



# T&PPPC

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# Theory & Practice of Physical Culture

**Athletic  
training**

**Sport  
psychology**

**Academic  
physical education**

**Sport  
physiology**



## Prospects for the promotion of the All-Russian physical culture and sports complex «Ready for Labor and Defense» in the context of social challenges



In recent decades, there has been a significant advancement of the GTO complex in the social sphere of modern Russian society.

A striking example of the successful implementation of the GTO complex is the holding of various sports events and festivals in the regions. Their main motivational feature was the involvement of famous athletes in mass events, the conduct of training sessions in preparation for passing the GTO standards.

Organizational projects aimed at optimizing the interaction of state, regional and municipal government institutions with other subjects of this social project can become the leading vectors for the prospective development of the "GTO" complex. Such an initiative can be implemented in the form of attracting volunteers from different segments of the population; technological optimization of digital platforms through the placement of innovative video content; expanding the scope of sports events with a focus on national traditions and

age preferences; additions to the system of incentives and rewards for those who pass the GTO standards, taking into account age characteristics, the interests of different social groups of the population.

*We invite scientists to publish the results of scientific research aimed at finding and developing social projects in the field of physical culture and sports*

**Editor-in-Chief of TPPC,  
Honored Worker of Physical Culture of the Russian Federation  
Dr. Hab., Professor L.I. Lubyшева**

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Theory and Practice  
of Physical Culture

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# International activity of sports universities: state and trends of development

UDC 796.071



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## Abstract

**Objective of the study** was to identify current trends and determine the vector of development of the international activities of Russian universities of physical culture and sports.

**Methods and structure of the study.** The analysis of the main parameters of international activity in Russian universities of physical culture and sports has been carried out.

**Results and conclusions.** At present, the state of international activity of universities is one of the key indicators of their effective development. The vectors for the development of international activities of sports universities are: the development of exports of educational services of scientific projects; formation of a stable contingent of foreign students, integration of educational organizations of higher education into the international educational and scientific space; increase in income from the export of educational services and scientific products of universities; promotion of the "brand" of universities in the international educational and scientific space; internationalization of educational and scientific activities of universities; development of academic mobility; implementation of network educational programs, etc. The goal of implementing the strategy for the development of international activities is to increase the competitiveness of sports universities in the international space and strengthen their export potential.

**Keywords:** *international activity, higher professional education, physical culture, sport.*

**Introduction.** A distinctive trend in the development of the Russian system of higher education has been the intensification of the international activities of universities aimed at their integration into the world educational and scientific space. According to the adopted priority project "Development of the export potential of the Russian education system", the target model of the international activities of universities involves the development of exports of educational services and scientific projects, an increase in extrabudgetary funds, the implementation of joint educational programs, the formation of a stable contingent of foreign students, the internationalization of the internal educational environment, the formation of intercultural competencies from employees and students, promotion of sports relations, etc. [2]. Given the special role of sports and sports diplomacy in establishing interna-

tional educational, scientific and humanitarian cooperation, these guidelines are of particular relevance in relation to the universities of physical culture.

**Objective of the study** was to identify current trends and determine the vector of development of the international activities of Russian universities of physical culture and sports.

**Methods and structure of the study.** The analysis of the main parameters of international activity in Russian universities of physical culture and sports has been carried out.

**Results of the study and their discussion.** In modern conditions, international activity acts as a priority direction for the development of Russian universities, which determines the establishment of educational, scientific and cultural interaction in the international space. The effectiveness of international



activity is determined by a number of indicators, which include: the share of the number of foreign students enrolled in bachelor's, specialist's, and master's programs in the total number of students (adjusted contingent); the share of the number of foreign citizens from among the scientific and pedagogical workers; the volume of international academic and scientific mobility, the implementation of network educational programs, etc. Taken together, these indicators determine the export potential of Russian universities and the possibility of their competitiveness in the international market of educational services.

An analysis of educational statistics in recent decades shows that despite the general decline in the number of Russian students, in recent decades there has been a steady increase in the number and proportion of foreign citizens studying at universities (2000 - 72.4 thousand people (1.5%) 2021 - 324 thousand people (8%) [5]. This has led to the fact that Russia currently attracts 6% of the global number of foreign students, while the total income from the export of Russian educational services in 2018 reached 13 billion rubles or approximately 200 million US dollars [3, p., Belarus, Ukraine, Kyrgyzstan), China, the countries of Southeast Asia, the Near and Middle East. Engineering, medical, information-computing and economic groups of specialties and directions stand out among the educational programs.

Speaking about the levels of education, the most attractive segment of the educational market in our country for foreigners is undergraduate programs, while 76.8% of foreign students choose full-time education. The distribution of foreign students by budgetary and contractual forms of education is 36.7% and 63.3%, respectively, while the main share of state scholarships (quotas) for the education of foreign citizens falls on the CIS countries (28.7%), Asia (32.5%), Africa and the Middle East (23.7%) [7, p. 303].

Undoubtedly, the indicated parameters largely reflect the current realities associated with the ongoing geopolitical processes.

The internationalization of education in Russian universities of physical culture and sports is characterized, on the one hand, by general parameters, and on the other hand, it has its own characteristics related to the content and forms of educational programs implemented in them. The main vector for the development of the educational activities of sports universities is the implementation of educational programs within the framework of an enlarged group of specialties and

areas of training (EGSA) 49.00.00 - Physical culture and sports, the areas of training of which account for over 80% of their student body. The training of athletes determines the special requirements for the level of physical fitness of students, as well as the organization of training and educational processes in accordance with educational and professional standards. Since the 2000s, industry universities have begun training personnel in related areas - sports pedagogy and psychology, sports management, journalism, sports and health services and tourism, state and municipal administration, advertising and public relations, sports diplomacy, which determined diversification of educational activities and made changes to the structure of their student body [3, p. 4]. The implemented educational programs are quite unique due to their sports component, which makes certain adjustments to the process of selecting potential applicants for physical education universities.

It should be noted the ambiguous trend of changes in the quantitative and qualitative parameters of the foreign student contingent in the universities of physical culture. In 2017, the total number of foreign students in Russian sports universities was 1922 people. (5.3% of their student body). 1240 foreign citizens (64.5%) were trained full-time according to the EGSA "Physical culture and sports", including: 993 people. - undergraduate programs (80.1%), 137 people. - in the magistracy (11.0%), 40 people. (3.2%) - in graduate school [4, pp. 165, 169]. In other areas of higher education, sports managers, specialists in the field of sports and health services and tourism, sports psychologists, etc. were trained. Over half of foreign citizens studied on a contract basis, while the total financial indicators of the export of educational services by sports universities amounted to 88.3 million rubles [4, p. 292]. As in all Russian educational institutions, there has been a reorientation of the geographical focus of the implementation of international activities - if earlier it was directed to the European educational market, then now most of the foreign students (51.4%) of the universities of physical culture began to fall on citizens of the CIS countries, Asia and the Middle East.

At the same time, by 2021 there was a decrease in the total number of foreign students in higher education institutions of physical culture to 1265 people. (854 (67.4%) full-time students and 413 (32.6%) part-time students). Undoubtedly, the unfavorable epidemiological situation associated with the spread of COVID-19 and the forced restriction of international





academic mobility contributed to the negative dynamics. At the same time, rather uneven distribution of the foreign student body in Russian sports universities attracts attention. At present, the leaders in the number of foreign students are the Russian University of Sports "GTSOLIFK", Moscow, the Smolensk University of Physical Culture, the Siberian University of Physical Culture, while in a number of other sports higher educational institutions foreigners are not trained at all. It is obvious that such a contradictory picture adversely affects the general state of the international sports educational space.

The current reality has indicated the need to develop a concept for the development of international activities of sports universities, based on a clear understanding of its current state. First of all, we are talking about the definition of unfavorable external and internal factors, which include: an extremely difficult geopolitical situation in the modern world and the aggravation of external threats against Russia, which fully affects the sphere of international sports diplomacy; the complexity of designing international programs and high competition in the international educational and scientific space; underdevelopment of network forms for the implementation of educational programs; weak internationalization of the internal environment associated with the study of the Russian language, the development of Russian culture and educational practice by foreign students; lack of competence in the field of international communications among teachers and university staff. On the other hand, Russian sports universities have a high export potential, which allows them to consistently develop international ties in various areas of educational and scientific cooperation.

**Conclusions.** An analysis of the current state of the international activities of Russian sports universities makes it possible to identify strategic guidelines for its development, including: integration of universities into the international educational and scientific space (establishing interaction with leading foreign sports educational and scientific organizations; increasing the volume of income from the export of educational services and scientific products of sports universities, formation of a stable contingent of foreign students); internationalization of educational and scientific activities of sports universities (improving the international competitiveness of universities through the development of academic mobility programs for teachers and students; the formation of communicative competen-

cies in foreign languages among employees and students of universities); promoting the brands of Russian sports universities in the international educational and scientific space (improving the position of universities in international academic rankings, diversifying country directions for the export of educational services, increasing the representation of Russian sports universities in information systems). The coordinated and consistent implementation of all components of the strategy for the development of international activities will lead to an increase in the competitiveness of sports universities in the international space and an increase in the export of their educational programs and scientific projects.

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# Limiting factors of investment activity of the sports industry on the example of international football competitions in Russia

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## Abstract

**Objective of the study** was to identify the limiting factors of investment activity in the organization and holding of international football competitions in Russia.

**Results and conclusions.** The article assesses the degree of realization of the sports potential of Russia, taking into account the problems of financing priority areas in the field of physical culture and sports, using the example of major international sports projects in Russia.

It is assumed that a cumulative solution to all existing financing problems is possible only on the basis of certain comprehensive actions in all relevant priority areas. Successful activity in the sports and physical culture industry entails the development of related industries, such as the construction industry, tourism. For systematic and rational investment activities in the field of physical culture and sports, it is necessary to resort to a larger-scale implementation of vertical integration mechanisms adjusted for a particular sport, when training centers are created on the basis of professional sports clubs not only in the direction of sports training (preparation of a sports reserve), but also in the direction of sports management, as well as the training of sports coaches and referees.

**Keywords:** *financing problems, investment activity, physical culture and sports, effective management of the sports industry.*

**Introduction.** The volume of investments and capital investments aimed at the development and maintenance of professional football in Russia resonates more and more every year with the results of professional teams in the international arena [2].

According to some authors, with fairly large-scale changes in the socio-economic and political systems of Russia over the past 20 years, the structure of football has not had time to rebuild in many ways, for example, in terms of self-financing and effective management, which is one of the reasons for the lag in the development of domestic football. In the structure of this management, the generally recognized problem is "the lack of a full-scale information system that meets the requirements of modern sports and is able to suc-

cessfully solve the tasks of coordinating the activities of the services of scientific and methodological support for the training of young athletes" [1, 4, 7].

**Objective of the study** was to identify the limiting factors of investment activity in the organization and holding of international football competitions in Russia.

**Results of the study and their discussion.** In European countries, about 0.2-2% of GNP (≈2 billion euros) is spent on professional sports (medical and biological support, scientific and methodological support, etc.), while funds from the state budget in Denmark and Germany are less than 20% of the funds of local budgets. In the UK, 95% of investment funds earmarked for sports budget expenditures are funds from



municipal and regional budgets, in Sweden this figure is 90%. In Russia, priority is given to financing *major international competitions* (Winter Olympic Games 2014, World Cup 2018), while youth and mass sports are much less affected by the organizational investment model [6]. The combined investment capital of the above two activities was \$80 billion.

In preparation for the 2018 World Championship and in the process of subsequent implementation of its program, in accordance with Decree of the Government of the Russian Federation No. 518 dated June 20, 2013, the *main burden fell on regional budgets, investors and the federal budget* and amounted to 664.1 billion rubles.

The cost of the Winter Olympic Games in Sochi amounted to 1.5 trillion rubles, which exceeded the planned budget by five times. According to Government Decree No. 117 of January 31, 2017, the main items of expenditure were:

- construction and restoration of sports facilities;
- organization of living conditions for the participants of the competitions;
- material support of sports facilities.

The amounts of required investments declared by domestic officials are much higher than those indicated by the initiators of previous sporting events in other countries.

Attracting large capitals to maintain and develop a positive image in the world market has an ambiguous effect. Large investments can be a factor in unpredictable growth in costs for various types of costs during the course of the transaction, as happened more than once in the implementation of projects of a similar size. The reasons for this were partly *inflation*, as well as an erroneous calculation of future expenses [3].

The amount of funds actually spent as a result for the implementation of these projects is much larger figures than previously announced. For example, the estimate of the "Olympic" project from the moment it was approved (beginning of 2008) to the beginning of 2011 increased by more than 250% (initially, Russian officials stated that the cost of this project would not exceed \$12 billion).

Against the background of indicators of some more global international projects, this is not yet critical. But, extrapolating the noted price increase dynamics for the next 2011-2013, even then it could be assumed that the *final cost would exceed the initially approved figures* by more than 400%. And such a forecast was made only for one of the two projects.

Whether these amounts of "unforeseen" expenses were included in the estimate is difficult to say. However, considering that international practice considers an average rise in the cost of a project designed for a five-year or six-year period to be 30-50% of the previously established value, this rise in price looks more than critical.

But the main question is not even in the volumes and reasons for the rise in prices, international practice knows similar motives and examples, but in achieving a positive ratio of "revenues / costs" - a cornerstone indicator of the effectiveness of any investment transaction.

It is known that the *current proceeds* from the "Olympic" project may simply not be enough to cover the investments attracted for it. Approximate amounts of possible "Olympic" income - from the accommodation of foreign tourists, advertising, leasing channels and satellite broadcast networks, selling tickets for matches, sports paraphernalia, and so on - are not disclosed in the domestic media and specialized sources. However, it is known from international practice that income from such sporting events exceeds the corresponding costs, as a rule, by rather modest amounts.

Thus, proceeds from the organization of the World Cup in South Africa, according to some sources, covered the investment costs of the initiating party by only 50%. Of course, these profitability indicators depend on the scale and advertising of the planned event, the infrastructural capabilities of the host country, and other circumstances. However, due to the increase in the cost of the "Sochi" project, the proceeds from this event should have covered the costs not two, but about five times. Is this dynamics economically possible and acceptable when implementing mass cultural events in the context of an international scale? – the answer to this question is rather ambiguous. But, given that in Russia there are *difficulties in controlling budget expenditures* on large government contracts and projects, it could be assumed that this dynamics of expenditures in comparison with revenues could become critical.

The volumes of the projected attraction of declared funds for the noted "sports" projects contrast sharply with the stagnation situation that is observed in the field of investments in the real sector of the Russian economy. To what extent is the fact of holding the Olympics and the world football championship a sufficient basis and prerequisite for a sharp growth of for-





eign investment in the host state, devoid of economic leverage?

If we take into account the statistics of the football championship in South Africa, the volume of foreign investment in recent years before the start of the event increased by a total of 15-20%, which made it possible to settle costs through private capital by only 30%. The remainder of the required expenditure appears to have been covered by South Africa from public sources. Since its "country" investment rating is at a rather low level (lower than that of Russia), it was probably not possible to attract larger "outside" resources.

However, even if we start from the amount of the "Olympic project" of 30 billion US dollars, its value already allows us to speak about the unprecedented scale of the transaction in comparison with the existing realities of attracting investment resources to the domestic economy. By the way, this is almost seven times more than the volume of foreign direct investment that came into the Russian economy in 2009, and almost the same amount as when converted into foreign currency came from total domestic financial reserves in the same period. We also note that this amount is equivalent to the cost of the Sakhalin-2 project, which is obviously the largest among all domestic oil and gas projects, investment resources for which have been mobilized for ten years.

**Conclusions.** A cumulative solution to all existing financing problems is possible only on the basis of certain comprehensive actions in all relevant priority areas. Successful activity in the sports and physical culture industry entails the development of related industries, such as the construction industry, tourism. For systematic and rational investment activities in the field of physical culture and sports, it is necessary to resort to a larger-scale implementation of vertical integration mechanisms adjusted for a particular sport, when training centers are created on the basis of professional sports clubs not only in the direction of sports training (preparation of a sports reserve), but also in the direction of sports management, as well as the training of sports coaches and referees.

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# Big data analysis as a tool for assessing professionalization of computer sports

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## Abstract

**Objective of the study** was to substantiate the criteria and assess the level of professionalization of the sport "Computer Sports" using big data analysis tools.

**Methods and structure of the study.** The analysis of organizational and economic characteristics of eSports tournaments of various levels (Tier 1 and Tier 2) was carried out using a Python script and library script for this study. A statistical analysis of the numerical variables of the Tier 1 and Tier 2 teams by years (2011-2022) is also presented.

**Results and conclusions.** The signs of professionalization of the studied eSports discipline were revealed, which indicated the need to build scientific and methodological support for sports training.

**Keywords:** artificial intelligence, big data, sports economics, professional sports, e-sports, computer sports, Dota2.

**Introduction.** Modern sports science cannot avoid turning to high-tech solutions that allow obtaining data, managing data and analyzing them to gain new knowledge in the field of theory and methodology of physical culture and sports [1]. Cybersport is a relevant research ground both from the point of view of digital technologies and strategically - in the Strategy for the Development of Physical Culture and Sports until 2030, approved by the Decree of the Government of the Russian Federation of November 24, 2020 No. 3081-r, the promotion of computer sports is written in a separate line. Therefore, the study of managerial and economic aspects of esports in general [1], as well as various problems in the most popular esports disciplines [2, 3, etc.] is relevant.

**Objective of the study** was to substantiate the criteria and assess the level of professionalization of the sport "Computer Sports" using big data analysis tools.

**Methods and structure of the study.** The professionalization of sports, as a process of the maturity of social institutions and their economic indicators, al-

lows us to assess the degree of development of a new sport, to which we include computer sports. The establishment of professionalization criteria determines the need for both the number of athletes and the quality of their training.

To analyze the economic indicators of the development of the sport "computer sports" (the identical term for cybersport), prize payments in the Dota2 game were chosen for highly qualified athletes, namely Tier 1 and Tier 2 teams of the world ranking. Payments were fixed for a ten-year period from 2011 to October 2022 for each level. For Tier 1 teams, 177 tournaments were analyzed (using artificial intelligence technology), and for Tier 2 teams, 322 tournaments, respectively. In each of the analyzed datasets, the following variables were recorded as variables: the name of the tournament, the time of its holding, the prize fund, the number of participating teams, the venue, the team that won first place, the team that took second place. The data were collected by scraping (web scraping) using a script specially written for this study.

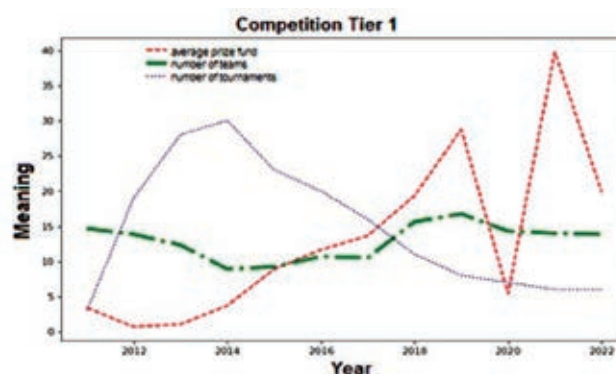
**Table 1.** Quantitative variables characterizing Dota2 tournaments

Tournament end year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
<b>Tier 1</b>												
Number of tournaments	3	19	28	30	23	20	16	11	8	7	6	6
Average prize pool	34361.11	6954.12	10708.22	37114.83	89027.23	116389.09	136443.04	193154.93	287309.50	54166.67	397217.08	198236.88
Average number of teams in the tournament	14.67	13.84	12.32	8.90	9.22	10.70	10.50	15.64	16.75	14.29	14.00	13.83
<b>Tier 2</b>												
Number of tournaments	2	12	22	37	19	32	20	18	23	59	24	32
Average prize pool	1524.88	518.53	1459.63	4132.74	8355.11	13792.83	18973.42	26122.73	23927.29	12311.63	19536.57	22311.62
Average number of teams in the tournament	8.00	14.42	12.05	9.05	11.32	10.50	9.90	10.39	8.49	9.09	8.38	7.59

**Results of the study and their discussion.** The distribution of quantitative variables characterizing tournaments according to the years of holding is presented in Table 1.

Looking at the variable data, one can notice differences in absolute values between Tier 1 and Tier 2 tournaments for all the given variables. For a more accurate assessment, we calculate descriptive statistics for our dataset and place them in Table 2.

When considering the obtained descriptive statistics, the rather large range of all of them attracts attention, and for a better understanding of the current situation, it is necessary to make a visual analysis of the data under study. First, we visualize the dynamics of the development of Dota2 tournaments for Tier1 teams (Fig. 1)



**Figure 1.** Dynamics of the development of Dota2 tournaments for Tier 1 teams (the average prize pool is measured here at \$10,000)

**Table 2.** Descriptive statistics of Dota2 tournaments for Tier 1 and Tier 2 teams

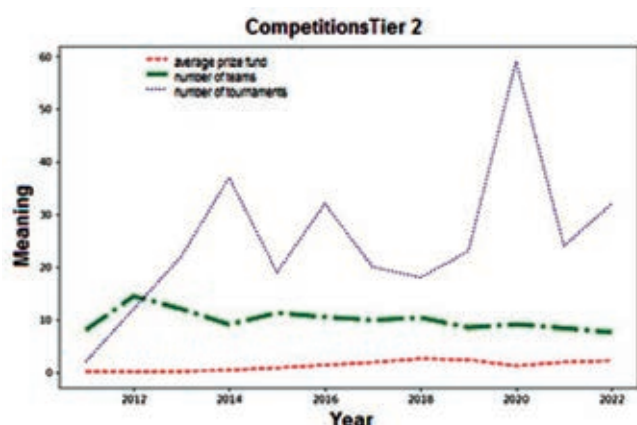
Variable data	Tier 1			Tier 2		
	Total prize pool	Average prize pool	Number of teams in the tournament	Total prize pool	Average prize pool	Number of teams in the tournament
Mean	1487808.05	93683.92	11.79	110109.1	13678.85	9.67
Standard deviation	5243244.42	295263.4	5.04	97846.95	12568	4.83
Minimum	6000.00	512.25	4.00	1500	145.83	4
Percentile 25%	50000.00	5375.75	8.00	40000	3750	8
Percentile 50%	208239.00	23770.25	10.00	80000	9045.46	8
Percentile 75%	500000.00	50999.75	16.00	185064	25000	10.25
Maximum	40018195.00	2223233	32.00	700000	70000	36



**Table 3.** Statistical analysis of numerical variables of Tier 1 and Tier 2 teams by years

Tournament Characteristics	Mann-Whitney U test		H-test Kruskal-Wallis	
	The meaning of statistics	Reliability of differences	The meaning of statistics	Reliability of differences
Number of teams	33758.5	$p \leq 0,001$	26.3	$p \leq 0,001$
Number of tournaments	16504.0	$p \leq 0,001$	48.2	$p \leq 0,001$
Average prize pool	35192.0	$p \leq 0,001$	35.3	$p \leq 0,001$
Total prize pool	35914.0	$p \leq 0,001$	41.5	$p \leq 0,001$

The visualization allows us to conclude that the number of tournaments for Tier 1 teams had its moment of growth, the peak of which was passed in 2014 and is now in the stabilization stage. The number of teams turned out to be the most stable variable and also came into some equilibrium with the other variables. The prize fund turned out to be the most variable variable. Global social factors have a great influence on it, for example, we see a significant drop in 2020 associated with the COVID-19 pandemic, which led to restrictions, including mass events, although it can be seen that the decrease in the number of tournaments is insignificant compared to a decrease in the prize fund. A somewhat different situation is observed in Dota2 tournaments for Tier 2 teams (Fig. 2)



**Figure 2.** Dynamics of the development of Dota2 tournaments for Tier 2 teams (the average prize pool is measured here at \$10,000)

For Tier 2 teams, the number of tournaments is the most variable, and you can see this number increase in 2020, where Tier 1 teams have seen a drop. The number of teams in the tournament and the average prize fund of the tournament can be considered stabilized. For reasonable conclusions, let's check the statistical relationship between these two levels. To do this, we apply an assessment according to two non-parametric criteria, the Mann-Whitney U-test and the Kruskal-Wallis H-test (Table 3).

It can be seen that all variables are significantly different and therefore we can conclude that there is no formed general model for holding Dota2 tournaments for Tier 1 and Tier 2 teams. When trying to create a regression model within each of the described levels, it also showed that such models will have low productivity. The highest coefficient of determination  $R^2$  was 0.067, which also allows us to state that there is no clearly visible productive model within the Tier 1 and Tier 2 levels themselves.

**Conclusions.** An analysis of the socio-economic characteristics of Dota2 tournaments for Tier 1 and Tier 2 teams showed that there are prerequisites for the formation of professional computer sports and its individual characteristics, such as: the number of tournaments; number of teams in the tournament for Tier 1; the number of teams in the tournament and the average prize pool for Tier 2 teams. At the same time, we see that there remains a strong dependence on the influence of global factors, such as the prize pool for Tier 1 teams and the number of tournaments for Tier 2. At the same time, the lack of productive models within esports and the absence of the statistical relationship between the variables between the groups suggests that although professionalization is quite active in the Dota2 esports discipline, it is still far from complete. In the future, with the application of certain efforts, it is possible to have a significant impact on its architectonics or hinder the professional development of computer sports.

When predicting the sports results of domestic cybersportmen at sports competitions of various levels, one should take into account the socio-economic conditions and the quality of scientific and methodological support for sports training.

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# Creating a training multimedia course on methodological support of training sessions

UDC 004.42:796.011



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## Abstract

**Objective of the study** was to substantiate the methodology for creating an educational multimedia course for a system of training sessions.

**Methods and structure of the study.** The methodological basis of the study is the theory of multimedia learning developed by the American educator and psychologist Richard E. Meyer, which states that optimal learning occurs when the visual and verbal components of the educational material are presented to the student together and simultaneously.

**Results and conclusions.** The process of creating a multimedia course consists of several stages: development of a didactic scenario for presenting the material of training activities; development of technological steps of the course scenario; selection of the content of training sessions in the form of digitized elements of what needs to be done in training; concrete creation of an integral system of training sessions of the course based on special computer software; testing and approbation of the multimedia system of training sessions.

Multimedia courses of a sports and coaching orientation have their own specific features, in particular, they contain a component associated with working on sports simulators that imitate real examples of coaching activities, for practicing and "polishing" various special techniques related to sports types of movement (according to sports). Such simulators virtually provide the conditions for measuring numerous indicators

**Keywords:** *educational multimedia course, multimedia creation methodology, training sessions, didactic scenario of material presentation, technological steps of the scenario, multimedia content.*

**Introduction.** The use of powerful computer multimedia systems and interactive software systems has become a new step in the application of modern types of presentation of educational information. But, despite the potential of information technologies and technical means of their implementation, it should be noted that the quality of education and training of athletes with their help depends, first of all, on the quality of the presentation of educational and training material and the form of its presentation in these software products. There are many problems associated not only with the development of completely new types and types of presentation of sports and training information, but also with the method of its presentation to users, as well as the method of creating educational multimedia material for training sessions and technological steps when using multimedia content of sports and training processes. In this regard, the emphasis is on new methodological ap-

proaches in the development of the content of the training session and the importance of the implementation of productive methodological systems for the creation of educational multimedia courses is increasing. The emergence of powerful multimedia tools and technologies with their connection to the global Internet network makes it possible to partially solve these problems.

**Objective of the study** was to substantiate the methodology for creating an educational multimedia course for a system of training sessions.

**Methods and structure of the study.** The methodological basis of the study is the theory of multimedia learning, developed by the American educator and psychologist Richard E. Meyer, which states that optimal learning occurs when the visual and verbal components of the educational material are presented to the student together and simultaneously [1]. It has been proven that with double coding of the visual (visual) and





auditory (verbal, oral) components of information, with its joint visual-spatial representation matrix and the repetition loop (in the so-called working memory model), educational material is absorbed much more efficiently. According to researcher I.M. Yaglom, the human hearing organ can miss about 1000 units of information at the same time, the tactile organ - 10,000, and the visual organ - 100,000 [2], and N.V. Krasnov confirms that a person remembers 15% of the information he receives in speech form, 25% in visual form, but if both of these methods are used simultaneously and synchronously, then he can perceive up to 65% of the content of this information [3, p. 16]. That is why the multimedia capabilities of presenting and transmitting information can enhance the learning effect, since multimedia is data or content that is presented simultaneously in different forms: sound and video, animated computer graphics. And if we take into account that multimedia capabilities add textual (voiced) and figurative (visual) graphic video information, as well as the possibility of interactive interaction with it, then this greatly enhances achievements in the assimilation of educational material.

**Results of the study and their discussion.** Recall that a *multimedia course* is understood as a complex of logically connected structured didactic units (thematic training sessions), which are presented in digital format and contain all the components of the educational and training process.

**The process of creating a multimedia course consists of several stages:**

*The first stage:* development of a didactic scenario for presenting the material of the training activity.

*The second stage:* development of technological steps of the course scenario.

*The third stage:* the selection of the content of the training sessions in the form of digitized elements of what needs to be done in training (taking into account their multimedia ambiguity).

*The fourth stage:* the concrete creation of an integral system of training sessions of the course based on special computer software.

*Fifth stage:* testing and approbation of the multimedia system of training sessions.

A *didactic scenario* is understood as a methodically built sequence of pedagogical techniques, methods and technologies that are aimed at a specific goal of a training session. Its characteristic feature is that it can have both a linear and a non-linear sequence of training exercises, including various branching options with the possibility of returning to its original position, including transitions via hyperlinks in the form of so-called "windows", and also it must necessarily have adaptability mechanisms, which consist in adjusting (adaptation) of the multimedia system to the capabilities and level of learning (training) of the person with whom they work in class.

The didactic scenario reflects the author's idea of the content side of the course and its structure. The scenario also reflects: the *pedagogical principles* underlying the training sports activities, *techniques and methods* that, as a rule, duplicate similar "run-in" pedagogical techniques and methods inherent in the corresponding sport with traditional support of the training process.

The next step in creating a multimedia course of the system of training sessions is the *stage of developing the technological steps of the scenario of this course*. It consists of a description of information and communication technologies used to implement the didactic scenario and the direction of its application, which allow you to determine the capabilities of the software for the implementation of a particular idea / action to implement the pedagogical side of the project, namely: how to most clearly and colorfully present the actions when performing physical techniques and exercises of an athlete; how to visually more clearly and understandably decipher the small details and nuances of emerging problem situations in the process of training actions, etc. It also includes steps to create a user-friendly user interface with a clear and comfortable system of transitions between fragments of one or more topics (or classes); steps to create convenient navigation between training material objects with different levels of detail, as well as with a convenient and intuitive toolbar of various switches, checkboxes, input and output windows, icons for launching various tools, etc.

In the technological scenario, the material is built according to the levels of the hierarchy, taking into account the following directions: the most optimal components of access to the content of the training material, the most convenient navigation between the components of the educational material presented to the user; colorful and ergonomically sound design of the interface of a computer program; convenient instrumental navigation; a sufficient set of special multimedia applications, including control ones.

The next stage is the stage of *concrete creation of an integral system of training sessions of the course*, which involves several nested sub-stages, namely [4]:

- *Preparatory*, on which the text part of the *explanatory material* is prepared in advance, *static illustrations* in the form of drawings, diagrams, photographs, ready-made sound recordings with the voices of famous personalities in sports and sound music accompaniment tracks are selected, as well as video clips of sports competitions for performing sports elements, techniques, exercises and so on.;

- *Creation of own multimedia*, where the following types of multimedia applications are used: *animations* - dynamic graphics based on the use of various moving visual effects; *audio applications* - audio recordings of comments (including copyright ones) of well-known and titled trainers, physiologists, massage therapists,



psychologists and other specialists to used diagrams, tables, illustrations, etc.; *video applications* - videos of the author's text being read, video clips of pop-up video footnotes, video explanations, etc.;

- *Layout of materials into a single software package*, in which all educational information (text, graphics and multimedia) is assembled into interactive frames in accordance with the intention of the script author. A feature of this stage is that, on the one hand, the student should be able to choose the pace and sequence of the studied training material, and on the other hand, the entire learning process should remain manageable. In terms of its implementation, it is one of the most responsible and difficult to implement.

- *Creation of the user interface of the multimedia system*. A well-thought-out interface makes it much easier to work with the system, and the use of certain standards saves the user from spending extra time on mastering it. Therefore, it is necessary to use elements, buttons and tools with well-established names, for example: Title bar, Menu bar, Status bar; Working field of the program; Scroll elements (bars), Standard buttons: "File", "View", "Help", etc. It is necessary that the user interface is intuitive and does not cause additional stress in the user's work.

- *Creation of network components*. Since modern multimedia systems are connected to the Internet, it is necessary to take into account in the created management tools a system of tools that take into account the use of Internet resources.

Multimedia sports and coaching courses have their own specific features. In particular, they use practical classes as a type of educational activity in the form of organizing a training process under the guidance of a trainer-teacher. Therefore, such courses necessarily include work with sports simulators that imitate real examples of coaching, to develop and "polish" a variety of special techniques associated with sports types of movement (by type of sports). Such simulators virtually provide the conditions for measuring numerous indicators and model characteristics of the athlete's physical and psychological state.

As an example of a constructor in the creation of electronic courses, we can name the eAuthor 3.1 system of the HyperMethod company, which has proven itself well as a tool for developing multimedia courses in the system of sports and training sessions, which includes interactive trainings, test tasks and exercises. They are intended for use by practicing trainers.

**Conclusions.** The analysis of the presented methodology for creating educational multimedia courses in the system of sports training sessions showed that their use in the training process leads to a reduction in volume and a simultaneous complication of the coach's activity to accompany this process. In such systems, the structure of control and consultation becomes more complicated, but the independent work of student athletes reaches a higher level, since there is a multiple repetition of training actions, with a detailed consideration of the complex moments of motor activity, which is the most important for training.

It should be noted that such systems, with numerous positive advantages, also have negative aspects of their application, in particular, the amount of preliminary work of the trainer in the preparation of methodological support increases dramatically. The negative side can also be attributed to the fact that, despite the fact that, on the one hand, the communicative openness of the training athlete increases, on the other hand, his alienation from direct contact with a living mentor increases.

Unfortunately, despite the undoubted didactic advantages of this tool, the use of multimedia courses in the training process is not yet sufficiently supported by the development of pedagogical technologies for their effective use.

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# Scientific foundations of sports training planning: a new methodological approach

UDC 796.011.3



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## Abstract

**Objective of the study** was to theoretically substantiate the application of the theory of oscillations in optimizing the planning of the training process.

**Results and conclusions.** The author argues that the generally recognized dynamics of the phases of the sports form does not correspond to the conditions for the implementation of the optimal (best among many others) options for the development of the physical abilities of the body of athletes, but is the result of the historically established practice of planning sports training. A theoretical substantiation of the use of the theory of fluctuations in the planning of the training process is given, in particular, taking into account the supercompensatory phenomenon in the functional state of the athlete's body.

**Keywords:** *training, sports form, optimal planning.*

**Introduction.** The problem of planning is one of the most important in the theory and practice of sports and is associated by specialists with the frequency of sports training and the achievement of optimal sports form, as a natural basis for planning.

The study of the currently available statistical, theoretical and experimental arguments gives grounds for the assertion that the generally recognized dynamics of the phases of the sports form does not correspond to the conditions for the implementation of the optimal (best among many others) option for the development of the physical abilities of the body of athletes, but is the result of historically established practice sports training planning.

Thus, the question arises: "Is there another way to solve the problem of optimizing the planning of athletes' training?" As an affirmative answer to the question posed, a reasoned theoretical justification for using the theory of oscillations in planning the training process, in particular, taking into account the supercompensatory phenomenon in the functional state of the athlete's body, is proposed [5].

**Objective of the study** was to theoretically substantiate the application of the theory of oscillations in optimizing the planning of the training process.

**Results of the study and their discussion.** An analysis of the publications of specialists shows that in the field of theory and methodology of sports, they record a large number of cycles of various nature and duration. In the systems of sports training L.P. Matveeva [7], Yu.V. Verkhoshansky [2], A.P. Bondarchuk [1], V.B. Issurin [4] and other specialists, the integrity of the training process is ensured on the basis of a certain structure of cycles, in particular, biological ones. Taking into account the length of time within which certain links of the training process are formed, there are, for example, microcycles, mesocycles, macrocycles, a large training cycle, etc. The lack of unified methodological principles for the analysis of cyclic wave processes leads to theories of physical education and sports to a paradoxical fact: in one subject area there are several concepts at the same time, offering the optimal solution to the same problem.

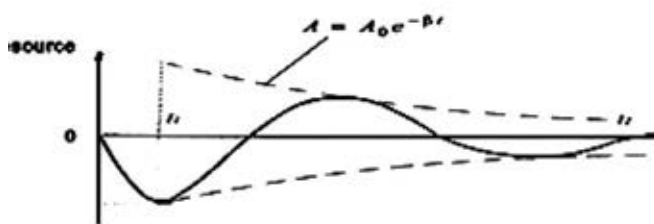




The factual content of the modern theory and practice of physical education and sports contains the potential for the implementation of the goal. Let's consider this possibility.

In the light of the general methodological principle of systematicity in the development of human abilities, it is necessary to observe the effect of layering each subsequent lesson on the traces of the previous one. It is known that the regular basis of this principle is the experimentally established phenomenon - supercompensation. The spatio-temporal dynamics of this process is a damped oscillation [3, 8], that is, it is possible, on the basis of the generally recognized laws of oscillatory processes, to theoretically analyze various options for the dynamics (development) of a damped process under various initial conditions for the action of a perturbing factor [5].

From the point of view of the theory of oscillations, the phenomenon - supercompensation, can be considered as a sequential alternation of two processes (phases) (Fig. 1).



**Figure 1.** Dynamics of the recovery process in the human body

First, on the time interval  $[t_0, t_1]$ , a driving force acts on the organism and takes it out of the state of equilibrium.

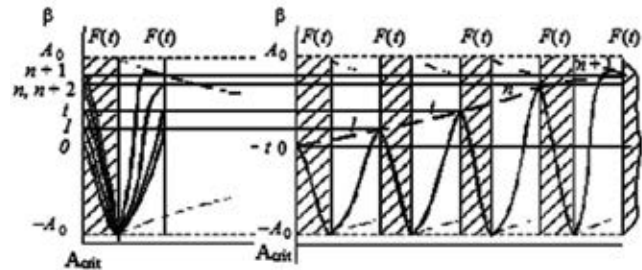
Secondly, after the end of the driving force on the time interval  $[t_1, t_2]$ , the state of the organism performs a free damped oscillation. From the moment the free damped oscillation ends, the organism returns to its original state.

In real life, in particular, in the process of sports training, the frequency of repetition of physical impact is commensurate with the duration of the phase of free damped oscillation of the state of the organism. In this regard, we can consider several options for the subsequent dynamics of the rhythm of the state of the body.

1. *Progressive changes in the structure of the rhythm of the system.*

Let us assume that a driving force  $F(t)$  periodically acts on an open oscillatory system with a constant frequency. Let us consider the case when the moment of application of the driving force  $F(t)$  falls on the ascend-

ing wave of the damped process, and the current values of the system parameters exceed their initial level, that is, in the first half of the phase of the supercompensation phenomenon. In the zero cycle, the system is brought out of equilibrium by the force  $F(t)$  (Fig. 2).



**Figure 2.** Dynamics of the rhythm of the system when a periodic driving force is applied in the interval from  $T/4$  to  $T/2$  of the ascending wave of the damped process

The process of increasing the amplitude of the rhythm and reducing the period of its oscillations will proceed from cycle to cycle until the moment of application of the driving force coincides with the half-period of the free damped oscillation of the system (the maximum of the overcompensation phenomenon), that is, for it the condition will be fulfilled - the resonant effect of the load on the oscillatory system. In the future, the amplitude and period of the oscillation of the system at the moment of application of the driving force from cycle to cycle will undergo only small fluctuations relative to the given state of the system (a consequence of the laws of damped oscillation).

An analysis of the dynamics of the "drawing" of an oscillatory system into the rhythm of oscillations by the driving force of a constant frequency gives grounds for fixing the following consequences.

1. As the system is drawn into the rhythm of oscillations of the driving force, the amplitude of the rhythm increases asymptotically, that is, the development of the system in a given region of space will be characterized as *asymptotically increasing*.

2. If the moment of application of the driving force coincides with the maximum of the wave of the damping process (the maximum of supercompensation), the development of the oscillatory system stops and this state of relative equilibrium can be indefinitely if the amplitude of the driving force and its repetition frequency are maintained constant in time.

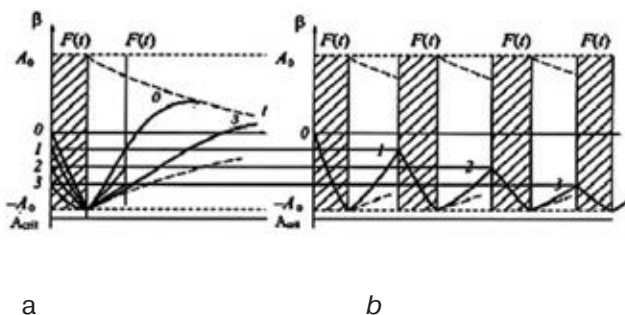
*The first consequence*, where the asymptotic development of the oscillatory system is realized, from the point of view of the content of the concept of "sports form", can be considered as the phase of "formation" of the sports form according to L.P. Matveev [7], ac-

cording to A.P. Bondarchuk [1] and V.B. Issurin [4], as a phase of “development” of sports form.

The second consequence assumes the end of development and the beginning of the preservation of the state of the system, which will correspond to the beginning of the phase of maintaining the sports form.

2. *Regressive changes in the structure of the rhythm, when the physical impact falls on the phase of under-recovery.*

Let us consider the case when a driving force  $F(t)$  acts periodically on an open oscillatory system with a constant frequency. At the same time, the moment of force application falls on that part of the ascending wave of the damped process, when the current values of the system parameters do not exceed their initial level, according to the terminology of the theory of sports, the phase of under-recovery. In the zero cycle, the driving force brings the system out of equilibrium (Fig. 3).



**Figure 3.** Regressive changes in the rhythm structure of the state of the body:

a – comparative dynamics of damped processes in cycles 0–3 (coordinates of the beginning cycles are superimposed on each other); b – dynamics of the regressive process

In accordance with the laws of the theory of oscillations, the process of reducing the amplitude of the rhythm and increasing the period of its oscillations will proceed until the current value of the parameters of the organism reaches the critical limits for a given person, beyond which the state of the organism loses its qualitative certainty. If the influence of the driving force is removed in the subcritical region of the system state, then a free damped oscillation (recovery) will occur in the body.

In the regressive version of the dynamics of the development of an oscillatory system, the third consequence can be distinguished:

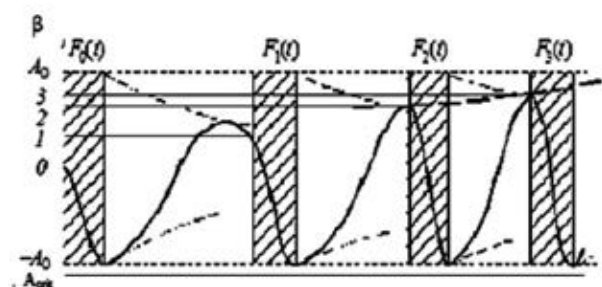
- the laws of the theory of oscillations reflect the presence of not only higher static characteristics of the body (initial level) before the onset of the driving force than after its removal, but also the dynamic characteristics of the body, which will be reduced in

the new state (see Fig. 3, a, cycles 0 and 3). This is due to the fact that the amplitude of each subsequent cycle will asymptotically decrease by an amount equal to:

This third consequence of the action of the laws of the theory of oscillations contradicts the axiom of the optimality of planning the development of a sports form (a type of strategy for adapting the body to physical activity, typical for athletes in speed-strength sports) in the concept of Yu.V. Verkhoshansky [2] and the axiom of V.B. Issurin [4] - “a certain sequence of highly concentrated training loads.” In accordance with these axioms, if several successive loads fall on the phase of under-restoration of the functional state of various organs and systems, then this option of load planning gives a greater effect. The failure of the axiom is proved, on the one hand, by its contradiction to the laws of damped oscillation. On the other hand, it is shown by the results of the experiment [6].

3. *The optimal variant of progressive changes in the structure of the rhythm of the system.*

The process of progressive development of the system with the imposition of a driving force on the interval will begin if the oscillation frequency and the amplitude of the driving force increase from cycle to cycle. In this case, the maximum growth rates of the system parameters over time will be maintained if the magnitude of the change in the frequency of the oscillation of the driving force is such that the driving force will act on the system in time with its rhythmic oscillations (Fig. 4). This is the fourth consequence of the action of the laws of the theory of oscillations.



**Figure 4.** Dynamics of the system under the imposition of a periodic driving force

variable oscillation frequency in the interval from  $T/2$  to  $3/4 T$  of the downward wave damped process

This variant of the dynamics of the development of an oscillatory system under the action of a driving force must be considered when planning the relationship be-



tween the training load and the duration of rest in the preparation of athletes, as the most effective, that is, the optimal variant.

Consider the reasons that do not allow in the practice of sports to implement the best option for planning the dynamics of the state of athletes.

Usually, the volumes of the training load and the growth of sports results in sports with recorded achievements (athletics, swimming, speed skating, cycling, etc.) are fixed. Coaches know the volume of exercises performed over a certain period of time and the increase in the result. It is generally accepted that the situation is normal in which training loads increase continuously, and the growth rate of performance decreases. According to V.B. Issurin [4], this natural decrease is determined primarily by biological adaptation to the applied training effects. Yu.V. Verkhoshansky believes that "the adaptation process, both at the compensatory and long-term levels of its expression, cannot continue indefinitely ... therefore, the dynamics of the latter in time is described by a monotonically decreasing parabola" [2, p. 36].

The points of view of specialists presented above contradict the fourth consequence of the theory of oscillations. In accordance with the laws of damped oscillations, indicators of the state of the body (the level of physical, functional readiness) can, under certain conditions, asymptotically increase up to a certain genetically determined limit for each athlete (see Fig. 4). This is a fundamentally important theoretical argument both in assessing the objectivity of the opinion of specialists, and, accordingly, the conceptual provisions of one or another concept of training athletes.

**Conclusions.** In the real practice of sports, a monotonically decreasing dynamics of a sports result is fixed both at the level of the sports form cycle formation and in the long term. The reasons for this are the following factors:

- in the training process, the conditions of the second consequence of the action of the laws of the theory of oscillations are preserved, that is, the magnitude of the training impact and its repetition frequency remain constant in time. The situation is aggravated if the measure of the training load is reduced;
- in the training process, the fourth consequence is violated, which requires not only to increase the strength of the physical impact at each subsequent lesson, but also to adjust the start time of the next lesson, taking into account the reduction in the duration of the cycles of the recovery process. If in the real practice

of training athletes the first condition is still somehow observed, then the second condition is to correct the beginning of the training session, taking into account the dynamics of the phase of the super-compensation phenomenon with a rigidly fixed time grid of training sessions within the boundaries (day, microcycle, mesocycle and etc.) - not executed.

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# Consistency of motor actions as a factor of comprehensive development of a dance couple at the stage of initial training

UDC 793.38



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## Abstract

Ballroom dancing is a complex coordination sport, one of the main components and characteristics of which is the performance of a dance duet by two partners.

The issue of motor consistency in a dance couple is relevant for research, especially among young dancers, since they have little experience in social interaction and dance practice to find motor compromises and work out their own consistency.

**Keywords:** *ballroom dancing; consistency of motor actions; methods*

**Introduction.** It is determined by the high significance of the search for means and methods aimed at optimizing the improvement of the training process of training in sports dancing, which will allow dancers to achieve better results in the process of joint activities. Ballroom dancing is a highly coordinated sport, one of the main components and characteristic features of which is the duet performance of the dance by two partners. Their effective physical and emotional interaction directly determines how beautiful and interesting the dance will be for the viewer and the judge[7].

The issues of psychological preparation of an individual dancer, self-adjustment, etc. are considered in the scientific literature quite often, in contrast to the ways of coordination of movements between partners. Although in practice, according to many coaches, the greater success of the dance as a whole depends on the consistency of actions. Many teachers note that the consistency of actions in a couple is primarily influenced by interpersonal relationships, the atmosphere in a couple. In addition, an important problem is the issue of leadership and the struggle for it in a dance couple.

The main indicators of positive compatibility of partners are the improvement of results and the stability of the formation of couples in sports dancing. The problem of consistency of motor actions based on psychological compatibility still does not find due attention in theoretical studies of teachers and psychologists.

Partners are involved in sports dancing, and it depends on how their sports activities are designed by the coach. It depends on their technical performance of a particular dance, but since sports activities should be reflexively constructed, this obliges the coach to pay attention to the interaction of partners, their emotional stability, conflict resolution[5].

Until now, the scientific literature has mainly considered the problems of improving the quality of dancers' performances, the possibility of self-regulation of their emotional state, and the formation of motivation for sports. At the same time, as practice shows, a decrease in the level of compatibility in sports activities occurs for a number of reasons, among which the most significant coaches-practitioners consider interpersonal relationships, the emotional state of part-



ners, as well as the problem of leadership in a sports couple [1,2,6].

Nevertheless, the problem of coordination of motor actions based on psychological compatibility still does not find due attention in theoretical studies of teachers and psychologists.

A.A. Kovalenko believes that sports dance, unlike other sports, significantly affects the development of psychophysiological characteristics of athletes (temperament, self-esteem, formation of self-image, physiological difference by gender, etc.). It is this effect that reflects the complexity of "couple dancing", which in turn affects the training and competitive activity of both performers [3].

According to A.G. Strebkova, in the structuring component of a flexible system of training and competitive processes in sports dancing to improve the physical, tactical, psychological and technical level of dance couples, there is a goal of joint activity in sports dancing. Thus, the question of motor consistency in a dance couple is relevant for research in order to find motor compromises and develop consistency independently [7].

Based on the analysis of scientific and methodological literature, the following conclusion can be made: The success of joint activities depends on the nature of interpersonal relationships, psychological atmosphere, group cohesion, distribution of role functions, etc. However, the influence of each factor on the effectiveness of joint work is ambiguous, it is due to the specificity of the joint activity performed. There is a link between the effectiveness of joint activities and the compatibility of its participants. The effectiveness of the group is determined not only by the individual indicators of the individual's skill in this type of activity, but also to no lesser extent by the optimal combination of the members of the couple according to their individual psychological parameters. The selection of participants in joint work should provide for the study of individual psychological characteristics that limit the effectiveness in this activity.

Each jointly performed activity has its own compatibility parameters. For some sports specializations (volleyball, tennis, etc.), compatibility criteria have been identified, methods of recruiting groups have been developed taking into account the individual psychological characteristics of partners. Practice shows that when recruiting couples in sports dances, the main attention is paid to physical and motor compatibility, however, the individual psychological char-

acteristics of athletes are not taken into account. This often leads to negative relationships, conflict situations, refusals to work in this composition.

The training system includes: General physical training includes a wide variety of exercises that affect all muscle groups and body systems of the dancer. Purposeful physical training should contribute to the more effective development of individual physical qualities, increase the level of functional capabilities of dancers. The complex of exercises used should constantly create prerequisites for optimal education of physical abilities necessary in sports dancing.

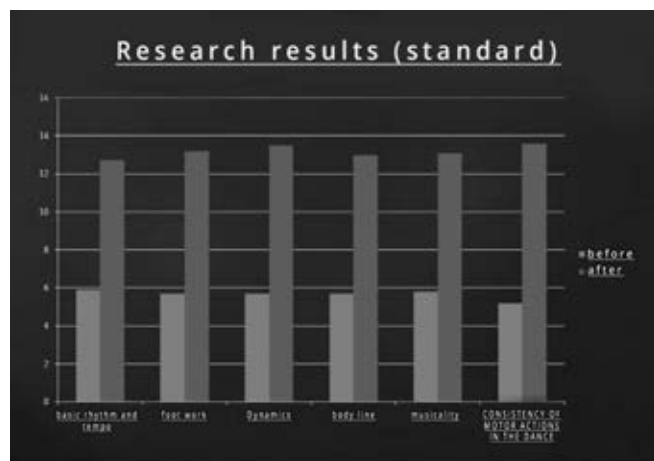
Special physical training of dancers in initial training groups takes quite a lot of time, since its successful implementation in the training process can be the key to both successful competitive activity and athletic longevity of athletes. The selection of SFP exercises was carried out taking into account the principle of unity of general and special training. When working on the coordination of movements in the training process, the following are worked out: - the positions of the legs of athletes - dancers in a dance couple; - the position of the body of partners in a couple; - parallelism of the feet of athletes — dancers when performing the movement in couples; - the positions of the hands of athletes - dancers (training and basic) for the European program, (closed, open) for the Latin American program; note: we consider only the main positions of the hands. - dance bundles based on several figures of sports dance; - dance compositions (golden variations). The "Golden Variation" is a composition based on dance movements that are most often used in sports dancing.

The psychological exercises included: - methods for determining the psychomotor compatibility of partners in a dance duet (V.I. Rumyantseva); - methods for determining the leadership qualities of athletes-dancers. (O. Potemkina). - Performance of a dance variation with preset emotions. - Discussion of competitions after participation in them. - "Mirror". One of the partners showed the action at a slow pace with some part of the body, for example, with his hand. The second partner had to repeat this movement as accurately as possible. Then the partners changed between an active and a passive party. - "Moving a couple by one partner". One partner closes his eyes and the second, taking him by the shoulder or waist, leads him around the hall at different tempos to different music, bypassing various obstacles. As well as various other psychological exercises similar in direction [4].

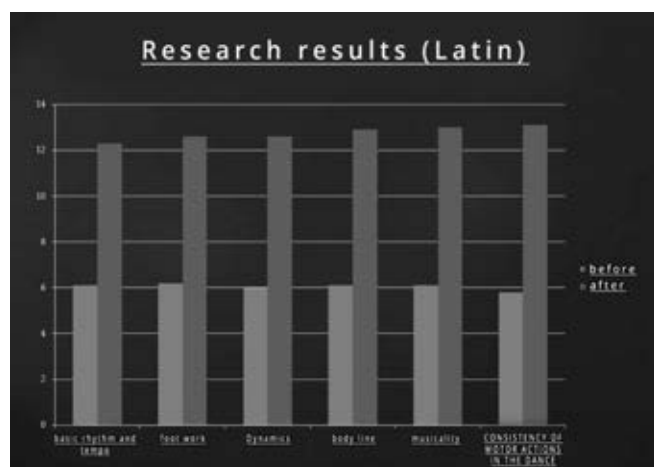


Test results for dance couples of initial training of 14-15 years.

Program	$\bar{x} \pm \sigma$		t-test	p
	before	after		
Standard	5,67±0,84	13,77±0,99	16,4	p≤0,01
Latin	6,05±0,99	12,77±0,83	18,3	p≤0,01



Research results (Standard)



Research results (Latin)

**Conclusion.** The expert assessment consisted in the evaluation by the judges and specialists of the performing skills of couples according to the main criteria used according to the rules of the Russian Dance Union. Each criterion was evaluated by the arbitrator on a scale from 1 to 3. For each criterion, the average

index was calculated, as well as the average index on the sum of the criteria. There were 5 professional judges who participated in the expert assessment. Couples performed the final 5 dances of the standard and 5 dances of the Latin American program. The results of the expert evaluation showed significant differences in performance skills according to all criteria. The development of coordination of motor actions in a dance pair of initial training significantly increases psychological and motor coordination in a pair, as well as develop other important criteria for a dance couple.

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# Increasing students' performance by the method of regulated breath control

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## Abstract

**Objective of the study** was experimental confirmation of the effectiveness of using the method of regulated breathing control to improve the performance of students.

**Methods and structure of the study.** The experiment involved 40 students of St. Petersburg State University aged 18-20, mastering "Elective disciplines in physical culture and sports." The students were divided into control (CG) and experimental (EG) groups of 20 people each. To determine the effectiveness of using the experimental method (regulated breathing control) in physical education classes, the following research methods were chosen: mental performance and stress resistance test (TMPSR), sustainable performance test (TST), VO2max test, 12-minute Cooper test.

**Results and conclusions.** It has been experimentally proven that the regulated control of breathing allows you to use not only the muscles of the chest, shoulders, but also the muscles of the abdomen, as well as the diaphragm, which helps to restore the breathing technique and increase the performance of the bronchopulmonary apparatus.

**Keywords:** *students, working capacity, physical culture, regulated breathing control, breathing exercises.*

**Introduction.** The constantly increasing amount of information, the increase in its volume and complexity, the increasing requirements for the future specialist not only in the field of professional knowledge and skills, but also in the level of health, as well as physical fitness, lead to changes in the functioning of the entire human body, as a result, to a decrease in its efficiency, and most importantly - the quality of the work performed [7, p. 83; 9, p. 10].

As non-drug methods to increase mental performance, a number of researchers point to the use of autogenic training, color and sound effects that have a beneficial effect, toning the body through alternating mental work with physical. According to K.N. Dementieva, N.S. Leshevoi, I.S. Moskalenko, L.V. Yarchikovskaya the best results are obtained by the inclusion of light aerobic physical activity in the middle or after the end of mental work and V.I. Grigoriev, T.I. Koval and others confirm with their research the benefits

of purposeful inclusion of breathing exercises in the program [1, p. 68; 3, p. 41; 4, p. 36; 5, p. 217; 8, p. 12; 11, p. 307]. Various arbitrary breathing modes as a methodical technique can be used in training, both to create oxygen deficiency and to increase aerobic capacity, as well as to adapt the respiratory apparatus to work in a variety of breathing modes. An analysis of the special literature allowed us to assume that not only the way of performing exercises, the nature of the load, but also the purposeful use of breathing exercises in a relatively short period will increase the performance of students [2, p.110; 10, p. 28].

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*Dynamics of the studied indicators at the beginning (before) and at the end (after) of the study*

Indicators	EG (n=20)		CG (n=20)	
	before	after	before	after
VO <sub>2max</sub> test				
% O <sub>2</sub>	4,08±0,59	3,88±0,40	3,80±0,44	3,68±0,37
RR, breath/min	46,4±10,8	50,3±9,2	55,3±7,8	55,5±5,3
RV, л	2,12±0,37	2,19±0,30	2,03±0,28	1,97±0,21
Time of onset of VO <sub>2max</sub> , s	308±70	395±89	345±77	386±55
<b>Tests for health research</b>				
TMPSR, number of errors	32,3±9,2	21,4±2,8	29,8±8,6	26,6±10,4
TST, number of errors	26,5±8,2	16,7±4,2	25,7±6,9	16,7±4,2
12-minute Cooper test, km	1,8±0,25	2,3±0,26	1,9±0,41	2,1±0,52

physical culture and sports.” The students were divided into control (CG) and experimental (EG) groups of 20 people each. To determine the effectiveness of the use of the experimental method (regulated control of breathing) in physical education lessons, the following research methods were chosen:

1. Test of mental performance and stress resistance (TMPSR). TMPSR is a time-limited attention test, with 88 tasks given 14 minutes. The test consists of four blocks:

- counting figures, 40 questions at a pace of no more than 5 seconds per task;
- counting figures of various shapes, 40 questions at a pace of no more than 4 seconds per task;
- search for mechanical errors in an excerpt of a literary text, four tasks at a pace of no more than 60 seconds per task;
- search for mechanical errors in a passage of text on professional topics, four tasks at a pace of no more than 60 seconds per task.

2. The Sustainability Test (TST) consists of three parts that are performed during one testing session:

- game block to determine the integral indicator “accuracy-speed” of actions in a situation of choice in conditions of time pressure;
- psychological questionnaire;
- intelligence test.

3. VO<sub>2max</sub> test: % O<sub>2</sub>, respiratory rate (RR), respiratory volume (RV), time to VO<sub>2max</sub>.

4. 12-minute Cooper test.

**Results of the study and their discussion.** For the EG and CG, a single program of 36 academic hours was compiled. The students from the EG used the method of regulated breathing control in all exercises, except for the complexes in the preparatory part. The CG followed the same program as the EG, but performed identical work without an emphasis on breath control.

The method of regulated breathing control consisted in the purposeful use of the abdominal type of breathing, involving the diaphragm, to train the muscles of the respiratory system apparatus. Milodan V.A.

(2009) argued that the use of this type of breathing, creating resistance to inhalation by the muscles of the larynx and bronchi, allows you to increase air pressure and improve ventilation of the lower zones of the lungs [6, p. 88]. In the main part of the lesson, while performing running tasks, the students from the EG were recommended to use the abdominal type of breathing with resistance during inhalation. The final part of the lesson included yoga exercises, with an emphasis on one of the breathing options - “inhale - hold the breath - exhale” at a pace of 4:16:8.

The selected research methods made it possible to consider what changes occurred in both groups as a result of the application of the experimental method (see table). At the beginning (before) and at the end (after) the study, the students from the EG showed significant differences in the studied indicators, in the CG the indicators did not change significantly.

The results of the test of mental performance and stress resistance and sustainability test at the end of the study indicate an increase in mental performance, as well as an increase in its efficiency. So, in the initial testing, students made a large number of mistakes and often did not have time to complete several tasks in the allotted time period. According to the subjective assessment of the students from the EG, it was noted that even a five-minute breathing exercises used in physical education classes allowed them to reduce the level of anxiety before performing complex tasks and increase their concentration, which had a positive effect on their results.

Control measurements of the time to overcome the 2 km distance showed that the use of the method of regulated breathing control during cyclic work allowed the students from the EG to increase the lag in the CG by 22.7 ± 5.4 s, which can also be tracked by the results of the 12-minute Cooper test.

**Conclusions.** The experimental method of breathing control allows you to use not only the muscles of the chest, shoulders, but also the abdomen, as well as the diaphragm, which helps to restore the breathing technique and increase the performance of the



bronchopulmonary apparatus. Thus, training under conditions of artificially created hypoxia by the method of regulated respiration control increases working capacity not only during cyclic exercises by increasing the power of both aerobic and anaerobic energy supply systems, but also contributes to longer and more efficient mental work.

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# Signs of adaptability of cybersportsmen to the virtual environment

UDC 796.015

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## Abstract

**Objective of the study** was to determine the dominant features that affect the adaptability of cybersportsmen aged 18-25 to the virtual environment.

**Methods and structure of the study.** As a result of the theoretical analysis, 125 features (characteristics) of e-sportsmen have been identified that affect the adaptability to the virtual environment. An online survey of 55 experts in the field of computer sports was conducted on the basis of the Yandex Forms service, where respondents evaluated each of the 125 features. To reduce the number of variables and determine the structure of relationships between variables, the data obtained were subjected to factor analysis, which made it possible to identify seven factors, including from three to 14 features.

**Results and conclusions.** The dominant features that affect the adaptability of a cybersportsman in the digital environment are determined: the ability to synthesize, concentration of attention, switching of attention, quickness of thinking, competition, strength of the nervous system, working capacity, emotional biorhythms, lack of need for acquiring knowledge. The results of the study can be used in the development of training programs for those involved in various disciplines of computer sports.

**Keywords:** computer sports, e-sportsmen, signs of adaptability, virtual environment, meta.

**Introduction.** One of the areas of scientific and technological development of educational activities in educational institutions is the direction associated with the development of computer sports. In connection with the ever-increasing interest in computer games among children and youth, the opening of eSports sections, increasing competition in the All-Russian and international arena, there is a need for appropriate training of professional personnel capable of solving such a large-scale problem. Coaches are limited by the number and quality of benchmarks that allow evaluating and predicting the performance of e-sports players. Some foreign sources indicate a strong correlation between the early pace of learning and the gaming efficiency of cybersportsmen in the future [2].

Based on this, it should be suggested that the level of adaptability to the new virtual environment can act as one of the criteria for evaluating the effectiveness of cybersportsmen in the future. A distinctive feature of computer sports from other sports, where the rules of competitive activity have not changed for decades, is the frequent updating of computer games used as

sports equipment and sometimes the replacement of some video games with others.

In computer sports, the concept of “meta” is used. “Meta” is the features of game mechanics, characters, skills, properties of game items, game balance, in a given period of time [1]. Often the “meta” changes during the release of major updates, at the request of the game manufacturer. The game producer has the ability to make changes to the game at any time and this will always be a problem for eSports competitors. The more global the update, the more time players need to adapt to it.

**Objective of the study** was to determine the dominant features that affect the adaptability of cybersportsmen aged 18-25 to the virtual environment.

**Methods and structure of the study.** As a result of the theoretical analysis [1], 125 features (characteristics) of cybersportsmen have been identified that affect the adaptability to the virtual environment. At the first stage of the study, an online survey of 55 experts in the field of computer sports was conducted. The contingent of respondents were: coaches,



teachers, teachers of additional education, managers, sports psychologists, video game developers. The survey was conducted on the basis of the Yandex Forms service, the respondents evaluated each of the 125 features on a scale from 1 to 10 (by the degree of influence on the player's adaptation to the new virtual environment), where 1 is a weak influence, 10 is the maximum influence.

In order to reduce the number of variables and determine the structure of relationships between variables, the data obtained were subjected to factor analysis using the factor extraction method (principal component extraction method). This method was intended to combine features into groups of factors. As a result, seven factors were identified (according to the "scree criterion"), including from three to 14 signs (43 signs).

At the next stage, to participate in the experiment, the subjects were asked to play the metroidvania "Ori and the Will of the Wisps" on a personal computer. The study group consisted of participants who had no previous experience of playing "Ori and the Will of the Wisps" or "Ori and the Blind Forest" (the first part of the game). All subjects played at a low level of difficulty, the speed of passing the game was estimated using the interface built into the game, which displays the percentage of completion of the game and the time spent on passing. The speed of passing (V) of the game was calculated by the formula:

$$V = \frac{P}{t}$$

where P is the game progress in %, t is the passage time in minutes.

After passing all the tests and filling out the questionnaire, a correlation analysis was made between

the speed of the game and the variables of each of the seven previously identified factors in order to identify the variables that affect adaptation to the new virtual environment.

**Results of the study and their discussion.** As a result of the correlation analysis between the speed of passing the game and the indicators of each of the seven factors, only nine indicators were identified that most affect the speed of passing the game (see table).

An average significant relationship was found between the speed of passing the game and the ability to synthesize 0.500 ( $p < 0.05$ ). Synthetic abilities allow you to identify the leading links in a continuous flow of information, assess the situation and make the right decision. During competitive activity in the disciplines of computer sports, especially team sports, the athlete constantly has to demonstrate the ability to synthesize, on the basis of a previously formulated task - in the form of a tangible result, evaluate the components of the current situation, simulate various options for the development of the game situation, evaluate the likelihood of its occurrence and make decisions. There is a high negative significant ( $p < 0.001$ ) relationship between the speed of passing the game by one of the indicators of concentration of attention - the number of errors, that is, the number of rings missed in the Landolt test in 10 minutes.

In the course of the correlation analysis between the variables of the second factor and the speed of the game, a significant ( $p < 0.05$ ) negative relationship with the time of switching attention was revealed. The higher the rate of attention switching, the higher the rate of adaptation to a new virtual environment. The high switching of attention in an athlete indicates a high speed of information processing, and the accuracy of

*A fragment of the correlation matrix between the speed of the game and the most significant indicators*

Indicators	The speed of passing the game, % per minute
Ability to synthesize	0,500*
Concentration of attention	-0,829***
Switching attention	-0,747***
Speed of thought	0,632**
Competition	0,638**
Emotional biorhythms	0,519*
Strength of the nervous system	0,719**
Monotony	-0,795**
The need to acquire knowledge	-0,536*

Notes: from 0.900 to 1 - very high connection; from 0.7 to 0.9 - high connection; from 0.5 to 0.7 - average connection; \*\*\* – differences are significant, at the significance level  $p < 0.001$ ; \*\* – differences are significant, at the significance level  $p < 0.01$ ; \* – differences are significant, at the  $p < 0.05$  significance level.





switching attention has a direct relationship with the strength of nervous processes.

An average significant ( $p < 0.01$ ) positive relationship between the speed of thinking and the speed of passing the game was revealed. In computer sports, the speed of thinking is manifested in the optimization of the speed of decision-making and the formation of an effective response to the opponent's actions.

An average, positive, significant ( $p < 0.05$ ) relationship between the speed of passing the game and the presence of competition (rivalry) was revealed. In the course of the study, in the situation of simultaneous completion of the game by two players, the subjects showed higher results compared to the players who completed the task one at a time, despite the fact that the task of completing the task better than the second participant was not set before the subjects. The revealed relationships indicate that the presence of rivalry helps to reduce monotony, one of the determining factors of emotional stability. A negative significant ( $p < 0.01$ ) relationship between the speed of passing the game and monotony, one of the performance indicators, was revealed.

The results obtained during the study indicate that players with a strong and medium strength of the nervous system, in accordance with the test of Ilyin E.P., show a higher speed of passing the game than players with a medium-weak and weak nervous system ( $p < 0.05$ ).

A positive, significant ( $p < 0.05$ ), average relationship between the speed of passing the game and emotional biorhythms was revealed. In classical sports, the control of athletes' biorhythms is one of the ways to increase the performance of those involved. A proven fact is the impact of biorhythms on the psycho-emotional state and, as a result, on human performance. As a rule, in classical sports, athletes show the highest results when the 2nd or 3rd type of biorhythm is in a positive phase. A positive,

significant ( $p < 0.05$ ), average relationship between emotional biorhythms and emotionality of an athlete was revealed. Based on the identified relationships, practical recommendations can be developed to solve the problems of increasing the emotional state of cybersportsmen before the start of a lesson or competitive activity.

A negative significant relationship ( $p < 0.01$ ) was found between the results in the need to acquire knowledge and the speed of the game. The best results in passing the game were demonstrated by athletes with the least need to acquire knowledge.

**Conclusion.** The dominant features that affect the adaptability of an e-sportsman in the digital environment have been identified: the ability to synthesize, concentration, attention switching, quickness of thinking, competition, strength of the nervous system, performance, emotional biorhythms, lack of need to acquire knowledge. A multi-stage analysis of the factors influencing the speed of the game, caused by the reasonable need to reduce the number of parameters that affect the athlete's playing efficiency, made it possible to determine the accounting parameters when compiling training programs.

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# Determination of the informative components of the validity of the reactive maneuverability of the motor potential of a fencer by the «information compression» method

UDC 37.037.1



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## Abstract

**Objective of the study** was to determine the integrative latent indicators of the validity of the reactive maneuverability of the fencers' motor potential.

**Methods and structure of the study.** The respondents were junior fencers aged 18-21, who train at the Children's and Youth Sports School of the Michurinsky district of Tambov (n=12). At the first stage of the work, parameters were studied that directly or indirectly influence the reactive maneuverability of the fencers' motor potential. At the second stage, a two-dimensional biometric analysis was performed using the paired Bravais-Pearson correlation coefficient (r). At the third stage of the work, the degree of significance of the indicators revealed by the two-dimensional mathematical and biometric analysis, which probabilistically affect the reactive maneuverability of the fencers' motor potential, was verified.

**Result and conclusions.** Integrative indicators of the validity of the latent reactive maneuverability of the fencer's motor potential as an important prognostic feature were established, namely: the search time for the motor unit, the coefficient of accuracy of the motor unit control, the average latent time according to the "tapping test" method, the duration of the potential of the motor unit of the biceps muscle of the shoulder, the speed propagation of excitation along the radial nerve.

**Keywords:** fencer's motor potential, reactive maneuverability, biometric analysis, integrative validity indicators, control and forecasting.

**Introduction.** A fencer's functional reactivity is a universal phenomenon of his motional readiness potential, a predictor of the effectiveness of a duel. It is no coincidence that in Appendix No. 4 of the Federal Standard of Sports Training (FSST) for the sport of fencing, speed-strength and coordination abilities are marked with the highest ("3") degree of significance in terms of the level of influence [5].

The deep mechanisms of the essence of the manifestation of the reactive maneuverability of fencers are concentrated in a more accelerated transmission of information through the system of neurosecretory synapses due to the mobilization of mediator-receptor connections to the second signaling system of the cerebral cortex and the corresponding more accelerated response of the muscles with the full involvement of the movement control system [6]. Initially, synapses

are involved in this process, transmitting information about the tactics of conducting a duel to the corresponding associative zone of the cerebral cortex, then, after processing the information, neuro-neuronal synapses pass the "baton" to the corresponding muscle cells through neuromuscular synapses, transforming into a universal technical implementation of the conceived idea. At the same time, an important condition for the effectiveness of performing a spontaneously creative tactical action (according to the situation) is the preliminary development of all possible variations in the manifestations of such probabilistic actions in order to save them in the memory of the motor stereotype of motor combinations [6].

An essential role in the sought process of the swordsman's reactive reproduction is also played by the hidden components of the latent reaction time of



psychophysiological parameters, which determine an earlier concentration of mobilization readiness and an advanced (sometimes caused by anticipation and intuition) explosive spurt at the start of a motor action. Latent reaction time is a feature of every fencer, who either initially was a “natural private gifted phenomenon”, or acquired these qualities in the process of painstaking and exhausting work in training.

It should be noted that the functional capacity of indicators of the latent period to the mobilization concentrated action of a fencer is directly related by a linear biometric dependence to his current psycho-emotional state, according to the same mechanism of operation of heart rate parameters [1, 2].

The aim of the study was to determine the integrative latent indicators of the validity of the reactive maneuverability of the fencer's motor potential, as a predictor phenomenon of the effective start of his attacking or defensive-defensive actions.

**Methods and structure of the study.** The main methods of hypothetical and empirical scientific knowledge were: “information compression” [3]; theoretical analysis and generalization; logical information processing (analysis, synthesis, comparison, in-

duction, deduction); testing; mathematical-statistical analysis. The procedure for the logical construction of the work algorithm was based on modern didactic principles and organizational and methodological forms of conducting training sessions, psychological, pedagogical and biomedical testing [4].

**Results of the study and their discussion.** The experiment involved 12 fencers of the Children's and Youth Sports School of the Michurinsky District of Tambov at the training stage of sports training (4 people from each coach, according to the FSST in the sport “fencing” [5]; 8 people - Candidates for the Master of Sports; 8 people - 1 category), whose age was  $19.54 \pm 0.93$  years.

At the first stage of the work, the parameters that directly or indirectly probabilistically affect the reactive maneuverability of their propulsion potential were studied. The parameters of psychophysiological functions were assessed using the computer “Psychophysiological Complex -PFC 01”. Subtle physiological mechanisms of motor activity and bioelectrogenesis of the neuromotor apparatus were measured using a Hungarian-made MG-440 electromyograph. The test results are presented in a summary table.

*The results of testing the parameters of fencers, directly or indirectly probabilistically influencing the reactive maneuverability of their motor potential (n=12)*

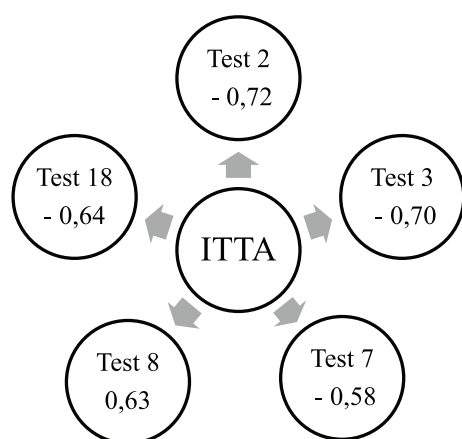
No.	Control test	Test results ( $\bar{X} \pm m$ )
<b>Indicators of psychophysiological functions</b>		
1.	Number of errors in the «Complex sensorimotor reaction» technique (number)	0,7±0,2
2.	Mean latent time of the technique «Complex sensorimotor reaction» (ms)	537,4±19,1
3.	Mean motor time of the technique «Complex sensorimotor reaction» (ms)	234,5±17,8
4.	The performance of the «Tapping test» technique (number of reactions)	329,2±1,9
5.	Average time of one reaction of the technique «Tapping test» (ms)	148,3±6,4
6.	Average latent time of the «Tapping test» technique (ms)	2,6±0,3
<b>Subtle physiological mechanisms of motor activity</b>		
7.	Motor unit search time (MU) (s)	32,4±3,1
8.	Coefficient of regularity of work MU (%)	80,2±3,6
9.	Control Accuracy Ratio MU (%)	78,7±2,0
<b>Биоэлектрогенез нейромоторного аппарата</b>		
10.	Potential duration (DP) MU of hand muscles (ms)	9,24±0,07
11.	DP MU muscles of the forearm (ms)	10,21±0,08
12.	DP MU biceps brachii (ms)	10,83±0,08
13.	DP MU triceps brachii (ms)	12,22±0,06
14.	Potential amplitude (AP) MU of hand muscles (μV)	1541,9±29,1
15.	AP MU of forearm muscles (μV)	814,4±7,2
16.	AP MU biceps brachii (μV)	374,5±3,3
17.	AP MU triceps brachii (μV)	962,6±12,8
18.	The speed of propagation of excitation along the radial nerve (ms)	55,5±1,5



It can be seen from the data in the table that all the studied indicators of the fencers are within the limits of the physiological and psychophysiological norm; the variability of the scatter of values corresponds to the bell-shaped distribution of test results that fit within  $\pm 3$ . This gave us a reason to apply further mathematical-biometric tools.

In order to further specify the degree of significance of individual indicators in the issue under study, we carried out a two-dimensional biometric analysis using the paired Bravais-Pearson correlation coefficient ( $r$ ). The matrix of intercorrelations included an integral indicator of tactical and technical actions (ITTA) of athletes, assessed on a conditional nine-point scale by experienced specialists. Concordance coefficients ( $W$ ) with a confidence interval of 92.0–94.3% corresponded to the values of 0.79–0.89. This confirmed the reliability of the experts' opinions.

The most significant intercorrelations are shown in the figure.



*Correlation galaxy of the integral indicator of tactical and technical actions of fencers with probabilistic parameters of reactive maneuverability of their motor potential*

*Note: test numbers correspond to the serial number of the table.*

Thus, a strong and negative degree of relationship was found between: the integral indicator of tactical and technical actions (ITTA) and the average latent time of the “Complex sensorimotor reaction” technique ( $r=-0.72$ ); ITTA and mean motor time of the “Complex sensorimotor reaction” technique ( $r=-0.70$ ). A positive and medium degree of relationship was established between the ITTA and the coefficient of the regularity of the work of the MU ( $r=0.63$ ). A negative and medium degree of relationship was established between ITTA and the speed of propagation of excitation along the radial nerve ( $r=-0.64$ ), as well as

between ITTA and the search time for MU ( $r=-0.58$ ).

At the third stage of the work, we verified the degree of significance of the indices revealed by the two-dimensional mathematical and biometric analysis, which probabilistically affect the reactive maneuverability of the fencers' motor potential. For this purpose, a multivariate analysis was applied to compare the values of private (PCC) and multiple correlation ( $R$ ) between the results of the ITTA rating of participants in the process and eighteen sought-for biostructure values. The essence of the biometric technology was that if, after leveling the particular value of the parameter, the previous value of  $R$  decreases significantly, then the indicator under study is the “most significant”. The linear regression equation was determined using the standard SPSS program.

It was clarified that the most informative in terms of the degree of differentiation are the following parameters: MU search time, MU control accuracy coefficient, average latent time according to the “tapping test” method, duration of the MU potential of the biceps muscle of the shoulder, speed of propagation of excitation along the radial nerve. In addition, the multiple correlation coefficients of the relationship of these structures with two parameters of the ITTA (the second parameter of the ITTA reflected the performance rating in the past macrocycle competitions) were:  $R=0.85$ ;  $R=0.83$ ;  $R=0.76$ ;  $R=0.74$ ;  $R=0.73$ . The above parameters reflect the conceptual basis of the latent component of the reactive maneuverability of the fencer's motor potential.

**Conclusions.** Thus, the stage-by-stage implementation of one-dimensional, two-dimensional and multidimensional biometric analyzes within the framework of the toolkit of the “information compression” principle revealed integrative indicators of the validity of the latent reactive maneuverability of the fencer's motor potential, namely: the search time for a motor unit, the coefficient of accuracy of motor unit control, the average latent time according to the method “tapping test”, the duration of the potential of the motor unit of the biceps muscle of the shoulder, the speed of propagation of excitation along the radial nerve, which is an important prognostic sign.

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# Influence of the speed abilities of swimmers-diverers on sports results

UDC 612.087



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## Abstract

**Objective of the study** was to determine the influence of the speed abilities of swimmers-diverers on sports results.

**Methods and structure of the study.** Swimmers-diverers aged 13-15 years old (10 girls, 10 boys) took part in the scientific work. All athletes are engaged in the sports school of the Olympic reserve "Sputnik" (Krasnoyarsk) and have a sports category not lower than the third adult. The study was conducted at the sports base of the Avangard sports club, from September 2021 to December 2022. The speed abilities of athletes were assessed based on the results of passing control standards on land and on water.

**Results and conclusions.** As the obtained data showed, athletes who are able to accelerate themselves from a standstill to maximum speed in the shortest time show the best sports result at a distance of 50 m. Swimmers who are able to maintain maximum speed for as long as possible throughout the serial operation of sprint simulators show the best sports result distance of 100 m. It was revealed that among girls and boys a strong degree of dependence on the sports result has a serial work four times 15 m to the finish line (maximum). Using data on the dependence of sports results on the level of development of the speed abilities of divers, the coach can correctly build the training process, both on land and on water, which will further lead to an increase in sports results.

**Keywords:** speed, underwater sports, distance, competitions, diver, sports equipment.

**Introduction.** The speed abilities of a submariner are characterized by his ability to overcome short distances at a high pace and are inextricably linked with the technical skills of the athlete. Without good swimming technique, competent execution of starts and turns, there are no high speeds. The perfection of swimming technique in the main way, the ability to perform movements with maximum mobilization, while maintaining accuracy, coordination and optimal amplitude, is the most important prerequisite for achieving a high level of speed abilities of a diver-submersible.

In underwater sports, the athlete's speed abilities are manifested when swimming distances of 50 and 100 m - such distances are considered to be sprint distances. It is at sprint distances that athletes fully demonstrate their level of development of speed abilities.

**Objective of the study** was to determine the influence of the speed abilities of swimmers-diverers on

sports results.

**Methods and structure of the study.** Swimmers-diverers aged 13-15 years old (10 girls, 10 boys) took part in the scientific work. All athletes are engaged in the sports school of the Olympic reserve "Sputnik" (Krasnoyarsk) and have a sports category not lower than the third adult. The study was conducted at the sports base of the Avangard sports club, from September 2021 to December 2022. The speed abilities of athletes were assessed based on the results of passing control standards on land and on water.

**Results of the study and their discussion.** The results of passing intermediate standards, speed series and sprint simulators among girls and boys are presented in Table 1, 2.

As the obtained data showed, athletes who are able to accelerate themselves from a standstill to maximum

**Table 1.** Results of passing intermediate standards, speed series and sprint simulators among girls (13-15 years old)

Distances	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10
Standard: shuttle run 3x10 m, s	8,8	9,0	8,4	8,1	9,2	8,4	9,5	9,9	9,3	9,4
Standard: 60 m run, s	10,0	9,8	9,6	9,7	9,3	10,1	10,2	9,8	10,3	10,4
Standard: glide from the start 5 m	1,5	1,6	1,6	1,4	1,5	1,6	1,9	1,8	1,7	1,9
Standard: glide after turning 5 m	2,3	2,8	2,2	2,3	2,6	2,4	2,6	2,5	2,7	2,6
Standard: start reaction, s	70	65	69	72	73	69	68	71	75	72
Series: 4 times 25 m (maximum), average speed	13	12	11	13	12	12,5	11,6	10,9	11	12,2
Simulator: 50 m from the start + 50 m from the water (10 s rest between segments)	23/ 24,5	24/ 26,10	22,5/ 24,0	23/ 24,3	21,5/ 23,0	22,5/ 24,0	23/ 24,2	22,6/ 24,0	24/ 25,1	24,2/ 25,6
Series: 15 m from the start + 25 m from the start + 35 m from the start + 50 m from the start (1 min mode)	5	6	5	5,5	5	5	6	5	6,5	7
	13	12,5	12	11	12	11	12	11	13	13
	19	18,4	18	19	18,5	17,5	19	18	19	18
	22,9	23,7	22,4	23,0	21,3	22,2	22,9	22,7	23,7	24,1
Series: 4 x 15m to finish (maximum)	6	5	4,8	6	5	5,5	5,4	6	6,4	6,6
Results at city competitions (place) 50 m / 100 m	2/1	3/4	1/3	4/6	1/1	2/3	3/2	3/2	5/7	3/6

**Table 2.** Results of passing intermediate standards, speed series and sprint simulators among boys (13-15 years old)

Distances	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10
Standard: shuttle run 3x10 m, s	8,1	9,0	8,5	8,3	7,0	7,4	7,8	9,0	9,3	8,4
Standard: 60 m run, s	8,2	8,4	9,2	8,7	9,1	8,6	9,0	9,5	8,6	8,9
Standard: glide from the start 5 m	2,0	1,5	1,8	2,1	2,3	1,3	1,6	2,3	1,8	1,9
Standard: glide after turning 5 m	2,0	2,5	2,1	1,9	1,7	1,9	2,2	2,5	2,4	2,7
Standard: start reaction, s	65	63	67	70	71	65	65	70	73	72
Series: 4 times 25 m (maximum), average speed	12	10	11	10,5	11,1	10,7	11	10,1	10	11,3
Simulator: 50 m from the start + 50 m from the water (10 s rest between segments)	22/ 23,2	23/ 23,8	22,3/ 24,0	21/ 22,6	21,5/ 23,0	22,5/ 23,4	22/ 23,2	22/ 22,9	23/ 24	23,1/ 24,3
Series: 15 m from the start + 25 m from the start + 35 m from the start + 50 m from the start (1 min mode)	5	5	4,5	5,4	5	5	6	5	6	6
	10	11	10	10	11	10	11	10	11	11
	16	17	17	16	17	17,5	17	11	18	18
	21,5	23,1	22,1	21,0	21,1	22,0	22,3	21,7	22,8	23,3
Series: 4 x 15m to finish (maximum)	5,5	5	4,5	4,9	5	5,2	5,1	5,7	5,2	5,7
Results at city competitions (place) 50 m / 100 m	4/5	5/6	5/3	2/1	1/2	3/4	5/7	6/8	7/5	8/9

speed in the shortest time show the best sports result at a distance of 50 m. Swimmers who are able to maintain maximum speed for as long as possible throughout the serial operation of sprint simulators show the best sports result distance 100 m.

Analyzing the results of a correlation analysis to establish the dependence of a sports result on the level of development of the speed abilities of athletes (Table 3), it was found that among girls and boys a strong degree of dependence on the sports result has a serial work four times 15 m to the finish line (maximum) ( $r = 0.82$  and  $r = 0.84$ ). A good degree of dependence

is observed with serial work: 15 m from the start + 25 m from the start + 35 m from the start + 50 m from the start (1 min mode) ( $r = 0.75$  and  $r = 0.79$ ), four times 25 m (maximum) ( $r = 0.76$ ,  $r = 0.80$ ), with a simulator 50 m from the start + 50 m from the water (rest between segments 10 s) ( $r = 0.75$ ,  $r = 0.78$ ), with running for a segment of 60 m ( $r = 0.73$ ,  $r = 0.75$ ). The average correlation relationship with the standards: sliding from the start of 5 meters ( $r = 0.51$ ,  $r = 0.63$ ), start reaction ( $r = 0.54$ ,  $r = 0.51$ ). Low degree with standards: shuttle run ( $r = 0.32$ ,  $r = 0.34$ ), sliding after turning 5 meters ( $r = 0.32$ ,  $r = 0.31$ ).



**Table 3.** Comparative analysis of the relationship between sports results and the development of speed abilities of sportsmen - divers

Control standards on land / water	Correlation coefficient girls	Correlation coefficient boys
Standard: shuttle run 3x10 m, s	0,32	0,43
Standard: 60 m run, s	0,73	0,75
Standard: glide from the start 5 m	0,51	0,63
Standard: glide after turning 5 m	0,32	0,31
Standard: start reaction, s	0,54	0,51
Control series/simulators on the water		
Series: 4 times 25 m (maximum) average speed	0,76	0,80
Series: 50 m from the start + 50 m from the water (rest between segments 10 s)	0,75	0,78
Series: 15m from the start + 25m from the start + 35m from the start + 50m from the start (1 min mode)	0,75	0,79
Series: 4 x 15m to finish (max)	0,82	0,84

Note: ( $r < 0.30$ ) - low relationship; ( $r$  from 0.31 to 0.50) - weak relationship; ( $r$  from 0.51 to 0.70) - average relationship; ( $r$  from 0.71 to 0.80) - good relationship; ( $r$  from 0.81 to 0.90 and above) - a strong relationship.

**Conclusion.** The growth of achievements in underwater sports is largely determined by the constant improvement of the methods of training athletes.

Using data on the dependence of sports results on the level of development of the speed abilities of divers, the coach can correctly build the training process, both on land and on water, which will further lead to an increase in sports results.

When training speed abilities at the age of 13-15 years, a distinctive feature is the use of speed-oriented exercises with a period of rest until full recovery. Also in this age period, the foundations are laid for a high level of not only speed at a distance, but also the starting reaction, as well as turning and repulsion.

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# The contribution of the accuracy of spatial tracking of moving objects to the competitive efficiency of hockey defenders 13-15 years old

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## Abstract

**Objective of the study** was to quantify the contribution of the accuracy of spatial tracking of moving objects to the effectiveness of the competitive activity of hockey defensemen aged 13-15.

**Methods and structure of the study.** As part of the sports program of the Sirius Educational Center, 132 hockey defenders, participants in the All-Russian hockey competition "Championship of club teams among boys under 15 years old", were tested. Competitive effectiveness was determined by the indicator of the expected number of team goals, calculated by video analysis of matches. In the course of the study, the task of spatial tracking of moving objects in virtual reality (multiple object tracking task, MOT) and the assessment of special physical fitness (SPT) using the "Complex Test" on ice were performed. The contribution of these factors to competitive efficiency was determined by constructing a multilevel regression model that takes into account the athlete's belonging to the team.

**Results and conclusions.** The accuracy of spatial tracking of moving objects is significantly correlated with the competitive efficiency of hockey defensemen both with and without taking into account the level of SPT. The ability to track the movement of objects during competitive matches does not depend on the special physical qualities of hockey defensemen. This determines the importance of testing the cognitive functions of athletes along with assessing the level of physical fitness. Further research should be aimed at both expanding the testing battery (to assess executive functions, memory, attention, anticipation, etc.) and determining the physiological parameters that characterize the "biological cost" of performing the tests considered in this paper.

**Keywords:** *cognitive indicators, spatial tracking of moving objects, virtual reality, hockey defenders, competitive efficiency.*

**Introduction.** Junior hockey at the level of the best club teams in Russia places high demands not only on the physical qualities and motor skills of athletes, but also on perceptual and cognitive abilities. One of the most important is the *ability to track the movements of players on the field* [1, 2], which is studied using the problem of spatial tracking of moving objects (the MOT task, as an abbreviation for the term multiple object tracking [3]). The relationship between sportsmanship and spatial tracking has been the subject of scientific research for many years [1, 2, 4], but so far no attempts have been made to quantify the contribution of tracking accuracy to competitive performance in team

sports. There is also no data on the performance of the MOT task by athletes in virtual reality, which determines the relevance of considering the results of the task in this environment.

**Objective of the study** was to quantify the contribution of the accuracy of spatial tracking of moving objects to the effectiveness of the competitive activity of hockey defensemen aged 13-15.

**Methods and structure of the study.** As part of the sports program of the Sirius Educational Center, 132 hockey defensemen aged 13-15 were tested, participants in the All-Russian hockey competition "Championship of club teams among boys under



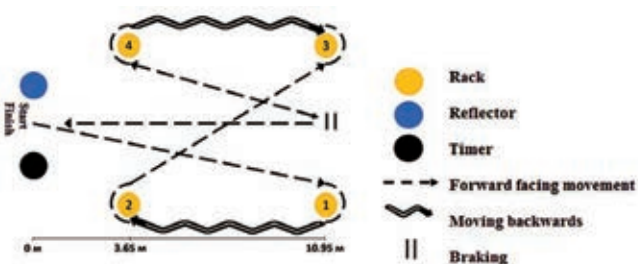
15" of the 2020/21 and 2021/22 seasons. Before the start of the tournament, hockey players passed testing SPT (special physical fitness), and also performed the MOT task. During the tournament, individual match statistics were recorded; time spent on ice; place of the team at the end of the competition. The data of athletes who spent less than 3% of their team time on the ice were excluded from the analysis ( $N=8$ ). The total number of participants was 124, age ( $M(SD)$ ) = 14.93 (3.30) years.

The MOT task was carried out in the HTC VIVE PRO EYE virtual reality helmet, which is part of the Sirin hardware and software complex (Russia). The participant had to track four target objects moving randomly among four identical distractors (yellow balls). The experimental session included 15 levels of 12 seconds. Each level consisted of several stages (Fig. 1). The start of the level was carried out by the participant, the preview time (stage 1) and the selection time (stage 3) were not limited. The speed of the balls at the first level was 1 m/s and increased by 0.2 m/s at each next level under the condition of 100% accuracy of the task. The result was calculated by multiplying the number of correctly tracked objects by the difficulty factor, which depends on the speed of the balls and the distance between them at each level.



(1) demonstration of balls; (2) movement of the balls, where the first four seconds the target balls remain red, and the next eight seconds turn yellow, as do the distractors; (3) stop movement, select target balls; (4) indicating the correct answer

**Figure 1.** Stages of the task of spatial tracking of moving objects



**Figure 2.** Scheme of movement in the "Complex test" on ice

To assess the level of special physical fitness, the "Complex Test" on ice (recommended by the Russian Ice Hockey Federation) was chosen, which includes overcoming several segments by different means of movement (Fig. 2). The test was performed with a stick, without dribbling the puck. The result was determined by the SmartSpeed Timing Gate System (Australia) with an accuracy of 0.001 s.

Competitive efficiency was assessed by the value of the individual parameter xG for, calculated on the basis of video analysis of matches (ICEBERG Sports Analytics, Russia) and indicating the *expected number of team goals for the period when the athlete is on the ice*. This indicator evaluates the "danger" of shots on goal based on a complex model that takes into account several parameters: position relative to the goal during shots, segments of the field from which passes were received, shot accuracy, etc. The circular system of competitions (each of nine teams played one match with each opposing team).

Statistical processing of the results was carried out in Rstudio 2021.09.0. To calculate the contribution of special physical training and spatial tracking to competitive performance, multilevel regression models were built using the maximum likelihood method with Satterthwaite correction. The dependent variable was the xG for parameter, and the predictors (independent variables) were the results of the Integrated Test (ICE) and the MOT task. The choice of the model type is due to the hierarchical organization of data: the xG for parameter has a high degree of similarity among hockey players of the same team. The interclass correlation coefficient of the "zero" model was preliminarily calculated to be 0.12, which gave reason to consider the intergroup variance sufficient for the chosen type of analysis. A likelihood ratio test was performed to evaluate the differences between the models.

**Results of the study and their discussion.** The obtained results indicate that for 13–15-year-old hockey defensemen from the strongest club teams in Russia, the individual value of the expected number of team goals for the period when the athlete is on the ice (xG for) depends on the accuracy of spatial tracking. The positive nature of this relationship is consistent with the results of intergroup studies [1, 4], which show the advantage of more qualified athletes in tracking accuracy. No significant interaction was found between the results of the "Complex Test" and the tasks of the MOT, from which it can



be concluded that the manifestation of spatial tracking in game situations does not depend on physical qualities. The lack of interaction between players also highlights the independent contribution of spatial tracking to competitive performance and points to the importance of this aspect of cognitive functioning for hockey defensemen. This implies the importance of balancing the content of testing athletes, where today the assessment of physical qualities prevails.

**Conclusions.** The accuracy of spatial tracking of moving objects is significantly correlated with the competitive effectiveness of hockey defenders, both with and without the level of special physical fitness, and can be used as a criterion for selecting candidates for the Russian U16 national hockey team.

The interaction of spatial tracking and physical fitness as factors of competitive efficiency is not statistically significant, which means that the ability to track the movement of objects during competitive matches does not depend on the special physical qualities of hockey defensemen. This determines the importance of testing the cognitive functions of athletes along with assessing the level of physical fitness.

Thus, the approach used to assess the joint influence of physical and cognitive functions on the competitive effectiveness of hockey defensemen aged 13-15 is promising for science and practice.

Further research should be aimed at both expanding the testing battery (to assess executive functions, memory, attention, anticipation, etc.) and determining the physiological parameters that characterize the “biological cost” of performing the tests considered in this paper.

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# Stages of adaptation as an important factor in the ability of the athletes' body to adapt to the action of loads of increasing power

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## Abstract

**Objective of the study** was to identify the stages of adaptation of the cardiorespiratory system of athletes of different sports, age and gender to the action of an increasing testing load.

**Methods and structure of the study.** Athletes of different sports, age and gender took part in the scientific work. Based on age, the athletes were divided into groups. Athletes of all groups worked on a bicycle ergometer with a power of 50 to 200 W with a pedaling frequency of 60-70 rpm, the duration of each load step was 3 minutes, the method of tetrapolar chest rheography according to Kubizek was also used, modified by Yu.S. Vanyushin.

**Results and conclusions.** Three stages of adaptation of the cardiorespiratory system of athletes, specializing in different sports, age and gender, with increasing power load on a bicycle ergometer, were revealed. It turned out that the existing first or lower stage of adaptation is associated with the function of respiration. The next stage of adaptation is manifested as a result of the activity of the circulatory system and is aimed at increasing the indicators of the chronotropic reaction and inotropic function of the heart. It can be classified as an intermediate level of adaptation of the body of athletes. And the highest stage of adaptation is aimed at increasing the characteristics of the body of athletes associated with gas exchange, and is manifested in the growth of the oxygen utilization factor.

**Keywords:** adaptation, cardiorespiratory system, athletes, increasing power loads.

**Introduction.** Adaptation is considered to be a process of adaptation to various conditions of the external world. More I.P. Pavlov [6] believed: "Human life is an eternal and infinite adaptation", inherent in all living beings, including humans. Therefore, those reactions of the body that underlie its adaptation to the environment and are aimed at maintaining homeostasis are associated with adaptation.

The problem of adaptation has attracted the minds of domestic and foreign scientists for many decades, being the leading one for the physiology of labor and sports [1, 5, 7]. As a result, a theory of adaptation appeared, acting as a leading factor in updating theoretical knowledge related to the methodology of development and improvement of physical qualities, increasing the functionality of various physiological systems of the body, and optimizing the structural ele-

ments of the process of training athletes. At the same time, the empirical basis of the theory of adaptation itself is expanding and deepening, which develops and improves in the process of adapting the body of athletes to various conditions of training and competitive influences. The result of such an adaptation is the adaptation of the organism to various physical loads, which should be attributed to environmental factors. At the same time, it is necessary to pay attention to the fact that the ability to adapt is not unlimited and it is largely influenced by hereditary factors.

The training process affects the adaptation of each individual gradually, improving it, by dialectically negating the previously achieved level of adaptive transformations. Therefore, any preparation for subsequent competitions with appropriate sports training to achieve a higher level of adaptation processes is built





as a negation of the previous lower level of adaptation [7]. It is expedient to consider this process from the point of view of the theory of physical education, which should take place constantly, provided that the athlete sets high goals for himself, which he strives to achieve under the guidance of a coach.

**Objective of the study** was to identify the stages of adaptation of the cardiorespiratory system of athletes of different sports, age and gender to the action of an increasing testing load.

**Methods and structure of the study.** Athletes of different sports, age and gender took part in the scientific work, which made up several groups of subjects. Focusing on age, the groups were divided as follows: teenagers 15-16 years old, youths 17-21 years old, adult athletes 22-35 years old and another group of athletes of the second period of adulthood - 36-60 years old. All of them specialized in endurance sports and belonged to men by gender. Other groups of subjects trained for endurance and were engaged in speed-strength sports. They were divided into males and females. Athletes of all groups worked on a bicycle ergometer with a power of 50 to 200 W with a pedaling frequency of 60-70 rpm, the duration of each load step was 3 minutes. Using the method of tetrapolar thoracic rheography according to Kubitschek [9], as modified by Yu.S. Vanyushin [2], determined the chronotropic response of the heart in terms of heart rate, inotropic capabilities of the myocardium in terms of blood ejection and minute volume of blood circulation. Respiratory rate, tidal volume and minute respiratory volume were found using a pneumotachograph device. Recording the indicators of the cardiorespiratory system was necessary to judge the multi-stage adaptation process during bicycle testing.

**Results of the study and their discussion.** In our previous work, we presented the types of different reactions of the cardiorespiratory system in athletes of different ages, specializing in endurance, with increasing power load [3].

As shown by the results of our further studies, the first or lowest stage of adaptation is associated with the indicators of external respiration (Fig. 1), which was determined by the indicator of the minute volume of respiration. It manifested itself in groups of adolescents aged 15-16 and veteran athletes aged 36-60 who train in endurance sports. On the part of the teenager's body, such a reaction to physical activity is natural, since at this age the body's needs for oxygen are met by the respiratory system, which is the leading and, apparently, the only one. However, this method of providing the body with oxygen is not so efficient and productive, because part of the oxygen consumed is spent on the work of the respiratory muscles. This must be taken into account when planning training sessions for adolescents during their training in new motor acts, when it is necessary to coordinate breathing with various body movements [4, 8]. It is surprising that athletes aged 36-60 showed this stage of adaptation. We assume that it is associated with an insufficiently high level of the state of fitness of the subjects.

The next stage of adaptation was noted in the group of young athletes aged 17-21 years, which was aimed at increasing blood circulation and was classified by us as intermediate.

The third or highest stage of adaptation was manifested in athletes aged 22-35 years and indicated an increase in gas exchange rates and, in particular, the oxygen utilization coefficient (UCO<sub>2</sub>).

Consequently, the results of our research have

**The highest level of adaptation** \_\_\_\_\_

Gas exchange

function

(UCO<sub>2</sub>)

Athletes aged 22-35

**Intermediate stage of adaptation**

\_\_\_\_\_

Circulation  
(chronotropic reaction,  
inotropic function)

Boys 17-21 years old

**The lowest level of adaptation**

\_\_\_\_\_

External respiration  
(minute respiratory volume)

Teenagers 15-16 years old  
Athletes 36-60 years old

**Figure 1.** Schematic representation of the multi-stage process of adaptation of the cardiorespiratory system



shown that there is a multi-stage adaptation process in athletes whose training is dominated by such a physical quality as endurance, and this multi-stage is associated with the age characteristics of the subjects.

In the future, we were interested in how the process of adaptation manifested itself depending on the type of sport and the gender characteristics of athletes? The next stage of adaptation of the cardiorespiratory system in athletes specializing in endurance and speed-strength sports, and regardless of gender, is associated with the chronotropic response of the heart to increasing physical activity (Fig. 1). This is a natural reaction of any organism to the exercise performed.

However, it should be noted that the younger the subject's body, the more pronounced this reaction was. In representatives of endurance sports, it is less pronounced than in groups of athletes developing speed-strength qualities. In groups of female athletes, regardless of the sport, such a reaction was preferable. To this stage of adaptation of the cardiorespiratory system, we include a group of young men aged 17-21, whose reaction was associated with an increase in the indicators of the circulatory system. Such a reaction is considered more appropriate, since the increase in physical performance occurred as a result of an increase in myocardial contractility, that is, the inotropic function of the heart. All of the above features of the reaction of the circulatory system we attribute to an intermediate stage, which is a link between the lower and higher levels of adaptation of the cardiorespiratory system with increasing physical activity.

**Conclusions.** Three stages of adaptation of the cardiorespiratory system of athletes, specializing in different sports, age and gender, with increasing power load on a bicycle ergometer, were revealed. It turned out that the existing first or lower stage of adaptation is associated with the function of respiration. The next stage of adaptation is manifested as a result of the activity of the circulatory system and is aimed at increasing the indicators of the chronotropic reaction and inotropic function of the heart. It can be classified as an intermediate level of adaptation of the body of athletes. And the highest stage of adaptation is aimed at increasing the characteristics of the body of athletes associated with gas exchange, and is manifested in the growth of the oxygen utilization coefficient.

Therefore, we can talk about the multi-stage adaptation process, which we considered against the background of studying the indicators of the cardiorespiratory system. Such variability of the adaptation process depends on the age and sex characteristics of ath-

letes and their activities in various sports. Identification of the stages of adaptation and their significance as a result of performing physical loads of increasing power is an important factor in the ability of the body of athletes to adapt to environmental conditions.

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# Urgent adaptive effects of a single intake of carbohydrate-electrolyte mixture with plant extracts in maintaining microcirculation parameters of highly qualified athletes

UDC 57.04



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## Abstract

**Objective of the study** was to evaluate the short-term adaptive effects of a single dose of a carbohydrate-electrolyte mixture with plant antioxidants (CEMA) in maintaining the microcirculation system using the example of highly qualified orienteers under the conditions of a two-stage bicycle ergometric test PWC170.

**Methods and structure of the study.** Highly skilled orienteers aged 17-22 years old were examined. Two cycles of the study were conducted: a placebo cycle in which athletes consumed 250 ml of bottled water; a cycle of taking 250 ml of CEMA. Laser Doppler flowmetry was used as a method for studying microcirculation.

**Results of the study and their discussion.** As a result of the conducted studies of a single dose of CEMA, a vasoprotective effect was established. This effect is due to the restoration of the functional activity of the microvascular endothelium and is expressed in an increase in the amplitude values of endothelial rhythms in the cycle of taking CEMA in comparison with the placebo cycle. Also, a single dose of CEMA contributed to a decrease in the effects of sympathetic adrenergic vasomotors on the vascular wall, which can be considered as a concomitant antihypoxic effect and is expressed in a decrease in lactate levels.

**Keywords:** *carbohydrate-electrolyte mixture with plant antioxidants, single dose, microcirculation; vasoprotective and antihypoxic effects; highly qualified guides.*

**Introduction.** Considering the seriousness of the problem of doping control of athletes taking vasoprotectors [3], studies of acceptable functional carbohydrate-electrolyte drinks with vasoprotective properties in combination with previously unused in their composition and not prohibited by anti-doping organizations, plant extracts acting as antioxidants, are of high practical importance [2, 4], namely, the use of Crimean rosemary hydrolate in the formulation of the carbohydrate-electrolyte composition in combination with aqueous extracts of rose hips, nettle leaf and lemon juice.

The expediency of adding antioxidant extracts to the carbohydrate-electrolyte mixture is justified by the need to correct damage to the vascular endothelium during muscular work for 30-120 minutes at an

oxygen consumption level of 75-80% of the  $VO_{2max}$ , since such work can lead to an increase in the content of lactic acid above the anaerobic threshold and, consequently, to shifts in the acid-base balance to the acid side [5, 8]. Also, under these conditions, an increase in dysfunction of the vascular endothelium can be triggered by the development of a state of dehydration - hypovolemia, activation of the renin-angiotensin-aldosterone system, vasoconstriction, increased blood viscosity, increased heart rate. The authors of [7] convincingly showed that antioxidants stimulate the processes of endothelium-dependent vasodilation under the condition of long-term use, that is, they involve the microvascular endothelium in adaptive responses to oxidative stress factors, including prolonged physical activity, which helps to



reduce the severity of endothelial damage. However, in highly qualified athletes participating in sports with a pronounced component of aerobic endurance manifestation, the effects of a single intake of carbohydrate-electrolyte mixtures with plant antioxidants (CEMA) have not been fully studied. Whereas in many sports, a single intake of functional drinks is practically convenient, and especially in case of urgent, timely and permitted by the competition rules, nutritional support for competitive activity [4].

**Objective of the study** was to evaluate the short-term adaptive effects of a single dose of a carbohydrate-electrolyte mixture with plant antioxidants (CEMA) in maintaining the microcirculation system using the example of highly qualified orienteers under the conditions of a two-stage bicycle ergometric test  $PWC_{170}$ .

**Methods and structure of the study.** The study involved 12 highly qualified orienteers (masters of sports) aged 17-22, who gave voluntary informed consent. The study of microcirculation processes was carried out on a laser analyzer "LAZMA-MC" by the method of laser Doppler flowmetry. The amplitude values of endothelial (Ae, perf. u.), myogenic (Am, perf. u.), neurogenic (An, perf. u.), respiratory (Ar, perf. u.) and pulse (Ap, perf. u.) rhythms were recorded. The registration area is the ventral surface of the index finger, which makes it possible to evaluate various regulatory factors that control microcirculation due to the high representation of sympathetic vasomotors. The short-term adaptive effects of a single intake of carbohydrate-electrolyte mixtures with plant antioxidants were studied under the conditions of a two-stage bicycle ergometric test  $PWC_{170}$  and included two study cycles: 1) a placebo cycle in which athletes consumed 250 ml of bottled water imitating the aroma of CEMA; 2) a cycle of taking 250 ml of carbohydrate-electrolyte mixtures with plant antioxidants. Water and CEMA were taken 15 minutes before bicycle ergometric exercise testing, in which heart rate (HR, beats/min) and work power ( $kg \cdot m \cdot min^{-1}$ ) were recorded at HR150 ( $W_1$ ) and HR170 ( $W_2$ ). The partial pressure of oxygen in the exhaled air ( $R_{EO_2}$ , mmHg) was determined by the gasometric method using a PGA-KM radio-measuring gas analyzer, the minute volume of respiration ( $V_E$ ,  $l \cdot min^{-1}$ ) was determined by a spirometer (SPIROBANK G, Italy), the indicators were recorded at the last minute  $W_1$  and  $W_2$  in the  $PWC_{170}$  test. Oxygen consumption ( $VO_2$ ,  $ml \cdot min^{-1}$ ) was calculated by the formula  $VO_2 = V_E \times \frac{P_{EO_2} - P_{EO_2}}{P_{EO_2} - P_{EO_2}} \times 1000 / 100$ , where D is the difference between  $P_{EO_2}$  at  $W_1$  and  $W_2$ . Maximum oxygen consumption

( $VO_{2max}$ ,  $ml \cdot min^{-1}$ ) was determined indirectly using Astrand nomograms. Peripheral blood lactate content (La, mmol/l) was determined using a lactate analyzer, LACTATE PLUS lactate analyzer, Lactate Plus Test Strips for lactate, capillary blood sampling (from a finger) was performed using Safety disposable lancets. The intake cycle of carbohydrate-electrolyte mixtures with plant antioxidants was carried out two weeks after the placebo cycle. The composition of a standard carbohydrate-electrolyte drink is enriched with a natural mineral complex (Black Sea sea salt - 0.4 g), rosemary hydrolate - 65 ml, water extract of rose hips (1:10) - 100 ml, water extract of nettle leaves (1:10) - 100 ml, lemon juice - 5 ml. The studied drink complies with TR TS 022/2011, standardized according to GOST R 56543-2015.

### Results of the study and their discussion.

When recording microcirculation parameters in athletes in the initial state in the cycles of placebo and carbohydrate-electrolyte mixtures with plant antioxidants, the pattern of hemodynamic rhythms was dominated by transient endothelial-neurogenic rhythms, which indicated adequate releasing of nitric oxide by the microvascular endothelium, as well as the absence of significant pressure from the sympathetic adrenergic vasomotors. The pronounced peak in the range of pulse rhythms determined by us indicates a moderate decrease in the tone of arterioles, and the established low values of the amplitudes of myogenic rhythms indicate the dominance of shunt blood flow in the registration area, which is a physiological norm.

In turn, the performance of physical work by athletes on a bicycle ergometer at the second stage of the  $PWC_{170}$  test was accompanied by an increase in the level of  $VO_2$  consumption to an average of 75% of  $VO_{2max}$ , which led to an increase in the level of La above the anaerobic threshold. Under such loading conditions in the placebo cycle, the Am indicator increased to  $13.24 \pm 2.17$ , perf. units ( $p < 0.05$ ), and the Ap indicator - up to  $15.03 \pm 1.75$  perf. units ( $p < 0.05$ ) in comparison with the initial state, which indicates a decrease in peripheral resistance in the region of precapillaries and arterioles. The increase in Am and Ap became natural due to the increase in La production due to the involvement of the anaerobic mechanism of energy supply during muscle work at the level of 75% of  $VO_{2max}$ , which is consistent with the metabolic regulation of tissue blood flow, where the accumulation of La above the anaerobic threshold causes relaxation of precapillaries, followed by activation capillary blood





flow. Whereas the increase in the Ap value registered by us under the conditions of test physical activity probably reflects an increase in cardiac output.

In addition, in the placebo cycle, the performance of physical work by athletes in the  $PWC_{170}$  test at the  $W_2$  stage was accompanied by a decrease in the Ae index to  $9.87 \pm 0.88$  perf. units, relative to the initial values equal to  $14.47 \pm 1.61$  ( $p < 0.05$ ), which indicates a moderate decrease in endothelial activity under these conditions of physical activity. The results obtained confirm the literature data on endothelial dysfunction in athletes during physical work at the level of 75% of  $VO_{2max}$  [1], which may be due to the accumulation of low-density lipoprotein molecules with the formation of oxidatively modified lipoproteins, as well as an increase in the level of homocysteine and D-dimer, as was shown in the study [6]. The values of An, which dominated in the initial state, also decreased after the test load ( $p < 0.05$ ) to the level of 9.96 perf. units, in comparison with the level of initial values - 14.15 perf. units, which indicates an increase in the activity of sympathetic adrenergic vasomotors innervating arterioles and anastomoses and is a normal physiological response to the proposed load.

Thus, the fulfillment by athletes of the conditions of the test load in the placebo cycle stimulates the myogenic component of the regulation of vascular tone, contributing to the relaxation of precapillary myocytes with subsequent blood filling of the capillaries against the background of shunt spasm and reduces the activity of the endothelial component of regulation.

Under similar conditions of the test load in the cycle of taking a CEMA, an increase in the values of the Ae index to the level of 16.00 perf. units ( $p < 0.05$ ), in comparison with the initial values of this indicator - 14.05 perf. units, as well as in comparison with the data of this indicator, registered in the placebo cycle - 9.89 perf. units ( $p < 0.05$ ), which may indicate an increase in the efficiency of the regulatory element of urgent adaptation. Also, a single intake of carbohydrate-electrolyte mixtures with plant antioxidants during a test load contributed to an increase in An values to  $16.41 \pm 0.96$  perf. units  $p < 0.05$ , relative to the data of this indicator registered in the placebo cycle - 9.96 perf. units, which indicates a decrease in vasomotor pressure from the sympathetic vasomotors and is confirmed by a significant decrease in the lactate value ( $p < 0.01$ ) to values not exceeding the level of anaerobic threshold.

At the same time, we did not determine a significant change in the values of the Am indicator in the

placebo cycle and in the cycle of taking CEMA, since physical work at the level of 75% of  $VO_{2max}$  is a stress factor that causes pronounced metabolic shifts and enhances the metabolic control of vascular regulation, regardless of adaptation cofactors.

**Conclusions.** A vasoprotective effect was found in highly qualified orienteers as a result of a single intake of carbohydrate-electrolyte mixtures with plant antioxidants when performing muscular work under the conditions of a two-stage bicycle ergometric test  $PWC_{170}$ . This effect is due to the restoration of the functional activity of the microvascular endothelium, which is expressed in an increase in the amplitude values of endothelial rhythms in the CEMA cycle compared to the placebo cycle. Also, a single dose of CEMA contributed to a decrease in the effects of sympathetic adrenergic vasomotors on the vascular wall, as evidenced by an increase in the amplitude values of neurogenic rhythms in comparison with the data of this indicator recorded in the placebo cycle. In turn, the established drop in adrenergic vasomotor influences can be considered as a concomitant antihypoxic effect of a single dose of CEMA and is expressed in a decrease in lactate levels.

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# Functional features of the heart in cyclists

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## Abstract

**Objective of the study** was to evaluate the effect of training loads on the functional parameters of the heart of cyclists.

**Methods and structure of the study.** The observation was made on 18 trained young cyclists with at least three years of sports training experience. The control group included 22 clinically healthy young men who did not go in for sports. Echocardiography was performed on the SSD-80 Aloka device (Japan).

**Results and conclusions.** Experienced cyclists have left ventricular myocardial hypertrophy. It was manifested by an increase in the thickness of its walls and its mass while maintaining the optimum of its overall size and the size of its cavity. Well-trained cyclists are characterized by a high rate of relaxation of the heart muscle. It is clear that regular cycling increases the physical capabilities of a person, trains his heart, while maintaining the optimum of general hemodynamics.

**Keywords:** cycling, left ventricle, heart, muscle activity, sports loads.

**Introduction.** Systematically repeated muscle loads provide a very pronounced training effect on the body and enhance the work of internal organs [1, 2]. Rational physical activity can lead to a clear improvement of the whole organism [3]. This is due to the fact that regular muscle activity can enhance the severity of a number of biochemical and physiological processes in muscle tissue and vital organs [4]. In the case of correct dosing of loads, they increase the resistance of the whole organism and increase its adaptive characteristics [5].

Dosed aerobic exercise has a beneficial effect on the morphological and functional parameters of the heart [6]. Strengthening of the myocardium is primarily associated with its thickening and increased contractile function of the left ventricle [7]. At the same time, the dynamics of the main cardiac parameters in various types of sports activities has not been fully studied and needs to be clarified [8]. Changes in the myocardium that occur in healthy young men as a result of regular aerobic exercise, including cycling, remain unclear. The need for further improvement and increase in the effectiveness of the entire training process in sports requires additional monitoring of

upcoming changes in the myocardium in well-trained athletes [9].

**Objective of the study** was to evaluate the effect of training loads on the functional parameters of the heart of cyclists.

**Methods and structure of the study.** The observation was made on 18 young cyclists aged from 18 to 21 years. Depending on the weather conditions, all young men taken in the study experienced daily cycling loads either on the track or on an exercise bike. All surveyed had a sports experience of at least three years. The control group included 22 clinically healthy young men aged 18 to 21 years who experienced significant muscle loads only during academic physical education lessons at the university.

In those taken under observation, a heart examination was performed using an ultrasonic device SSD-80 manufactured by the Japanese company Aloka, recording a number of basic cardiac parameters.

**Results of the study and their discussion.** The work performed made it possible to obtain information about the state of the recorded indicators among cyclists and find their differences from the values in the control group (see table).



### Cardiac parameters of the examined

Cardiac indicators	Cyclists, M±m, n=18	Control, M±m, n=22
Left atrial diameter, cm/m <sup>2</sup>	1,93±0,06	1,80±0,09
Anteroposterior size of the left ventricle in diastole, cm	5,35±0,14	5,11±0,11
Reduction of the anteroposterior value of the left ventricle, %	35,05±0,85	32,91±0,72
Diastolic thickness of the left ventricle in the posterior wall, cm	1,18±0,06	1,01±0,08 p<0,05
End diastolic volume of the heart, cm <sup>3</sup> /kg	1,82±0,14	1,96±0,09
Stroke volume, cm <sup>3</sup> /kg	1,11±0,15	1,09±0,10
Myocardial mass, cm <sup>3</sup> /kg	2,52±0,22	2,19±0,18 p<0,05
The highest rate of relaxation of the left ventricle in the posterior wall, cm/s	13,3±1,31	10,5±0,67 p<0,05
Ratio of end-diastolic volume to myocardial mass, cm <sup>3</sup> /kg	0,72±0,09	0,89±0,16 p<0,01
Ejection fraction, %	61,74±1,16	60,33±0,74

Note: p - the obtained significance of differences between groups of subjects.

The diameter of the left atrium in cyclists tended to exceed the value in the control by 7.2%. Cyclists had a tendency to exceed the value of the anteroposterior diameter of the left ventricle during diastole (by 4.6%) and reduce this size (by 6.5%) compared with the control group.

The left ventricular posterior wall at the time of diastole had a greater thickness in cyclists by 16.8% (p<0.05). The end diastolic heart volume of cyclists tended to be lower than the control value (by 7.7%). However, the stroke volume in both observed groups was similar.

The value of myocardial mass in cyclists was higher (by 15.1%) than in the control group, indicating the formation of myocardial hypertrophy in them. However, this did not affect their ejection fraction, which was comparable in both groups of patients.

In the region of the posterior wall of the left ventricle, the highest rate of development of relaxation in cyclists (by 26.2%) exceeded that in physically inactive young men.

It can be assumed that cycling leads to left ventricular myocardial hypertrophy, as indicated by thickening of its posterior wall and an increase in its mass. At the same time, the athletes retained the optimum volume and size of the left ventricular cavity, which were similar to those in the control group. The ratio of the end diastolic volume to the mass of the heart muscle was inferior in cyclists (by 23.6%) to the control level, indicating a high sensitivity of this indicator to cycling.

No differences were found between the groups and in the parameters of central hemodynamics and

myocardial contractility. The ratio of end-diastolic volume to myocardial mass under conditions of cycling decreased due to an increase in myocardial mass. A decrease in the ratio of end-diastolic volume to myocardial mass to  $0.72 \pm 0.09$  in cyclists proves the predominance of left ventricular muscle hypertrophy phenomena over dilatation of the cardiac cavities [10].

A significant rate of myocardial relaxation is typical for well-trained people [11]. It can be considered that the rate of relaxation of the left ventricle in the region of the posterior wall is a marker that allows assessing the development of diastole [12]. In our observation, this indicator was higher among cyclists.

**Conclusions.** Regular cycling stimulates hemodynamics and improves myocardial contractility. Cycling develops the heart, increases the mass of its left ventricle and enhances the functional characteristics of the heart. In the case of systematic cycling loads, there is a tendency to accelerate the relaxation of the left ventricular muscle, which improves hemodynamics.

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# Physiological mechanisms determining the performance of passing control standards for physical culture

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## Abstract

**Objective of the study** was to identify significant physiological mechanisms of performance formation when passing control standards in physical culture and to establish the relationship between performance indicators and individual psychophysiological characteristics.

**Methods and structure of the study.** 120 young men aged 18-20 years old belonging to the main health group were examined. With the help of cluster analysis, groups were identified with different performance in passing control standards in terms of speed endurance and speed-strength indicators. To solve the problem of classifying students, taking into account their psychophysiological characteristics, an artificial neural network (ANN) was created, distributing students into groups with specified characteristics.

**Results and conclusions.** When analyzing the motivational basis of behavior, it was revealed that the students of the first cluster were dominated by an internal motive and the motive of focusing on success, with at the same time high rates of assessing their potential. The students of the second cluster were dominated by the motive for assessing the significance of the result of activity. Statistically significant differences in personal psychophysiological characteristics and indicators of physical performance were established in the subjects of the identified clusters. On the basis of a set of data obtained, cluster analysis and ANN technology made it possible to predict the performance of students with a high probability, as well as to rank indicators according to their significance for the formation of unequal performance.

**Keywords:** *psychophysiological characteristics, cluster analysis, artificial neural networks.*

**Introduction.** The level of physical fitness as the ratio of the effectiveness of activity and physiological costs for its implementation is the key concept of sports physiology [2, 5, 12]. An important factor determining the effectiveness of purposeful human activity is the interaction of such physiological mechanisms as psychophysiological features [4, 7, 15], indicators of dynamic functional lateralization [1], physical performance, and the motivational basis of behavior [6, 10]. The functioning of the mechanisms that reflect the effectiveness of sports activities from the standpoint of systemic physiology is associated with the "physiological price" of the result of an activity [13, 16], which determines one of the aspects of its effectiveness.

Today, the formation of a person's physical fitness is considered as a complex systemic phenomenon. In accordance with the theory of functional systems, the effectiveness of purposeful human activity is ensured

by the interaction of various physiological mechanisms [11, 14]. At the same time, psychophysiological characteristics in conjunction with the results of sports activities can serve as markers of the systemic organization of purposeful activities carried out with different results [5].

**Objective of the study** was to identify significant physiological mechanisms of performance formation when passing control standards in physical culture and to establish the relationship between performance indicators and individual psychophysiological characteristics.

**Methods and structure of the study.** Statistical data processing was carried out using the Statistica 13.0 software package. Quantitative indicators were assessed for compliance with the normal distribution using the Shapiro-Wilk test. Cluster analysis (k-means method) was used to identify groups. The median

**Table 1.** Characteristics of the implementation of control standards

Indicator	Group 1			Group 2			U (Z)	p
	Me	LQ	UQ	Me	LQ	UQ		
100 m run, s	12,9	12,4	14,3	14,3	14,0	14,5	860,5	0,001
1000 m run, s	245,0	240,0	248,0	255,0	246,0	268,0	734,0	0,001
Standing long jump, cm	257,0	248,0	265,0	275,0	264,0	280,0	716,5	0,001
Pull-ups, times	12,0	10,0	12,0	15,0	14,0	17,0	264,5	0,001

(Me), upper (UQ), and lower quartile (LQ) were used to describe the study groups. A comparative analysis of the indicators was carried out using the nonparametric Mann-Whitney test (U) for paired independent samples [8].

The construction of an artificial neural network (ANN) was carried out in an automatic mode based on groups of a number of indicators: neuroenergy mapping (NEM) with registration of the level of constant potential (LCP) in leads Fz, Cz, Oz, Td, Ts; motivational basis of behavior (test for assessing the level of claims according to V.K. Gerbachevsky); psychodynamic characteristics (the general structure of V.M. Rusalov's temperament - ergicity, plasticity, pace and speed, emotionality, social ergicity, social plasticity, social tempo and social emotionality, as well as the type of behavioral activity); the level of basic physical performance with the calculation of the normalized indicator  $PWC_{170}$ ; asymmetry coefficients (Annette

questionnaire, lateral organization profile (PLO), motor and sensory asymmetries).

The selection of indicators was based on a consistent assessment of the improvement in the quality of the model. ANNs were characterized by a certain architecture, training performance, control and test performance [3]. The study was approved by the Local Ethical Committee at the Ryazan State Medical University of the Ministry of Health of Russia on April 11, 2021. All study participants signed an informed consent.

**Results of the study and their discussion.** By the method of cluster analysis, two groups of students were identified depending on the effectiveness of passing the control standards for physical culture (Table 1). Group 1 (70 people) was designated as "effective in running disciplines", and group 2 (50 people) – as "effective in strength disciplines".

The creation, training and testing of the ANN was carried out using the Statistica Basic Academic 13.0

**Table 2.** Ranked list of indicators used by the ANN to predict the effectiveness of passing control standards

Indicator	Rank	Sensitivity *
Internal motive	1	13,86
Cognitive motive	2	4,30
Significance of results	3	2,79
Assessment of the level of results achieved	4	1,74
$PWC_{170}$ Test	5	1,48
The initial background (Td-Ts lead) of the NEM	6	1,41
Social tempo	7	1,26
Annette's questionnaire coefficient	8	1,14
Coefficient manual asymmetry	9	1,10
Anxiety level	10	1,08
Lateral Organization profile coefficient	11	1,05
Social plasticity	12	1,00
LCP Verbal fluency test (Ts lead) NEM	13	1,00
LCP Schulte-Platonov test (lead Td-Ts) NEM	14	1,00
LCP Verbal fluency test (Td-Ts lead) NEM	15	0,99
Source Background (Cz lead) NEM	16	0,96
LCP Test of fluency of verbal responses (lead Td) NEM	17	0,70

\* – values are rounded to hundredths (differences in other digits are taken into account when ranking indicators by sensitivity).



(Ru) software package. Machine learning technology assumed the use of an automatic advanced algorithm for creating and training ANNs in the mode of solving classification problems. Initially, an ANN was created using the following data as predictors: NEM (the level of constant potential of abduction Fz, Cz, Oz, Td, Ts), the motivational basis of behavior (the test for assessing the level of claims according to V.K. Gerbachevsky), psychodynamic characteristics (general structure of temperament V.M. Rusalova - ergicity, plasticity, pace and speed, emotionality, social ergicity, social plasticity, social tempo and social emotionality, as well as the type of behavioral activity), the level of basic physical performance ( $PWC_{170}$  (wt/kg), asymmetry coefficients (questionnaire Annette, lateral organization profile, motor and sensory asymmetries). The selection of indicators was based on a sequential assessment of the improvement in the quality of the model. This neural network was a multilayer perceptron with 17 input neurons, 17 intermediate layer neurons and two output neurons. The performance of the training sample was 100%, control - 100%, test - 100% (MLP 17-1 7-2; 100:100:100). In table. 2 shows the predictors used to solve the forecasting problem.

The use of ANN technology made it possible to solve the problem of classifying students by the effectiveness of passing control standards in physical culture based on a set of indicators, which has applied practical significance, and also allows ranking groups of indicators according to their classification significance. The sensitivity of this ANN in determining the effective group of practically healthy individuals was 100%; specificity - 100%.

The indicators of the motivational basis of behavior, the level of basic physical performance, indicators of dynamic functional asymmetry of the brain according to NEM criteria, indicators of psychodynamic characteristics and behavioral phenotypic lateralization were of the greatest importance for solving this problem. The mutual assistance of the indicated indicators of the systemic organization of the purposeful activity of the subjects of the identified clusters reflects the features and reasons for the formation of its various effectiveness.

**Conclusions.** The formation of physical fitness is associated not only with physical performance, but also with a certain combination of psychophysiological characteristics: anxiety, ergicity, plasticity, speed indicators of behavior, emotionality, focus on results, functional lateralization.

The effectiveness of passing control standards can be successfully predicted on the basis of a complex of physiological and psychophysiological indicators using cluster analysis and ANN technology. The proposed algorithm for solving the problem of distributing subjects into groups with a different set of physi-

ological, physical indicators and psychophysiological characteristics suggests the possibility of its use in the practice of sports selection. The good classification ability of the algorithm allows solving the applied problem of predicting "effective in running disciplines" and "effective in strength disciplines".

The obtained facts in the future will allow us to describe the optimal "psycho-physiological portraits of a person" that contribute to a certain direction of his physical fitness.

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# Dependence of the state of metabolism on the time of cessation of sports activities of former athletes

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## Abstract

**Objective of the study** was to study the main indicators of metabolism in the blood plasma of former athletes, depending on the time of completion of sports activities.

**Methods and structure of the study.** The study involved 24 former male athletes, with various sports specializations, qualifications from III adult category to Candidates for Master of Sports, aged 19-29 years. Depending on the time of completion of an active sports career, former athletes were divided into two groups: those who completed sports for a period of up to two years and more than two years. The control group consisted of untrained men of the same age. Indicators of protein, carbohydrate, lipid, purine metabolism and oxidative balance were studied in blood plasma.

**Results and conclusions.** The initial post-sport period is characterized by the predominance of catabolic processes (manifested in the form of a significant increase in the concentration of urea, medium molecular weight peptides, uric acid), carbohydrate metabolism disorders (a significant increase in glucose levels), lipid metabolism (a significant increase in total cholesterol, triacylglycerols) and oxidative balance in the form of accumulation TBA-active products against the background of a trend towards a decrease in total antioxidant activity. In the late post-sport period, there were no significant differences from the examined control group in terms of the studied indicators.

The initial post-sport period is characterized by an unfavorable change in the indicators of all types of metabolism, followed by a reverse trend in the late post-sport period. A comprehensive study of key metabolic indicators is a reliable criterion for diagnosing the development of a state of detraining. Metabolic changes accompanying the development of the state of detraining are recommended to be taken into account in the interpretation of biochemical analyzes during the rehabilitation of former athletes.

**Keywords:** *detraining, metabolism.*

**Introduction.** Sport implies an increased, in comparison with the usual, motor mode, which leads to the body's adaptation to constant intense physical activity, which turns into an attribute of an athlete's life [7-10]. The end of a sports career, especially a forced one, inevitably leads to a significant decrease in motor activity, which can be interpreted as relative physical inactivity. It has been shown that an abrupt cessation of the training process leads to adverse metabolic changes, including lipid metabolism [3], which are aggravated by the consequences of injuries and psychological discomfort. According to [6], 74.6% of the surveyed sports veterans would seek medical help in resolving the issue of

adaptation to reduced physical activity. The study of metabolic rearrangements in people who have completed their sports career seems to be a rather urgent task both in terms of diagnosing the impact of developing relative physical inactivity on the health status of former athletes and preventing adverse consequences.

Objective of the study was to study the main indicators of metabolism in the blood plasma of former athletes, depending on the time of completion of sports activities.

**Methods and structure of the study.** The study involved 24 former male athletes, with various sports specializations, qualifications from III adult category



to Candidate for Master of Sports, aged 19-29 years. Depending on the time of completion of an active sports career, former athletes were divided into two groups: those who completed sports for up to two years (Group 1;  $n=12$ ) and over two years (Group 2;  $n=12$ ). The control group ( $n=15$ ) consisted of conditionally healthy untrained male students of the same age, who go in for physical culture within the program of the university.

Blood for the study was taken from the cubital vein and centrifuged. Indicators of protein, carbohydrate, lipid, purine metabolism and oxidative balance were studied in blood plasma. The concentration of total protein (TP), creatinine, urea, glucose, triacylglycerols (TG), uric acid (UA) was determined by standard sets of reagents, total cholesterol (TC) - by the Zlatkis-Zak method [4], TBA of active products (TBAap) - spectrophotometrically, at 535 nm. The level of medium molecular weight peptides (MP) was studied according to the method [1] on a Shimadzu UV mini-1240 spectrophotometer (Japan). The MP value was expressed in units equal to extinction (E) multiplied by 1000. The study of total antioxidant activity (TAA) was carried out on an Emilite 1105 chemiluminometer (Russia) according to the method [5] and expressed in conventional units (c.u.).

Statistical processing was performed by the Statistica 10.0 package. Arithmetic mean (M) and 95%

confidence interval (95% CI) were calculated. The normality of distribution was checked using the Shapiro-Wilk test, the significance of the difference was determined by Student's t-test and considered significant at  $p<0.05$ .

**Results of the study and their discussion.** Data on the state of metabolism are presented in the table.

The concentration of total protein in the subjects of the 1st group, when compared with the data of the control group, was higher by 6.5% ( $p=0.091$ ), which can be explained by the intensification of protein metabolism associated with adaptive changes during the transition to a lower level of motor activity. At the same time, the higher values of creatinine in former athletes of the 1st group by 10.8% ( $p=0.092$ ) can be explained by a large amount of muscle mass compared to untrained people in the control group. However, there is reason to believe that the cessation of sports leads to a decrease in the efficiency of the phosphate energy supply system, which is confirmed by a lower creatinine level in former athletes of the 2nd group.

The indicator of medium molecular weight peptides in former athletes of the 1st group was significantly higher by 30.0% ( $p=0.008$ ). At the same time, in former athletes of the 2nd group, the concentration of medium molecular weight peptides was lower compared to the 1st group by 14.6% ( $p=0.084$ ), but higher than in the control group by 11.1% ( $p>0.1$ ). Such a

*Plasma Metabolism Rates in Detrained Individuals (M; 95% CI)*

Researched indicator	Control group ( $n=15$ )	Former athletes	
		1st group ( $n=12$ )	2nd group ( $n=12$ )
Total protein, g/l	<b>69,3</b> (66,4 - 72,2)	<b>73,8</b> (69,7 - 77,9)	<b>72,4</b> (68,5 - 76,3)
Creatinine, $\mu\text{M/l}$	<b>60,3</b> (55,9 - 64,7)	<b>66,8</b> (61,4 - 72,7)	<b>62,6</b> (57,1 - 68,1)
Medium molecular weight peptides, $\text{Ex}1000$	<b>237</b> (206 - 268)	<b>308</b> (273 - 343)*	<b>263</b> (230 - 296)
Urea, mm/l	<b>4,80</b> (4,45 - 5,15)	<b>5,84</b> (5,33 - 6,35)*	<b>5,13</b> (4,70 - 5,56)
Glucose, mM/l	<b>4,65</b> (4,43 - 4,87)	<b>5,15</b> (4,88 - 5,42)*	<b>4,89</b> (4,58 - 5,20)
Uric acid, $\mu\text{M/l}$	<b>262</b> (235 - 289)	<b>325</b> (290 - 360)*	<b>296</b> (263 - 329)
Triacylglycerols, mM/l	<b>0,94</b> (0,86 - 1,02)	<b>1,19</b> (1,07 - 1,31)*	<b>0,96</b> (0,86 - 1,06)
Total cholesterol, mm/l	<b>4,12</b> (3,85 - 4,39)	<b>5,52</b> (5,05 - 5,99)*	<b>4,46</b> (4,07 - 4,85)
TBA active products, $\mu\text{M/l}$	<b>5,38</b> (4,87 - 5,89)	<b>7,46</b> (6,87 - 8,05)*	<b>5,65</b> (5,14 - 6,16)
Total antioxidant activity, c.u.	<b>0,073</b> (0,069-0,077)	<b>0,072</b> (0,068 - 0,076)	<b>0,073</b> (0,069-0,077)

Note: \* - the difference with the control is statistically significant ( $p<0.05$ ).



distribution of this indicator indicates a certain staging in the development of the state of detraining, namely, an increase in catabolic processes at the initial stage of cessation of regular training, followed by adaptation to a changed level of physical activity. This position is confirmed by the study of indicators of urea and UA.

An increase in the concentration of urea in the development of the state of detraining can be associated with the consequences of a stress reaction, as well as with a decrease in the muscle mass of a former athlete, with a subsequent increase in the content of protein degradation products in the blood, including urea. In addition, the dietary habits of ex-athletes should also be taken into account, usually including the consumption of foods high in protein. The content of uric acid also agrees well with this. An increase in uric acid can also be associated with an intensification of the catabolism of unclaimed adenine associated with a decrease in ATP production.

Higher glucose values during the development of detraining, in our opinion, are associated with a stress response to relative physical inactivity, which leads to the activation of the sympathoadrenal system and the synthesis of hormones with contra-insular action. This leads both to inhibition of insulin production and to a decrease in the utilization of glucose by muscle tissue, since only a functioning muscle is able to consume glucose with a minimum amount of insulin in the blood.

A decrease in the role of lipid metabolism in the energy supply of muscle activity was established, confirmed by higher, by 26.6% ( $p=0.003$ ), TG values in the initial post-sport period.

In detrained individuals, higher values of total cholesterol were noted. At the same time, if in the initial post-sport period, these differences, compared with the control group, were significant and amounted to 34.0% ( $p 0.001$ ), then in the late post-sport period, the differences were not statistically significant, which, in our opinion, indicates ending adaptive restructuring to the changed level of physical activity.

The revealed increase in the concentration of TBAap by 38.6% ( $p 0.001$ ) in the initial post-sport period indicates the intensification of free radical oxidation reactions, leading to the destruction of cell membranes, which explains atrophic processes and a decrease in muscle mass. In addition, the processes associated with the destruction of membranes lead to the disruption of membrane-dependent processes with the potentiation of atherogenesis, which is consistent with the results of the study of the total cholesterol index. The study of the total antioxidant activity in blood plasma did not reveal significant differences

in this indicator in former athletes compared to the control group. However, studies conducted at the cellular level indicate a significant decrease in TAA in the erythrocytes of former athletes [2], therefore, in general, we can talk about a decrease in the effectiveness of the antioxidant defense system in detrained individuals.

**Conclusions.** The initial post-sport period is characterized by an unfavorable change in the indicators of all types of metabolism, followed by a reverse trend in the late post-sport period.

A comprehensive study of key metabolic indicators is a reliable criterion for diagnosing the development of a state of detraining.

Metabolic changes accompanying the development of the state of detraining are recommended to be taken into account in the interpretation of biochemical analyzes during the rehabilitation of former athletes.

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# The influence of functional states on the normative indicators of cross-country running of students before and after the COVID-19 pandemic

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## Abstract

**Objective of the study** was to assess the impact of functional states on the performance of normative indicators of cross-country running of students before and after the COVID-19 pandemic.

**Methods and structure of the study.** 42 subjects took part in the scientific work (gender - female, average age 19.5 years, health group - main). Group X - students who took the Applied Physical Education course in full-time before the start of the pandemic (duration of the course: 2015-2018); group Y - students who took the course "Applied Physical Education" in full-time and remote form during the pandemic (duration of the course: 2019-2022). To measure the level of fatigue, monotony, satiety and stress, the method "Differential diagnosis of conditions of reduced performance" (DORS) by A.B. Leonova and S.B. Velichkovskaya (modified). A comparative evaluation of the results of a 3000 m cross-country run was also carried out.

**Results and conclusions.** The conditions of self-isolation, distance learning and quarantine measures during the pandemic had an impact on the physical and mental health of students who had an increased level of monotony, a lower result in cross-country running than in the group of students involved in the traditional mode of study before the pandemic. The results obtained give grounds to assume that the limitation of life activity leads to dysfunction of the motivational-volitional sphere, apathy, boredom, physical and mental fatigue of students and, accordingly, affects their results in long-distance running.

The issue of maintaining health, both physical and psychological, in conditions of self-isolation is still relevant, and therefore there is an increasing need to develop and apply various types of monitoring the results of people's motor activity in various conditions of life.

**Keywords:** *pandemic, coronavirus infection, students, cross-country, running, stress, fatigue, monotony, distance learning.*

**Introduction.** In the context of the pandemic, a large number of higher educational institutions were forced to switch to a distance learning format, and many public organizations stopped working, including fitness centers, sports grounds, and stadiums. Maintaining the fitness and health of students in a pandemic situation turned into a real problem, which was exacerbated by social distancing and isolation [2, 3, 6, 7]. The protracted stay at home for a long time seriously complicated the observance of the necessary motor regime of students and, in particular, the fulfillment of long-distance running tasks. It is believed that

the success of this exercise depends on the overall endurance of a person, the consistency and frequency of exercises that increase the level of endurance, as well as its psychological characteristics, in particular the will and motivation of a person.

**Objective of the study** was to assess the impact of functional states on the performance of normative indicators of cross-country running of students before and after the COVID-19 pandemic.

**Methods and structure of the study.** 42 subjects took part in the scientific work (gender - female, average age 19.5 years, health group - main). Group



X - students who took the Applied Physical Education course in full-time before the start of the pandemic (duration of the course: 2015-2018); group Y - students who took the course "Applied Physical Education" in full-time and remote form during the pandemic (duration of the course: 2019-2022). To measure the level of fatigue, monotony, satiety and stress, the method "Differential diagnosis of conditions of reduced performance" (DORS) by A.B. Leonova and S.B. Velichkovskaya (modified) [4]. A comparative evaluation of the results of a 3000 m cross-country run was also carried out.

**Results of the study and their discussion.** The difference in the average cross-country running time between the groups of subjects is quite large and amounts to 48 seconds, with the average in group X being 1011 s. and in group Y being 1059 s. (see table).

*Normative results of the 3000 m cross-country run of group X and group Y*

Time (T, s)/ Subject's no.	X Tx, s.	Y Ty, s.
1	889	914
2	889	970
3	942	972
4	957	978
5	972	981
6	974	983
7	974	1002
8	993	1025
9	996	1042
10	1006	1044
11	1009	1054
12	1013	1065
13	1013	1070
14	1020	1083
15	1026	1090
16	1043	1116
17	1043	1119
18	1056	1120
19	1062	1165
20	1103	1200
21	1127	1260
<b>Tav., s</b>	<b>1011</b>	<b>1059</b>
<b>Δ, s.</b>	<b>48</b>	

This difference is explained by the fact that under the conditions of disability during the pandemic, it was not possible to conduct systematic classes to develop endurance and motor skills, unlike the traditional face-to-face regimen.

Along with this, in the background of self-isolation and other socio-psychological factors, the subjects

may develop some forms of asthenia and disorders of the motivational-volitional sphere. As the performance diagnostic data showed, there is a tendency to a pronounced state of stress, monotony, fatigue and mental satiety in group Y.

From the results of the study, it follows that of the four psychological states presented, monotony is pronounced, which indicates a decrease in conscious control of activity caused by monotonous work and stereotyped actions, and leads to boredom or drowsiness, a desire to change activities. The relationship between fatigue and mental satiety ( $r=0.9$ ) is highlighted, which is caused by the peculiarities of the organization of physical activity during distance learning and the consequences of the isolation mode due to the pandemic, while the intensity of work, increased workload and monotony lead to greater fatigue and increased stress levels. . It can be concluded that the most stressful and relevant aspect of a student's activity during a pandemic is stereotypical physical activity, which leads to mental satiety, a desire for changes in activity.

The influence of mental processes on the physical state of a person is reflected in experiments conducted before the pandemic. The experiment of Bexton and Chiron, carried out on students during their isolation in special boxes under conditions of artificial deprivation, is well known and described. Food intake and physiological administration were carried out on demand. Individuals who took part in the experiment had thought disorders, false sensations, physical and mental fatigue, boredom, leading to a decrease in motivation [5]. Similar results were also confirmed by the studies of F.D. Gorbova, V.I. Myasnikov and V.I. Yazdovsky [1]. The subjects showed physiological changes (depression of the adrenal glands, the development of fatigue, etc.), manifested apathy, boredom, anxiety and fear, increased suggestibility.

The absence of significant connections between the results of cross-country running and the scales of the questionnaire showing the levels of fatigue, monotony, satiety and stress can be explained by the influence of other reasons, rather from the motivational-volitional sphere of the subjects.

Thus, the resulting difference in the results of cross-country running among students can be due not only to a physical factor, but also to an equally psychological one, however, this problem remains not completely solved, it requires continued search for reasons.



**Conclusions.** The conditions of self-isolation, distance learning and quarantine measures during the pandemic had an impact on the physical and mental health of students who had an increased level of monotony, a lower result in cross-country running than in the group of students involved in the traditional mode of study before the pandemic. The results obtained give grounds to assume that the limitation of life activity leads to dysfunction of the motivational-volitional sphere, apathy, boredom, physical and mental fatigue of students and, accordingly, affects their results in long-distance running.

The issue of maintaining health, both physical and psychological, in conditions of self-isolation is still relevant, and therefore there is an increasing need to develop and apply various types of monitoring the results of people's motor activity in various conditions of life.

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# Formation of professional competencies of future physical education teachers

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## Abstract

**Objective of the study** was to identify the conditions and stages of formation of professionally significant technological competencies of bachelors of physical culture to improve the quality of training of future teachers of physical culture.

**Methods and structure of the study.** The methods of generalization, systematization, methods of document analysis, generalization of the experience of pedagogical universities were used to specify the goals and objectives of the main educational program for the preparation of bachelors of physical culture in accordance with the requirements of the State Educational Standard of Higher Professional Education in the direction of "Physical Education" (2021) and the development of professional competencies of a physical education teacher in accordance with the stages of the learning process at the university.

**Results and conclusions.** The content of the curricula for the training of bachelors of physical culture has been developed, in accordance with the requirements of the new State Standard of Higher Professional Education in the direction of "Physical Education" (2021), based on the principles of consistency, continuity, humanization of education, competence-based, personality-oriented and activity-based approaches to education. It was revealed that the use of a practice-oriented health-saving education trajectory contributes to the formation of professionally significant competencies of future physical education teachers.

**Keywords:** *humanization of education, human health, technological competencies, teaching principles.*

**Introduction.** The most important principle of state policy in the field of education is the humanistic nature of education, the priority of universal values, human life and health, and the free development of the individual. In 2020, the Government of the Kyrgyz Republic approved the "Program for the Development of Education in the Kyrgyz Republic for 2021-2040", which outlines the need to improve the quality of school education and train teachers who are able to meet modern challenges, solve problems of socialization, the formation of physical culture and the health of students and students.

To improve the efficiency of education at different levels, from preschool to vocational education, it is necessary to reformat its content aspects, develop and implement new state standards at all levels of education [1, 7].

The effectiveness of teaching, its humanistic essence and quality are predetermined, first of all, by the professionalism and high technological culture of the teacher.

**Objective of the study** was to identify the conditions and stages of formation of professionally significant technological competencies of bachelors of physical culture to improve the quality of training of future teachers of physical culture.

**Methods and structure of the study.** The methods of generalization, systematization, methods of document analysis, generalization of the experience of pedagogical universities were used to specify the goals and objectives of the main educational program for the preparation of bachelors of physical culture in accordance with the requirements of the State Educational Standard of Higher Professional Education in



the direction of “Physical Education” (2021) and the development of professional competencies of a physical education teacher in accordance with the stages of the learning process at the university.

**Results of the study and their discussion.** It has been proven that the structure and content of the environment of an educational institution is of great importance for the formation of physical culture competencies among students, while “... a physical culture and sports environment should encourage the search for their own results of educational and extracurricular activities for the manifestation and self-expression of its individuality by means of physical culture and mass sports” [9].

Today, in the system of general secondary education, a physical education teacher is in demand, who has the necessary competencies in health protection, the use of extracurricular and extracurricular forms of classes to improve health and form a positive motivation for schoolchildren for active physical education and sports.

According to N.K. Smirnov, “health-saving educational technologies are a systematic approach to education and upbringing, built on the teacher’s desire not to harm the health of students” [11].

In the State Educational Standard of Higher Professional Education in the direction 532000 «Physical Culture», approved by the Ministry of Education and Science of the Kyrgyz Republic in 2015, the tasks of training future teachers of physical culture were defined in the following wording: «... to promote the formation of a general culture of the individual by means of physical culture in the process of physical universal values and a healthy lifestyle; promote the conscious use of physical culture as a means of restoring and strengthening health, familiarizing with a healthy lifestyle” [4].

In this version of the SES HPE (2015), the list of professional competencies included only two compe-

tencies related to the formation of the personality of those involved. In addition, an emphasis was placed on the disciplines of the basic part of the professional block, as a result of which a number of disciplines of the humanitarian and natural science block “dropped out” of the educational program (“Olympic education”, “Age psychology”, “Age physiology”, “Information technologies « etc.).

In 2021, by the Order of the Ministry of Education and Science of the Kyrgyz Republic No. 1578/1 dated September 21, 2021, a new State Educational Standard of Higher Professional Education was approved in the direction 532000 «Physical Education».

The new State Educational Standard of Higher Professional Education «Physical Education» (2017) took into account the above shortcomings and omissions. A provision has been adopted that “the university independently determines the set of disciplines (modules) and their labor intensity, which relate to each block of the Main Educational Program for the preparation of bachelors of physical education” [5].

Modern scientists note the high efficiency of practice-oriented learning technologies that contribute to the formation of significant professional personality traits in students, research and project competencies for the development of health programs for different contingents, while it is important to form the ability to determine priority tasks, taking into account various factors and limitations [10].

In 2022, we have developed and approved the curricula for the preparation of bachelors of physical education and sports at the Faculty of Sports Sciences at KTU «Manas», taking into account national traditions, regional and environmental conditions of educational institutions, features of the development of health programs for different contingents, a variety of organizational forms and methods of work on the introduction of the basics of a healthy lifestyle, which leads to the

**Table 1.** Structure of the Main Educational Program for bachelor’s degree (State Higher Educational Institution, direction 532000 “Physical culture and sports”: Bachelor, 21.09 2021 № 1578/1)

Structure of the Main Educational Program for the preparation of bachelors		The scope of the MEP and its blocks (in credits)
<b>Block 1</b>	<b>Disciplines</b>	<b>215</b>
	I. Humanitarian, social and economic cycle	<b>34</b>
	II. Mathematical and natural science cycle	<b>12</b>
	III. Professional cycle	<b>169</b>
<b>Block 2</b>	Practice	<b>15</b>
<b>Block 3</b>	State final certification	<b>10</b>
<b>The scope of the MEP HPE for the preparation of bachelors</b>		<b>240</b>



**Table 2.** *Professionally significant competencies of future teachers of Physical Education*

State Educational Standard of Higher Professional Education, direction: 532000 «Physical culture», approved by the Order of the Ministry of Education and Science of the Kyrgyz Republic dated September 15, 2015 No. 1179/1	State Educational Standard of Higher Professional Education, direction: 532000 «Physical Culture and Sports», qualification: Bachelor approved by Order of the Ministry of Education and Science of the Kyrgyz Republic dated September 21, 2021 No. 1578/1
<p>Competencies in health care</p> <ul style="list-style-type: none"> <li>• Use in the practice of physical education knowledge about the physiological processes occurring in the human body in the process of its development;</li> <li>• Use pedagogical, biomedical methods, monitoring the state of students, the impact of physical activity on them and adjust them depending on the results of control.</li> </ul>	<p>Competencies in health care</p> <ul style="list-style-type: none"> <li>• Is able to use the value potential of physical education and sports to form a general culture of students' personality, the foundations of a healthy lifestyle, interest and need for physical exercises and sports;</li> <li>• Able to plan and conduct physical education classes and extracurricular activities in educational institutions with various contingents and ensure the protection of life and health of students in the UVP and extracurricular activities;</li> <li>• Able to implement various forms of sports and recreation activities, taking into account the individual characteristics of those involved, hygienic, climatic, environmental and other factors;</li> <li>• Able to use the spiritual values accumulated in the field of physical culture and sports, the knowledge gained about the characteristics of the personality of those involved in the education of patriotism, the prevention of deviant behavior, the formation of a healthy lifestyle, the need for regular physical education and sports.</li> </ul>

creation of a dynamic educational environment and a certain freedom in choosing the path of learning.

For the formation of cognitive, research abilities of a physical education teacher, the ability to logically generalize, conduct a comparative analysis of the results of activities, contributing to the improvement of the professional culture of graduates of the Faculty of Sports Sciences of KTU «Manas», we have developed the following professional competencies of health formation:

- the ability to use the value potential of physical culture and sports for the formation of a general culture of the personality of students, the foundations of a healthy lifestyle, interest and need for physical education and sports;
- the ability to plan and conduct training sessions and extracurricular activities in physical culture with a different contingent and ensure the protection of life and health of students;
- the ability to implement various forms of sports and recreation activities, taking into account the individual characteristics of those involved, hygienic, climatic, environmental and other factors;
- the ability to use the spiritual values of physical culture and sports, the knowledge gained about the characteristics of the personality of those involved in

the education of patriotism, the prevention of deviant behavior, the formation of a healthy lifestyle, the need for regular physical education and sports.

When developing educational and methodological support and the content of the disciplines of the main educational program, we adhered to the idea of a practice-oriented health-saving trajectory of education, relying on the principles of consistency and continuity, humanization of education, competence-based, student-oriented, activity-based approaches and innovative technologies of physical education (personality-oriented technology of physical education (M.Ya. Vilensky), the formation of a healthy lifestyle and sports-oriented physical education (L.I. Lubysheva), the Spartan technology of spiritual and physical rehabilitation of children and youth (V.I. Stolyarov) [2, 8, 12].

Experts note that for the effective formation of technological competence among future physical education teachers, it is important to create the following pedagogical conditions: the formation of positive motivation to master the technological foundations of the organization of the educational process; using the possibilities of formal and non-formal education in the formation of technological competence; stages of formation of technological competence [3].



The disciplines of the professional cycle are arranged in a certain sequence, taking into account the continuity of the stages of formation of students' competencies: Stage 1 - the formation of students' professional and pedagogical knowledge and skills; 2nd stage - providing subject and professional training; 3rd stage – result-competence: personal and professional development of the future physical culture teacher [10].

The process of forming professional competencies of students of the Faculty of Sports Sciences is associated with the development of pedagogical technologies aimed at protecting the health of schoolchildren and their application in the process of passing summer recreational, school and state pedagogical practice.

When preparing educational and methodological support and educational and methodological complexes in the disciplines: "Human Physiology", "Biochemistry of Sports", "Kinesiology", "Sports Medicine", "Hygienic Fundamentals of Physical Culture and Sports", "Planning Physical Education Lessons and Assessment Methods", "Age Physiology", etc. laboratory workshops were developed on the development of express tests for assessing somatic health, self-diagnosis and correction of physique, conditions were created to attract students to design and educational and research work.

**Conclusions.** The formation of professionally significant technological competencies of a physical education teacher based on the creation of a practice-oriented health-saving trajectory for the education of bachelors of physical culture involves the gradual development of the value potential of physical culture, the development of cognitive, research abilities, mastery of the necessary health-saving technologies, the presence of readiness and personal experience in the implementation of physical culture and sports activities in various environmental conditions.

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# Performance as the basis of goal-directed behavior

UDC 612.06



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## Abstract

**Objective of the study** was to evaluate the effectiveness of students entering a specialized university faculty, taking into account their motivation for future professional activities.

**Methods and structure of the study.** The study was carried out on the basis of the results of the competitive selection of 251 students in the period from 1996 to 2000. To select the best of the most motivated students for future activities, students of the 2nd and 3rd courses of specialized universities of the Russian Federation with high educational results were admitted to competitive tests.

**Results and conclusions.** The dominant learning motivation, reflecting the intellectual preparation of the student, his success in mastering the fundamental disciplines is the leading one in the effectiveness of admission to a specialized research faculty. At the same time, the student's creative abilities are an important, however, independent characteristic of the individual. Thus, emotionally colored motivation is the basis for the effectiveness of a behavioral act.

**Keywords:** *motivation, behavioral act, Fisher's exact test.*

**Introduction.** An essential moment that determines the effectiveness of a purposeful human activity is the interaction of the psychophysiological characteristics of the body, physical performance and the motivational basis of behavior. An ideal example illustrating the importance of emotionally colored motivation for the effectiveness of a purposeful behavioral act is the achievement of high results by an athlete.

The functioning of the mechanisms responsible for the effectiveness of any activity from the standpoint of systemic physiology is associated with its *physiological cost* - specific efficiency. Theory of functional systems P.K. Anokhin, based on the cybernetic principle of self-regulation, explains the vital activity of the organism from a systemic standpoint. The unification of all central and peripheral components of the functional system of a behavioral act is based on the principle of effectiveness [1–3]. The achievement of the final result ends with its evaluation, comparison of the achieved result with its predicted ideal model. Ensuring the effectiveness of a behavioral act is achieved by

the work of the acceptor of the result of the action - the physiological apparatus for predicting and evaluating the achieved result. Continuous feedback about the achieved result ensures its evaluation and the effectiveness of the functional system of the behavioral act. The acceptor of the result of the action provides the possibility of correcting errors and improving the behavioral act.

The most important components of the functional system of a behavioral act are the dominant motivation, the severity of which ensures overcoming difficulties in achieving results, as well as emotions, subjective experiences of the state of the organism and its needs. The effectiveness of a purposeful behavioral act is determined by motivation and not only by avoiding negative emotions, but also by including expected positive ones in the apparatus of foresight [1–3, 5, 8–11].

**Objective of the study** was to evaluate the effectiveness of students entering a specialized university faculty (SF), taking into account their motivation for future professional activities.

**Table 1.** *Research data*

Indicators	Results	A 3 <sup>rd</sup> year	B 2 <sup>nd</sup> year	C 3 <sup>rd</sup> year	D 2 <sup>nd</sup> year	E 2 <sup>nd</sup> year
Number of students	Admitted	44	32	33	27	34
	Not admitted	14	17	5	17	28
Average mark	Admitted	4.818	4.844	4.828	4.773	4.833
	Not admitted	4.806	4.698	4.582	4.760	4.716
Test score	Admitted	21.06	20.71	18.69	20.60	21.18
	Not admitted	17.35	15.39	11.76	15.12	15.20
Interlocution score	Admitted	4.855	4.778	4.600	4.489	4.615
	Not admitted	4.386	4.529	4.542	4.024	4.290

**Methods and structure of the study.** The study was carried out on the basis of the results of the competitive selection of 251 students for a specialized faculty for the period from 1996 to 2000. To choose the best students among the most motivated to succeed in future scientific research, only students of 2<sup>nd</sup> and 3<sup>rd</sup> years of specialised Russian universities who achieved high academic results were allowed in the competition: the average marks of aforetime examinations ranged from 5.0 to 4.5. The entrance examinations consisted of three stages: the examination test (MCQs), the foreign language examination, and interlocution.

The tests for students who graduate the 2<sup>nd</sup> and 3<sup>rd</sup> years covered the basic disciplines of the corresponding year. The number of test questions was equal to 180, which complied with standards; one minute was allowed to answer a test question, so the testing lasted for 3 hours. The correct choices in the MCQs were placed randomly with account for the known central tendency: a human strives to avoid the extreme choices. The difficulty index was 30–70%; the discrimination index was 0.25 and greater. The test was valid, reliable, and relevant [9].

At the last stage, an academic commission estimated the students' personal creative abilities by the method of expert evaluations with the use of the following criteria: creative imagination, "outside-the-box" thinking; cultural level; inquisitiveness and overall range of interests. The results were recorded in the expert evaluation cards.

**Results of the study and their discussion.** According to the results of the entrance exams, the mean scores of the examination grades of the past sessions in the record book, the results of testing fundamental subjects and interviews were calculated (Table 1).

The obtained results reveal a higher value of the average score in the record book of students who passed the competition and were enrolled in a specialized faculty compared to students who did not pass the competition.

The construction of histograms of the distribution of the examination test score among those who entered and those who did not enter revealed the absence of a normal distribution in the samples. The size of the samples themselves is small. For these reasons, the contingency analysis of features was carried out using Fisher's exact test, a nonparametric test of statistical significance used in the analysis of contingency tables for small samples with variables whose distribution is unknown [10, 11].

A significant difference in the average scores of the test exam among admitted and not admitted students was revealed. Consider the admission of students of the 2<sup>nd</sup> year in 1997: the average score of the test exam is 18.87, a total of 49 people, of which 32 passed the competition, and 17 did not enter.

The number of points scored in the examination test shows the level of knowledge of the student in fundamental disciplines, his intellectual readiness, and thus reflects the level of his learning motivation. Processing showed a significant difference in

**Table 2.** *Contingency table for test examination*

Indicator	Admitted	Not admitted
The score is smaller than the average	3	16
The score is equal or greater than the average	29	1

**Table 3.** Contingency table for interlocution

Indicators	Admitted	Not admitted
Score is smaller than the average	7	8
Score is equal or greater than the average	25	9

the average scores of the examination test between those who entered and those who did not enter the specialized faculty: the average test score of the enrolled students significantly exceeded the average test score of those who did not enter. Thus, the level of motivation, reflected by the average test score, turned out to be significantly higher in the group of admitted students.

Let's build a four-digit contingency table of features (Table 2) "the test exam score is greater than or equal to the average test exam score" and "admission".

Fisher's exact test for this table yields  $p \approx 4.5 \times 10^{-9}$ , strongly rejecting the hypothesis that these features were unrelated. In other words, a student who was most motivated to carry out scientific research and hence got a higher test score had a greater chance to join the SD.

As concerns the interlocution scores characterising the personal creative abilities, a detectable difference between those groups also manifested itself: the students who passed the competition and were admitted to the SF had a higher interlocution average score than those who did not get in. So the degree of expressiveness of personal creative abilities required for a successive researching, which was estimated by interlocution average score, appeared to be markedly higher in the group of admitted students.

The contingency table for the features "the interlocution score is equal or greater than the interlocution average score" and "admittance" is given in Table 3:

The value of Fisher's exact test  $p \approx 5.2 \times 10^{-2}$  does not allow us to reject the hypothesis of independence of these features. It is known that all incoming students belong to the category of motivated and have high grades, thus, the associative analysis of the interview results revealed the presence of personality abilities necessary for creative research work, inherent in the entire group of applicants. In other words, the sample of studied students is obviously biased in the sense that all incoming students have a close and high level of creative abilities according to the results of the interview. At the same time, the sample size for the analysis of the contingency of features allows us to apply the Pearson  $\chi^2$  criterion [4, 6], which has an asymptotic character; the resulting conclusions remain unchanged.

**Conclusions.** On the basis of the data obtained on dependence between admittance and the average MCQ test scores on fundamental courses, the significance of the learning motivation for entering the SF was stated. This dependence is supported by the fact that the 2<sup>nd</sup> year students who had not admitted tried to enter the SF again next year, which reflects the strength of emotionally-charged motivation to learn advanced knowledges and techniques.

Thus, the dominant motivation, which reflects the students' intellectual background and success in learning fundamental knowledges, holds the leading position in successfulness of entering to the specialised research department. At the same time, student's personal creative ability is an important but independent characteristic.

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# Physical training of highly qualified paracanoeists in a year macrocycle

UDC 96.015



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## Abstract

**Objective of the study** was to scientifically substantiate the content of the physical training of highly qualified paracanoeists in a one-year macrocycle and evaluate the effectiveness of its use in the training process.

**Methods and structure of the study.** The experiment involved 9 highly skilled paracanoe athletes classified as LTA-IVF according to the ICF classification. The content of the physical training of athletes of this category is structured with the allocation of three stages that differ from each other in tasks, organization, goals, content of methodological techniques and a set of actions, means that determine the mechanisms for their use to achieve the highest possible sports results of highly qualified paracanoeists.

**Results and conclusions.** It was determined that the content of physical training with the allocation of three successively implemented stages of highly qualified paracanoeists in the annual macrocycle contributed to the increase in the level of physical fitness of athletes in this category, as well as to improve their competitive results.

**Keywords:** *physical training, highly qualified paracanoeists, competitive activity, competitive result.*

**Introduction.** The physical training of highly qualified rowers with lesions of the musculoskeletal system is constantly present in practice, as in paracanoe, regardless of whether the training process is aimed at improving technical techniques, performing tactical actions or at forming mental qualities through various techniques at any intensity can not be on its own without doing exercise. When preparing highly qualified paracanoe rowers, there is a significant predominance of special physical training over general, and an insufficient reserve of the level of general physical fitness does not provide an opportunity to improve sports results [3]. Thus, athletes with amputation of the lower extremities have lesions of the central nervous system, which is accompanied by sensory, motor and vegetative dysfunction, while at the same time, aerobic productivity and overall performance are reduced [1, 4]. These features served as the basis for the research work on the study of the content of the physical training of highly qualified paracanoeists.

**Objective of the study** was to scientifically substantiate the content of the physical training of highly qualified paracanoeists in a one-year macrocycle and evaluate the effectiveness of its use in the training process.

**Methods and structure of the study.** The pedagogical experiment was carried out on the basis of the public regional organization "Regional Sports Federation of Kayaking and Canoeing of the Leningrad Region". The experiment involved 9 highly qualified paracanoe athletes classified as LTA-IVF (ICF classification), who are members of the Russian national paracanoe team and members of the Leningrad Region national team.

To assess the effectiveness of the content of physical training of highly qualified paracanoeists in the annual macrocycle, pedagogical testing of physical fitness, the functional state of athletes was carried out, the dynamics of the competitive activity of paracanoe rowers was assessed over the period of the pedagogical experiment.



**Results of the study and their discussion.** The content of the physical training of highly qualified paracanoeists with amputations of the lower extremities in the annual cycle implies a phased construction.

At the first stage (general preparatory), the main direction of training is the predominant increase in compensatory capabilities for performing specific work in parkano and the increase in the state of the main functional systems that ensure successful specialization in the aftermath. This stage includes retracting and basic mesocycles. A variety of means and methods of sports training are used for the comprehensive development of the physical abilities of paracanoe rowers: a set of corrective exercises, swimming, cross-travels, adapted sports games, strength-oriented exercises. Means of general physical training occupy 75-85%, special preparatory exercises - 10-15%, competitive exercises - 5-10% of the total training load.

At the second stage (special preparatory) training is aimed at accumulating the maximum physical potential. A functional base is formed for the successful use of the achieved physical potential in competitions, the level of special physical abilities increases with an emphasis on muscle groups that perform compensatory functions when performing specific work in paracanoe. included basic, control-preparatory and precompetitive mesocycles. The main means of training at this stage is rowing in a boat, general preparations aimed at increasing the compensatory capabilities of the musculoskeletal system occupy 50-55% of the total volume of work performed, special preparatory exercises on land - 25-30%, competitive exer-

cises for the development of leading physical abilities - 20-25%.

At the third stage (precompetitive) training is aimed at transforming the accumulated physical potential into a high sports result. The achieved level of special preparedness increases, the ability to overcome the distance in competitions with maximum speed is formed. The stage includes control-preparatory and precompetitive mesocycles. The training load is distributed strictly taking into account the timing of the competition, and methods are used that are distinguished by a strict regimen of loads and rest (interval, repeated, competitive). Means of general physical training occupy 25-30%, special preparatory exercises - 40-45%, competitive exercises - 30-35% of the total training load.

At the same time, the organizational and pedagogical conditions that contribute to the successful implementation of the content of the physical training of highly qualified paracanoeists in the annual macrocycle include the requirements for planning the process and organizing classes, and methodological recommendations for conducting classes. Analysis of the test indicators of highly qualified paracanoe athletes obtained during the formative experiment (Table 1) allowed us to identify significant ( $p < 0.05$ ) intergroup differences in tests that assess the level of speed-strength, coordination, strength and speed abilities; speed and strength endurance; general endurance, flexibility.

The results of the study presented in table. 2, indicate that the content of physical training of highly qualified paracanoeists in the annual macrocycle, implemented with the allocation of three stages, had a posi-

**Table 1.** Physical readiness of highly qualified paracanoeists ( $n = 9$ ) during the formative experiment ( $M \pm \delta$ )

Test	Background values of indicators	Indicator values at the end of the preparatory period	Values of indicators in the competitive period (the period of the main competitions)
Imitation of rowing on a rowing machine, number of strokes in 20 s	21,33±1,89	25,78±1,55*	30,33±2,36**, ***
4 paracanoe turns, s	93,81±1,66	91,14±1,41*	88,43±1,29**, ***
30 strokes, s	24,46±0,65	23,08±0,58*	21,87±0,61**, ***
Push-ups on the uneven bars, the number of times	42,22±1,99	46,56±1,95*	49,00±2,05**, ***
Barbell row lying 50% of max., number of times	86,11±3,41	93,78±3,12*	99,89±3,14**, ***
Front crawl 200 m	195,47±1,07	193,10±1,06*	190,39±1,08**, ***
Rowing 50 m, s	14,84±0,16	14,59±0,14*	14,29±0,13**, ***
"Twist", centimeters	73,92±3,94	66,07±3,79*	58,59±3,67**, ***

\* – Statistically significant differences between the background values of indicators and indicators at the end of the preparatory period ( $p < 0,05$ ); \*\* – Statistically significant differences between the values of indicators at the end of the preparatory period and indicators during the main competitions ( $p < 0,05$ ). \*\*\* – Statistically significant differences between the background values of indicators and indicators during the main competitions ( $p < 0,05$ ).



**Table 2.** Dynamics of the results of competitive activity of paracanoids during the pedagogical experiment ( $M \pm \delta$ )

No. athlete	Before the experiment (points by rating)	After the experiment (points by rating)
1	74,00	112,00
2	84,00	104,00
3	84,00	112,00
4	74,00	90,00
5	102,00	104,00
6	77,00	77,00
7	66,00	79,00
8	89,00	92,00
9	86,00	84,00
$M \pm \delta$	$81,78 \pm 9,90$	$94,89 \pm 12,80$ *

\* – Statistically significant differences between the indicators of competitive activity of paracanoids ( $p < 0,05$ );

tive impact on the dynamics of the competitive activity of athletes with lower limb amputations ( $p < 0.05$ ) [4].

**Conclusions.** The physical training of highly qualified paracanoids in the annual macrocycle, built with the allocation of three successively implemented stages, the differences of which are determined by the target settings, tasks to be solved, the content of corrective and general preparatory physical exercises, the use of methodological actions and techniques, the volume and intensity of the load, provided an increase in the physical fitness of paracanoids and had positive impact on the dynamics of their competitive activity.

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# Prospects for the development of the vfsk GTO, taking into account the monitoring data of test results

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## Abstract

**Objective of the study** was to determine the prospects for the development of the VFSK GTO, taking into account the results of monitoring the implementation of the complex in 2018-2021 on the territory of the Russian Federation.

**Methods and structure of the study.** In the course of scientific work, sources containing information on organizational and managerial, personnel, material and technical activities, physical activity of the population of the Russian Federation were studied during the implementation of the GTO complex, including the number of those who blunted and completed the tests of the complex, the level of physical fitness of the population of the Russian Federation on based on testing physical qualities and applied skills in the population from 6 to 70 years and older.

**Results and conclusions.** It has been established that the results of monitoring the implementation of the GTO complex for 2018-2021 show a positive trend in the number of people who started (24.2%) and completed the tests (34.9%), with the exception of 2020, in which there is a decline in all indicators. A two-fold increase in the number of those who completed the tests for insignia in 2021 was revealed, an increase in the number of children aged 6-12 years who completed the tests of the complex was recorded up to 15%, with a clear predominance of adolescents aged 16-17 years (34%) and a steady decrease in the number of adults as aging (up to 3.4% in stage XI). Analysis of the results of organizational and managerial activities for the preparation and evaluation of compliance with the test standards of the complex in the constituent entities of the Russian Federation testifies to the formed model of organizational activity and ensuring the process of implementing the GTO complex by testing centers.

The presented proposals for improving the GTO complex are aimed at optimizing state requirements related to the progressive development of standards in accordance with the current level of physical fitness of the population from 6 to 70 years and older and the industry development targets.

**Keywords:** *monitoring, level of physical fitness, those who started, completed, tests of the GTO complex.*

**Introduction.** The revival of the GTO complex and its integration into the domestic system of physical education has created an actual social order for the integration of scientific knowledge. The modern vector of the development of the motor activity of the population involves the formation of knowledge that generalizes the physiological, biomechanical, pedagogical and socio-psychological approaches to the development of state requirements of the VFSK GTO. The normatively approved frequency of improving the state requirements of the GTO complex is determined by: modernization of the state policy in the field of physical culture and sports every four years; the changing level of physical fitness of the population; the accumulated array of scientific data on the

ranges of motor activity and the level of physical fitness [2].

To identify the above factors, the Ministry of Sports of Russia has developed and implemented a nationwide system for monitoring, analyzing, evaluating and predicting the state of physical fitness of the population based on annual monitoring of the 2-GTO, which allows you to receive information in a timely manner for making informed management decisions, to determine stage and long-term measures to prevent and eliminate negative trends, contribute to the development of measures to improve the VFSK GTO. Consolidation of statistical information, methodological and scientific databases formed the basis for the development of the progressive development of the GTO com-



plex for the next four-year period, taking into account the implementation and synchronization of the targets of the national project "Demography" and the federal project "Sport is the norm of life" and further improvement of the system of physical education of the population Russian Federation [1, 4].

**Objective of the study** was to determine the prospects for the development of the VFSK GTO, taking into account the results of monitoring the implementation of the complex in 2018-2021 on the territory of the Russian Federation.

**Methods and structure of the study.** In the course of the study, sources containing information on organizational and managerial, personnel, material and technical activities, physical activity of the population of the Russian Federation were studied during the implementation of the GTO complex, including the number of those who blunted and completed the tests of the complex, the level of physical fitness of the population of the Russian Federation based on testing physical qualities and applied skills in the population from 6 to 70 years and older.

**Results of the study and their discussion.** The ongoing longitudinal study of the population level of development of physical fitness of the population of the Russian Federation showed that from September 1, 2014 to January 1, 2022 (inclusive) 18,201,857 Russians were registered and have personal accounts of participants on the Internet portal of the GTO complex, which out of the total of the population older than 6 years is 12.3%.

Obtained indicators in the period from 2018 to

2021 indicate a positive trend in the number of people who started testing (by 24.2% by 2021), with the exception of 2020, in which epidemiological restrictions were introduced throughout the country. At the same time, the proportion of the population from 6 to 24 years old and from 25 years of age and older who started the tests is in the same range, changing insignificantly, which is presented in Table 1.

The number of those who completed the tests of the GTO complex in this period amounted to about 5 million people (of which, on average, 83.6% of the population is from 6 to 24 years old and 16.4% of the total number of people aged 25 years and older of the total number of people who completed the tests of the complex), increasing to 2021 by 34.9% of the GTO.

There is a positive trend in the number of those who completed the tests for insignia: for gold from 15.9% to 33.4%, for silver - from 17.3% to 34.4%, for bronze - from 15.2% to 32.1%. In 2021, the greatest effectiveness of the implementation of the GTO complex is observed, the activity of the population returned to the pre-pandemic level and exceeded it by 13.6% in people with a high level of physical fitness, by 12.4% with an average level and by 13.5% with a base level corresponding to the bronze badge of the GTO. In 2020, the period of the pandemic, there is a decline in this indicator for all insignia (Table 3) [3].

Quite a lot of activity in fulfilling the regulatory requirements for testing the GTO complex is shown by primary school students from grades I to III (age from 6 to 12 years old), where the majority fulfill the standards for a silver badge (an average of 42.7%). Adoles-

**Table 1.** The total number of the population of the Russian Federation from 6 to 70 years old and older who started testing the GTO complex

Year	Number of people started to the test from I to XI steps	Number of people started to the test from I to VI (1) steps	%	Number of people started to the test from VI (2) to XI steps	%
2018	2050019	1685770	82,2	364247	17,8
2019	2598226	2143595	82,5	454629	17,5
2020	1966578	1539909	79,2	426669	21,7
2021	2704711	2235823	82,7	468891	17,3
Total	9297314	7605097	81,8	1714436	18,4

**Table 2.** The total number of the population of the Russian Federation from 6 to 70 years and older who completed the tests of the GTO complex in the period from 2018 to 2021

Year	Number of people who completed the tests I to XI steps	Number of people who completed the tests from I to VI (1) steps	%	Number of people who completed the tests from VI(2) to XI steps	%
2018	973798	798016	81,9	175794	18,1
2019	1543884	1330427	86,2	213450	13,8
2020	902737	720151	79,8	182580	20,2
2021	1496124	1261637	84,3	234490	15,7
Total	4916543	4110231	83,6	806314	16,4



**Table 3.** The ratio of the effectiveness of the implementation of the standards of the GTO complex by difficulty levels (for gold, silver and bronze badges) by the population of the Russian Federation from 6 to 70 years and older

Year	Number of people who started for the performance of GTO tests (persons)	The number of those who completed the tests of the GTO complex by insignia, % of the total number of those who started testing the GTO (persons /%)					
		Golden badge		Silver badge		Bronze badge	
		Number of completed	%	Number of completed	%	Number of completed	%
2018	2050019	308711	15,1	353728	17,3	311359	15,2
2019	2598226	514832	19,8	544750	21,0	484299	18,6
2020	1944358	319491	16,4	298413	15,3	284827	14,6
2021	2704711	499802	33,4	515494	34,4	480726	32,1

cents aged 16-17 years (stage V) are the largest group that performs tests of the GTO complex for a gold badge (an average of 53.8%). Participants from 18 to 49 years old (VI-VIII stages) show instability - in 2019, the majority fulfilled the standards of the GTO complex for a gold badge 41.4%, in 2018 and 2020. the bronze sign prevailed 35.9 and 37.5%, respectively. In grades IX-XI (ages 50 and older), there is an annual decrease in the number of those who completed the tests for the golden badge of distinction from 46.6 to 38.1% and an increase in the number of participants who received silver and bronze badges of distinction.

Thus, a comparative analysis of data on the implementation of the regulatory and testing part of the VFSK GTO by the population of the Russian Federation from 6 to 70 years and older (stages I-XI) for 2018-2021 showed that children, adolescents and youth up to 24 years old (I-VI (2) stages) make up the bulk of the participants who have fulfilled the state requirements for a badge of distinction (83.6% on average), thereby highlighting work with the adult population as a priority for all participants in the process (public authorities, sports organizations, etc.).

The evidence-based proposals for improving the state requirements of the VFSK GTO were based on the results of many years of scientific research, the results of a survey and questioning of specialists from 72 regions of the Russian Federation, universities subordinate to the Ministry of Sports, experts in the field of physical culture and sports (total 695 people).

Taking into account the need to synchronize with the form of statistical accounting 1- GTO and 2- GTO on citizens of various gender and age groups systematically involved in sports, it is proposed to increase the number of age levels of the GTO complex from 11 to 18: from 6 to 19 years, it is proposed to divide the age levels in the interval of two years; in the adult population (20 years and older) - reduce the step of age steps to 5 years.

Based on the data obtained in the course of monitoring the implementation of the GTO complex, a population study of the physical fitness of the population from 6 to 70 years old, taking into account sensitive periods of development and mathematical modeling, is proposed in the new state requirements of the GTO complex to adjust upwards the standard of the gold sign by 1.5%, silver sign - by 2%, while reducing the standards of the bronze sign by 1.5%, which will contribute to the progressive development of the level of physical fitness of the population and expand the coverage of the population with physical culture and sports services. The reduction of the bronze standard, with their simultaneous balance in terms of the importance of possession, and the possibility of obtaining additional points for the Unified State Examination and other preferences for the adult population, will expand the coverage of the population with the GTO complex, increase the demand for this level of physical fitness for all categories of citizens.

It is necessary to regroup tests in the structure of state requirements for basic physical qualities (speed, flexibility, agility, strength, endurance) and applied skills, more clearly reflecting the principle of harmonious development underlying the GTO complex. The proposed approach reduces the number of tests required to perform from four to six trials.

**Conclusions.** The results of monitoring the implementation of the GTO complex for 2018-2021 show a positive trend in the number of people who started (24.2%) and completed the tests (34.9%), with the exception of 2020, in which there is a decline in all indicators. A two-fold increase in the number of those who completed the tests for insignia in 2021 was revealed, an increase in the number of children aged 6-12 years who completed the tests of the complex was recorded up to 15%, with a clear predominance of adolescents aged 16-17 years (34%) and a steady decrease in the number of adults as aging (up to 3.4% in stage XI).



Analysis of the results of organizational and managerial activities for the preparation and evaluation of compliance with the test standards of the complex in the constituent entities of the Russian Federation testifies to the formed model of organizational activity and ensuring the process of implementing the GTO complex by testing centers.

The presented proposals for improving the GTO complex are aimed at optimizing state requirements related to the progressive development of standards in accordance with the current level of physical fitness of the population from 6 to 70 years and older, and the industry development targets.

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# Functioning model of the GTO testing center on the basis of a pedagogical university

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## Abstract

**Objective of the study** was the theoretical and methodological substantiation of the functioning model of the GTO Testing Center on the basis of a pedagogical university (hereinafter referred to as the Center).

**Methods and structure of the study.** Carried out: study of normative and program documents; analysis of scientific and methodological works, empirical material on the activities of the Center; modeling.

**Results and conclusions.** On the basis of the provisions of the system, activity, personality-oriented approaches, a model for the functioning of the GTO Testing Center has been developed; substantiated the multi-level structure and nature of the relationship in the process of organizing the activities of the Center, shows the effectiveness of solving the main tasks of attracting students, various groups of the population to the implementation of the GTO standards, the development of mass physical culture and student sports.

**Keywords:** *physical education, All-Russian physical culture and sports complex "Ready for work and defense", physical education, student youth, model, Center.*

**Introduction.** Since the introduction of the All-Russian physical culture and sports complex "Ready for Labor and Defense" (hereinafter referred to as the VFSK GTO), as a program and regulatory basis for the physical education of the population of the Russian Federation, special attention has been paid to solving organizational and methodological issues for the introduction and implementation of these activities, the creation of testing centers and providing conditions for their effective functioning [6, 7].

GTO testing centers created on the basis of educational organizations, in addition to solving the main tasks of attracting students, students, various groups of the population to the implementation of the GTO standards, organizing advisory and methodological assistance in the preparation process, should become a tool for increasing the level of physical activity of students and workers education systems; ensure the transition to a higher quality level of the process of physical education in the university.

To date, there is still a tendency towards a decrease in the health level of students, low attendance at compulsory physical education classes, insufficient awareness of students about the VFSK GTO and the lack of motivation for most students to participate in program events [1, 3, 4, 8]. The problem of increasing the level of physical activity of students based on the search for effective ways to promote the activities of the VFSK GTO in the university requires its solution.

**Objective of the study** was the theoretical and methodological substantiation of the functioning model of the GTO Testing Center on the basis of a pedagogical university.

**Methods and structure of the study.** Carried out: study of normative and program documents; analysis of scientific and methodological works, empirical material on the activities of the "Center"; modeling.

Since February 2020, on the basis of the Ulyanovsk State University of Education named after I.N. Ulyanov, the GTO Testing Center operates. The success

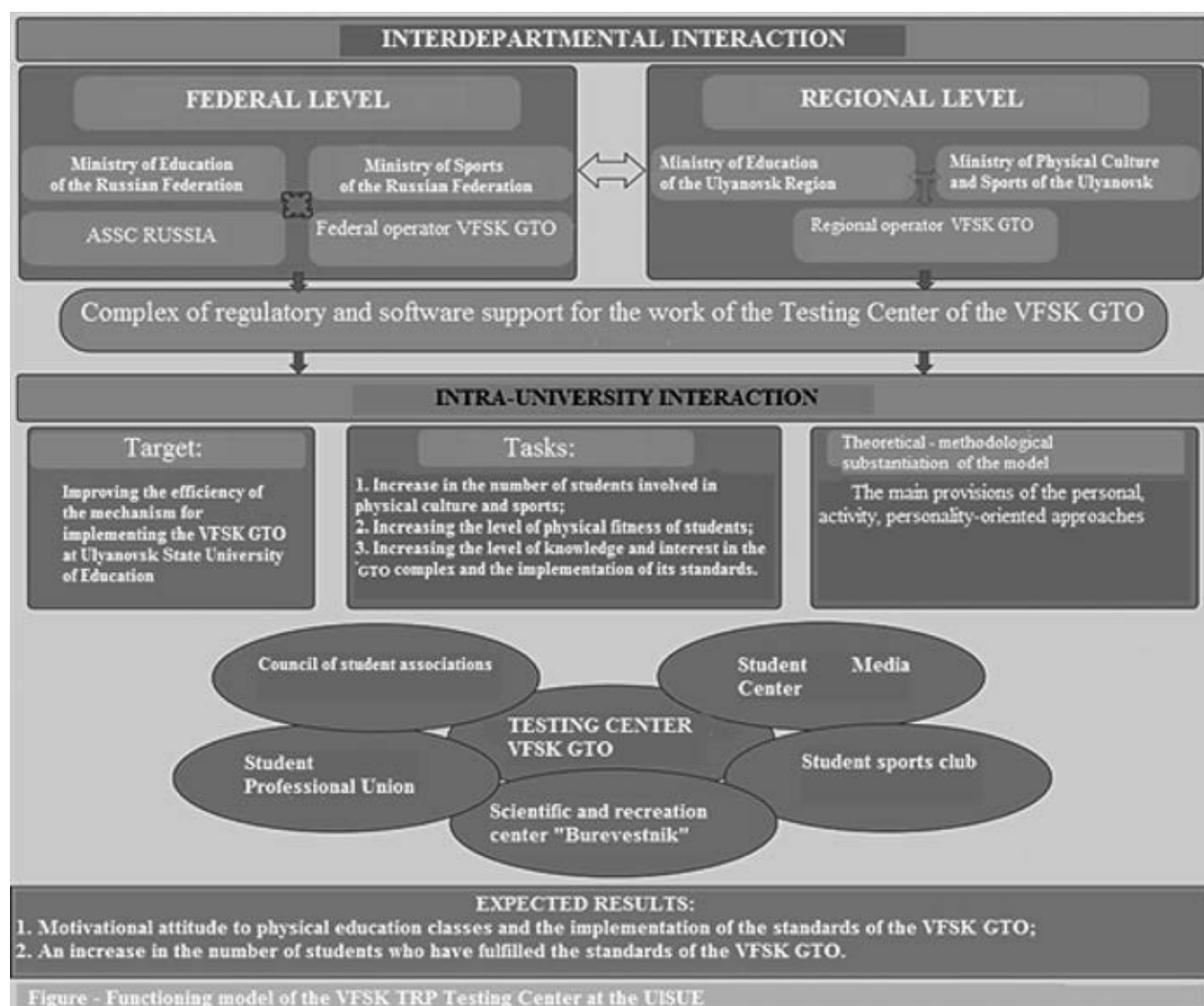


of the "Center" in promoting the program activities of the GTO in the student environment is due to the organization of effective interaction of all subjects (on the one hand, leaders, physical education teachers, athletes, students, volunteers, etc.; on the other hand, education, physical culture management bodies of the federal, regional level and structural subdivisions of the Pedagogical University). In the period from September 2021 to the present, more than 1200 people took part in the implementation of the standards of the GTO complex, among them most of the student youth aged 18 to 24 years, the rest refers to the population of the city of Ulyanovsk aged 6 to 65 years.

**Results of the study and their discussion.** The development and implementation of the structural and functional model of the Center's activities based on the key methodological provisions of the systemic approach, personality-activity, personality-oriented approaches will make it possible to achieve the

planned target indicators in the field of mass physical culture development, popularization of the GTO among the students [5]. From the provisions of a systematic approach, the activities of the Center should be considered as a process of multi-level organizational interaction of various elements in the structure of the phased implementation of complex measures of various directions to promote the VFSK GTO in the university.

The process of physical education in the university, various forms of its implementation (educational, extracurricular and independent activities) are presented in the model as a purposeful physical culture and sports activity related to the preparation for the implementation of the test standards of the VFSK GTO, taking into account individual characteristics, motives and needs of students; the opportunity to participate in the outreach, educational activities of the Center. In the structure of the functioning model of the Center,





three basic levels are distinguished: federal, regional, university.

The federal level includes state authorities for education, physical culture and sports (the Ministry of Education of the Russian Federation, the Ministry of Sports, the Federal Operator of the VFSK GTO, the Association of Student Sports Clubs of Russia, hereinafter ASSCR); the regional level is represented by the Ministry of Education and Education of the Ulyanovsk Region, the Ministry of Sports of the Ulyanovsk Region, the regional branch of the ASSCR, the Regional Operator of the VFSK GTO.

Together, the interaction of federal and regional authorities ensures the development of a set of regulatory and program support for the work of the GTO Testing Center (see figure). The activities of the Center at the university level cover almost all structural divisions of the Ulyanovsk State University of Education named after I.N. Ulyanov, associated with educational, physical culture and health, sports work.

The work of the Center is built in cooperation with the Regional Operator VFSK GTO. This includes not only the participation of university students in regional sports events, but also participation in their organization by the Center's specialists themselves. For 2021-2022 17 judges were trained from among the students and teachers of the Faculty of Physical Culture and Sports, who took part in serving 19 events of the regional and all-Russian level held in the Ulyanovsk region.

The most important result of working with the regional operator and the Ministry of Physical Culture and Sports was the inclusion of the GTO All-Around as one of the types of the annual regional Universiade.

Most of the events held by the Center together with the student sports club (hereinafter referred to as the SSC) are held under the auspices of the ASSCR, which manages not only the development of student sports, but also the promotion of the GTO complex in universities through the implementation of such projects as "Studzachet", "Around sports".

The interaction of the Center and teachers of the Faculty of Physical Culture and Sports is built as a joint activity to achieve one of the target indicators of the Faculty Development Program until 2025 - "an increase in the proportion of students who have completed the tests of the VFSK GTO in the total number of full-time students." In order to achieve this indicator, the specialists of the Center have developed a point-rating system that provides students with the oppor-

tunity to receive additional points in the discipline "Physical Education" for participating in sports events held by the Center together with the SSC; allowing students to resolve issues with absenteeism and motivating them to more actively participate in these activities. Also, the Department of Sports Disciplines and Physical Education decided to count the results of the GTO all-around competitions in the framework of festivals and other sports events as the fulfillment of identical educational standards in the discipline of physical culture to obtain the final standings.

The interaction of the Center with the Student Media Center is based on the provision of mutual information assistance in the form of current news, announcements and results of actions and events, which makes it possible for a larger audience to get acquainted with the activities of the Center.

The student trade union organization acts as a partner and sponsor of award paraphernalia for students who take part in the events of the VFSK GTO. The Council of Student Associations presents at its events a base for the promotional sites of the Center, providing recognition of the GTO complex, visibility of the work of the Center's employees. Most often, such sites are types of tests in which you can participate and get some kind of valuable prize. Of great attraction is the electronic shooting range, where students can compete in shooting accuracy.

The Burevestnik Research and Health Center has a swimming pool, which provides the opportunity to prepare for swimming tests under the guidance of experienced instructors for both students (free of charge) and the public. The specialists of the Center, according to the contract-agreement, conduct swimming tests on a regular basis. The well-established interaction of the SSC "SPARTA" and the Center has already brought quite serious results in the implementation of the GTO complex not only among the students of the university, but also among the residents of Ulyanovsk. This is evidenced by a large number of sports events and promotions aimed at the adoption of standards, general statistics of the most important indicators of the federal operator [3].

The most important component of the attractiveness of the VFSK GTO program is its correct positioning. One of the activities of the Center is the promotion of the VFSK GTO in modern formats for young people. As successful promotional projects of the Center, one can name the work of the GTO - sites within the framework of the open day of student associations of UISUE



(09/05/2022) and the Day of the city of Ulyanovsk (09/11/2022), where every willing resident of the city could test his strength in the implementation of the complex, as well as pass the standards. The emphasis in the work of the sites was made on familiarizing the residents of the city with the GTO testing centers operating in the city, the procedure for obtaining insignia; online registration of all comers with a motivational component (participation in a lottery among those who meet the standards). The total number of people who visited the sites was more than 700, active interest was observed to a greater extent among children and youth.

Another activity of the Center is the organization and holding on the basis of the university qualifying stages for the formation of national teams in order to participate in the regional and all-Russian stages of the VFSK GTO festival among university teams, holding the all-around GTO as part of the first-year spartakiad or the annual spartakiad of students, which are held jointly with the student sports university club and with the support of the teaching staff of the Faculty of Physical Culture and Sports.

The effectiveness of the functioning of the Center in a pedagogical university is due to the need to address the lack of targeted funding for areas of activity; high workload of sports facilities of the university, in connection with which we implemented two formats of work.

The first format is associated with the holding of sports festivals included in the calendar plan of the Center and the SSC "SPARTA", and supplementing the program of these events with a stage with testing of the GTO complex (intrauniversity stage of the VFSK GTO Festival among universities, GTO All-Around within the framework of the Spartakiad of students of UI-SUE named after I.N. Ulyanov and others). This format does not allow achieving high performance in terms of the quality of fulfilling the standards for insignia, but it allows to ensure the mass character of these events.

The second format is the organization of work according to the "schedule" within the framework of the availability of time free from the educational and training process at the university's sports facilities (track and field arena, stadium, shooting gallery, gym), which provides the opportunity to prepare, take part in tests and fulfill the regulatory requirements of the complex GTO for both students and all residents of the city.

**Conclusions.** In the course of the study, the issues of organizing the interaction of structural divisions of

the university for the implementation of the VFSK GTO complex were considered, a model for the functioning of the GTO Testing Center on the basis of a pedagogical university was developed, and the content of various areas of work of the Center with university students, various population groups was presented. The analysis of the Center's activities for the first three years testifies to the effectiveness of the developed model and allows us to identify further aspects of the strategic planning of work to promote the VFSK GTO, the development of mass physical culture and student sports.

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# Features of the influence of the factor of internal aggression on the socialization of athletes after the completion of the career

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## Abstract

**Objective of the study** was to determine the level of aggressiveness of athletes of various specializations who have completed their careers as a factor in their asocialization.

**Methods and structure of the study.** 55 former athletes took part in the scientific study (2 Masters of Sports of international class, 17 Masters of Sports, 20 Candidates for Master of Sports and 16 first-class athletes). All subjects were tested according to the method of L.G. Pochebut to determine the level and direction of aggression [4]. Based on the data obtained, the correlation coefficients between the variables of aggression and the type of sports activity were determined, as well as the percentage of former athletes of various specializations with high and medium levels of aggressiveness.

**Results and conclusions.** It has been established that aggressive behavior is more characteristic of former athletes of cyclic sports. For complex coordination sports, martial arts and sports games, aggressiveness is not the dominant way of behavior in the process of achieving the goal. It is necessary to organize competent psychological support by coaches and specialists for athletes of cyclic sports, which will help reduce the likelihood of frustration phenomena in the latter throughout their career and after its completion.

**Keywords:** *level of aggressiveness, kinds of sports, asocialization of sportsmen.*

**Introduction.** In the scientific literature, psychological problems associated with the end of a sports career have been considered in sufficient detail [1, 2, 6, 8]. Despite this, the study of the subject area of social adaptation of former athletes is still relevant.

Post-sport social adaptation is the process of forming relationships with colleagues at work, with people at the household level and in personal life [2]. The basis for positive adaptation is the effective assimilation of new social and labor communication values. The main obstacle on this path can be a set of negative individual-personal qualities acquired during the previous sports experience [7]. The most destructive of them is aggression, which is generated by sports anger and is approved as an internal stimulus in the process of achieving the goal. Over time, the so-called instrumental aggression can manifest itself in the form of verbal, physical, emotional or objective hostility. This phenomenon creates the cause of conflict incompatibility between the sports character and

the need for a positive adaptation to life after the end of a sports career.

Sports anger as an object of psychological transfer can provoke cognitive dissonance in relationships with work colleagues or family members [6]. The so-called psychological transfer looks like an attempt on reality and is the cause of the destruction of socialization to the detriment of oneself and the people around.

**Objective of the study** was to determine the level of aggressiveness of athletes of various specializations who have completed their careers as a factor in their asocialization.

**Methods and structure of the study.** In the course of the scientific study, psychological testing was carried out according to the method of L.G. Pochebut to determine the level and direction of aggression [4]. The experimental group included 55 athletes (2 Masters of Sports of international class, 17 Masters of Sports, 20 Candidates for Master of Sports and 16 first-class athletes). Testing the hypothesis



about the presence of a relationship between the variables of aggression and the type of sports activity was carried out on the basis of the correlation coefficient of two-dimensional descriptive statistics for a quantitative measure of interaction.

**Results of the study and their discussion.** Analytical data processing revealed some regularities. First, the features of sports activity are characterized by a certain interaction with aggression. Moreover, the magnitude of the interaction of variables depends on the direction of aggressive manifestations. The average value of the correlation coefficient between the variables for the classification of sports with verbal and physical aggression (0.6) was found. At the same time, a weak connection with emotional (0.4) and a very weak one with objective aggression was revealed. The weak relationship between indicators of emotional and object aggression with sports indicates that this group of data is included in the complex of interaction under the influence of the shadow factor, which is not identified, but its obvious influence excludes randomness at the level of a very weak correlation dependence.

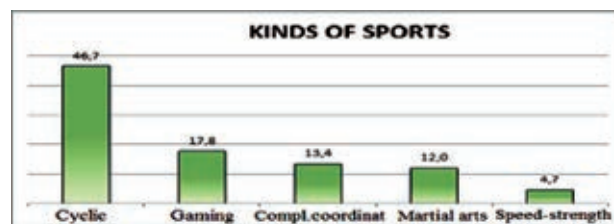
At the next stage of processing the results, an average and high rate of aggression was revealed in former athletes by sports. To distribute them into groups, the following classification was used [3]:

1. Cyclic sports.
2. Complicated coordination sports.
3. Martial arts.
4. Sports games.
5. Speed-strength sports.

The data obtained are presented in the table. They are expressed as a percentage of the number in the group of representatives of one of the sports.

Analyzing the results, it can be noted that the aggressiveness of former athletes from various sports is subject to a certain logic. The leaders in all types of aggression are athletes of cyclic sports. 46.7% of respondents from this group have medium and high levels of hostility. This type of behavior is used by 17.8% of representatives of team sports, 13.4% of complicated coordination sports and 12% of martial arts. Interesting is the fact that athletes of complex coordination sports completely lack physical and emotional

aggression. At the same time, 23% of the surveyed representatives of martial arts and complex coordination sports are ready to solve their problems with the use of physical force (see figure).



*Number of ex-athletes (%) with high and medium levels of aggression*

Thus, it can be assumed that cyclic sports have a greater influence on the social maladjustment of athletes. Many kilometers and many circles overcome form a peremptory character that does not accept compromises. The lack of communication with rivals during training and competition, as well as the narrowness of the goal at the "overtake or run" level, create conditions for limited thinking. The absence of any kind of communication with rivals, isolation in oneself, the exclusion of aesthetic and creative activity during the competitive struggle for the coveted medal creates the danger of raising aggression to the rank of the main way of behavior. Without proper psychological support, athletes of cyclic sports are very likely to lose the opportunity to gain positive experience for socialization.

**Conclusions.** Based on the analysis of experimental data, it can be argued that aggressive behavior is more characteristic of athletes in cyclic sports.

The absence of any kind of communication with rivals, isolation in oneself, the exclusion of aesthetic and creative activity during the competitive struggle is one of the main reasons for negative socialization.

In complex coordination sports, martial arts and sports games, aggressiveness is not the dominant way of behavior in the process of achieving the goal.

Competent psychological support will help reduce the likelihood of frustration in athletes of cyclic sports after the end of their career.

*Percentage of former athletes with high and medium levels of aggression of various kinds*

Kinds aggression	Kinds of sports				
	Cyclic	Gaming	Complicated coordination	Martial arts	Speed-strength
Verbal	43,8	18,8	12,5	12,5	6,3
Physical	38,5	15,4	23,1	23,1	0,0
Emotional	54,5	18,2	18,2	0,0	0,0
Subject	50,0	18,8	0,0	12,5	12,5
$\mu$	46,7	17,8	13,5	12,0	4,7



Additional educational information on social adaptation in the education system of future coaches of cyclic sports will reduce the degree of asociality of athletes after the end of their careers.

The supremacy of psychological support of social orientation over victorious affirmation will help to form social tolerance among athletes of cyclic sports as a way of liberation from aggression.

**Practical recommendations.** An important component of the training of athletes in cyclic sports is the issue of acquiring positive social experience. One of the methods for solving the problem is the expansion of socially oriented activities: the assimilation of social roles, behavior patterns and positive social values.

To achieve this goal, three tasks must be solved:

- Diagnostics to assess the level of social adaptation of an athlete.
- Psychological training in the form of imitation of the right decisions when interacting with teammates and opponents.
- Consolidation of the behavioral ability to show tolerance, elevating the value of surrounding people, regardless of sports qualifications.

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