



# Diagnostics of the functional state of athletes and engaged in fitness based on heart rate variability

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## Abstract

**Objective of the study** was to assess heart rate variability and determine the type of autonomic regulation in athletes, as well as in people involved in fitness.

**Methods and structure of the study.** We examined 15 athletes, men aged 22-29 years, as well as 15 people involved in fitness, men aged 22-30 years. Both groups of subjects trained five to seven times a week for 2.5 hours, physical activity was of a mixed, predominantly anaerobic-aerobic nature, exercises of a speed-strength, strength orientation were performed.

**Results and conclusions.** The largest group of individuals was found with type III autonomic regulation both in the general sample and separately in each group. This type of regulation is the most favorable for adaptation, it is characterized by a moderate predominance of autonomous regulation of the heart rate, self-regulation is very effective for such individuals. Special attention should always be paid to individuals who belong to type IV; in the studied groups, a small number of individuals with this type of regulation were found. The method of HRV analysis allows you to identify the state of overtraining. No statistically significant differences were found for all indicators of variability, except for the TP indicator (total power of the spectrum) between athletes and people involved in fitness.

**Keywords:** sport, fitness, functional state, heart rate variability, autonomic regulation type.

**Introduction.** One of the fundamental problems of increasing the effectiveness of training effects on athletes and people involved in fitness is the systematic introduction of modern technologies for complex control and management of the functional state. The use of non-invasive methods for diagnosing, as well as controlling and managing the process of sports training, has great prospects and is relevant not only in the preparation of athletes, but also for diagnosing the condition of persons systematically engaged in physical activity.

Assessment of heart rate variability is included in the program of examinations by complex scientific groups of combined teams, this method allows you to quickly identify the functional state, which makes it very informative for operational and current examina-

tions. Also, this method is widely used in sports selection, in the hardware-software complex "Become a Champion", which indicates the recognition of the effectiveness of this method [1, 4, 6].

**Objective of the study** was to assess heart rate variability and determine the type of autonomic regulation in athletes, as well as in people involved in fitness.

**Methods and structure of the study.** 15 athletes were examined - men aged 22-29 years, as well as 15 people involved in fitness - men aged 22-30 years. Both groups of subjects trained five to seven times a week for 2.5 hours, physical activity was of a mixed, predominantly anaerobic-aerobic nature, exercises of a speed-strength, strength orientation were performed. The study involved practically healthy individ-



uals who have no contraindications for exercise. The study was conducted in the morning after recovery.

HRV spectral analysis indicators were evaluated: ULF - ultra-low-frequency (ultra-low-frequency) oscillations, TP - total power of the spectrum, LF/HF - index of vagosympathetic interaction; HF - high-frequency oscillations, LF - low-frequency oscillations, VLF - very low-frequency oscillations, adaptation index: IS - stress index (Baevsky index).

**Results of the study and their discussion.** In this work, we used the classification of types of autonomic regulation proposed by N.I. Shlyk: moderate and pronounced predominance of the central regulation circuit (types I and II), moderate and pronounced predominance of the autonomous regulation circuit (types III and IV) [4, 5, 6]. Particular attention is paid to the fourth type of vegetative regulation, since in normal sinus rhythm it is physiological in nature and reflects a high level of fitness, in the presence of extrasystoles-parasystoles and other rhythm disturbances, which makes it possible to determine the visual assessment of the cardiointervalogram, is pathological and indicates overstrain and overtraining. Systematic monitoring of the heart rate also avoids the risk of sudden death.

Table 1 shows the results of a study of heart rate variability for athletes (group 1) and for people involved in sports (group 2).

Table 1 reflects the absence of statistically significant differences in all indicators of variability, except for the TP indicator (total spectrum power). For athletes, this indicator is  $2893.6 \pm 439.34$  ms<sup>2</sup>, for those involved in fitness -  $2753.80 \pm 94.14$  ms<sup>2</sup>. It can be seen

that the indicator of the total power of the spectrum is statistically significantly higher in athletes ( $p < 0.05$ ).

According to the data of Table 2, the following distribution of the examined persons according to the types of autonomic regulation is observed:

✓ 20% of the total sample of subjects in the first group are persons with I vegetative type of regulation, among the representatives of the first group the proportion of persons with this type of regulation is 26.7%, in the second group - 13.1%. Such persons have a moderate increase in the sympathetic tone of the nervous system;

✓ No persons with type II vegetative regulation were found among the surveyed;

✓ The proportion of people with type III regulation in the total sample is 70%, in the first group - 60%, in the second group - 80%. Using the  $\chi^2$  criterion, having compiled contingency tables, the prevalence of persons with III type of regulation ( $\chi^2=18.6$ ,  $p < 0.001$ ) was revealed in the total sample and in the second group ( $\chi^2=14.8$ ,  $p < 0.05$ ), in the first group the predominance of type III autonomic regulation is also noted, but it is statistically insignificant ( $\chi^2=5.8$ ,  $p > 0.05$ );

✓ There are also representatives with IV type of regulation - in the total sample 10%, in the first group - 13.3%, in the second group - 6.7%.

✓ There were no statistically significant differences in the predominance of the type of regulation between the groups ( $\chi^2=1.43$ ,  $p > 0.05$ ).

Express diagnostics of heart rate variability allows you to timely determine the risks of maladjustment, as well as possible health problems. This is of great importance, since overloading the cardiovascular

**Table 1.** The results of the study of indicators of heart rate variability in athletes and people involved in fitness

Indicators	Groups	n	M	m	p
IS, c.u.	group 1	15	75,66	10,32	>0,05
	group 2	15	72,08	11,41	
VLF, ms <sup>2</sup>	group 1	15	1461,8	291,65	>0,05
	group 2	15	985,36	28,62	
LF, ms <sup>2</sup>	group 1	15	901,73	112,97	>0,05
	group 2	15	956,05	18,01	
HF, ms <sup>2</sup>	group 1	15	531,47	135,86	>0,05
	group 2	15	584,81	31,46	
TP, ms <sup>2</sup>	group 1	15	2893,6	439,34	<0,05
	group 2	15	2753,8	94,17	
LF/HF	group 1	15	2,75	0,55	>0,05
	group 2	15	2,25	0,24	



**Table 2.** Frequency analysis of types of vegetative regulation in athletes and people involved in fitness

Vegetative type regulation	General sample		Group 1		Group 2	
	Number of people	%	Number of people	%	Number of people	%
I	6	20	4	26,7	2	13,1
II	-	-	-	-	-	-
III	21	70	9	60	12	80
IV	3	10	2	13,3	1	6,7
Level statistical significance	Type III predominance autonomic regulation in the total sample ( $\chi^2=18.6$ , $p<0.001$ )		The predominance of one of the types autonomic regulation in group 1 was not detected ( $\chi^2=5.8$ , $p>0.05$ )		Type III predominance autonomic regulation in group 2 ( $\chi^2=14.8$ , $p<0.05$ )	
			Statistically significant differences in the predominance of the type of regulation between the groups were not revealed ( $\chi^2=1.43$ , $p>0.05$ )			

system can cause sudden death in sports, and there are also cases of deaths during fitness activities. Arrhythmias are especially dangerous. Due to the violation of regulatory mechanisms, the athlete's condition becomes unstable.

The fitness of an athlete is manifested in the physiological adaptation of the cardiovascular system, which affects the economization of processes at rest and maximum mobilization under loads, as well as the ability to recover. R.V. Alekseev, A.Yu. Meigal note that the regulation of heart rate in athletes is subject to the greatest adaptive shifts in highly qualified athletes with a long experience (>15 years) during training of the "endurance" quality [1].

In addition, the motor skills of highly qualified athletes should be brought to automatism, the participation of the central regulation in the process of execution should not be dominant. According to researchers, relatively autonomous regulation is preferable, which contributes not only to the manifestation of the automatism of motor skills, but also to their variability. In addition, autonomous self-regulation by athletes of their condition is possible.

N.I. Shlyk also recommends selecting children with type III autonomic regulation, since these children have good physiological prerequisites for sports. Type III is the most favorable for adaptation, since representatives of this type have the most effective self-regulation.

Many trainers actively use the method of pulsometry to control the state, the palpation method has been replaced by an automated method for determining pulse zones, pulse characteristics, however, the method of pulsometry does not fully reflect the state. With the same heart rate values, adaptation and recovery processes can proceed differently. Therefore, it is

necessary to analyze the physiological cost by heart rate variability.

**Conclusions.** Interpretation of heart rate variability indicators according to the method of N.I. Shlyk is accessible and informative not only for sports doctors and physiologists, but also for trainers, as well as representatives of complex scientific groups, fitness industry specialists. It is advisable to control the functional state not only for athletes, but also for people who are engaged in fitness, especially if the classes are held independently. Always special attention should be paid to individuals who belong to the IV type of vegetative regulation. This may reflect high adaptive capabilities, as well as indicate a failure of adaptation, a disease state, and overtraining. If pronounced HRV disorders are detected, information should be brought to the attention of medical workers.

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