Available online at http://www.ifgdg.org

Int. J. Biol. Chem. Sci. 16(5): 2281-2288, October 2022

ISSN 1997-342X (Online), ISSN 1991-8631 (Print)

International Journal of Biological and Chemical Sciences

Original Paper http://ajol.info/index.php/ijbcs http://indexmedicus.afro.who.int

Changes of the eeg oscillations in the temporal lobe of the cerebral cortex under the effect of examination process in students with choleric temperament

T.V. RUSTAMOVA[1*], Kh.Y. ISMAYILOVA[2] and Ə. H. KAZIMOV[3]

[1]Ganja State University, Ganja Azerbaijan. H.Aliyev Ave. 429, Ganja, AZ2001 rustamovatukezban72@mail.ru https://orcid.org/0000-0002-6828-7904

[2]Institute of Physiology named after Academician Abdulla Garayev of Azerbaijan National Academy of Sciences, Sharifzade str. 78, Baku city, AZ1100 ismailovakh@gmail.com, https://orcid.org/0000-0003-0926-068

[3]Department of Normal Physiology, Azerbaijan Medical University.

[*] Corresponding author; E-mail: ahmedkaz@mail.ru

Received: 31-08-2022 Accepted: 20-10-2022 Published: 31-10-2022

ABSTRACT

To identify age-related changes in the amplitudes of delta, theta, alpha and beta waves in the temporal lobes of the cerebral cortex during emotional stress caused by examination process in choleric students. The research involved 23 male students with choleric temperament aged 17 and 21. EEG recording of the right and left temporal lobes was carried out for 10-12 minutes on ordinary days (OD), as well as before (BE) and after exam (AE). The type of temperament of students was determined according to test of Eysenck before starting the experiment. The personal and situational level of anxiety was determined according to Spielberger in 3 states: on ordinary days (OD), before the exam (BE) and after the exam (AE). It was established that differences in the electrical activity of the brain of 1st year and 5th year choleric students were observed in all stages (OD, BE, AE). In 17-year-old choleric students, the amplitude of the EEG delta, theta and alpha waves on both sides of the temporal lobe changed in waves under the influence of emotional tension in the 1st semester of the BE and AE periods, while the amplitude of the EEG beta waves in the AE periods sharply decreased, which differed from the indicators in the 5th year. Data on the oscillations of EEG waves in the temporal lobe of the cerebral cortex of students can be used for an objective method of diagnosing students' psycho-emotional stress and determining the ways of self-regulation of their condition.

Keywords: EEG waves, stress, anxiety, temperament.

INTRODUCTION

Currently, the study of the physiological and psychological functions of people in the conditions of their professional activity remains one of the actual problems. In this regard, the educational process of students in higher educational institutions is associated with high assessment of physiological activity. According to our previous research (Rustamova. 2020) and other literary sources (Alexandrov and Lukyanenok, 2016; Berezneva and Krisova, 2015) the emotional stress arised due to waiting process of the exam results leads to an increase in situational and personal anxiety in majority

DOI: https://dx.doi.org/10.4314/ijbcs.v16i5.36

of students. It results in disturbance of regulatory mechanisms of mental and vegetative-hormonal systems, which cause the changes in the dynamics of the perception and memorization processes, as well as the weakening of the adaptation functions to stressful conditions (Zorin and Zhadnov, 2016; Monier, 2019). Regarding the situation mentioned above it is necessary to search the objective individual electrophysiological indicators of regulatory mechanisms and adaptive processes characterizing the optimization of the educational process and the prevention of adaptation disorders in students (Zorin et al., 2016). Accordingly, the psychological and physiological functions of the body proceeded in interaction with the purposeful educational process of students (Dolgova and Kapitanech, 2016). The study of the mechanism of emotional stress occurring in students during and after the exam is one of the actively studied problems of electrophysiology (Novikova, 2015).

Along with it, since a comprehensive study of the adaptive functions of students is of great interest for assessing the functional activity of the central nervous system (CNS) and at the same time, for electroencephalography (EEG), it is the main method allowing to obtain highly informative description about the functioning of the brain (Poulsen et al., 2017; Conley et al., 2019). Change in the amplitude-frequency characteristics of the EEG is the indicator of change in the functional state of the central nervous system during emotional stress (Pavlova, 2017). However, some indicators of the mechanism of change in the amplitude-frequency characteristics of the EEG during emotional stress in students during the days of the usual educational process, as well as during the exam still remains poorly studied (Trushina and Vedyasova, 2016). Thus, the study of some aspects of the neurophysiological mechanisms of formation of these states in the examination process of students is of great importance both in theoretical and applied terms (Novikova, 2015). At the same time, based on the topography of neurophysiological mechanisms, it is worthy to note that the temporal lobe of the cerebral cortex (Owoeye and Farombi, 2015) is associated with short-term and long-term memory (Pillon et al., 1999; Cashdollar et al., 2011). However, it was found in other studies that the temporal lobe is involved in social-emotional processes such as social semantic processing (Ross and Olson, 2010), emotional information processing (Critchley et al., 2000), as well as problem solving process (Sassa et al., 2007; Dolcos et al., 2004). Moreover, a connection was found between the temporal lobe and personality traits basing on the Eysenck's theory (Kehoe et al., 2012).

Thuswise, the purpose of our study was to identify age-related amplitudes on both sides of the temporal lobe of the cerebral cortex during emotional stress caused by the examination process.

MATERIALS AND METHODS

A total of 23 practically healthy male students aged 17 and 21 (students of I and V courses) studying at Ganja State University were involved in the study on a voluntary basis. The research was carried out during the first examination session of students aged 17. The students involved in the research were divided into three groups: the studies of the first group students were carried out on regular academic days 2 months before the exam, the studies of the second group students were carried out 30 minutes before the exam and the studies of the third group students - 30 minutes after the exam. Before starting the research, the temperament types of students were determined using the G. Eysenck test (Eysenk, 1993). Moreover, using the express version of the Spielberg-Khanin test questionnaire (Khanin, 1978; Spielberger, 2013), the situational anxiety was determined in three states: on ordinary days, before the exam and after the exam. In neurophysiological studies, EEG recording of the left and right sides of the temporal lobe of the cerebral cortex was carried out for 10-12 minutes on ordinary days, as well as before and after the exam. An indifferent electrode was fixed ipsilaterally on the earlobe. Using the hardware-software complex "Neuron-spectrum 16A" ("Neurosoft" LLC, Ivanovo), the obtained EEG waves were subjected to amplitude and frequency-spectral analysis. All data obtained during the study were statistically analyzed taking into account modern

recommendations. The Wilcoxon rank sum test was used. All calculations were carried out in the EXCEL-2016 spreadsheet and in the SPSS-22 package software, the results of which are describedn the tables displayed.

RESULTS

In the first stage of the study, the changes in the amplitudes of the delta, theta, alpha, and beta EEG waves of the right and left sides of the temporal lobe of the cerebral cortex were studied during emotional stress caused by the first examination session in 17-year-old first-year students. Based on the results of G. Eysenck's test for temperament types, we have choosen students with a choleric temperament type for further research, since they made up the majority of the research subjects.

The results of the research showed that the amplitudes of delta and theta waves on the left side of the temporal lobe before the exam (BE) decreased by 8.2-8.1 mkV (3.6-5.1%,) compared to the indicators obtained on ordinary days (OD), while the amplitude of alpha waves increased by 11.5% (7.7 mkV) (Table 1). The amplitude of the beta waves increased by only 2.8% (8.1 mkV). However, the amplitudes of EEG waves in the studies after the exam (AE) changed markedly. Thus, in comparison with the indicators of OD, the amplitude of AE delta waves increased by 12.8% (29.4 mkV), the amplitude of theta waves by 6.75% (10.6 mkV), the amplitude of alpha waves by 17 .2% (11.5 mkV), while the amplitude of beta waves sharply decreased. This decrease was 46% (15.9 mkV). At the same time, in students of the same age, the amplitudes of EEG waves recorded AE in comparison with BE indicators changed as a percentage in a following manner: delta waves increased by 17% (37.6 mkV), theta waves by 12.4 % (18.7 mkV), alpha waves by 5.1% (3.8 mkV), while beta waves decreased by 50% (18.7 mkV).

A number of regularities is observed in the amplitudes of EEG waves on the right side of the temporal lobe of the cerebral cortex of 17-year students in the period BE compared to OD. Although the amplitude of the EEG theta waves on this side practically does not change, changes are noted in the amplitudes of other rhythms. So, if the amplitude of delta waves changed by only 4.5% (9.3 mkV), then the amplitudes of alpha and beta waves increased by 16.1% (11.3 mkV) and by 11.6% (3.7 mkV) respectively.

More dramatic changes in the indices of EEG waves were observed in the period of AE. In particular, in students of this age compared to OD, the amplitude of delta waves in the period AE increased by 27.6% (57.5 mkV) and the amplitude of theta waves by 10.7% (16.1 mkV), while the amplitude of alpha waves increased by only 2.4% (1.7 mkV). However, along with the increase in the amplitudes of these rhythms, the amplitude of the beta waves sharply decreased and was 48% (15 mkV).

As for the amplitudes of EEG waves in AE period compared to BE period, there was an increase in the amplitudes of delta waves by 22.2% (48.2 mkV) and theta waves by 10.5% (15.8 mkV), while the amplitudes of alpha waves and beta waves decreased by 11.2% (9.6 mkV) and 53.5% (19.0 mkV), respectively.

In the next stage of study, changes in the amplitudes of EEG waves of the left side of the temporal lobe of the cerebral cortex under emotional stress caused during an examination session were studied in 21-year-old fifth-year choleric students (Table 2). The results showed that if the amplitudes of EEG waves in the period of BE decreased slightly compared to OD, in particular, the amplitudes of delta waves decreased by 0.7% (2 mkV), alpha waves by 0.4% (0.3 mkV) and beta waves by 8.1% (1.4 mkV), the amplitude of theta waves slightly increased by 3% (5.3 mkV).

Regarding the EEG waves in the period AE compared to the OD, the amplitudes of delta, theta and alpha waves practically don’t change, while the amplitude of the beta waves increases by 13.9% (2.4 mkV). It indicates that since the emotional stress caused by the examination process does not significantly affect the electrical activity of EEG waves on the left side of the temporal lobe of the cortex of V-year choleric patients, no difference is observed in the

switching of waves from one to another. Moreover, an increase in the amplitude of Beta waves by 23.9% (3.8 mkV) was noted in the AE period compared to the BE.

On the right side of the temporal lobe of the cerebral cortex in 21-year-old students, the amplitudes of delta and alpha waves in the period BE decreased by only 1.1% (2.8 mkV) and by 3% (2.2 mkV) compared to the OD, respectively, while the amplitude of beta waves decreased by 7% (1.3 mkV). In regard to theta waves, their amplitude in the BE period increased to some extent compared to the OD. Together with all these changes, there are no sharp deviations in the amplitudes of EEG waves in the AE period excluding beta waves the amplitude of which increases by 10%. Compared to OD in the AE period, the amplitude of delta waves in 21-year-old students does not change and the amplitude of theta waves increases only by 3% (5 mkV), while the amplitude of alpha waves decreases by 3% (2.3 mkV). In the AE period, the amplitude of beta waves on the right side of the temporal lobe of the cerebral cortex in these students increased by 9.7% (1.8 mkV), while the amplitudes of other EEG waves in the AE period compared to BE changed differently.

Table 1: Comparative analysis of EEG wave amplitudes on the left and right sides of the temporal lobe of the cerebral cortex in 17 students *(n=23), M ± m*

Sides of the temporal lobe	**parametres**	***Ordinary days***				***Before exam***				***After exam***			
		Delta	**Theta**	**Alpha**	**Beta**	**Delta**	**Theta**	**Alpha**	**Beta**	**Delta**	**Theta**	**Alpha**	**Beta**
Left side	M	229,6	159,0	67,0	34,6	221,4	150,9	74,7	37,4	259,0	169,6	78,5	18,7
	± m	21,4	14,2	7,5	7,7	26,1	16,3	8,6	9,4	4,6	2,8	2,9	2,3
	Min	120	80	30	15	69	73	19	12	230	156	65	12
	Max	296	198	92	80	285	200	120	96	271	180	89	29
	ОД					0,646	0,445	0,285	0,838	0,374	0,906	0,260	**0,021**
	BE									0,508	0,475	0,859	**0,028**
Right side	M	208,1	150,8	70,1	31,8	217,4	151,1	81,4	35,5	265,6	166,9	71,8	16,5
	± m	30,6	16,2	5,7	7,3	29,9	17,8	7,2	9,1	10,1	3,4	2,9	1,9
	Min	40	50	41	14	59	65	57	11	225	150	52	10
	Max	294	199	95	75	289	212	125	89	345	179	80	27
	OD					0,878	0,721	**0,041**	**0,005**	0,314	0,678	0,906	**0,008**
	BE									0,203	0,575	0,878	**0,014**

Notes to the table: OD – indicators of the amplitudes of EEG waves on an ordinary day; BE – indicators of amplitudes of EEG waves before exam (according to Wilcoxon rank sum test); bold - statistically significant relationship.

Table 2: Comparative analysis of EEG wave amplitudes on the left and right sides of the temporal lobe of the cerebral cortex in 21-year-old students *(n=23), M ± m*

Sides of the temporal lobe		*Ordinary days*				*Before exam*				*After exam*			
		Delta	**Theta**	**Alpha**	**Beta**	**Delta**	**Theta**	**Alpha**	**Beta**	**Delta**	**Theta**	**Alpha**	**Beta**
Left side	M	269,4	169,8	73,6	17,3	267,4	175,1	73,9	15,9	267,9	171,9	73,8	19,7
	± m	3,4	3,7	3,2	1,6	1,7	3,4	2,9	1,4	3,2	2,8	3,0	1,3
	Min	251	150	54	11	259	155	55	10	249	159	55	11
	Max	286	191	96	28	278	197	90	27	287	198	89	28
	ОД					0,552	0,485	0,875	0,529	0,701	0,727	0,875	0,202
	BE									0,894	0,529	0,917	0,141
Right side	M	273,1	170,5	75,7	18,5	270,3	175,7	73,5	17,2	270,8	175,5	73,4	20,3
	± m	3,2	4,3	2,8	1,3	1,6	2,7	3,3	1,3	3,0	3,0	3,3	1,4
	Min	256	145	61	12	263	159	50	12	254	162	50	14
	Max	289	192	98	27	280	191	89	27	290	203	90	27
	ОД					0,481	0,463	0,649	**0,001**	0,576	0,421	0,727	0,206
	BE									0,814	0,889	0,917	0,221

Notes to the table: OD – indicators of the amplitudes of EEG waves on an ordinary day; BE – indicators of amplitudes of EEG waves before exam (according to Wilcoxon rank sum test); bold - statistically significant relationship

DISCUSSION

The results of the study demonstrated that emotional stress caused by both BE and AE processes exert both amplifying and decelerating effect on the amplitudes of EEG waves on the left and right sides of the temporal lobe of the cerebral cortex in 17-year-old choleric students. It is possible that at this age the process of adaptation to the process of the first exam has not been fully formed at these students [3, 5]. On the other hand, it is shown that situational and personal anxiety levels have been weakened at 21-year-old choleric students participating in the examination processes for 5 years, as well as the level of emotional stress in all periods of the examination process has been decreased and it is reflected in the wave-like pattern of amplitudes of EEG waves on both sides of the temporal lobe of the cerebral cortex. Unlike 21-year-old students, in 17-year-old choleric students emotional stress in the AE period exerts a sharply weakening effect on the amplitude of EEG beta waves both on the left and on the right sides of the temporal lobe of the cortex.

Nevertheless, although some differences were partially revealed in the rhythm of the amplitudes of all EEG waves on the right and left sides of the temporal lobe of

the cerebral cortex in the periods BE and AE in 17-year-old (I year) and 21-year-old (V year) choleric students, any way, sharp differences in the amplitude of all EEG waves were noted precisely in 17-year-old students. Specifically, due to the high emotional stress in students of this age, the rhythm of the amplitude of the EEG delta waves increased on both sides of the temporal lobe of the cerebral cortex, while the rhythm of the EEG alpha waves changed slightly and mainly in the period AE. it was found in our previous study (Rustamova, 2020) that while waiting for the results of the exam, all students of the initial course had an increased state of anxiety. In these studies, an increase in the state of anxiety in choleric patients before the periods BE and AE affects the increase in the amplitudes of the rhythms of EEG waves in the temporal cortex, except the sharp decrease in the amplitude of beta waves. On the other hand, the degree of emotional stress during the examination session increased by different ways in different students (Yumatov et al., 2019). The main reason was the lack of self-confidence in achieving the required results among 1st year students participating in the examination process for the first time. The matter is that the exam is a psycho-emotional stress affecting the functional state of the body as a whole in different ways. The manifestation of emotional stress during the exam is an assessment of both the subjective and objective state of the student (Alexandrov and Lukyanenok, 2016; Korobeynikova et al., 2018). Therefore, individual tension among 1st year students in period of BE varies within high scores.

Thus, the characteristics of the rhythm of EEG waves in the temporal lobes of the cerebral cortex in the periods of BE and AE caused by anxiety changes in different ways. The neurophysiological correlation of emotional stress in an examination situation is weaker for 5th year students than for 1st year students. This is due to the fact that 1st year students have a low level of adaptation to emotional stress in an examination situation. The importance of the problem we are studying is also explained by the fact that in recent years the contradictions between the impact of psychosocial, environmental factors and the biopsychosocial essence of a person have become aggravated leading to disturbance of adaptation, the development of stress, the formation of psychosomatic disorders. In this regard, attempts can be made in the ongoing research to explain the role of temperament under stressful influences by studying the psychophysiological methods of testing and electrophysiological methods of students of various courses.

Conclusion

Depending on the individual characteristics of the nervous system, differences in EEG activity on both sides of the temporal lobe of the cerebral cortex are observed in choleric type students of the 1st and 5th years. The amplitude of the delta-, theta- and alpha-waves of the EEG in both temporal lobes of the cortex manifests itself in waves under the influence of emotional tension, while the amplitude of the Beta-waves of the EEG in the period of AE decreases sharply in 17-year-old choleric students in the 1st semester of the BE and AE periods. There are no sharp deviations in the rhythm of EEG wave amplitudes on both sides of the temporal lobe of the cerebral cortex against the background of emotional stress caused during the examination process in 5th year choleric students. Changes in the rhythm of the amplitude of EEG waves on both temporal lobes of the cerebral cortex in the periods BE and AE in 17-21-year-old choleric students have different nature.As the study of the EEG rhythms of students during the examination sessions is one of the most important problems of age-related physiology and biomedicine in general, its solution is closely related to the need to develop theoretical criteria for absolute assessments of the physiological norm during the educational process, as well as the relationships reflecting the functions of the temporal lobe of cerebral cortex.

ETHICAL CONSIDERATIONS

The study was conducted after receiving a science and ethical permission from the Committee of Ethics of Ganja State University.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

All authors contributed to this work and to the preaparation of the manuscript.

REFERENCES

Alexandrov AG, Lukyanenok PI 2016. Changes in the levels of students' anxiety in the contet of educational activity. *Scientific Education*. *Medical Sciences*, **6**: 5-14. DOI: https://doi.org/10.17513/srms.2016.

Berezneva EY, Krisova TI .2015. Relationship of motivation for learning activities in adolescents with types of temperament, situational anxiety and interpersonal relationships in the family. *International Journal of Applied and Basic Research,* **10**: 357-360.

Conley AC, Cooper PS, Karayanidis F. Gardner AJ, Levi CR, Stanwell P. Gaetz MB, Iverson GL.2019. Resting state electroencephalography and sports-related concussion: a systematic review. *J. Neurotrauma*, **36**(1): 1-13. DOI: https://doi.org/10.1089/neu.2018.5761

Cashdollar N, Duncan JS, Duzel E. 2011.Challenging the classical distinction between long-term and short-term memory: reconsidering the role of the hippocampus. *Future Neurology*, **6**(3): 351-362. DOI: https://doi.org/10.2217/fnl.11.12

Critchley H, Daly E, Phillips M, Brammer M, Bullmore E, Williams S, Van Amelsvoort T, Robertson D, David A, Murphy D. 2000. Explicit and implicit neural mechanisms for processing of social information from facial expressions: a functional magnetic resonance imaging study. *Human Brain Mapping*, **9**(2): 93-105. DOI: https://doi.org/10.1002/(SICI)1097-0193(200002)9:2%3C93::AID-HBM4%3E3.0.CO;2-Z

Dolcos F, LaBar KS, Cabeza R. 2004.Interaction between the amygdala and the medial temporal lobe memory system predicts better memory for emotional events. *Neuron*, **42**(5): 855-863. DOI: https://doi.org/10.1016/S0896-6273(04)00289-2

Dolgova VI, Kapitanech EG, Kupchov MV. 2016. Modeling of psychological and pedagogical correction of situational anxiety in adolescents during the state final certification. Scientific notes of the University named after PF. Lesgaft. 5 (135): 272-278

Eysenck GY. 1993 Number of dimensions of personality: taxonomic paradigm. *Foreign Psychology,* **1**(2): 9-24.

Kehoe EG, Toomey JM, Balsters JH, Bokde AL. 2012. Personality modulates the effects of emotional arousal and valence on brain activation. *Social Cognitive Affective Neurosci.*, **7**(7): 858-870. DOI: https://doi.org/10.1093/scan/nsr059

Korobeynikova II, Venerina YA, Biryukova EV, Karatigin NA. 2018. Spectral characteristics of the EEG alpha-rhythm and temporal parameters of the intellectual activities. *Mental Health,* **6**: 33-39.

Khanin YL. 1978. Research on anxiety in sports. *Questions of Psychology,* **6**: 94-105.

Monier EB, Araújo DV, Oliveira AEF, Baesse DCL, Pinho JRO, Brasil GVS, Mesquita MN. 2019; Student evaluation of distance learning for health care professionals. *Telemedicine and e-Health*, **25**(6): 485-491. DOI: https://doi.org/10.1089/tmj.2018.0065

Novikova SI. 2015. EEG rhythms and cognitive processes. *Modern Foreign Psychology*, **4**(1): 91-108.

Owoeye O, Farombi EO. 2015. Tomato pomace protects against mercuric chloride-induced neurodegeneration and motor abnormality in adult rat. *International Journal of Biological and Chemical Sciences*, **9**(3): 1142-1153. DOI: https://doi.org/10.4314/ijbcs.v9i3.1

Rustamova TV. 2020. Situational Excitement Indicators of the Examination Process Influence to the Nervous System in 17 and 20-Year-Old Students in I and IV Courses Depending on Their Types of Temperament. *Bull. Sci. Pract.*, **6**(8): 55-64. DOI: https://doi.org/10.33619/2414-2948/57/07

Rustamova TV. 2020; Influence of examination stress on the amplitude of EEG waves in the parietal region of the brain in students of the Faculty of Biology and Chemistry with different individual typological features. *J. Life Sci. Agriculture*, **12**(5): 97-112. DOI: https://doi.org/10.12731/2658-6649-2020-12-5-97-112

Poulsen AT, Kamronn S, Dmochowski J, Parra LC, Hansen LK. 2017; EEG in the classroom: Synchronised neural recordings during video presentation. *Sci. Rep.*, **7**: 43916. DOI: https://doi.org/10.1038/srep43916

Pavlova LP. 2017: Dominants of human brain activity. Systemic psychophysiological approach to EEG analysis. SPb: Inform. navigator, 432.

Pillon B, Bazin B, Deweer B, Ehrlé N, Baulac M, Dubois B. 1999. Specificity of memory deficits after right or left temporal lobectomy. *Cortex*, **35** (4): 561-571. DOI: https://doi.org/10.1016/S0010-9452(08)70819-0

Ross LA, Olson IR. 2010; Social cognition and the anterior temporal lobes. *Neuroimage*, **49**(4): 3452-3462. DOI: https://doi.org/10.1016/j.neuroimage.2009.11.012

Sassa Y, Sugiura M, Jeong H, Horie K, Sato S, Kawashima R. 2007; Cortical mechanism of communicative speech production. *Neuroimage*, **37**(3): 985-992. DOI: https://doi.org/10.1016/j.neuroimage.2007.05.059

Spielberger CD. 2013. *Anxiety and Behavior*. Academic Press; 430.

Trushina DA, Vedyasova OA, Pavlenko SI. 2016. Spatial pattern of electroencephalogram rhythms in right-handed students with different levels of anxiety at rest and during examination stress. *Ulyanovsk Biomedical Journal*, **2**: 141-150.

Yumatov EA, Glazachev OS, Perchov SS. 2019. Psychophysiological state of students under emotional stress. *Bulletin of Psychophysiology*, **1**: 19-29.

Zorin RA, Jadnov VA, Lapkin MM. 2016. Electrophysiological correlates of the systemic organization of physiological functions in individuals with different effectiveness of purposeful activity. *Bulletin of New Medical Technologies*, **23**(2): 44-49. DOI: https://doi.org/10.12737/20423