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**Analysis of cardiovascular system of students in different periods of training**

The study of individual characteristics of functional changes and adapt to stressful loads of students is one of the important physiological problems. The aim of the study was to investigate the changes in the parameters of the cardiovascular system of students with different levels of mental and emotional stress under the influence of the exam. Analysis of the results demonstrated that most of the students respond to the situation as an examination on stressor and experiencing significant psycho-emotional stress, which are reflected in the functional state of the cardiovascular system. Can also be said about the underdeveloped cardiovascular system and the students of psycho-physiological instability of the body. Nature of the reaction of the cardiovascular system in the psycho-emotional stress among students varies considerably depending on the subjective forecast of passing the examination.

**Key words:** psycho-emotional stress, the level of anxiety, cardiovascular system.

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**Әртүрлі дәуірлерінде студенттердің жүрек-қан тамырлар жүйесінің көрсеткіштерін талдау**

Өзекті физиологиялық проблемалардан біреу студенттердің функционал өзгертулердің ерекшеліктерді және стресс жүктілерге бейімделу процесі зерттеу. Зерттеу мақсаты – емтихан ықпалынан әртүрлі деңгейімен дамытылған психоэмоционалды стресті студенттердің жүрек-қан тамырлар жүйесінің көрсеткіштердің өзгертулер арқылы зерттеу. Нәтижелердің талдауы көрнекті көрсетті, студенттер емтихандық жағдайға сезімталды және психоэмоционалдық жағынан жүктілер жүрек-қан тамырлар жүйесінің қызметіне түседі. Емтихан тапсыру субъективті болжауының табыстылығы психоэмоционалдық стрестің орында жүрек-қан тамырлар жүйесінің жауабының реакцияларына әсер етеді.

**Түйін сөздер:** психоэмоционалды стресс, абыржудың даму деңгейі, жүрек-қан тамыр жүйесі.

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**Анализ показателей сердечно-сосудистой системы у студентов в различные периоды обучения**

Изучение индивидуальных особенностей функциональных изменений и адаптации студентов к стрессогенным нагрузкам является одной из актуальных физиологических проблем. Целью исследования явилось изучение изменений показателей сердечно-сосудистой системы у студентов с разным уровнем психоэмоционального напряжения под влиянием экзамена. Анализ результатов наглядно показал, что основная масса студентов реагирует на экзаменационную ситуацию, как на стрессорную, и испытывает значительные психоэмоциональные нагрузки, которые отражаются на функциональном состоянии сердечно-сосудистой системы. Также можно сказать о слаборазвитой сердечно-сосудистой системе у студентов и о психофизиологической неустойчивости организма. Характер реакции сердечно-сосудистой системы на психоэмоциональный стресс у студентов значительно варьирует в зависимости от субъективного прогноза успешности сдачи экзамена.

**Ключевые слова:** психоэмоциональный стресс, уровень развития тревожности, сердечно-сосудистая система.

During study students can experience considerable psychoemotional strain which can be reflected in their physiological state, and in some cases cause deterioration of a state of health and lead to pathology [1,2]. One such situation is the examination session, the results of which are for the student great social importance. Examination loadings are followed by emotional experiences, and these experiences creating a prepotential condition of psychoemotional tension, are individually different [3]. Properties of the individual response, usually formed as a result of unequal engagement functional systems of adaptive changes in the process of the organism. Therefore, the study of the individual characteristics of functional changes and adaptations students to stressful loads accompanying the learning process, is one of actual physiological problems.

**The aim of the study** was to investigate the changes in indicators of the cardiovascular system of students with different levels of mental and emotional stress under the influence of the exam.

### Material and methods

Researches were conducted in two stages: at the first stage examined 38 students of faculty of biology and biotechnology of Al-Farabi Kazakh National University aged from 18 till 23 years during training during a semester (“background researches”), on the second — the same students in the period of examinations. In the latter case, a survey was carried out for 30-35 minutes before the exam, and an hour after the exam. Used electrocardiograph CardioVit 2.2.3, by which registered the 12-lead ECG, hemodynamic studies were performed using the apparatus of Riva Rochy. The resulting unscrambled cardiogram, hemodynamic parameters were calculated: percussion blood volume (PBV), cardiac index(CI), mean dynamic pressure (MDP), total peripheral resistance (TPR), reographic index (RI) and ejection time of blood from the left ventricle (TE) with assessment of the type of hemodynamics.

Psychophysiological diagnostics of a level of development of uneasiness was carried out by means of psychophysiological tests: Taylor’s – Spielberg, test “Man in the rain.” Mathematical analysis was performed using the program “STADIA 4.5”, developed by A.P. Kulachev. It included: a statistical description of the parameters, calculating the average, the average error, variance, standard deviation, median, kvartely, trust mean and variance; determination of the normal distribution of

the analyzed data and compare the absolute values of the parameters of different classes of functional states on the criterion of “X-square”.

### The results of the study

According to the results of psycho-physiological testing, students were divided into three troupes. The first group consisted of 12 students with a minimum level of anxiety in the second group were 19 students with an average degree of anxiety and the third group consisted of 7 students with the highest level of anxiety.

In the course of the experiment were collected electrocardiographic and hemodynamic performance of the cardiovascular system. The data obtained showed strong psychophysiological stress on students exam stress.

Hemodynamics of the cardiovascular system is greatly changed in the three groups studied, but the most significant changes were observed in the third group with the high level of anxiety. Preliminary examination cardiac index in the time interval increased by 1.25 times, reaching a value of  $3,25 \pm 0,12$  c.u. at  $2,59 \pm 0,37$  c.u. semester of study. But after passing the exam cardiac index remained very high, up to  $3,45 \pm 0,11$  c.u. (Table 1). Total peripheral resistance (TPR) and mean dynamic pressure (MDP) also decreased after passing the exam. TPR before the exam was  $1,878 \pm 8,25$  c.u. and after the exam was  $1,777 \pm 7,25$  c.u., and the MDP before and after the exam was  $87,2 \pm 2,5$  mm Hg. Very high value was of the specific volume of blood. Figure to the exam  $88,3 \pm 1,7$  ml was higher than during the semester learning  $58,45 \pm 2,8$  ml of 1.5 times (Table. 1). These values did not decrease after the exam. These high values are not recorded in the other groups, and indicators are not reduced to figures semester and after the exam.

Hemodynamic values in the group with low levels of anxiety were within the normal range during the semester learning, increased slightly before the exam and returned to normal after the exam. Slightly higher hemodynamic parameters were in the group with an average level of anxiety. They were relatively high in the semester training period and during the exam and returned to normal after the exam (Table. 1).

The dynamics of growth of the level of anxiety in the main number of students confirmed cardiographic ECG in a variety of cardiac arrhythmias. The expression violations were observed in the examination period, especially in the group with an average level of

anxiety. But changes in the ECG during the exam quickly returned to normal after the exam (Fig. 1). Parameters such as nonspecific changes ST interval and wave T, characterised preheart attack state began to appear in the Preliminary examination period at 42.1%. However, pathological changes in the ECG is not recorded in 20% of 42.1%, after only an hour after the exam. Subepicardial ischemia semester increased from a value of 5% to 12% during the exam stress, but also indicators began to decline after the removal of exam stress (Figure 1). In the group with high levels of anxiety, changes in the

ECG did not reach high values, as in the group with an average level of anxiety, but were more stable and did not decrease even after the exam. In the group with high levels of anxiety signs of ischemia subepicardial muscle, blockade of the left branch of Gisa, intraventricular block, nonspecific changes ST interval and wave T, indicating pre-heart attack state, which did not pass even after the exam. In this group, the percentage of students with pathological features in the ECG increased slightly, by 2-5%, but the performance has not consistently decreased after the exam.

**Table 1** – Hemodynamic indices of cardiovascular system of students with different levels of anxiety in different periods of study

Hemodynamics of the cardiovascular system	Groups of students with different levels of anxiety								
	with low level			middle			high		
	during the semester learning	before the exam	after exam	during the semester learning	before the exam	after exam	during the semester learning	before the exam	after exam
	1	2	3	4	5	6	7	8	9
SI, c.u.	2,25±0,12	2,63±0,37	2,49±0,37	2,46±0,11	2,73±0,16	2,34±0,11	2,59±0,37	3,25±0,12	3,45±0,11
								$P_{7-8} \leq 0.5$	$P_{7-9} \leq 0.5$
TPR, c.u.	1078±8,25	1597±180	1004±75,5	1721±82,45	1733±168	1511±99	1704±75,5	1878±8,25	1777±7,25
		$P_{1-2} \leq 0.5$							
MDP, mm Hg	83,2±2,5	84,0±3,4	85,7±0,99	87,7±0,96	89,8±1,31	86,4±1,6	87,7±0,99	87,2±2,5	87,2±2,5
PBV, ml.	58,3±1,7	59,2±5,6	56,45±2,8	52,15±2,6	53,3±5,4	52,6±5,4	58,45±2,8	88,3±1,7	85,3±1,7
								$P_{7-8} \leq 0.5$	$P_{7-9} \leq 0.5$
TE, c.	0,23±0,023	0,2±0,014	0,2±0,013	0,18±0,013	0,18±0,017	0,17±0,012	0,2±0,013	0,43±0,023	0,42±0,033
								$P_{7-8} \leq 0.5$	$P_{7-9} \leq 0.5$
RI, c.u.	0,61±0,04	0,58±0,07	0,6±0,06	0,96±0,06	0,6±0,01	0,64±0,06	0,9±0,06	0,71±0,04	0,69±0,05

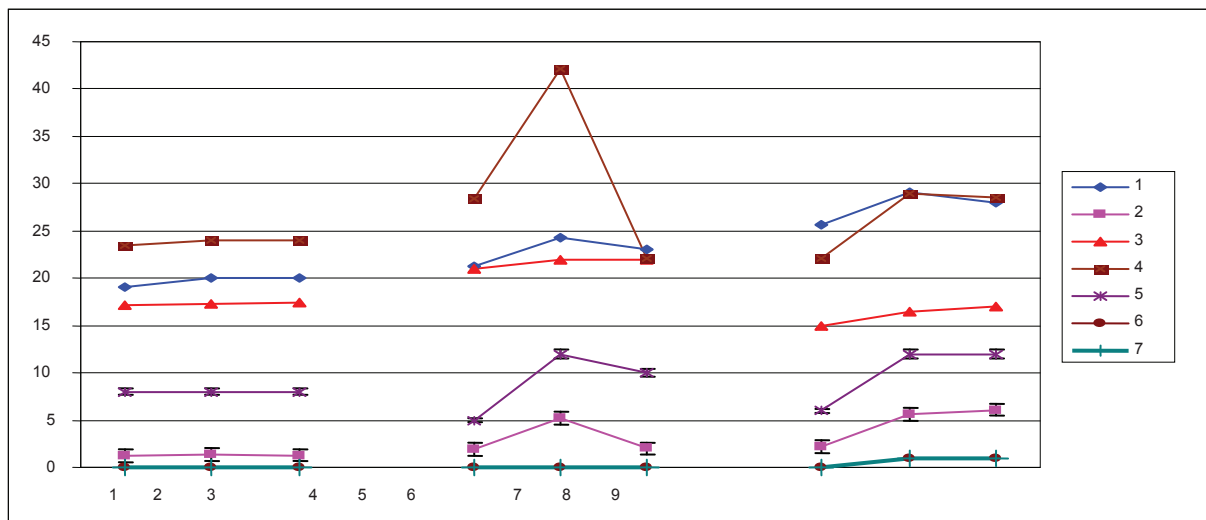
The x-axis – a group of students with different levels of anxiety: 1,2,3 – ECG group of students with low levels of anxiety, 4,5,6 – ECG students with an average level of anxiety, 7,8,9 – ECG students with high levels of anxiety (performance 1, 4, 7 – ECG during the semester learning; 2, 5, 8 – ECG before the exam, 3, 6, 9 – ECG after passing the exam); the y-axis – the percentage of students with disabilities in the ECG

Range 1 – incomplete right bundle branch block, range 2 – left bundle branch block, range 3 – ventricular hypertrophy, range 4 – nonspecific changes ST interval and wave T, range 5 – subepicardial ischemia, range 6 – intraventricular block, range 7 – a suspected heart attack

Thus, many students with low and medium level of anxiety in the first place there was a decrease of vegetative imbalance in the direction of the norm when you remove the stress factor, but the balance of the autonomic regulation after removal of exam stress was not observed in any case. Quickly exposed to stress are most students with a high level of anxiety in which hemodynamic and ECG parameters rapidly change in the direction of pathology and did not return to normal even after the exam. In this group were observed uncertainty and worries about getting a positive assessment of the exam. It is in this group included students with high GPA. Most minor changes in the cardiovascular system were in the group with low levels of anxiety.

They vary slightly during the exam and quickly returned to normal after the exam. In this group, the level of performance was below 3.0 GPA. Analysis of the results demonstrated that most of the students respond to the situation as an examination on stressor and experiencing significant psycho-emotional stress, which are reflected in the functional state of

the cardiovascular system. Can also be said about the underdeveloped cardiovascular system and the students of psycho-physiological instability of the body. Nature of the reaction of the cardiovascular system in the psycho-emotional stress among students varies considerably depending on the subjective forecast of passing the examination.



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**Figure 1** – Dynamics of ECG in groups with different levels of anxiety

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