

## Methodological foundations for ensuring the stability in training athletes of various kinds of sports

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### Abstract

A unified approach to the problems of health preservation in athletes, taking into account the options for phenotyping their health and basing on the main indicators of homeostatic potential, makes it possible not only to diagnose the initial functional disorders of the organism and monitor its basic capabilities, but also maintain the current functional reserves of the athlete at the proper level. This is provided by the use of a diagnostic and recovery unit, the recovery component of which forms complex medical and biological effects: it improves central and peripheral hemodynamics and increases the energy supply of cellular structures, i.e. increases the energy supply of the athlete's organism as a whole. This is the main component of the stability in training athletes of various kinds of sports.

### Keywords

Health phenotyping, Homeostatic potential, Reserve capabilities, Energy supply, Adaptation potential, Biomedical effects

### Imprint

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### Analysis of the necessity for athletes' health preservation

Sports medicine is characterized by a high complexity of the tasks to be solved, which imposes increased requirements to the level of health of athletes demonstrating their physical and spiritual capabilities in training and competition processes. Analysis of literature, diaries of coaches and observations of sports doctors reveal the need to improve the comprehensive control of athletes' fitness. This circumstance makes it necessary to preserve the health of athletes and monitor their reserve capabilities. Achieving high sports results is ensured by overcoming the athlete's exorbitant training and competitive loads. A large number of scientific and methodological works, both domestic and foreign, are devoted to the study of professional sports, which reveal the biological, physiological, psychological, pedagogical, biomechanical, biochemical and genetic potentials. But all the works are reduced to reflecting the individual capabilities of the athlete, that does not provide a comprehensive solution to the analyzed problem [1].

### Variants of the athletes' health phenotyping

The intensity of loads in training and competitive activities requires an appropriate level of functional capabilities of the athlete's organism, but in sports theory, functional capabilities are considered as a complex constant responsible for a certain component of the organism listed above.

To present the problem as a whole, sports doctors and coaches need to remember that the athlete's health should be considered as a structure aimed at performing the necessary functions: physical activity, counteracting stress influences, complex social conditions, various conflicts, solving logical and semantic tasks, etc. If the structure is resistant to external and internal influences, then we can talk about the optimal state of athlete's health (the first variant of health phenotyping). If there are negative changes in the parameters of the organism that threaten to lose the stability of the structure, we can talk about a suboptimal state of the organism with the potential for loss of health (the second variant of health phenotyping). The structure in this case still retains its stability. The third variant of health phenotyping characterizes the transition period. This variant corresponds to the meaning of pre-existing disease.

The fourth variant of health phenotyping is characterized by the loss of structural stability in the organism with the occurrence of disease or death. The state of the athlete's organism indicated by the first three variants of phenotyping should be the subject of sports and rehabilitation medicine practice. The fourth variant belongs to the competence of clinical medicine [2].

### Homeostatic potential as a measure of the athlete's organism capabilities

When prescribing maximum physical loads to athletes, coaches and sports doctors should not forget about homeostasis, which is a relatively dynamic constancy of the internal environment and organism functions in relation to the external environment. The concepts of reliability, safety margin, level of the organism reserves, current area of homeostasis and homeostatic potential are synonymous. The organism's response to loads can vary significantly in different athletes, as well as in the same athlete, depending on their current morphofunctional state. When the homeostatic potential is large, morphofunctional reserves are expended economically, and, conversely, when the homeostatic potential is depleted, there is a pronounced intensity and time-lengthened reaction that further weakens the organism. In the first case, the "unbalance" of homeostasis is insignificant in magnitude and short in time, and vice-versa in the second case.

Therefore, homeostatic potential refers to the ability of the organism to provide, maintain and restore functioning modes after various loads. From the physiological point of view, homeostatic potential includes morphofunctional reserves, reactivity (i.e. reaction to external and internal stimuli, including stress response), current (i.e. instantaneous) value of the functional state, and resistance (rigidity) to a variety of random influences in real time. In other words, the homeostatic potential is a measure of the organism's adaptive capabilities and a measure of compensation for these capabilities, which characterize the organism's resistance to various influences at the level of physiological and functional systems. Excessive uncontrollable loads, emotional background, improper rest mode lead to a decrease in immunity, a decrease in performance indicators of the athlete and an increase in the risk of developing diseases. When these loads influence the athlete, the dynamics of his physiological and biochemical processes, a decrease

in functional activity and the disintegration of the phase characteristics of subsystems and systems of the organism at the subcellular, cellular and organ levels are observed. These processes inevitably lead to unproductive energy consumption, and, consequently, a decrease in energy reserves. The physiological component of the homeostatic potential characterizes the organism's resistance to influences at the level of indicators of the immune, cardiovascular, hormonal, and other systems [3].

Indicators of homeostatic potential allow us to integrally assess the basic, long-term reserves of the organism, but the current state of a particular individual can vary significantly depending on the degree of intensity of training, its duration, chronic stress effects, sleep deprivation, etc. Therefore, in addition to evaluating the basic reserves of the organism, it is customary to determine its current functional state.

### The role of prenosological diagnostics in assessing the functional reserves of athletes

The most sensitive to initial changes in the organism is prenosological diagnostics, the main indicators of which fully reflect the state of homeostatic potential. Deviations of physiological indicators to a greater or lesser extent from the generally accepted norms indicate the transition of the athlete's health status from optimal to suboptimal or a state of pre-existing disease. The use of physiological indicators to assess the functional state of an athlete in the mode of dynamic monitoring allows the coach and sports doctor to quickly make the right decisions.

For this purpose, we describe a proven scientifically based unit that allows us to study the rate of loss and recovery of functional reserves of an athlete and the dynamics of the energy potential of his organism according to the main indicators of homeostasis, using only domestic devices.

The unit consists of two components: diagnostic and restorative (therapeutic).

As for diagnostics, first of all, the cardiovascular system functional state is evaluated. The method is based on simultaneous recording of single lead ECG and rheogram from the ascending aorta with high accuracy of phase characteristics measurements, mathematical analysis of which provides accurate information about qualitative and quantitative changes in the state of heart and blood vessels (hardware and software unit "Cardiocode").

For example: the individual norm of blood circulation can be reflected in the cardiac index (calculated mathematically taking into account the indicators of stroke volume, heart rate, minute volume, body weight, height, body surface area). Increased CI should be considered as the initial or pronounced signs of tissue hypoxia. A decrease in CI is usually interpreted as a significant sign of heart failure. However, practice shows that quite often there is a decrease in the CI index with reference values of MV, which in most cases is not a sign of heart and vascular diseases. Its decrease shows that the blood supply to tissues does not correspond to the needs of the organism with a certain body weight and growth parameters. To normalize the CI in case of excess body weight, it will be enough to reduce it. A decrease in the CI in athletes with normal body weight indicates the need to increase the MV within normal limits, which is achieved by increasing physical activity. An increase in the frequency of reduced CI is associated with an increase in the number of athletes with "sluggish" hemodynamics due to low physical activity or complete detraining. Obtaining such data will allow the doctor to make recommendations about the need to increase physical activity. In this regard, the CI index is of particular importance in sports medicine. An increase in the CI to the upper limits of the norm or even above the norm indicates overtraining, which threatens to overstrain the heart muscle. On the contrary, a low CI index makes it possible and dictates the need to increase the degree and amount of physical activity during training [4].

Second, assessment of the adaptive state of the athlete's organism. The method is based on the study of thermoregulation in the organism associated with periodic changes in blood composition, depending on the impact of loads, which makes it possible to identify adaptive levels of functioning and assess the degree of lost functional reserves associated with indicators of the following regulatory systems: central nervous, endocrine and immune (hardware and software system Adaptolog).

For example: non-specific adaptation reaction of an athlete to physical loads and other impacts reflect the functional state of his organism as an integral system and make it possible to assess its adaptive potential.

Adaptive potential describes the adaptive state of the organism and is the combined evaluation of the adaptation level and coefficient of the functional state

reactions of the organism from low to high threshold of its reserve structure activation.

Changes occur within seven periods designated as adaptation levels. Low adaptation levels (0-1) are associated with a lack of energy for the development of full-fledged organism responses to loads. High adaptation levels (5-6) are associated with the impact of extremely high loads and excessive expenditure of energy potential on any, even very weak loads. Optimal are the average levels of adaptation (2-4), which bring the organism's structures into working condition. Knowledge of an athlete's adaptation level (his energy resource) is crucial for the training process and assessment of his condition before competitions [5].

Third, an accurate assessment of the functional state of the athlete's organs and systems of the organism in general using electropuncture diagnostics [6, 7].

### Ensuring the stability of athletes' functional reserves during training

To restore the functional reserves of the athlete's organism, we used ultra-weak (1 mT) complex magnetic fields of general impact (the "Multimag" hardware system). Such fields course application (1-2 times a year) improves central and peripheral hemodynamics and increases the energy supply of cellular structures, i.e. increases the energy supply of the athlete's organism as a whole.

The following complex medical and biological effects are formed:

- increases the level of metabolism (improves trophic tissue);
- increases the partial pressure of oxygen in the blood;
- improves blood microcirculation;
- the protective functions of the immune system are increased (innate and adaptive immunity is restored);
- the organism is detoxified;
- cell membrane stabilization (improvement of the potassium-sodium pump);
- the regeneration of cells and tissue structures is accelerated;
- observed is an improvement in the function of the gas transmission system and the mobilization of antioxidant processes.

The technical arrangement of the complex allows you to individually assign modes depending on the desired end result [8].

The system has no analogues.

## Findings:

1) the level of health of an athlete is a value determined by certain indicators of homeostasis, the main of which are indicators of the cardiovascular, immune, endocrine, and central nervous systems;

2) integral characteristics of an athlete's health are the following: morphofunctional reserves, reactivity, stress resistance, adaptation abilities, individual properties of regulation and compensation of the organism;

3) the integral characteristics of health under the influence of various exo and endo factors are not a constant value, which is reflected by the organism's transitions from one adaptation level to another;

4) the main principles in measures to restore the athlete's health are to increase the energy supply of his organism as a whole, improve peripheral and central hemodynamics, restore and maintain its functional reserves.

## Conclusions

An integrated approach to the study and restoration of functional reserves of the athletes' organism makes it possible to improve the comprehensive control of their fitness. Innovative technologies presented by the instrumental methods of the present article allow the sports doctor not only to evaluate the functional capabilities of athletes, analyze their results and get a higher level of information about the complex state of the athlete and his readiness to participate in training and competitive processes, but also to restore his potential [9,10].

To assess the stability of reducing the physiological reserves of the athlete's organism, it is necessary to take into account the schedules of competitions, training camps, daily training modes and rest schedules. The minimum energy potential is usually observed 6-7 months after the vacation, and in conditions when the daily training process is on the verge of the energy potential of athletes, the coaches and experts working with them need prompt and simple control of how the organism of their charges reacts to loads [11].

Helping the coach to calculate physical activity, assess the recovery time of the organism after rest, and the sports doctor to diagnose at the initial stage of the occurrence of functional disorders of the organism, the system provides for the prevention and restoration of formed pathological processes.

The versatility of the system should be noted, it can be used in both cyclic and acyclic (including

game) kinds of sports. Minimal equipment, easy to use, large carrying capacity, reliability and informative value in the assessment of the functional state of an athlete, necessitates the use of the system in sports, and the methods of the organism reserves recovery has proved its effectiveness when applied in health forming technologies [12]. This gives grounds for using the system to maintain the fitness of athletes in various kinds of sports, including top and paralympic athletes.

## Statement on ethical issues

Research involving people and/or animals is in full compliance with current national and international ethical standards.

## Conflict of interest

None declared.

## Author contributions

The authors read the ICMJE criteria for authorship and approved the final manuscript.

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