

CARDIOVASCULAR ADAPTATIONS OF FOREIGN STUDENTS TO CLIMATIC AND GEOGRAPHICAL CONDITIONS OF STAVROPOL REGION

I.M. Lisova¹, O.I. Anfnogenova¹, T.I. Dzhandarova¹, N.G. Belyaev¹, A.B. Elkanova¹, V.A. Anfnogenov², D.A. Domenyuk³, A.S. Rechitsky¹

¹ North Caucasus Federal University, Institute of living systems, Department of Biomedicine and Physiology, Russian Federation, Stavropol, Pushkin Street, 1, building 3, Russia 355000. E-mail: okstav@mail.ru, tel: 8-937-402-4937.

² Senior research associate of SIC-1, Research Institute of the Federal Penitentiary Service of Russia, Moscow, 125130, Narvskaya St., 15A-1, Moscow. E-mail: 01vaang@mail.ru, tel: +7 928 352 6300.

³ Department of General Practice Dentistry and Child Dentistry, Stavropol State Medical University of the Ministry of Healthcare of the Russian Federation, 310, Mira Street, Stavropol, Russia 355017. E-mail: domenyukda@mail.ru, tel: +7 918 870 1205.

ABSTRACT — PURPOSE OF RESEARCH: studying adaptive opportunities of the cardiovascular system of foreign students to the climatic and geographical conditions of Stavropol region.

METHODS: The data sample included the Stavropol and foreign students, natives of the countries of the Southern Asia, the Western Asia and Africa in the youthful period of ontogenesis and the first period of a maturity. In total 218 students, from them the Russian students were examined: youths — 73 persons, men — 55 people; foreign students: youths — 36 people, men — 54 persons.

RESULTS: Stable and compensatory adaptive reactions are characteristic to youths and men from the Southern Asia and to men from the Western Asia. A condition of the critical tension (excessive tension) are characteristic to first-year students and senior students from Africa.

FINDINGS: It is established that the greatest stress of adaptation mechanisms is experienced by students from Africa.

KEYWORDS — adaptation, mathematical analysis of the heart rhythm, variational pulsometry, foreign students, Stavropol region.

INTRODUCTION

There are a lot of publications in modern scientific literature, which reflect the issues of adaptation of foreign students to different living conditions in Russia. These are issues of adaptation to different climatic and geographical conditions, to sociocultural conditions, and to the learning process. Moving foreign students to Russia is accompanied by the expressed

morphofunctional reorganization of all systems of an organism. Against this background, the effects of stress experienced by students during the study period make high demands on their bodies leading to significant changes in the cardiovascular system [9, 10, 14]. In addition, it is necessary to consider possible action of a desynchronization, absence at an organism of experience of adaptation to a new food and a number of other factors, new to an organism.

Climatic and geographical conditions in the new area influence population in two aspects. The first of them is actually physical-geographical – the certain combination of landscape and climatic conditions characteristic of this area, favorably or adversely influencing the human body adapted to other physiographical conditions. The second aspect is medical geographical combination of disease with natural nidity which is localized in this area and telling him as the habitat certain medical geographical specifics [3, 7].

In the most general sense, human diseases are the result of a violation of historically developed forms of communication of the organism with the environment. However, in the process of adaptation with very strong or prolonged exposure to adverse environmental factors, or in case the adaptation mechanisms in the body are weak, there is a disadaptation (disturbance or disruption of adaptation) and morbid conditions develop. It is called "adaptation diseases".

Disadaptation and development of morbid conditions happens step by step [1]. The initial stage of a border area between health and pathology is a condition of functional tension of mechanisms of adaptation. Its most characteristic sign is the high level of functioning which is provided at the expense of the intensive or long tension of regulatory systems [19, 25].

The later stage of the border zone is a state of unsatisfactory adaptation. It is characterized by a decrease in the level of functioning the biosystem, mismatch of its individual elements, the development of fatigue and overwork. The state of unsatisfactory adaptation is an active adaptive process. The body tries to adapt to excessive conditions of existence by changing the

Article history:

Received 16 February 2019

Received in revised form 1 April 2019

Accepted 3 April 2019

functional activity of individual systems and the corresponding voltage of regulatory mechanisms. However, due to the development of insufficiency, violations extend to energy and metabolic processes, and the optimal mode of operation cannot be provided.

The condition of disruption of adaptation can be shown in two forms: preillness (Premorbidity) and illness. Preillness is balance between health and illness or manifestation of initial symptoms of diseases. This condition contains information about the localization of possible pathological changes. This stage is reversible, since the observed deviations are functional in nature and are not accompanied by a significant anatomical and morphological restructuring [21, 24].

The leading sign of the disease is to limit the adaptive capacity of the organism. The insufficiency of general adaptation mechanisms in the disease is complemented by the development of pathological syndromes. It is associated with anatomical and morphological changes, which demonstrates emergence of the centers of local wear of structures. Despite the specific anatomical and morphological localization, the disease remains a reaction of the whole organism. It is accompanied by the inclusion of compensatory reactions, representing a physiological measure of the body's protection against the disease [20, 23].

To determine the effectiveness of adaptation processes, criteria and methods for diagnosing the functional states of the body were developed. Baevsky R.M. suggested to consider five main criteria: level of functioning physiological systems; degree of tension of regulatory mechanisms; functional reserve; extent of compensation; steadiness of elements of a functional system [1].

Diagnostic methods of functional states are directed to assessment of each of the listed criteria. Level of functioning physiological systems is defined by traditional physiological methods. Degree of tension of regulatory mechanisms is investigated the next ways: by methods of the mathematical analysis of a heart rhythm, by studying secretory function of salivary glands, daily fluctuations of physiological functions, etc.

To prevent premorbidity (prenosological conditions), it is important to control the functional state of the body of students. An effective method of assessing the state of health is a mathematical analysis of heart rhythm. Thanks to this method, physiological indicators have been established, the magnitude of which most clearly responds to the loss of health during the development of the disease [5, 11, 13, 22].

For this reason, purpose our research was studying adaptive opportunities of the cardiovascular system of foreign students to the climatic and geographical conditions of Stavropol region.

MATERIALS AND METHODS

Stavropol and foreign students were included in the cross-sectional study. The age of people is 17–21 years (the youthful period of ontogenesis) and 22–28 years (the first period of mature age). Foreign students are natives of the countries of the Southern Asia (India), the Western Asia (Cyprus, Kuwait, Lebanon, Palestine, Syria) and Africa (Morocco, Sudan). In total 218 students, from them the Russian students were examined: youths — 73 persons, men — 55 people; foreign students: youths — 36 people, men — 54 persons.

To analyze the heart rhythm, we used the method of variation pulsometry using a clinorostatic test on the Varicard 2.5 diagnostic device (Institute of Introduction of New Medical Technologies RAMENA) using the "Iskim 6.1" software.

The clinorotostatic test is a widely used test for studying the reserves of the autonomic regulation of blood circulation. It consists in registration the heart rate and blood pressure when a person moves from a lying position (horizontal position) to a standing position (vertical position). Analysis of the cardiointervalogram during the clinorostatic test with the calculation of the Stress Index allows us to estimate the vegetative reactivity. We used the STATISTICA 10 software package for data processing (StatSoft, USA). Differences were considered statistically significant at $p < 0.05$.

RESULTS AND DISCUSSION

In the horizontal position, youths from the Southern Asia in comparison with the Stavropol students are characterized by authentically big sizes of the Stress Index and amplitude of fashion (Table 1). Youths from the Western Asia and Africa illustrate the minimum values of mode, Standard deviation and variation scope. These results it is reliable below the specified parameters of youths of Stavropol Territory, and standard deviation of the African youths is significantly more same indicator of West Asian students. Analysis of stress index values for students from different climatic and geographic regions showed that their vegetative homeostasis, as well as among local youths, is within the normal range, but South Asian students have some tension of compensatory mechanisms, a higher level of functioning the sympathetic level and the central contour of heart rate regulation. Men of the Western Asia have a decrease of function of the central contour in the management of heart rate, as well as an increasing influence of the parasympathetic division.

Men from West Asia in a horizontal position are characterized by reliably maximum values of the stress index, the amplitude of the mode and minimum values of the standard deviation (Table 2). The maximum

Table 1. Results of the mathematical analysis of the heart rhythm of students of the youthful period of ontogenesis in the lying (horizontal) position, ($M \pm m$)

Statistical significance (P-value)	Stavropol Region	South Asia	West Asia	Africa
Stress Index				
	58,2±9,39	135,6±20,11	81,1±29,52	104,2±26,79
P1		<0,001	>0,10	>0,10
P2			>0,10	>0,10
P3				>0,10
Mode, s				
	822,6±20,47	634,2±18,48	692,8±32,82	534,8±116,97
P1		<0,001	<0,001	<0,02
P2			>0,10	>0,10
P3				>0,10
Amplitude of the mode, %				
	30,6±1,52	42,8±4,22	38,6±2,59	35,2±7,30
P1		<0,01	<0,01	>0,10
P2			>0,10	>0,10
P3				>0,10
Standard deviation, s				
	86,1±4,30	69,6±15,68	50,1±8,50	109,3±21,66
P1		>0,10	<0,001	>0,10
P2			>0,10	>0,10
P3				<0,05
Range, s				
	789,8±57,30	303,7±33,77	395,0±83,17	269,7±65,57
P1		<0,001	<0,001	<0,001
P2			>0,10	>0,10
P3				>0,10

Note: P1 — Significance of differences of indicators of South Asian, West Asian and African youths in comparison with the Stavropol youths; P2 — Significance of differences of indicators of West Asian and African boys compared with South Asian men; P3 — Significance of differences of indicators of African youths in comparison with West Asian youths.

values of the variation range were found in Stavropol students in comparison with men from the Western Asia. South Asian men in horizontal position have significantly lower values of mode, standard deviation and variation range than among representatives of the Stavropol region. All senior students have vegetative homeostasis in the normal range, this is confirmed by the values of the stress index. However, students from Western Asia have the highest tension of compensatory mechanisms, a high level of functioning the sympathetic part of the autonomic nervous system and the central contour of heart rhythm regulation. Stavropol men students have a decrease of role of the central contour in managing the heart rhythm, and in the autonomous contour they have a restructuring the relationship between the sympathetic and parasympathetic systems. As a result, we can see that the influence of the parasympathetic division increases.

Moving from horizontal to vertical position of students from South Asia and Africa, caused significant changes in the parameters of the cardiovascular system — an increase of variation range, indicating the activation of the parasympathetic division of the autonomic nervous system. Moving from a horizontal to a vertical position of students from Western Asia, caused significant changes in the parameters of the cardiovascular system — increase amplitude of the mode, indicating the activation of the sympathetic System, what provides the stability of hemodynamics in the vertical position. In the vertical position, South Asian youths have an increase of the stress index, low values of mode, low values of standard deviation, low values of variation range and high values of amplitude of the mode. At the same time, compared with students from South Asia, we can see significantly higher diastolic blood pressure values, large values of mode and low

Table 2. Results of the mathematical analysis of the heart rhythm of students of the first period of a maturity in the lying (horizontal) position, ($M \pm m$)

Statistical significance (P-value)	Stavropol Region	South Asia	West Asia	Africa
Stress Index				
	58,7±10,90	104,1±23,07	129,0±20,26	107,2±24,99
P1		>0,10	<0,01	>0,10
P2			>0,10	>0,10
P3				>0,10
Mode, s				
	831,4±22,30	692,0±24,73	731,1±22,26	587,0±72,05
P1		<0,001	<0,002	<0,002
P2			>0,10	>0,10
P3				>0,10
Amplitude of the mode, %				
	34,8±2,03	39,1±4,11	48,8±3,81	42,8±5,64
P1		>0,10	<0,002	>0,10
P2			>0,10	>0,10
P3				>0,10
Standard deviation, s				
	94,9±5,25	60,1±10,88	51,0±4,61	108,0±21,05
P1		<0,01	<0,001	>0,10
P2			>0,10	>0,10
P3				<0,01
Range, s				
	849,2±70,33	341,1±42,91	371,2±46,99	234,3±41,17
P1		<0,001	<0,001	<0,001
P2			>0,10	>0,10
P3				<0,05

Note: P1 — Significance of differences of indicators of South Asian, West Asian and African students in comparison with the Stavropol students. P2 — Significance of differences of indicators of West Asian and African students in comparison with the South Asian. P3 — Significance of differences of indicators of the African students in comparison with the West Asian.

values of stress index at West Asian and African students (Table 3).

In group of foreign senior students moving to horizontal position caused reliable changes of parameters of a cardiovascular system — it is increase amplitude of the mode at representatives from the Western Asia, which exceeded the same indicator at the Stavropol, South Asian and African men. Also we can see increase value of variation range at students of Africa, decrease the mode at the Stavropol students and decrease values of variation range at West Asian men. It demonstrates activation of sympathetic part of the autonomic nervous system at local senior students and parasympathetic — at African (Table 4). However, the stress index in a standing position among senior students from Africa was significantly lower than that of Asian representatives.

The assessment of vegetative reactivity revealed among the first-year students from South Asia the

prevalence of the asympathicotonic (pathological) variant — 50.0%, among the boys from Western Asia — equally hyper — and asympathicotonic variants (37.5%). The difference is African students had only asympathicotonic variant of vegetative reactivity. Assessment of autonomic reactivity in students of the first period of maturity, meaning a rapid restructuring the peripheral apparatus of the autonomic nervous system during performing a clinorotostatic test, also revealed three variants. Stavropol students (41.8%) had a normal reaction to the test. Asian students had hypersympathicotonic vegetative reactivity (50.0% — South Asia and 40.7% — West Asia), with an excessive connection of the sympathoadrenal system. Students from Africa had asympathicotonic (pathological) autonomic reactivity (72.7%).

Table 3. Results of the mathematical analysis of the heart rhythm of students of the youthful period of ontogenesis in the vertical position, ($M \pm m$)

Statistical significance (P-value)	Stavropol Region	South Asia	West Asia	Africa
Stress Index				
	76,4±11,75	106,8±15,41	70,9±8,46	51,8±10,43
P1		>0,10	>0,10	>0,10
P2			<0,01	<0,01
P3				>0,10
Mode, s				
	715,2±17,58	616,8±25,00	627,4±45,25	689,0±19,86
P1		<0,001	>0,10	>0,10
P2			>0,10	<0,05
P3				>0,10
Amplitude of the mode, %				
	32,7±1,68	48,9±4,07	56,5±6,14	39,7±7,96
P1		<0,001	<0,001	>0,10
P2			>0,10	>0,10
P3				>0,10
Standard deviation, s				
	86,5±4,45	55,4±7,98	52,8±6,07	66,2±6,83
P1		<0,001	<0,001	<0,02
P2			>0,10	>0,10
P3				>0,10
Range, s				
	670,5±46,74	490,6±63,60	460,6±39,62	650,3±118,36
P1		<0,05	<0,001	>0,10
P2			>0,10	>0,10
P3				>0,10

Note: P1 — Significance of differences of indicators of South Asian, West Asian and African youths in comparison with the Stavropol youths. P2 — Significance of differences of indicators of West Asian and African youths in comparison with South Asian youths. P3 — Significance of differences of indicators of the African youths in comparison with West Asian youths.

CONCLUSIONS

On the basis of indicators of a heart rhythm we found out that in horizontal position of the youths of Stavropol Krai have parasympathetic influence on a heart rhythm, and students of the I period of a maturity — sympathetic influence on a heart rhythm. In horizontal position South Asian youth and men have prevalence of a sympathetic part of the autonomic nervous system in regulation of a heart rhythm. Youth from West Asia and Africa have a predominance of parasympathetic influences, and men from the same regions have sympathetic influences. The data obtained by us coincides with the data of references [4, 6, 12]. In a horizontal position, all students have an activation of the sympathetic part of the autonomic nervous system in the regulation of heart rhythm, which is a normal reaction of the organism to a clinorotostatic test. The exception is made by the

African students who have increased parasympathetic influences.

Evaluation of autonomic reactivity revealed the following: African youths, South Asian youths and African men have more pronounced asympathicotonic reactivity among foreign students. The examined youths and men of the Western Asia have pathological options of vegetative reactivity (hypersympathicotonic and asympathicotonic). We can think about the individual specificity of the identified vegetative response, which has a constitutionally determined pattern of vegetative response, because students from Stavropol, South Asia, West Asia and Africa respond to the same stimulus with various changes in vegetative indicators.

During analyzing the indicators of the heart rhythm in the prone position and in the standing position, three types of adaptive responses of the vegetative regulation system were identified:

Table 4. Results of the mathematical analysis of the heart rhythm of students of the first period of a maturity in the vertical position, ($M \pm m$)

Statistical significance (P-value)	Stavropol Region	South Asia	West Asia	Africa
Stress Index				
	82,3±12,51	155,9±37,89	151,4±35,48	65,5±6,88
P1		>0,10	>0,10	>0,10
P2			>0,10	<0,05
P3				<0,02
Mode, s				
	711,7±18,91	626,8±31,91	609,4±26,62	536,0±45,52
P1		<0,05	<0,002	<0,001
P2			>0,10	>0,10
P3				>0,10
Amplitude of the mode, %				
	38,3±2,29	46,5±3,83	66,1±3,19	46,4±6,27
P1		>0,10	<0,001	>0,10
P2			<0,001	>0,10
P3				<0,01
Standard deviation, s				
	85,5±5,11	52,3±5,40	56,1±7,02	83,2±19,37
P1		<0,001	<0,001	>0,10
P2			>0,10	>0,10
P3				>0,10
Range, s				
	643,8±50,87	449,9±90,00	494,1±48,12	642,6±81,09
P1		>0,10	<0,05	>0,10
P2			>0,10	>0,10
P3				>0,10

Note: P1 — Significance of differences of indicators of South Asian, West Asian and African students in comparison with the Stavropol students. P2 — Significance of differences of indicators of West Asian and African students in comparison with South Asian students. P3 — Significance of differences of indicators of the African students in comparison with West Asian students.

1. Stable adaptive response, characterized by a balanced influence of the part of the autonomic nervous system on the heart rhythm and the preservation of hemodynamic homeostasis, typical mostly of Stavropol youths and men, and South Asian youths.
2. Compensatory response, manifesting by increased activity of the sympathetic part of the autonomic nervous system in the regulation of heart rhythm (youths and men from South and West Asia have it)
3. The condition of critical tension, expressed in the inhibition of the activity of the autonomous contour of the control and the decrease in the functional reserve of the circulatory system (it is typical for African boys and men).

Identifying the types of adaptive reactions of the vegetative regulation system allows us to estimate the

spectrum of the prenosological conditions of the body of students from different climatic and geographical regions from a stable adaptive response (young men of Stavropol and South Asian young people) to a condition of critical tension (African boys and men).

Thus, the vegetative homeostasis, indicating the adaptive abilities of the organism, reflects the state of health of students in the youthful period of ontogenesis and mature age (I period) in different climatic and geographical regions of the world. After assessing the level of health, the next stage is development of criteria for identifying risk groups, taking into account the already identified signs of possible pathology and disadaptation.

The results we obtained confirmed the greatest difference between the variational pulsometry index of African students and Stavropol students and confirmed the greatest similarity (and therefore adapta-

tion) of South and West Asian students to the climatic and geographical conditions of the Stavropol region, because the most optimal adaptation effect is achieved when morphofunctional parameters are similar (according to N.A. Agadzhanian) [2, 8].

Foreign students in South Asia, West Asia and Africa have the opportunity to adapt to the conditions of Stavropol, it depends on the period of ontogenesis (youth and adulthood). It can assume that the optimal adaptation effect is achieved by South Asian youths and West Asian men. The basis of the adaptation effect is the greatest similarity of the morphofunctional characteristics of nonresident and indigenous people. With some caution, we can talk about the unsatisfactory nature of the adaptation process among students from Africa. The results of this study allow to approach the task of purposeful management of the adaptation process, since adaptation to any factor is associated not only with the waste of energy, but also the structural resources of the body.

REFERENCES

1. **AGADZHANYAN N.A.** Adaptation and ethnic physiology: life expectancy and human health. Moscow: Publ. RUDN, 2009. 34 p. (In Russ.).
2. **AGADZHANYAN N.A.** Ecological and physiological features of adaptation of the body of students from different climatic and geographical regions to the conditions of study and life in Moscow in the acute period of adaptation. Ecology and Health: Materials of the Satellite Symposium of the 20th Congress of Russian Physiologists. Moscow: Publ. RUDN, 2007, pp. 1–3. (In Russ.).
3. **AXMADULLINA X.M.** Ecology and human health. Ufa: Publ. VEYuGA. 2017. 215 p. (In Russ.).
4. **GOVORUXINA A.A.** The functional state and regulatory and adaptive capabilities of the body of teachers and students in the North. Dr. Sci. (Biology) diss. Ulyanovsk, 2013, 43 p.
5. **KALININA I.N.** Ontogenetic aspects of the vegetative homeostasis of men and women 15–60 years old with different health conditions. Health, education and safety. 2016; 3 (7): 7–18. (In Russ.).
6. **ANFINOGENOVA O.I.** The assessment of the status of non-specific protection factors for the first-year students in the framework of the "Electronic Health Passport project" // Biodiversity, bioresources, biotechnologies and population health in the North Caucasus region. Materials of the I-st scientific and practical conference "University science to the region" (April 5–26, 2013). – Stavropol: NCFU Publishing House, 2013. – 244 p.
7. **KASHINA YU.V.** Assessment of students' adaptation at the beginning and at the end of the school year according to heart rate variability. Basic research. 2014;10(3);514–517. (In Russ.).
8. **KUCHERUK V.V.** Selected Works on Natural Disease Nidality. Moscow: Publ. RUSAKI, 2006, 306 p.
9. **LISOVA I.M.** Adaptation possibilities and constitutional features of the body of students from different climatic and geographical regions Ph.D. (Biology) Thesis. Stavropol, 2002. 22 p.
10. **SAMAROV V.V., GULIN A.V., ZASYADKO K.I.** Features of the functional state of the cardiovascular system of the body of students from South-East Asia and Africa in the process of adaptation to the process of learning in the university. Bulletin of the University of Tambov. Series: Natural and Technical Sciences. 2012; 17; 4; 1303–1305.
11. **ANFINOGENOVA O.I.** Ethnic peculiarities of morphometric parameters of peripheral blood in assessment of health of the first-year students. Materials of the II All-Russian Scientific and Practical Conference dedicated to the 90th anniversary of the birth of Academician N.A. Agajanian. 2018. pp. 25–26.
12. **SATARKULOVA A.M.** Dynamics of heart rate changes in foreign students in the course of the annual cycle of study. Bulletin of the KSMA them. I.K. Akhunbaeva. 2018;1;14–19. (In Russ.).
13. **SUBBOTINA N.S., DORSHAKOVA O.V., KOZLOVSKAYA E.M., BELOUSOVA G.P.** The state of vegetative regulation of heart rhythm in chronic cerebrovascular insufficiency. Scientific notes of Petrozavodsk State University. 2015;4(149);55–60. (In Russ.).
14. **SHHANKIN A.A., KOSHELEVA O.A.** Constitutional features of the circulatory system and electrical potentials of the heart at rest and during muscular activity. Moscow: Publ. Berlin: Direkt-Media, 2015, 111 p.
15. **M.D. JERZY SACHA.** Interaction between heart rate and heart rate variability. Ann Noninvasive Electrocardiol. 2014; Vol. 19 (3);207–216. doi: 10.1111/anec.12148.
16. **J.R. SHIE, T.Y. CHEN, C.W. KAO.** The Effect of Exercise Training on Heart Rate Variability in Patients With Hemodialysis: A Systematic Review. Hu Li Za Zhi. 2018;Feb;66(1);70-83. doi: 10.6224/JN.201902_66(1).09.
17. **LAKIN G.F.** Biometrics / Study Guide for Biol. specialist. universities, 4th ed., Pererab. and additional - M.: Higher School, 1990. – 352 p.
18. **YU.K. NOVODERZHKINA, Z.G. SHISHKANOVA, G.I. KOZINETS.** Configuration and surface of blood cells in health and disease. M., 2004. - 153 p.
19. **DOMENYUK D.A., ZELENSKY V.A., RZHEPAKOVSKY I.V., ANFINOGENOVA O.I., PUSHKIN S.V.** Application of laboratory and x-ray central studies in early diagnostics of metabolic disturbances of bone tissue in children with autoimmune diabetes mellitus. Entomology and Applied Science Letters. 2018; 5(4): 1–12.
20. **GILMIYAROVA F.N., DAVYDOV B.N., DOMENYUK D.A., IVCHENKO L.G.** Influence of severity of type I diabetes mellitus in children on dental status and immunological, biochemical parameters of blood serum

- and oral fluid. Part I. *Parodontologiya*. 2017; Vol. XXII; 2 (83): 53–60. (In Russ.).
21. **GILMIYAROVA F.N., DAVYDOV B.N., DOMENYUK D.A., IVCHENKO L.G.** Influence of severity of type I diabetes mellitus in children on dental status and immunological, biochemical parameters of blood serum and oral fluid. Part II. *Parodontologiya*. 2017; Vol. XXII; 3 (84): 36–41. (In Russ.).
 22. **DAVYDOV B.N., DOMENYUK D.A., BYKOV I.M., IVCHENKO L.G., DMITRIENKO S.V.** Modern possibilities of clinical, laboratory, X-ray studies in preclinical diagnosis and prediction of the risk of developing periodontal diseases in children with diabetes mellitus type one. Part I. *Parodontologiya*. 2018; Vol. XXIV; 3-24 (88): 4–11. (In Russ.). DOI: 10.25636/PMP.1.2018.3.1
 23. **DAVYDOV B.N., DOMENYUK D.A., DMITRIENKO S.V.** Peculiarities of microcirculation in periodont tissues in children of key age groups sufficient type 1 diabetes. Part I. *Parodontologiya*. 2019; Vol. XXIV; 1–24 (90): 4–10. (In Russ.). DOI: 10.25636/PMP.1.2019.1.1
 24. **DOMENYUK D.A., PORFYRIADIS M.P., BUDAYCHIEV G. M-A.** Contemporary methodological approaches to diagnosing bone tissue disturbances in children with type i diabetes. *Archiv EuroMedica*, 2018; 8(2): 71–81.
 25. **DOMENYUK D.A., ZELENSKY V.A., DMITRIENKO S.V., ANFINOGENOVA O.I., PUSHKIN S.V.** Peculiarities of phosphorine calcium exchange in the pathogenesis of dental caries in children with diabetes of the first type. *Entomology and Applied Science Letters*. 2018; 5(4): 49–64.