

# Integral assessment of the functional status for individualization of sports reserve training

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*Abstract. The purpose of the study was to develop and implement an integrated assessment of the functional fitness of athletes in the training process. Materials and methods. The study was conducted on the premises of the Olympic Sports Research Institute of the Ural State University of Physical Education. Athletes of cyclic sports aged 16-20 years (sports qualification: first rank, CMS, MS) participated in the study. For three years, we studied the parameters of the functional status of athletes at different stages of the annual training cycle. A number of studies was carried out, including an assessment of physical performance, the cardiovascular system, vegetative status, the activity of neurovegetative regulation of the cardiovascular system at rest and under exercise (active orthostatic test). Results. To clarify the contribution of the studied indicators to functional preparedness, a correlation analysis was carried out, which revealed the priority of indicators included in the integrated assessment scale. The introduction of an integrated assessment in training resulted in an increase in the number of athletes with an optimal level of functionality and an increase in sports performance. Conclusion. The presented approach to assessing functional abilities has proved its efficiency in the management of sports training.*

*Keywords: integral assessment, functional fitness, aerobic power, aerobic performance, anaerobic power, type of blood circulation, vegetative balance.*

## I. INTRODUCTION

In modern sports, the development of informative criteria for assessing the functional abilities of the body at the premorbid stage is a factor that directly affects the efficiency of the training process [6]. At the same time, the need to improve the methodology for evaluating indicators that serve as adaptation criteria is well-reasoned. The correct selection of means and methods of control allows obtaining objective information about the health status and the level of preparedness in athletes. Diagnostics of the functional status is the basis for timely and effective corrective measures,

differentiated in terms of identified deviations in homeostasis under the influence of loads of various intensities [10; 13]. This makes the planning, forecasting and modeling process effective both in long-term (macrocycles) and in short-term (periods, stages, meso- and microcycles) preparation cycles [5; 14]. Based on the results of functional diagnostics, it is possible to identify the phases of acquiring, maintaining and temporarily losing physical fitness in athletes, which is the key task of the coach and athlete for achieving better sports results in the main competitions of the season [9].

Structural and functional changes in the athlete's body depend on the type of physical activity, which forms the optimal "model of the functional system" [8]. However, fundamentally different adaptation mechanisms in athletes of cyclic sports, sprinters and styers, require the search for criteria for evaluating the "model functional" features of the body systems.

## II. MATERIALS AND METHODS

The studies were conducted at the Olympic Sports Research Institute of the Ural State University of Physical Education. The research involved male athletes aged 16-20 years (n = 128) from the sports reserve of the national teams of the Chelyabinsk region. The training experience of athletes was more than 5 years, sports qualifications: first rank, candidates for masters of sports, masters of sports.

For three years (2017-2019), we studied the indicators of the functional status of athletes from cyclic sports (athletics, speed skating) specializing in long- and middle-distance running. Each year, control measurements were carried out at different stages of the annual training cycle.

The measurements included the assessment of physical performance [3], the functional status of the

cardiovascular system, vegetative status, activity of neurovegetative regulation of the cardiovascular system at rest (in supine position) and under exercise (active orthostatic test) [2; 7].

Hemodynamics and heart rate variability were investigated using the Centaur technological system (Microlux) [4]. This system allows simultaneously recording hemodynamic and slow-wave oscillations. The indicators of central hemodynamics were recorded using tetrapolar bioimpedance transthoracic rheography.

The study of morphological and functional indicators of the myocardium was performed by echocardiography. Echocardiographic evaluation of intracardiac structures was performed using the Unison-2-03 equipment.

To assess the physical performance of athletes the technique of B.F. Vashlyayev was used ("A way for determining (evaluating) physical performance by the dynamics of the ratio of the minute volume of respiration to the power of an increasing load" (Rospatent No. 2442797) [11].

**III. RESULTS AND DISCUSSION**

As a result of a 3-year monitoring of the functional status of athletes, the contribution of various indicators determining the level of their functional fitness was determined. Correlation analysis made it possible to identify the degree of correlation between functional fitness and the indicators studied.

The presented approach makes it possible to identify pre-nosological changes in various indicators of the functional status and timely make adjustments to the training process.

If all the studied indicators of an athlete are at the optimal level, this proves high functional abilities of an athlete and the effectiveness of the training process (Table 1).

If an athlete is characterized by the indicators that belong to the transition level (prenosological changes), this situation requires adjustments to the training process with subsequent re-examination.

The low level in certain indicators of the functional status shows that the athlete requires a specialized examination with the subsequent correction measures and adjustments to the training process.

The final protocol of the integrated assessment of the athlete's functional status contains information presented in an accessible and convenient form. It is necessary to identify indicators at the transition or low level requiring further correction (Table 1).

**TABLE 1 – Functional fitness of athletes in cyclic sports and its integrated assessment**

Qualitative characteristics	Level		
	Optimal	Transition (prenosological changes)	Low (premorbid changes)
Cardiovascular system			
HR	Moderate bradycardia	Upper limits of the reference values	Pronounced tachycardia or pronounced "rigidity" of the heart rhythm
Type of blood circulation	Eukinetic	Hypokinetic	Hyperkinetic

Vegetative balance at rest	Eutonia or parasymphaticotonia, unstressed vegetative balance at rest	Eutonia, insufficient vegetative support of activity	Hypersympathicotonic reaction, excessive vegetative support
Response to the orthostatic test	Adaptive response	Adaptive response in terms of HR and blood pressure values but with significantly increased activity of the sympathetic nervous system (increased high-frequency oscillations)	Maladaptive response
ECG	Lack of ECG variants of chronic physical overstrain of the heart (CPEH)	No more than one ECG variant of CPEH	More than one ECG variant of CPEH
Echocardiography	Stability of hypertrophy and hyperfunction of the heart, the absence of "myocardial changes"	Instability of hypertrophy and hyperfunction of the heart	Instability of hypertrophy and hyperfunction of the heart, the presence of "myocardial changes"
Physical performance (middle distance)			
Maximum power of the performed load	Increase of the maximum power in dynamics (from the preparatory to the competitive period)	Stable values of the maximum power	Decrease of the maximum power in dynamics (from the preparatory to the competitive period)
Aerobic capacity	Stable high values at all stages of the experiment	Decrease of the aerobic process from the preparatory to the competitive period	Pronounced increase in specific respiratory volume under low load
Aerobic power			
Anaerobic capacity	Increase in the indicator by the competitive period	Stability of the indicator from the preparatory to the competitive period	
Anaerobic power	Increase in the indicator by the competitive period		
Aerobic performance	High (7.0 c.u. or less)	Reduced (more than 7.0 c.u.)	Significantly reduced (more than 10.0 c.u.)
Physical performance (long distance)			
Maximum power of the performed load	Increase of the maximum power in dynamics (from the preparatory to the competitive period)	Stable values of the maximum power	Decrease of the maximum power in dynamics (from the preparatory to the competitive period)
Aerobic capacity	Stable high values at all stages of the experiment	Decrease of the aerobic process from the preparatory to the competitive period	Pronounced increase in specific respiratory volume under low load
Aerobic power			
Anaerobic capacity	Average values of the indicator	High values of the	

Anaerobic power		indicator	
Aerobic performance	High (7.0 c.u. or less)	Reduced (more than 7.0 c.u.)	Significantly reduced (more than 10.0 c.u.)

One of the most important functional systems that limits sports achievements is the cardiovascular system. When evaluating the response to the orthostatic test, two options are possible: adaptive and maladaptive response. Adaptive response to an orthoprobe is characterized by slight changes in the minute volume of blood circulation (decreasing trend) due to a moderate increase in heart rate and a moderate decrease in contractile function (decrease in stroke volume within 30-50% and ejection fraction 10-20%), a slight increase in systolic arterial pressure (up to 20 mmHg) and diastolic blood pressure (10-15 mmHg), a moderate increase in the activity of the sympathetic nervous system (the increase of low-frequency oscillations by no more than 50%).

Maladaptive responses are characterized by a sharp increase in the number of heart contractions (more than 40 bpm) or a pronounced "rigidity" of the heart rate at a hypersympathicotonic reaction, as well as excessive or insufficient vegetative support of activity with a marked increase or decrease in systolic pressure [7].

Physical stress resulting from the irrational training and competitive loads that is most often manifested by chronic physical overstrain of the heart. Comparing ECG indicators at various stages of the training process and identifying ECG variants of CPEH allow assessing the physical fitness and health status of an athlete and optimizing the training process [13].

ECG variants of CPEH [1]:

1. Repolarization overstrain syndrome
2. T wave asymmetry syndrome
3. Diastolic overstrain syndrome
4. Arrhythmic overstrain syndrome
5. Overstrain syndrome with impaired automatism
6. Overstrain syndrome with impaired conductivity.

The perfect level of regulation (stability of the left ventricular myocardial mass index), increasing reserve capabilities (increased diastolic size of the left ventricle), a gradual increase in functionality (shortening of myocardial fibers) - all these factors characterize the stability of hypertrophy and hyperfunction of the heart in athletes and the absence of "myocardial changes."

The use of integral assessment allows assessing the functional status, paying attention to the strengths and weaknesses.

#### IV. CONCLUSION

The training process, which is based on the integrated assessment of the functional status, is expedient and effective due to the fact that:

1. The integrated assessment of the functional status provides the express information about the level of functional fitness of an athlete.
2. The introduction of an integrated assessment in the training process allows isolating the indicators of functional fitness characterized by the prenosological changes and conducting timely and directed correction of these indicators.
3. The use of an integrated assessment of the functional fitness is an effective means of managing sports training, which allows increasing the performance of athletes [13].

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