compared to their healthy peers, which determines their low functional readiness. Our study found that adolescents with cerebral palsy who play sledge hockey have a 30.58% higher score than adolescents with cerebral palsy who do not play sports.

The results of the Genchi test can be used to judge the degree of physical fitness and oxygen supply to the body. According to the literature, the indicators for people with cerebral palsy are significantly lower, while those for trained individuals are above the minimum values but below the average [3, 4, 5]. In other words, the oxygen supply to the body in adolescents with cerebral palsy is insufficient.

Our study found that athletes with cerebral palsy achieve the values of their healthy peers in this parameter and were able to improve this function by 21.84% under the influence of systematic training.

The results obtained indicate an improvement in the respiratory efficiency of adolescents with cerebral palsy under the influence of regular sports activities in the range of 13.31-38.33%. These data are extremely important for understanding the need to include regular sports activities in the lifestyle of adolescents with cerebral palsy, as well as for improving the effectiveness of comprehensive rehabilitation programmes for children with musculoskeletal disorders.

Conclusions. Thus, the state of external respiration in adolescents with cerebral palsy who regularly play sledge hockey, compared to their peers who do not play sports, is characterised by better respiratory tract health, greater resistance to hypoxia, greater involvement of the respiratory muscles, and deeper breathing. All this indirectly indicates an increase in rehabilitation potential under the influence of regular sports activities.

The experimental data obtained open up a new perspective on the resource potential of regular and targeted adaptive sports activities in terms of improving the functional abilities of adolescents with cerebral palsy and confirm the need to include specially designed breathing exercise blocks in the comprehensive rehabilitation methodology for children with musculoskeletal disorders.

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Use of dance exercises in adaptive physical education for children with intellectual development disabilities

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Abstract

Objective of the study is to identify scientific approaches and methodological foundations for the use of dance exercises in adaptive physical education for children with intellectual disabilities.

Methods and structure of the study. The analysis and synthesis of the scientific positions of classical and modern researchers, structuring, and comparative characteristics allowed us to identify methodological approaches and specific principles of using dance exercises in adaptive physical education of children with intellectual disabilities.

Results and conclusions. Theoretical approaches to the use of dance exercises in sports and correctional activities of children with intellectual disabilities have been identified as a methodological basis: neuropsychological (activation and stimulation of functional brain systems through special coordination and rhythmic movements), cultural and historical (dance as a means of development and compensation), activity (dance is a special type of activity, mastering through interiorization), personality-oriented (taking into account individual characteristics), structural-level (hierarchy of motor acts).

Keywords: adaptive physical education, children with intellectual disabilities, sports and corrective work, dance exercises.

Introduction. In Russia, the number of children with intellectual disabilities (1-3% of the child population) who need specialised assistance is growing. Progressive trends in state policy are aimed at ensuring their right to quality education, including adaptive physical education (Federal State Educational Standard) [3, 4]. Traditional approaches often do not take into account the specific needs and abilities of this category of children, which reduces the motivation and effectiveness of physical education classes, leading to the search for and scientific justification of innovative and attractive physical education and sports methods [2].

Intellectual disorders affect the uniqueness of children's motor development: the formation of stereotypes and the ability to control movements, impaired spatial perception, rhythmic structure and voluntary regulation of motor actions.

In this regard, dance exercises and elements of dance sport represent a promising corrective and developmental social and sporting direction, combining physical activity, emotional expression and social interaction.

However, the methodological foundations for their application in the system of adaptive physical education have not been sufficiently developed, which determines the relevance of this study.

Objective of the study is to identify scientific approaches and methodological foundations for the use of dance exercises in adaptive physical education (APE) for children with intellectual disabilities (ID).

Methods and structure of the study. An analysis of the scientific positions of classical and contemporary researchers has made it possible to identify the defining methodological approaches to the use of dance exercises in APE for children with ID.

Results of the study and discussion. In the context of dance therapy, the neuropsychological approach, based on the theory of the functional organisation of the brain (A.R. Luria, A.V. Semenovich), involves:

- targeted influence on various functional blocks of the brain through specially selected dance and coordination-rhythmic exercises;

- the use of rhythmic cross-movements to optimise interhemispheric interaction;

- the development of dance programmes taking into account the levels of movement construction (according to N.A. Bernstein);

- the integration of dance and breathing techniques to activate the brain's energy potential.

Based on L.S. Vygotsky's theory of the cultural-historical development of the psyche and the role of cultural means in the formation of higher mental functions, the cultural-historical approach considers dance exercises as: special cultural means of a child's mental development; a tool for socialisation through the mastery of cultural forms of movement; a way of internalising external actions, a means of expanding the zone of proximal development. L.S. Vygotsky emphasised that 'detours in cultural development' are especially important for children with developmental disorders. In this context, dance exercises act as an alternative path of development, allowing the activation of preserved functions and compensation for impaired ones, contributing to the realisation of individual and personal development potential [4].

According to the activity approach (A.N. Leontiev, P.Ya. Galperin), dance exercises represent a special type of activity with its own structure and patterns, which implies:

- the formation of movements from external control to internalised action;

- structuring of activity taking into account motivational, operational and control components;

- stimulation of mental functions through active activity;

- organisation of joint dance activity as a form of social interaction.

The personality-oriented approach recognises the uniqueness and self-worth of each child, focusing on their personal development through dance exercises, which is achieved by: taking into account individual characteristics, interests and preferences; creating situations of success to form positive self-esteem; providing opportunities for self-expression through individual interpretation of dance movements; forming the child's subjective position in the process of mastering dance exercises.

The structural-level approach in APE for children

Table. Key differences in the development of motor skills among representatives of different levels

Level	Children with intellectual disabilities		Typically developing children
Level A (rubrosinal) – muscle tone, balance	- muscle tone imbalance (hypo- or hypertonia) is often observed; - slower formation of automatisms	- special exercises are required to strengthen the vestibular system and develop balance; - more time is needed to master basic stability	learn basic balance skills faster; need fewer special exercises
Level B (thalamic-pallidal) – synergies, involuntary movements, rhythm	difficulty perceiving and reproducing rhythmic structures	- multiple repetitions with lively musical accompaniment are necessary; - it is important to use images and associations ('jump like bunnies')	better perceive and reproduce rhythmic structures of varying complexity
Level C (pyramidal-striatal) – spatial field, purposeful movements	difficulties with spatial orientation and body schema	- clear spatial markers (coloured marks on the floor) are necessary; - movements are learned in separate elements and then combined.	find it easier to orient themselves in space and master complex transitions
Level D (parietal-premotor) – object-oriented actions, complex motor skills	difficulties memorising dance movement sequences	- visual support is required (cards, diagrams, video samples); - short dance combinations with gradual complexity are effective.	meaningful memorisation with an understanding of the logic of movement; better transfer of skills
Level E (cortical) – intellectual motor acts, symbolic actions	- significant difficulties and limited abilities with improvisation and creating new movements; - reduced ability for symbolic expression through dance	- a structured environment with minimal distractions is necessary; - structured tasks are preferable.	dance improvisation is accessible; understanding of the figurative language of dance

with ID is based on N.A. Bernstein's physiological theory of movement construction levels [1]. It views dance exercises as a hierarchical structure of inter-related levels – from simple motor acts to complex dance combinations (Fig. 1).
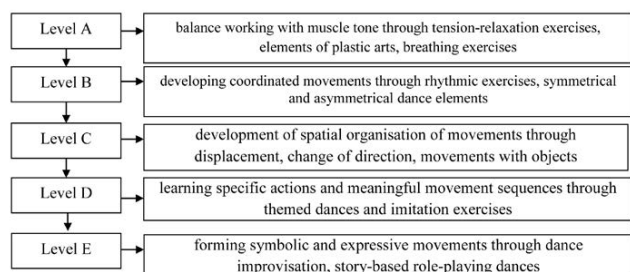

Fig. 1. Structural and level-based organisation of dance exercise formation

Sequential training in dance elements, taking into account the level-based organisation of movements, allows for the formation of a solid motor foundation necessary for mastering more complex elements, taking into account the characteristics of the psycho-physical development of children with ID.

The effective use of dance exercises in APE for children with ID is based on a system of pedagogical and rehabilitation principles, as well as specific principles of dance activity, which we have identified as the key methodological basis (Fig. 2).
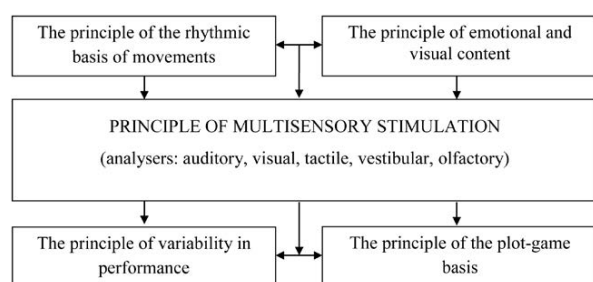

Fig. 2. Specific principles for applying dance exercises in APE

The need for scientifically grounded modifications to the methods and techniques used to teach dance exercises to children with ID served as the basis for a comparative analysis of the process of learning choreographic elements by children with intellectual disabilities and their typically developing peers through the prism of N.A. Bernstein's theory of the level organisation of movements (Table).

This analysis made it possible to identify key differences in the formation of motor skills in representatives of both groups, determine the dominant levels of movement construction at different stages of training, and develop a differentiated system of pedagogical influences. The study found that children with ID rely more heavily on the rubrospinal (A) and thalamic-pallidal (B) levels when learning dance exercises, while their typically developing peers move more quickly to the pyramidal-striatal (C) and parietal-premotor (D) levels, which requires appropriate adaptation of teaching methods to take these neurophysiological characteristics into account.

Conclusions. The study integrated interdisciplinary knowledge and formed a fundamental conceptual basis for the application of dance exercises in the process of adaptive physical education. The scientific and theoretical results obtained create a solid methodological platform that ensures the organisation of effective sports and corrective work aimed at realising the individual potential of children with intellectual disabilities and opening up new avenues for their development.

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Promoting employee health through the creation of a neuropositive organisational and physical culture

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Abstract

Objective of the study is to provide a theoretical basis for promoting employee health in companies using digital employee profiles based on building a neuropositive organisational culture and developing physical culture and sport.

Methods and structure of the study. The empirical base was formed in the period from February to September 2025, data obtained during a pilot project in an educational organization (the total sample size is 15 employees). To assess neurophysiological and behavioral parameters, a psychometric and author's questionnaire was used, including statements grouped on three scales: 'Dopamine activity' (motivation, initiative, goal orientation), 'Oxytocin activity' (trust, cooperation, sense of belonging), 'Noradrenaline balance' (stress tolerance, concentration, recovery after exertion).

Results and conclusions. A systematic assessment of the level of neuroculture and the physical condition of employees through the creation of a digital profile of employees becomes a necessary condition for the formation of a neuropositive organizational environment and motivation of the team, which should include, among other things, caring for human health and providing opportunities for physical culture and sports, which will directly affect the neurophysiological mechanisms underlying motivation, engagement and stress resistance. The proposed neuropositive assessment system, through pilot studies or correlation analysis between sports involvement and the use of knowledge about neurophysiological responses to positive stimuli, simultaneously reflects the organizational culture and the level of physical well-being of employees through their involvement in corporate sports and activities.

Keywords: company employees, neuromanagement, motivation, physical education and sports, neuropositive organizational culture.

Introduction. Modern organisations face challenges related to increased burnout, decreased engagement, and a shortage of skilled personnel [1, 5, 7]. The development of neuroscience has led to the formation of neuromanagement, a unique field that combines knowledge from three areas: management, psychology, and neurobiology. It is an attractive management system for companies, where special attention is paid to three key neurotransmitters: dopamine, oxytocin and noradrenaline, which play a central role in employee reward, trust and alertness [3].

Neuroculture is a deep, neurobiologically determined level of organisational culture that reflects unconscious emotional, cognitive and behavioural patterns controlled by the dopamine (motivation), oxytocin (trust) and noradrenaline (stress/attention) systems. Unlike traditional organisational culture, which is focused on values and norms, neuroculture explains the reasons for employee behaviour at the level of brain function, which allows them to be managed not through pressure, but through the creation of a neuropositive environment. In turn, brain function depends on a person's physical activity, as evidenced by numerous studies by both Russian and foreign scientists [6, 10].

Objective of the study is to provide a theoretical basis for promoting employee health in companies using digital employee profiles based on building a neuropositive organisational culture and developing physical culture and sport.

Methods and structure of the study. The study is based on the integration of quantitative and qualitative approaches (mixed methods research) [9]. The empirical base was formed between February and

September 2025, with data obtained during a pilot project in an educational organisation (total sample size – 15 employees). To assess neurophysiological and behavioural parameters, a psychometric and author's questionnaire was used, including statements grouped into three scales: 'Dopamine activity' (motivation, initiative, goal orientation), 'Oxytocin activity' (trust, cooperation, sense of belonging), 'Noradrenaline balance' (stress resistance, concentration, recovery after stress). All participants gave their informed consent to participate in the study. The data was processed anonymously, in compliance with ethical standards and requirements.

Results of the study and discussion. Western studies emphasise that the neurobiological sphere itself is seen as a driving force for economic growth, and in a corporate culture based on an understanding of the neural mechanisms of human behaviour in organisations and social responsibility towards employees, the introduction of neuro-management tools acts as "micro-political health technologies" aimed at showing care for the team [8].

To justify the methodology for building a neuropositive organisational culture through the formation of an employee's digital profile, the key aspects of neuroculture that determine its role in a modern organisation are considered (Table 1).

The stages of creating and evaluating a neuropositive organisational environment, including the development of physical culture and sports in the company, are presented in the figure. Neurophysiological and behavioural parameters are assessed using a number of tools.

1. A psychometric questionnaire to measure engagement, assess stress levels and diagnose psychological safety levels.

2. An author's questionnaire, including statements grouped into three scales: 'Dopamine activity' (motivation, initiative, goal orientation), 'Oxytocin activity' (trust, cooperation, sense of belonging), 'Noradrenaline balance' (stress resistance, concentration, recovery after stress).

3. Semi-structured interviews with department heads.

4. Focus groups with employees (5 people each) to identify implicit cultural attitudes and patterns of behaviour and motivation.

5. Study of employee health levels using digital tools [2].

6. Formation of a general indicator of the neuroculture (INC) of the team and creation of a digital employee profile (DEP) that takes into account both the psycho-emotional state of the individual and indicators of physical health (taking into account physical activity outside working hours).

Table 1. System-forming aspects of neuroculture in organisation

| Aspects	Approval	Justification
Neuroculture – as the basis of organisational behaviour	- combines neurophysiological and cognitive patterns that underlie collective thinking and behaviour in an organisation; - shapes the level of psychological safety, leadership style, communication habits, and responses to stress and uncertainty	- will reveal hidden causes of inefficiency, conflicts or low engagement that are not visible in a superficial analysis
Neuroculture – as a link to productivity and innovation	- influences the company's innovation and effectiveness; - psychological safety activates the prefrontal cortex, which is responsible for creativity and decision-making, while chronic stress suppresses cognitive functions and reduces the ability to learn and adapt	- will help determine the extent to which the organisation promotes or, conversely, suppresses the cognitive and emotional potential of employees
Neuroculture – as a mechanism for managing change	- forces organisations to adapt quickly, where resistance to change is not based on logic but on neurobiological responses to threats (e.g., activation of the amygdala when changes are perceived as dangerous)	- will reveal 'points of resistance' at the neurological level; - helps to design changes taking into account the neuropsychological characteristics of the team
Neuroculture – as a competitive advantage through the company's human capital	- increases the company's competitive advantage; - stimulates cognitive flexibility, emotional intelligence and employee engagement, which directly enhances innovation, adaptability and productivity	- creates an environment where people think flexibly, collaborate effectively, learn, grow and take care of their own health
Neuroculture – as a tool for mental health and stress resilience	- supports mental health and employee resilience to burnout and anxiety; - determines the level of emotion regulation, recovery from stress, sense of belonging and meaning	- allows for timely adjustments to the culture towards greater sustainability and support

(Source: compiled by the authors)
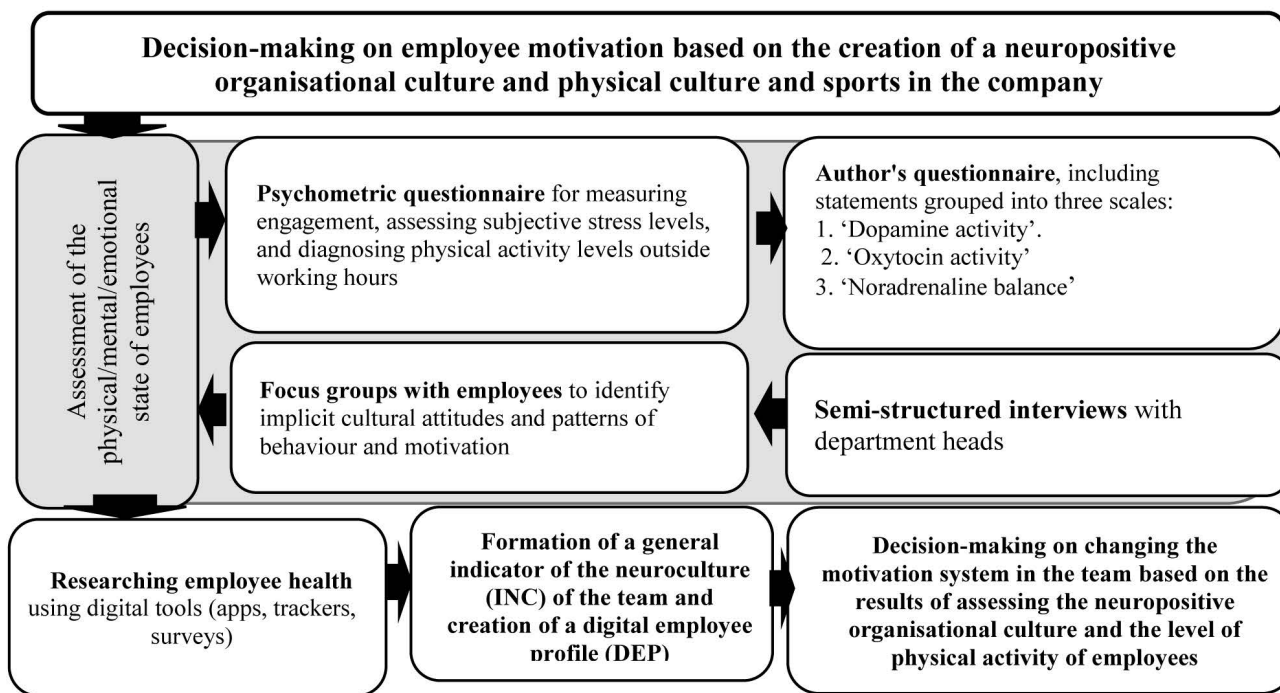
Figure. Stages of work on creating a 'neuropositive' organisational and physical culture and sports in the company (Source: compiled by the authors)

7. Making a decision on the formation (if the organisation is just being created) or modification of the existing motivation system in the team based on the results of the assessment of the neuropositive organisational culture and the level of physical activity of employees.

The result of the assessment testing of neurophysiological and behavioural parameters is the indicator of the neuroculture (INC) – an integral indirect index reflecting the complex interaction of cognitive, emotional, behavioural and social factors. Indirect means an index based on behavioural and psychological proxies (rather than direct biochemical analysis), which is not measured directly but is derived from other observable data

(proxy indicators) that indirectly reflect the phenomenon under consideration [4]. The validation of the INC level determination scale is presented in Table 2.

During the survey or expert assessment stage, each component is rated on a scale from 0 to 100, where 0 indicates a complete absence of the trait (e.g., 'no motivation') and 100 indicates the maximum value ('highest engagement'). Next, the values from the 0–100 scale are linearly transformed to a scale of −1 to +1 so that the final INC can be interpreted as a bipolar index (with the possibility of negative values reflecting destructive patterns). The initial assessments must be converted using formula 1:

Table 2. Scales of employee neuroculture indicator (INC) levels

INC level	Description	Value
High level	Employees demonstrate exceptionally high levels of engagement, psychological safety, initiative and stress resistance; high levels of innovation and physical activity during and outside working hours (e.g. aerobic, strength training, etc.)	from +0.8 to +1
Positive level	Positive emotional and cognitive patterns prevail; employees are motivated, trust management, cope effectively with stress, and are physically active	from +0.4 to +0.79
Neutral level	Employees demonstrate an average level of engagement, job satisfaction and stress resistance; no significant dysfunctions, but also no obvious interest in work; physical activity is minimal	from −0.39 to + 0.39
Low level	There is a decrease in motivation, an increase in anxiety, weak cooperation; frequent conflicts, passivity, signs of burnout, lack of physical activity	from − 0.4 to − 0.79
Negative level	Employees demonstrate low levels of engagement, job satisfaction and stress resilience; a negative attitude towards work and the organisation prevails, lack of physical activity during and outside working hours	from − 0.8 to −1.0

(Source: compiled by the authors to evaluate the results of the author's questionnaire)

$$N_{i\text{норм}} \frac{Ni_{\text{исх}}}{50},$$

where: $Ni_{initial}$ – initial assessment on a scale of 0-100,

Ni_{norm} – normalised assessment in the range [−1; +1].

The range [−1; +1] should be interpreted as follows: +1 – most favourable neuroculture; 0 – neutral state; −1 destructive neuroculture (high stress, low trust, apathy, lack of physical activity).

The employee neuroculture index (INC) is calculated using formula 2:

$$ПНК = \frac{\sum(Vi + Vf) \cdot Ni_{\text{норм}}}{\sum(Vi + Vf)},$$

where Vi is the weight of the neurophysiological component (dopamine, oxytocin, noradrenaline);

Vf – weight of the physical component (intensity, regularity and duration of physical activity; types of physical activity, e.g. aerobic, strength training, etc.)

This approach allows you to compare departments, teams, and time periods. Visualise dynamics (e.g., 'INC grew from -0.2 to +0.5 over the year'). Make management decisions based on an objective threshold (e.g., when INC < -0.4, a psychological support programme is launched).

In a pilot study, the department showed an INC of -0.85, which is close to the threshold value of -1. Analysis of qualitative data revealed that:

– 92% of employees reported a constant feeling of anxiety,

– 65% reported a lack of support from management,

– 78% reported a loss of meaning in their work.

The data confirms the validity of interpreting low INC values as indicators of a systemic crisis in the overall health of the organisation's workforce.

Conclusions. Systematic assessment of the level of neuroculture and physical condition of employees through the creation of digital employee profiles is becoming a prerequisite for the formation of a neuro-positive organisational environment and team motivation, which should include, among other things, care for human health and the provision of opportunities for physical culture and sport, which will directly affect the neurophysiological mechanisms underlying motivation, engagement and stress resistance.

The proposed neuropositive assessment system, based on pilot studies or correlation analysis between involvement in sports and the use of knowledge about neurophysiological responses to positive stimuli, simultaneously reflects the organisational culture and level of physical well-being of employees through their involvement in corporate sports and activities.

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Development of coordination abilities in children with intellectual disabilities using exercises on neurotrainers

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Keywords: neuro-exercisers, mental disorders, coordination disorders, adaptive physical education, psychophysical development.

Abstract. The purpose of the study is to substantiate the methodology for developing motor and coordination abilities in children with intellectual disabilities of secondary school age using neuro-exercisers. The data from our study: suggest that the developed methodology for developing coordination abilities using neuro-exercisers is effective. This conclusion is based on the statistically significant results of the control tests.

Relevance. In the process of studying and analyzing the data of scientific and methodological literature, we have found that the development of coordination abilities in children with intellectual disabilities is quite relevant. The development of coordination abilities is the basis for the harmonious development of physical abilities and the distribution of motor load, as well as the ability to quickly respond to changes in the external environment and optimally solve motor tasks [1]. The theoretical review confirms that the combination of adaptive physical education with neuro-exercisers creates conditions for overcoming motor and cognitive deficits in children with intellectual disabilities.

The purpose of the study: substantiation of the methodology for the development of motor-coordination abilities of children with intellectual disabilities of secondary school age using neuro-training devices. The study was conducted on the basis of the Kazan School No. 61 for Children with Limited Health Opportunities. The study involved 20 children with intellectual disabilities of secondary school age. Control and experimental groups were formed. The control group followed the school curriculum approved by the educational organization. The experimental group was engaged in the developed method of developing coordination abilities using various neuro-exercisers, which is a comprehensive approach structured into three interconnected stages: adaptation, basic and fixing. As the main neuro-exercisers were used: balance for the legs, balancing track (neurotrack), hemispheres, kinesio-bags, kinesio-balls.

The program of exercises within the framework of the method took into account the following aspects:

1. Gradual progression from simple exercises to complex ones that take into account the specific needs of children with intellectual disabilities.

2. Integration of neuro-exercisers that stimulate not only motor but also cognitive functions.

3. The presence of a game component that supports motivation and emotional engagement.

4. Systematic stages.

The results of the study and their discussion. At the beginning of the experiment, to determine the level of development of coordination abilities, we were offered the following tests: the test "Stork"; walking along the line sideways; wall toss test; quadrant jump test (QJT); throwing a tennis ball at a target; falling ruler test; the method "Schulte table". At the end of the study, it was determined that all the studied indicators in the experimental group were significantly higher than the control group: the level of development of static equilibrium was significantly better by 9.7% ($p<0.05$), indicators of dynamic equilibrium by 11% ($p<0.05$), the level of hand-eye coordination by 11.7% ($p<0.05$), the level of dexterity and motor coordination increased by 13.8% ($p<0.05$), accuracy by 12.5% ($p<0.05$), reaction speed by 5.3% ($p<0.05$), dynamic attention span by 6% ($p<0.05$).

Conclusion. The data of the study conducted by us allow us to speak about the effectiveness of the developed by us technique of development of coordination abilities in children with impaired intelligence of secondary school age with the use of neuro-trainers. The basis for this statement is the positive dynamics of the conducted control tests.

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Assessment of the psychophysiological compatibility of sports team members

UDC 612.821

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Abstract

Objective of the study is to analyze modern approaches to assessing psychophysiological compatibility and correcting teamwork among sports team members.

Methods and structure of the study. The object of the study was domestic and foreign scientific literature on the problem of psychophysiological compatibility in sports. To achieve this goal, theoretical research methods were used: analysis and synthesis; abstraction; induction and deduction.

Results and conclusions. Based on a comparative analysis of existing hardware methods for assessing psychophysiological compatibility, requirements for approaches that improve the quality of monitoring and correction of athletes' teamwork have been formulated. The conclusion is made about the importance of taking into account the psychophysiological level of compatibility and suggests ways to improve the technology of its measurement to improve performance in team and group sports.

Keywords: *sports teams, social and psychological compatibility, group activities, analysis.*

Introduction. In team sports, the coordination of athletes' actions within a specific closed sensorimotor field plays an important role, in which athletes must perform their actions at similar levels of activation, reaction speeds, attention switching, etc. In this regard, psychophysiological, psychological, and socio-psychological levels of compatibility are distinguished.

Psychophysiological compatibility (or biological, functional) is described as the ratio of the psychophysiological qualities of group members: reaction speed, coordination of emotional-vegetative and behavioural reactions, pace of joint work, temperament characteristics [3, 8], which ensures similarity of reactions and actions.

Psychophysiological compatibility is of particular importance in sports such as gymnastics, figure skating, etc., where the actions of athletes must be synchronised as much as possible [1]. In particular, the effectiveness of performances in group exercises in artistic gymnastics is associated with the similarity of the psychophysiological characteristics of gymnasts, which include the activity of analysers, the level of coordination and expressive abilities, agility, accuracy of differentiation of muscular efforts and perception of spatial parameters of movement. Compatibility in team sports is associated with a similar sense of timing [2, 6].

The next level of compatibility among members of a small group is psychological compatibility, which is understood as the best combination of mental qualities: sustained attention, working memory capacity, speed of decision-making, character traits, intelligence, empathy, motivational and personality traits, etc. [13].

Social and psychological compatibility consists of an optimal balance of needs, values, value orientations, goals, motives, interests, and social attitudes of group members. Groups that are diverse in terms of their functional and role structure are significantly more successful at solving creative tasks than homogeneous groups [15]. In sports, the most effective combination of players is based on their inclination to be leaders or followers [7].

Objective of the study is to analyze modern approaches to assessing psychophysiological compatibility and correcting teamwork among sports team members.

Methods and structure of the study. The object of the study was domestic and foreign scientific literature on the problem of psychophysiological compatibility in sports. To achieve this goal, theoretical research methods were used: analysis and synthesis; abstraction; induction and deduction.

Results of the study and discussion. Analysis of the interaction between athletes in sports teams allows us to identify two main types of group sports activities:

- coordinated movements in a relatively short period of time when performing pre-learned elements (synchronised swimming, artistic gymnastics, pair figure skating), carried out under an external 'rhythm driver' (musical composition), which requires the synchronisation of a sense of rhythm, timing, tempo, and emotional expression based on coordinated auditory-motor actions and similar levels of psycho-emotional activation;

- interaction in complex game situations when jointly controlling game objects (hockey, football), implemented through visual-motor interaction between team members, which requires coordinated visual-motor coordination and response in conditions of divided attention, the ability to interact while moving, passing and receiving the ball (puck), taking into account the relative positions of the team's players and the opposing side; synchronisation of sensory-effector systems in the perception of significant signals [10].

Research into the compatibility of small groups, which includes sports teams, was conducted in two directions: the use of questionnaire tests (mainly in foreign psychology) and the introduction of various instrumental techniques, which were widely used in the USSR and continue to be developed in modern Russia [4].

Socio-psychological studies show ambiguous results. For example, according to F.K. Fiedler [14], teams in which there was no great need for friendly relations among participants performed much better than groups where individuals had a need for warm and friendly relations. G. Lenk [16] confirmed in his research that it is possible to achieve high results despite existing contradictions within a team, which refutes the idea that teams are only successful when there are friendly relations between team members. The works of E.S. Avdeev [1] show that a high level of psychological compatibility does not always lead to a decrease in the effectiveness of joint actions. This is explained by the fact that a low level of psychological compatibility contributes to the creation of conditions for less effort to be spent on interpersonal contacts and focuses directly on the performance of the task at hand.

In this regard, it is important for sports teams to develop a basic level of psychophysiological compatibility. Taking into account the generalisation of literary data, psychophysiological compatibility in sport can be defined as the similarity in the development of physical and psychomotor qualities, sensorimotor functions, basic mental processes, the severity of emotional and vegetative reactions, and the degree of training of team members (development of professionally important qualities).

In a team environment, certain psychophysiological and psychological characteristics of a person's activity change, which distorts the assessment of real group interaction in a team environment [5]. Thus, N.N. Obozov shows [9] that in the presence of other people, individuals may experience a decrease in: the generation of original ideas, the volume and concentration of attention, sensitivity (olfactory, pain, kinesthetic, auditory), the accuracy of performing simple arithmetic operations, i.e., those characteristics that determine the productivity of mental activity.

At the same time, there may be an increase in muscle strength, concentration, and the development of long-term memory, i.e., everything that determines the speed (temporal) characteristics of mental activity. Therefore, an adequate assessment of psycho-physiological compatibility is only possible when using approaches to assessing psychophysiological indicators that allow modelling simultaneous physical and psycho-emotional stress during collective work, since the individual psychological approach to solving this problem has proven ineffective.

A comparative analysis of the hardware methods described in the literature shows that different equipment is used for each characteristic of joint activity being assessed [12]: the Group Sensory-Motor Integrator, Arch, and Stressor are used to assess group organisation and identify leadership qualities; 'Rhythmograph' is used to assess emotional interaction; 'Voluntograph' is used to analyse volitional communication; 'Voluntograph' and 'Rhythmograph' are used to assess the total impact; 'Homeostat' is used to analyse multi-linked balance control in the system; Group sensorimotor integrator, Cybermeter – for modelling multi-linked control of a moving object.

At the same time, existing homeostatic methods involve collective work without significant physical effort, do not allow for flexible setting of different teamwork models to assess the characteristics of coordinated tempo-rhythmic processes, and do not fully reflect the degree of participation of each team member in joint activities. A number of authors point to the insufficient attention paid to assessing the effectiveness of joint activities depending on the various psycho-emotional states of group members.

Conclusions. In sports, especially professional sports, psychophysiological compatibility plays an im-

portant role, while psychological and socio-psychological levels of compatibility become less significant (unlike in children's and teenage teams, where interest is the main factor in team activity).

An important motivation is not only the overall result, but also the individual contribution, as this often determines the level of income of both the team as a whole and the individual player. Therefore, in order to achieve these goals, effective joint activity will take place even in the absence of psychological and socio-psychological compatibility.

The psychophysiological level of compatibility comes to the fore, based on the unity of the tempo-rhythmic characteristics of joint activity, specific contribution, a number of properties of the nervous system, as well as the ability to form similar speeds and levels of activation, which allows achieving high levels of coordination (teamwork) in collective activity.

All this requires the formation of new methodological approaches to the assessment and training of psychophysiological compatibility.

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