

Rustamova T.V., Huseynova A.A.¹, Kazimov A.Kh.², Zulfuqarova P.A.², Abdullazadeh G.A.¹,
Ismayilova A.I.², Garayeva A.R.²
Ganja State University, Ganja, Azerbaijan, ¹Azerbaijan State Agricultural University, Baku,
Azerbaijan, ²Azerbaijan Medical University, Baku, Azerbaijan

EFFECT OF EXAM STRESS ON THE DYNAMICS OF VEGETATIVE INDICATORS OF STUDENTS WITH MELANCHOLIC TEMPERAMENT TYPE

e-mail: rustamovatukeyban72@mail.ru

The research work was devoted to the change of vegetative indicators under the influence of the examination process in 32 first-year students depending on the temperament type of the nervous system. The vegetative indicators of students belonging to the melancholic temperament type were determined and recorded in 3 groups: on ordinary days, before the exam and after the exam. Before the exam process, systolic arterial pressure increased 115.9 ± 3.0 mmHg ($P < 0.05$), and diastolic arterial pressure increased to 78.4 ± 3.0 mmHg ($P < 0.05$), respectively. The number of heart beats per minute in the same group of students also increased by 6.7 units to 87.5 ± 3.2 ($P < 0.05$). The differences in vegetative indicators were also observed in all 3 groups. Thus, the results of this study we have obtained can be used in optimizing teaching activities, correcting exam stress, and protecting students' health.

Key words: temperament, melancholic type, vegetative indicator, students, nervous system.

Рустамова Т.В., Гусейнова А.А., Казімов А.Х., Зульфугарова П.А., Абдуллазаде Г.А.,
Ісмаїлова А.І., Гарасва А.Р.

ВПЛИВ ЕКЗАМЕНАЦІЙНОГО СТРЕСУ НА ДИНАМІКУ ВЕГЕТАТИВНИХ ПОКАЗНИКІВ СТУДЕНТІВ З МЕЛАНХОЛІЧНИМ ТИПОМ ТЕМПЕРАМЕНТУ

Дослідження присвячене змінам вегетативних показників під впливом екзаменаційного процесу у 32 студентів першого курсу залежно від типу темпераменту нервової системи. Вегетативні показники студентів, що належать до меланхолійного типу темпераменту, визначалися та реєструвалися у 3 групах: у звичайні дні, перед іспитом та після іспиту. Перед початком іспиту систолічний артеріальний тиск збільшився до $115,9 \pm 3,0$ мм рт. ст. ($P < 0,05$), а діастолічний – до $78,4 \pm 3,0$ мм рт. ст. ($P < 0,05$). Кількість серцевих скорочень за хвилину в тій самій групі студентів також збільшилася на 6,7 одиниць до $87,5 \pm 3,2$ ($P < 0,05$). Відмінності у вегетативних показниках спостерігалися у всіх 3 групах. Таким чином, отримані нами результати можуть бути використані для оптимізації навчальної діяльності, корекції екзаменаційного стресу та захисту здоров'я студентів.

Ключові слова: темперамент, меланхолійний тип, вегетативний показник, студенти, нервова система.

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Among the risk factors that negatively affect the health of people, especially at a young age, psycho-emotional factors play a key role [4]. The learning process in higher education students requires a long period of time and significant physical and intellectual efforts, psychological and emotional stability, the ability to correctly overcome various stressful situations that arise almost every day, especially during exams [8]. As for students, each individual has the concept of "exam stress", which occurs at different intervals before the exam: from several days to several weeks, when a feeling of anxiety arises, develops and reaches its peak during the exam itself. In numerous studies, a weak similarity in temperament between parents and adolescents was confirmed. Exam stress ends at the cellular level, as well as sympathetic and parasympathetic disorders of the autonomic nervous system, disruption of autonomic homeostasis, and an increase in the reaction of the cardiovascular system [1, 6, 9]. When analyzing the opinions of scientists involved in the study of anxiety, it can be concluded that any change in human life can cause anxiety, and

in preventing this, a high level of adaptation processes and temperament type play an important role. Continuous stress can hinder students' academic achievements and personal or professional development [4, 7]. Despite numerous studies, the mechanisms of neurotic anxiety have not yet been fully studied.

The purpose of the study was to assess changes in vegetative indicators (arterial blood pressure and heart rate) in first-year students under examination stress depending on the temperament type of the nervous system.

Materials and methods. The study was conducted at Ganja State University (Ganja, Azerbaijan), Azerbaijan State Agricultural University (Baku, Azerbaijan), and Azerbaijan Medical University (Baku, Azerbaijan) from April 2024 to July 2024. A total of 32 first-year students participated in the study.

Inclusion criteria: first-year university students; age 18–19 years; practically healthy individuals without diagnosed cardiovascular or neurological disorders; voluntary participation in the study.

Exclusion criteria: presence of chronic somatic or mental diseases; intake of medications affecting the cardiovascular or autonomic nervous system; acute illness at the time of examination; refusal to participate.

The participants in the study were practically healthy and voluntarily participated. The temperament types of the students' higher nervous activity were determined using the G. Eysenck Personality Questionnaire (EPQ).

Systolic arterial pressure (SAP), diastolic arterial pressure (DAP), and heart rate (HR) were assessed on an ordinary day, before the examination, and after the examination. Arterial pressure was measured by the N.S. Korotkov auscultatory method using a standard upper-arm sphygmomanometer and stethoscope. Heart rate was determined by pulse counting over 1 minute. Blood pressure was measured using a standard aneroid sphygmomanometer (Microlife AG1-20, Switzerland) and a stethoscope. Based on the results of these indicators, vegetative tone was determined. That is, vegetative tone was calculated based on Kerdon's vegetative index.

Statistical analysis was performed using the SPSS software package. Given the need to assess changes in vegetative indicators across three different conditions (baseline, pre-examination, and post-examination) and to perform both intra-group and between-group comparisons, appropriate non-parametric tests were selected. In particular, the Wilcoxon signed-rank test was used to evaluate differences between paired observations within the same group.

The study was conducted in accordance with generally accepted ethical standards for biomedical research involving human participants. The study adhered to the principles of the Declaration of Helsinki (2013 revision). Due to the observational,

non-invasive design of the study and the absence of interventions beyond standard physiological measurements, formal approval by a university bioethics committee was not required in accordance with institutional regulations. All participants provided informed voluntary consent prior to inclusion in the study. Consent was obtained in written form after explanation of the study purpose, procedures, and confidentiality assurances. All participants were adults (18–19 years).

Results of the study and their discussion. In order to study the effect of exam stress on the educational process in detail, the activity of the central nervous system was studied in the studies to be conducted depending on the severity of the exam. Taking all these considerations as a basis, after determining a number of regularities in the temperament types of higher nervous activity in the age dynamics of students, we examined the effect of emotional tension of exam stress on autonomic indicators.

The results of the examinations conducted show that on ordinary school days, systolic arterial pressure in melancholic temperament type students (1st year) was 102.3 ± 4.3 mmHg, diastolic arterial pressure was 70.3 ± 3.6 mmHg, and the number of heart beats per minute was 80.8 ± 1.9 beats. The Kerdon vegetative index calculated based on the hemodynamic indicators obtained on ordinary school days of melancholic temperament type students of the same age was equal to 13.

At this time, 30 minutes before the exam process, systolic arterial pressure in first-year students with melancholic temperament type increased by 13.6 mmHg to 115.9 ± 3.0 ($P < 0.05$) mmHg, and diastolic arterial pressure increased by 8.1 mmHg to 78.4 ± 3.0 ($P < 0.05$) mmHg, respectively. The number of heart beats per minute in the same group of students also increased by 6.7 units to 87.5 ± 3.2 ($P < 0.05$) (Table 1).

Table 1

Comparison of heart rate and blood pressure dynamics in first-year students with melancholic temperament type due to emotional stress of the exam process (M \pm m)

Stage	Melancholic (n=32)	M \pm m	Min	Max	POD	PBE
(OD)	SAP (mmHg)	102.3 \pm 4.3	90	122		
	DAP (mmHg)	70.3 \pm 3.6	57	85		
	HR	80.8 \pm 1.9	75	90		
(BE)	SAP (mmHg)	115.9 \pm 3.0	100	125	0.026	
	DAP (mmHg)	78.4 \pm 3.0	60	86	0.027	
	HR	87.5 \pm 3.2	75	100	0.091	
(AE)	SAP (mmHg)	107.5 \pm 4.2	90	125	0.547	0.141
	DAP (mmHg)	70.8 \pm 3.4	60	81	0.917	0.080
	HR	82.1 \pm 1.6	75	90	0.362	0.205

Note: Statistical significance of the difference between the indicators:

1. POD – with the indicators of a normal day in the corresponding group (according to the paired Wilcoxon criterion).
2. PBE – with the indicators before the exam in the corresponding group (according to the paired Wilcoxon criterion).

The Kerdon vegetative index, calculated based on hemodynamic indicators obtained 30 minutes before the exam process from first-year melancholic temperament type students, was 10.5. This result is

2.5 units lower than the results on regular school days. Analysis of the results of hemodynamic changes obtained under the influence of exam stress by groups shows that systolic arterial pressure

increased by 13.3 % ($P < 0.05$) and diastolic arterial pressure by 11.5 % 30 minutes before the exam process compared to regular school days.

Meanwhile, the number of heart beats increased by 8.7 %. Kerdon's vegetative index, calculated based on hemodynamic indicators of 1st year melancholic type students, shows the predominance of sympathetic tone on ordinary school days, this indicator also indicates that sympathetic tone is in a state of predominance before the exam. During the examination of IS I year melancholic students, systolic arterial pressure increased slightly (5.1 %) compared to a normal day and reached 107.5 ± 4.23 ($P < 0.05$) mmHg, while diastolic arterial pressure decreased further and reached the level of normal school days, i.e. 70.8 ± 3.4 mmHg (0.7 %) (Fig. 1).

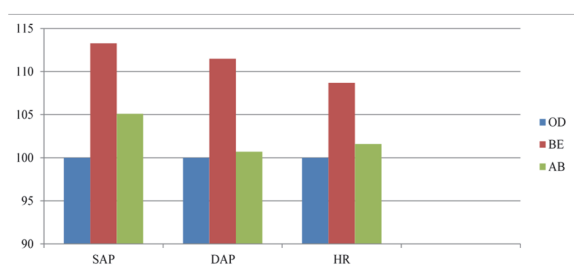


Fig. 1. Comparison of the dynamics of heart rate and blood pressure in 1st year students with melancholic temperament type due to the emotional stress of the exam process (%).

The number of heart beats per minute also decreased significantly compared to the level before the exam and approached the level of normal school days (1.6 %) and corresponded to the stress of 82.1 ± 1.6 ($P > 0.05$).

Based on the obtained hemodynamic indicators, Kerdon's vegetative index was equal to 13.8 which, as in other groups, again indicates a predominance of sympathetic tone.

There are several studies devoted to the autonomic responses of young people under academic stress. However, some approaches have attempted to base conclusions and treatment strategies solely on the assessment of individual indicators without a comprehensive solution [10].

One of the interesting points found in the literature is that, in addition to depending on the type of higher nervous activity, emotional stress also causes psychophysiological changes of different levels depending on the physiological age periods [8].

It should be noted that we also compared the results of the study according to groups. Analysis of the results of these studies shows that the hemodynamic indicators of students change in two phases due to the influence of exam stress. Thus, the results of these changes show that systolic arterial pressure increased by 5.08 % 30 minutes after the exam process compared to normal school days. This indicator of systolic arterial pressure is 7.2 % lower than the indicator of the IA. Although it was observed

that the diastolic arterial pressure of first-year melancholic temperament type students tended to return to the level of normal school days 30 minutes after the exam process, no specific differences were found. However, its amount was significantly (9.6 %) lower than the level 30 minutes before the exam process.

Kerdon's vegetative index calculated based on hemodynamic indicators shows that sympathetic tone prevails in all three cases. Kerdon's vegetative index of first-year melancholic temperament type students proves that this advantage is due to the superiority of sympathetic tone. This indicates that the tone of the sympathetic nervous system has a predominance over the vegetative nervous system indicators of the changes that occurred in the level of situational and individual arousal during the psycho-emotional activity of the exam process throughout the entire exam period. These results show that during the examination process, the indicators of situational and individual arousal levels in students with a melancholic temperament type of higher nervous activity increase, and the tone of the sympathetic division of the vegetative nervous system is sharply increased.

Thus, the increase in the level of the arousal process arising from one or another influence in the melancholic type indicates an exacerbation of the Kerdon vegetative index in all groups. The increase in the level of the arousal process arising from the influence of the emotional tension of the exam in the melancholic type leads to people's health, psychophysiological changes, as well as the manifestation of a number of diseases. Therefore, approaches are recommended in the teaching process in accordance with the nature of the nervous system types of students of different courses. By determining the temperament types of students of different courses during the examination period and determining the changes in the activity of the vegetative nervous system under the emotional tension of the exam, undergraduate students can achieve their goals. Thus, in studies conducted on students studying in different courses, it was found that under the influence of neuro-emotional stress, psychophysiological changes in students studying in the lower course are higher than in those studying in the upper course, and this can be explained by the students' adaptation to the educational process. However, in some sources, an increase in the level of emotional stress is again noted in senior students, which is explained by the fact that this is the last year of education and that final exams are decisive in life [1, 2].

In studies conducted in the IS period, high functional stress of the body is noted, and the indicators are lower than in the pre-exam period. The occurrence of emotional stress during the exam is an assessment of both the subjective and objective state of the student. Although the Kerdon vegetative index

in these students shows the predominance of the sympathetic tone of the autonomic nervous system on ordinary days and in the IS, this indicator is in a state of predominance of the parasympathetic tone after the exam. After the exam, it was observed that the autonomic indicators of students tend to return to the level they were on ordinary days due to the removal of the stress factor, the main reason for this may be the decrease in the tone of the ASS associated with fatigue, the acceleration of the slowing processes in the CNS, the development of the body's defense reactions and the full activation of adaptive processes [2, 7].

In fact, the exam is one of the factors that creates psycho-emotional tension and has a different effect on the functional state of the body. Stress is generally defined as any environmental problem that threatens the well-being of the body [5, 8].

In the study of Koudela-Hamila S, et al (2020), psychological and physiological variables were assessed in 154 students in their daily lives using electronic diaries and blood pressure monitors at the beginning of the semester and before exams. Multilevel analyses revealed lower levels of calm, greater negative valence, higher task-related stress, higher demands, lower perceived control, lower frequency of social contact, and a higher desire for solitude during exam periods (all $p < 0.0001$), as well as lower ambulatory systolic blood pressure

($p = 0.004$), higher cortisol levels upon awakening ($p = 0.021$), and a smaller increase in cortisol ($p = 0.012$) [6].

The occurrence of emotional tension during the exam is an assessment of both the subjective and objective state of the student. Studying the systemic mechanisms of integration of physiological functions during the rise in arousal levels in various emotional states is one of the most important problems of modern age physiology and biomedicine as a whole [3, 5]. In particular, it remains important to evaluate and identify ways to study the neurophysiological mechanism of the impact of the level of emotional arousal on the functional state of the CNS on the eve of classes and exams and in the subsequent periods in students with different temperament types [10]. It should be noted that in the literature there is information about the incompatibility of emotional stress with the components of the human heart and metabolic response.

Limitations. The study is limited by the relatively small sample size, which may restrict the generalizability of the findings. In addition, the short-term observational design and the assessment of vegetative indicators at limited time points may not fully reflect the variability of stress responses over time. Despite these limitations, the study provides valuable insights into the dynamics of vegetative responses under examination stress.

Conclusions

1. The Kerdon vegetative index, calculated based on hemodynamic indicators obtained 30 minutes before the exam process from first-year melancholic temperament type students, was 10.5. This result is 2.5 units lower than the results on regular school days.

2. Analysis of the results of hemodynamic changes obtained under the influence of exam stress by groups shows that systolic arterial pressure increased by 13.3 % ($P < 0.05$) and diastolic arterial pressure by 11.5 % 30 minutes before the exam process compared to regular school days.

Thus, the results of this study we have obtained can be used in optimizing teaching activities, correcting exam stress, and protecting students' health. Most likely, it indicates that at this age, adaptation to the exam process is already fully formed in students.

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ORCID: Rustamova T.V. <https://orcid.org/0000-0002-6828-7904>, Huseynova A.A. <https://orcid.org/0009-0002-1455-8817>, Kazimov A.Kh. <https://orcid.org/0009-0004-4268-0582>, Zulfuqarova P.A. <https://orcid.org/0000-0001-5619-4316>, Abdullazadeh G.A. <https://orcid.org/00090000-6343-0299>, Ismayilova A.I. <https://orcid.org/0009-0001-1248-2604>, Garayeva A.R. <https://orcid.org/0009-0007-6075-8111>.

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Salayeva L.A.

Azerbaijan Medical University, Baku, Azerbaijan

MULTIMODAL APPROACH TO THE DIAGNOSIS OF BONE METASTASES USING COMPUTED TOMOGRAPHY, POSITRON EMISSION TOMOGRAPHY WITH COMPUTED TOMOGRAPHY AND OSTEOSCINTIGRAPHY

e-mail: mic_amu@mail.ru

The purpose of the study was to conduct a comparative analysis of the results of computed tomography, positron emission tomography combined with computed tomography, and osteoscintigraphy in the diagnosis of bone metastases. The diagnostic value and consistency levels of these methods in oncology patients were investigated. The results showed that positron emission tomography combined with computed tomography demonstrates higher diagnostic accuracy in detecting bone metastases and has the ability to provide additional complementary information in cases of discrepancy. Although computed tomography is useful in morphological assessment, in some cases its sensitivity in detecting metastases may be lower. Osteoscintigraphy, while suitable for widespread screening, may result in non-specific findings. Based on the obtained results, practical recommendations for diagnostic conclusions were proposed.

Key words: bone metastasis, positron emission tomography combined with computed tomography, computed tomography, osteoscintigraphy, diagnostic concordance, radiological examination, SUV max.

Саласва Л.А.

МУЛЬТИМОДАЛЬНИЙ ПІДХІД ДО ДІАГНОСТИКИ КІСТКОВИХ МЕТАСТАЗІВ З ВИКОРИСТАННЯМ КОМП'ЮТЕРНОЇ ТОМОГРАФІЇ, ПОЗИТРОННО-ЕМІСІЙНОЇ ТОМОГРАФІЇ З КОМП'ЮТЕРНОЮ ТОМОГРАФІЄЮ ТА ОСТЕОСЦІНТИГРАФІЇ

Метою даного дослідження був порівняльний аналіз результатів комп'ютерної томографії, позитронно-емісійної томографії в поєднанні з комп'ютерною томографією та остеосцинтиграфії в діагностиці метастазів у кістках. Вивчено діагностичну цінність та достовірність цих методів у онкологічних хворих. Результати показали, що позитронно-емісійна томографія в поєднанні з комп'ютерною томографією демонструє вищу діагностичну точність у виявленні метастазів у кістках і дозволяє отримати додаткову інформацію у разі розбіжності результатів. Хоча комп'ютерна томографія корисна для морфологічної оцінки, у деяких випадках її чутливість у виявленні метастазів може бути нижчою. Остеосцинтиграфія, хоча й підходить для широкого скринінгу, може давати неспецифічні результати. На підставі отриманих результатів було запропоновано практичні рекомендації щодо діагностичних висновків.

Ключові слова: метастази в кістках, позитронно-емісійна томографія у поєднанні з комп'ютерною томографією, комп'ютерна томографія, остеосцинтиграфія, діагностична конкордантність, рентгенологічне дослідження, SUV max.

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Bone metastases are very frequently encountered in oncology patients and lead to serious clinical complications (pain, pathological fractures, etc.) as well as a decrease in the patient's quality of life. The likelihood of bone metastasis is particularly high in breast, prostate, lung, and kidney cancers, and in such cases early diagnosis has a significant impact on surgical, radiotherapy, or systemic treatment planning [6, 12].

Several modern imaging methods are available for the diagnosis of bone metastases. While

computed tomography (CT) is highly useful for evaluating structural changes, it does not fully reflect functional alterations. Osteoscintigraphy allows for systemic evaluation of metabolic activity in bone tissue, but its specificity is relatively low [5, 11]. Positron emission tomography combined with computed tomography (PET-CT), especially with radiopharmaceuticals such as ¹⁸F-NaF, PSMA, or ¹⁸F-FDG, combines both morphological and functional assessment, thereby achieving higher diagnostic accuracy [10, 15].