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Assessment of Tension of the Students' Organism Regulatory Systems during the Initial Period of Study at the University¹ Aiman E. Konkabaeva² Sabina S. Kozhuhova³ Rakhat T. Bodeeva

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ABSTRACT. The article presents research results of the current functional state of students by recording the heart rate variability during the study period. Imbalance of parts of the autonomic nervous system and reactivity reduction of parasympathetic and sympathetic divisions at large number of examinees were detected.

Keywords: heart rate variability; orthostatic test; autonomic nervous system; regulation; reactivity.

INTRODUCTION. Currently, one of the most important problems of higher professional education is the adaptation of student organism to the academic load. Information overload of students appearing in the study of many disciplines, scientific level and amount of information which increases all the time becomes a serious challenge for the organism [1]. This is reflected in the current functional state of the organism and causes significant stress of adaptive-compensatory systems [2], in some cases the failure of adaptation, as well as a significant reduction in mental and physical health of students. The intensive mental stress combined with physical inactivity creates certain preconditions for deterioration of physical and mental health of young people. Circulatory system is considered as a sensitive indicator of adaptive reactions and heart rate variability reflects the degree of tension of regulatory systems caused by activation of the pituitary-adrenal, arising in response to a stressor effects [3].

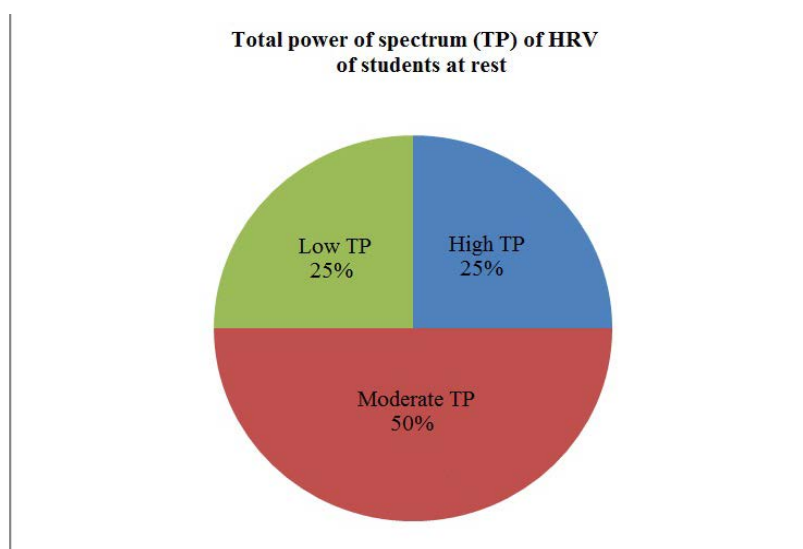
Analysis of heart rate variability (HRV) consists in quantitative assessment of spontaneous fluctuations of heart rate caused by neurohumoral factors. For this purpose the methods of temporal and spectral analyzes are used, the first of which allows to quantify the emerging changes, and the second – to establish their cause. Heart rate variability, measured on a short time interval, is a dynamic indicator, rapidly and significantly responsive to the changing external environment and internal medium of organism [4]. In this connection, we studied the current functional state of students' organism at the beginning of the learning process to assess the level of tension of the organism regulatory systems.

MATERIALS AND METHODS. The study involved 25 students of 1 year (at the end of the first semester), male sex, no bad habits, at the age of 19–20 years from bio-geographical and historical faculties of Academician E.A.Buketov Karaganda State University. The current functional state of organism was assessed by heart rate variability. Heart rate variability was studied with a computerized complex "Varikard" (Russia). Assessment of heart rate variability was conducted by the method of mathematical statistics of Baevsky R.M. (1997) [5, 6]. Recording Mode – a short-

term, in the supine position (5-minute recording). In a standing position (2-minute recording) the active orthostatic test (AOT) in the second standard lead was registered. The studies were conducted one and a half hours later after meals, in a quiet environment. The article contains the most informative parameters of heart rate variability (HRV). Statistical analysis of received data was conducted on a personal computer with the use of Excel.

DISCUSSION. Approximate assessment of adaptive capacity of the organism and its rehabilitative potential can be estimated using the parameters of spectral analysis: the index of total power of spectrum (TP), the balance of departments of autonomic nervous system (ANS) (LF / HF) and the structure of the spectral power (HF, LF, VLF) [7].

In the studied groups: moderate level of total power of spectrum at 50 % of the surveyed and in 25 % of cases high level of total power of spectrum was found (pic. 1). Along with this, at 25 % of students who passed the survey low level of total power of spectrum was noted.



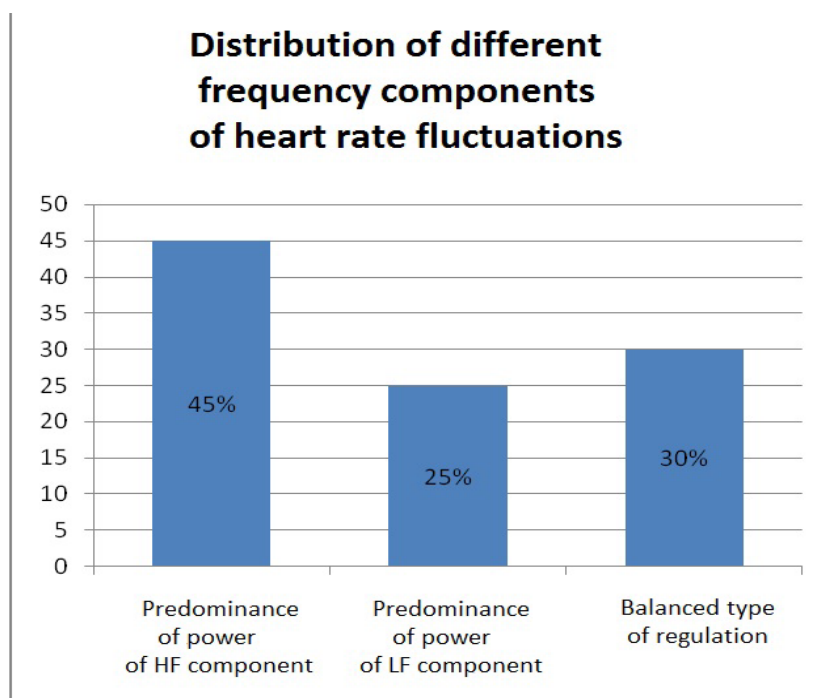
Pic. 1: Total power of spectrum (TP) of heart rate variability of students at rest.

The estimate of total spectral power of HRV at students allows to conclude that the current functional state of the organism in the studied group should be considered ambiguous. Low level of total power of spectrum detected at 25 % of students is an indication reflecting the reduction of adaptive reserves of the organism.

To resolve the question of character of the distribution of different frequency components of heart rate fluctuations, we analyzed the structure of the spectral power of HRV (pic. 2). Spectral analysis allowed to characterize relation of the vegetative influence contributions to heart rate regulation. Predominance of parasympathetic regulation was detected at 45 % of the surveyed that in general is natural for young people. In 25 % of the cases predominance of sympathetic regulation of heart rate was revealed. Mixed-balanced type of regulation was observed in 30 % of cases.

Obtained results allow to conclude that a quarter of the surveyed has high level of sympathetic influences in modulation of heart rate indicating to the stress of regulatory systems.

The circulatory system, its functional reserves are considered as a leading system, which determines the adaptability of the organism. We conducted active orthostatic test (AOT). Orthostatic test is an informative method revealing hidden changes in the regulatory mechanisms of the cardiovascular system. The transition from the "supine" position to the "standing" position itself does not represent a significant load for a practically healthy person. However, with a decrease in functional reserves or hidden deficiency of the circulatory system, orthostasis turns out to be stressor impact for the organism [6].



Pic. 2: Distribution of different frequency components of heart rate fluctuations.

Analysis of the transient period, which has an independent diagnostic value, the so-called coefficient $K_{30:15}$, allowed to discover the following: relation $K_{30:15}$ equal to $1,471 \pm 0,049$, characterizing the normal reactivity of parasympathetic part of ANS, was detected at 13 % of students. Arbitrary standard ($K_{30:15} = 1,282 \pm 0,042$) was observed at 48% of the surveyed. Insufficient reactivity of the parasympathetic part of ANS ($K_{30:15} = 1,160 \pm 0,033$) was revealed at 39 % of the surveyed students ($P < 0,01$) (table).

Active orthostatic test	Normal parameter n= 5	Arbitrary standard n=11	Insufficient reactivity n=9
Transient period	$1,471 \pm 0,049^*$	$1,282 \pm 0,042$	$1,160 \pm 0,033^*$
Percentage	13 %	48 %	39 %

Table: Results of the transient period of the active orthostatic test ($K_{30:15}$).

Note: * differences are significant ($P < 0,01$)

Thus, analysis of the transient period during the active orthostatic test of practically healthy students testifies to insufficient reactivity of the parasympathetic part of ANS at 39% of the surveyed and reduction of the organism functional reserves.

Study of wave structure during the transition of rhythm in the vertical position showed a reduction of power of high frequency components of the spectrogram. Reduction of power of high frequency components we observed at 80 % of the surveyed. Reduction of the total power of spectrum was observed in 50% of cases. Power increase of low frequency waves(LF component), reflecting the activity of the sympathetic part of ANS, we observed at 60% of the surveyed students. Parameter LF/HF, reflecting relation of sympathetic and parasympathetic divisions, increased by 3,5 times compared with the supine position at 60% of students.

Complex estimation of heart rate variability can be carried out by the parameter of activity of regulatory systems (PARS). It is calculated in points by a special algorithm that takes into account statistics, histograms and data of spectral analysis cardio intervals. PARS allows to differentiate the degree of tension of regulatory systems.

In our studies state of optimal tension of regulatory systems necessary to maintain an active balance of organism with the environment was found at 25 % of the surveyed that reflects the state of satisfactory adaptation.

The state of moderate tension of regulatory systems, when for adaptation to the environment the organism requires additional functional reserves, arises in the process of adaptation to work, during emotional stress, or when exposed to adverse environmental factors. In our studies state of the functional stress was detected in 55 % of the surveye.

The state of frank stress of regulatory systems connected with the mobilization of protective mechanisms, increased activity of the pituitary-adrenal system was observed at 20 % of the surveyed students.

Thus, revealed moderate and low total power of spectrum, reflects the reduction of adaptive reserves of the organism at 75 % of surveyed students. The high level of sympathetic effects in modulation of heart rate testifies to the imbalance of parts of ANS and stress tension of the organism caused, probably, by the learning process.

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Оценка напряженности регуляторных систем организма у студентов в начальный период обучения в вузе

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Аннотация. В статье представлены результаты исследований текущего функционального состояния студентов с помощью регистрации variability сердечного ритма в период обучения. Обнаружен дисбаланс отделов вегетативной нервной системы и снижение реактивности парасимпатического и симпатического отделов у значительного количества обследуемых.

Ключевые слова: variability сердечного ритма; ортостатическая проба; вегетативная нервная система; регуляция; реактивность.