al'nogo okruga [On the question of the emerging system of continuous medical education in Russia in the opinions of doctors and health care organizers of the Far Eastern Federal District]. Tihookeanskij medicinskij zhurnal [Pacific Medical Journal. 2017; 3: 75-89 (In Russ.).]

3. Valeev R. Opros Minzdrava: medrabotniki schitayut, chto vnedryat' sistemu NMO ne sleduet [Survey of the Ministry of Health: health workers believe not to implement the Continuing Medical Education system]. February 08, 2018 (In Russ.).] URL: https://lekoboz.ru/professiya-farmatsevt/career/opros-minzdrava-medra wbotniki-schitayut-chto-vnedryat-sistemu-nmo-ne-sleduet.

4. Zakharenko G.A., Kurlyanchik A.A. Osobennosti prohozhdeniya akkreditacii v 2021 g. [Features of accreditation in 2021.] Med. obrazovanie i professional'noe razvitie.[Meditsinskoe obrazovanie i professional'noe razvitie. 2021; 12(2): 136–141 (In Russ.).] (DOI: https://doi.org/10.33029/2220-8453-2021-12-2-136-141.

5. Zvonnikov V.I., Svistunov A.A., Semenova T.V. Ocenka professional'noj gotovnosti specialistov v sisteme zdravoohraneniya [Assessment of the professional readiness of specialists in the healthcare system] pod red. T.V. Semenovoj. M. [ed. T.V. Semenova.: GEOTAR-Media, 2019; 272 (In Russ.).]

6. Ob obrazovanii v Rossijskoj Federacii. [On Education in the Russian Federation] Federal'nyj zakon ot 29.12.2012 N 273-FZ (poslednyaya redakciya) [Federal Law. 12/29/2012 N 273-FZ (last edition) (In Russ.).] URL: https://www.consultant.ru/document/cons_doc_LAW_140174/.

7. Ob osnovah ohrany zdorov'ya grazhdan v Rossijskoj Federacii [On the basics of protecting the health of citizens in the Russian Federation]. Federal'nyj zakon ot 21.11.2011 n 323-fz (red. ot 28.12.2022) [Federal Law N. 323-fz of 11/21/2011 (as amended on 12/28/2022) (In Russ.).] URL: https://www.zakonrf.info/zakon-o-zdorovye-grazhdan/

8. Ob utverzhdenii Polozheniya ob akkreditacii specialistov № 1081[On approval of the Regulation on Accreditation of Specialists № 1081 n. November 22, 2021 (In Russ.).] URL: http://publication.pravo.gov.ru/Document/View/0001202111300081.

9. Otdel'nov L.A., Goroh O.V. Sovremennye podhody k obucheniyu programmam Point-of-care ultrasound [Modern approaches to teaching programs Point-of-care ultrasound.] Medicinskoe obrazovanie i professional'noe razvitie.[Meditsinskoe obrazovanie i professional'noe razvitie. 2021; 12 (2): 86–94 (In Russ.).] DOI: https://doi.org/10.33029/2220-8453-2021-12-2-86-94.

10. Oficial'nyj internet-portal pravovoj informacii [Official Internet portal of legal information] (In Russ.).] URL:http://publication.pravo.gov.ru/Document/View/0001202102150018.

11. Prikaz MZ RF ot 28.10.2022 N 709n «Ob utverzhdenii Polozheniya ob akkreditacii specialistov» dejstvitelen do 01.01.2029 g. [On approval of the Regulations on the accreditation of specialists, Order of the Ministry of Health of the Russian Federation of October 28, 2022 N 709n is valid until 01.01.2029. (In Russ.).] URL: https://www.garant.ru/products/ipo/prime/doc/405742919/.

12. Professor akademii nepreryvnogo profobrazovaniya Minzdrava RF Zalim Balkizov: Probely v normativnoj baze prepyatstvuyut real'nomu povysheniyu kvalifikacii vrachej [Zalim Balkizov, Professor of the Academy of Continuous Vocational Education of the Ministry of Health of the Russian Federation: Gaps in the regulatory framework hinder real professional development of doctors.] Rossijskaya gazeta - Special Issue: Pharmaceutics. 287 (8935). URL: https://rg.ru/2022/12/20/doktor-obiazan-uchitsia.html

13. Reshetnikov A.V. Sociologiya mediciny [Sociology of medicine]. Moscow: Medicine. 2002; 975.

14. Shumatov V.B., Krukovich E.V., Trusova L.N., Rasskazova V.N. Rol' medicinskogo vuza v realizacii gosudarstvennoj politiki v oblasti nepreryvnogo professional'nogo obrazovaniya kadrov dlya sistemy zdravoohraneniya dal'nevostochnogo regiona [The role of the medical university in the implementation of the state policy in the field of continuing professional education of personnel for the healthcare system of the Far Eastern region]. Mezhdunarodnyj zhurnal prikladnyh i fundamental'nyh issledovanij [International Journal of Applied and Fundamental Research. 2014, 8 (4): 69-73 (In Russ.).]

15. Artino A. R. Jr, La Rochelle J. S., Dezee K. J., Gehlbach H. Translation from English edited by A.Y. Alekseeva. Rukovodstvo AMEE № 87. Razrabotka anket dlya nauchnyh issledovanij v oblasti medicinskogo obrazovaniya [Developing questionnaires for educational research: AMEE Guide No. 87]. Medicinskoe obrazovanie [Medical education. 2021. 12. 2. rosmedobr.ru. (In Russ.).] URL: https://www.rosmedobr.ru/journal/2021/rukovodstvo-amee-87-razrabotka-anket-dlya-nauchnykh-issledovaniy-v-oblasti-meditsinskogo-obrazovaniya/.

16. Fadeeva E. V. Elektronnoe zdravoohranenie sdelaet medicinu dostupnee? [Will electronic healthcare make medicine more accessible?]. Sociologicheskie issledovaniya [Sociological research]. 2020; 11: 68-75 (In Russ.).] URL: http://ras.jes.su/socis/s013216250010580-1-1 (date of application: 16.02.2023). DOI: 10.31857/S013216250010580-1.

17. Olgers T.J., Azizi N., Blans M.J., [et al.]. Point-of-care ultrasound (PoCUS) for the internist in acute medicine: a uniform curriculum. Neth J Med. 2019; 77 (5): 168–76. DOI: https://doi.org/10.1186/s12909–020–1949–4.

HYGIENE, SANITATION, EPIDEMIOLOGY AND MEDICAL ECOLOGY

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FEATURES OF STRESS-IMPLEMENTING AND REGULATORY SYSTEMS OF THE BODY OF MEDICAL STUDENTS IN HIGH LATITUDES

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The aim of the study was to study the influence of the level of situational (SA), personal anxiety (PA) on the psycho-emotional state of the body and the cardiovascular system (CS) in high latitudes. The study involved 65 people (girls, age 18.67± 3.75 years) who filled out questionnaires of differentiated self-assessment of functional status (WAM), the methodology for determining the level of situational anxiety and personal anxiety by C. D. Spielberger and Y. L. Khanin. The heart rate variability (HRV) indicators were recorded using the Omega-M hardware diagnostic medical complex. To quantify the concentration of cortisol in blood serum, the method of solid-phase enzyme immunoassay was used. To analyze the prevalence of vitamin D deficiency, an enzyme immunoassay was used to quantify 25-OH in serum and plasma. It is shown that with a change in the level of anxiety, the subjective assessment of well-being, activity, and mood decreases. At the functional level of the work of the cardiovascular system, significant differences were found in the form of changes in the temporal and frequency characteristics of the HRV, in which the influence of the mechanisms of sympathetic modulation of the heart rhythm prevails. The functional state of the hypothalamic-pituitary-adrenal system (HPAS), estimated as the quantitative content of cortisol in the blood and does not change depending on the level of anxiety. Significant differences in the level of vitamin D in the blood and its general deficiency in the study participants were shown.

Keywords: well-being, activity, mood, situational and personal anxiety, cortisol, vitamin D, heart rate variability.

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Introduction. The Geneva Conference of 1964 defined the territories lying north of 66°33 north latitude to be designated by the term "high latitudes" [1].Living here is determined by the influence of a number of external factors, among which the cold factor, contrast photoperiodics, heliogeomagnetic effects, color

deprivation, the peculiarity of the diet, etc. stand out. Currently, it is considered that the effects on the human body of non-runaway climatic stimuli are integrative in nature [2-4]. The process of adaptation to living conditions in "high latitudes" has certain features, including hemodynamic, vasomotor, psychoemotional and others [5-7]. It is important to note that adaptation processes are not only physiological in nature, but also manifest themselves through psychological and social features. "Severeral climatic and geophysical conditions of the northern latitudes cause the development of northern stress in humans ("polar stress syndrome")"[8]. One of the manifestations of this syndrome is free-floating anxiety of varying severity, as well as physiological deviations of regulatory systems, manifested by the dominance of sympathicotonic vegetative reactions. With prolonged exposure, the polar stress syndrome can lead to the development of various psychosomatic forms of pathology.

Understanding the impact of all of the above factors and, in particular, establishing a link between the state of regulatory systems and stress markers contributes to solving the issues of human adaptation to unchangeable environmental factors. The study of regional peculiarities and mechanisms of the formation of the health of children and adolescents living in various territories of the Russian Federation is of great importance for the preservation of the health of the younger generation [9, 10].

Methodology. Comparative results of a cross-sectional study of the psychophysiological state (PPHS) of 1st-year students of the Kola Medical College (KMC) in Apatity, Murmansk region in the number of 65 people (girls, average age 18.67±3.75 years) are presented. The study was conducted in the autumn period (october), before the session, after school, in the evening. At the time of the study, the selection criterion was the absence of complaints and diseases in the acute stage of the course. Anonymous questioning allowed to obtain information about the phase of the ovarian-menstrual cycle (OMC) and differentiate the subjects into groups. The participants were familiarized with the purpose, conditions and methods of the study with the provision of written consent to the processing of personal data. The possibility of conducting the study was confirmed by the local ethics committee, Protocol No. 11 of 19.12.2016.

The psychophysiological state was assessed by the following methods: C. D. Spielberger – Y. L. Khanin, situational (SA) and personal (PA) anxiety, at the

Table 1

Indicators of HRV, well-being, activity, mood, vitamin D and cortisol levels at low and medium levels of anxiety

	Situational anxiety		p-уров.	Personal anxiety		p-уров.
Level	<=30 (n=9)	31-44 (n=37)		<=30 (n=9)	31-44 (n=37)	
HR (b/pm)	70.22±1.92	70.83±1.86	0.977	59.1±4.45	72.62±2.12	0.052
RRNN (ms)	858.39±23.86	864.49±22.26	0.977	1032.17±85.48*	847.24±24.15*	0.045*
R-R min (ms)	664.67±21.3	696.39±17.11	0.383	699.83±20.74	688.81±17.74	0.715
R-R max (ms)	1061.39±47.44	1043.59±33.42	0.718	1269±65.9*	1026.5±38.96*	0.038*
SI	107.78±39	119.87±22.69	0.657	22.3±1.37	138.47±28.04	0.059
RMSSD (ms)	82.29±18.96	78.48±10.87	0.579	146.17±35.73*	69.29±10.5*	0.038*
pNN50 (%)	41.52±9.77	37.48±4.28	0.677	74±4.5*	32.68±4.55*	0.012*
SDNN (ms)	75.36±13.48	69.45±7.09	0.618	113±20.04	65.27±7.25	0.068
CV (%)	8.6±1.36	7.81±0.69	0.454	11.3±2.47	7.42±0.66	0.114
AMo (%)	33.58±5.49	37.27±2.58	0.390	24.1±3.88	38.78±2.89	0.078
TP (ms^2)	5055.06±1300.33	4557.48±697.15	0.781	7884.17±1255.53	4613.56±811.69	0.145
HF (ms^2)	2155.78±770.55	2446.13±514.72	0.955	4502.5±1434.43	2415.58±600.83	0.089
LF (ms^2)	1384.22±452.61	1096.54±158.52	0.677	1485.5±425.81	1193.77±211.32	0.331
VLF (ms^2)	1514.94±571.7	1014.67±157.19	0.824	1896±1211.18	1004.13±157.28	0.395
%HF	42.52±7.67	43.95±3.45	0.739	62.23±18.26	40.33±3.59	0.224
%LF	28.01±5.22	26.95±1.54	0.824	16.23±5.52	29.08±1.75	0.052
%VLF	29.53±7.18	29.13±2.67	0.835	21.6±12.99	30.63±2.74	0.362
LF/HF	0.92±0.21	1.06±0.18	0.657	0.4±0.25	1.22±0.2	0.114
Index of vegetative equilibrium	132.43±45.92	165.25±25.68	0.406	45.23±8.05	177.51±29.64	0.078
Vegetative rhythm indicator	2.89±0.99	3.59±0.51	0.438	1.9±0.2	4.18±0.58	0.202
An indicator of the adequacy of regulatory processes	41.5±7.31	46.08±4.09	0.406	24.17±0.97	48.73±4.79	0.073
Well-being	5.76±0.26*	4.77±0.17*	0.016*	6±0.64	5.02±0.19	0.181
Activity	5.09±0.32	4.41±0.13	0.056	5.47±0.47	4.57±0.17	0.162
Mood	6.37±0.13*	5.42±0.16*	0.007*	6.33±0.18	5.65±0.16	0.171
Vitamin D	17.34±3.78*	9.32±1.49*	0.037*	22.27±5.38	9.9±1.6	0.067
Cortisol	535.03±23.8	569.43±13.86	0.689	524.81±25.46	565.33±27.72	0.942

*– significantly significant differences.

level of 30 and less points – low, 31-45 – average, 46 and more – high [11];, at the level of 30 and less points – low, 30-50 – average, 50 and more – high indicators [12], the "Individual minute" test according to the Halberg method (1969) with indicators of 30 seconds. and less – mental instability, 30-40 – high anxiety, 40-55 – mild anxiety and 55-65 – optimal condition.

The physiological state of the body was assessed by indicators of heart rate variability (HRV). The conditions for the registration of HRV indicators were carried out in standard leads, in a lying position, at rest, for 5 minutes using the Omega-M hardware diagnostic medical complex (research and production company «Dynamics», St. Petersburg) in accordance with the standards adopted in 1996. standards of measurement, physiological interpretation and clinical use of HRV indicators [13].HRV assessment included the following data: time indicators of the cardiorhythmogram: "R–R (ms) is the average interval, SDNN (ms) is the standard deviation of NN intervals, RMSSD (ms) is the square root of the sum of the squares of the difference in the values of consecutive pairs of intervals NN, <...> the voltage index of regulatory systems (Si, u. e.) – the state of the central regulation circuit; <...> spectral analysis by nonparametric fast Fourier transform method: high–frequency range (HF, ms^2)–0.4–0.15 Hz, low–frequency range (LF, ms^2)–0.15–0.04 Hz, very low-frequency range (VLF, ms^2) - 0.04-0.003 Hz and total power of the spectrum (TP, ms^2)" [14]; analysis of the structure of wave power contributions (HF,%, LF,%, VLF,%), LF/HF balance – the ratio of sympathetic, parasympathetic effects and secondary indicators of variational pulsometry according to RM. To Bayevsky: index of vegetative equilibrium, vegetative indicator of rhythm, indicator of the adequacy of regulatory processes [14].

To assess the functional state of the hypothalamic-pituitary-adrenal system (HPAS), quantitative determination of the concentration of cortisol in human blood serum by solid-phase enzyme immunoassay using a set of reagents "Steroid ELISA-cortisol" ("Alkor–bio", St. Petersburg) was used. A range of reference values from the sets was used as normative indicators.

To analyze the prevalence of vitamin D deficiency, an enzyme immunoassay for

Table 2

Indicators of HRV. well-being. activity. mood. vitamin D and cortisol levels at low and high levels of anxiety

	Situational anxiety		p- level	Personal anxiety		p- level
Level	<=30 (n=9)	>45 (n=19)		<=30 (n=9)	>45 (n=19)	
HR (b/pm)	70.22±1.92	78.29±2.44	0.052	59.1±4.45*	74.79±1.75*	0.007*
RRNN (ms)	858.39±23.86	799.44±23.67	0.140	1032.17±85.48	822.17±16.6	0.011*
R-R min (ms)	664.67±21.3	677.79±17.45	0.921	699.83±20.74	681.79±16.55	0.638
R-R max (ms)	1061.39±47.44	955.53±33.37	0.115	1269±65.9*	989.76±23.8*	0.009*
SI	107.78±39	150.48±29.94	0.192	22.3±1.37*	128.34±19.89*	0.011*
RMSSD (ms)	82.29±18.96	50.96±6.88	0.140	146.17±35.73*	65.27±9.71*	0.026*
pNN50 (%)	41.52±9.77	27.65±5.27	0.237	74±4.5*	33.29±4.55*	0.013*
SDNN (ms)	75.36±13.48	52.17±5.67	0.153	113±20.04*	60.71±6.51*	0.026*
CV (%)	8.6±1.36	6.39±0.57	0.184	11.3±2.47	7.25±0.69	0.097
AMo (%)	33.58±5.49	39.98±3.68	0.218	24.1±3.88	37.99±2.9	0.141
TP (ms^2)	5055.06±1300.33	2919.91±635.34	0.218	7884.17±1255.53*	3353.92±542.84*	0.048*
HF (ms^2)	2155.78±770.55	1210.01±328.26	0.279	4502.5±1434.43*	1463.35±281.92*	0.026*
LF (ms^2)	1384.22±452.61	874.65±215.91	0.301	1485.5±425.81	895.89±156.2	0.124
VLF (ms^2)	1514.94±571.7	835.04±167.45	0.622	1896±1211.18	994.47±198.73	0.363
%HF	42.52±7.67	36.17±3.79	0.605	62.23±18.26	41.1±3.43	0.178
%LF	28.01±5.22	30.41±2.35	0.712	16.23±5.52	27.33±1.8	0.085
%VLF	29.53±7.18	33.48±3.83	0.431	21.6±12.99	31.61±3.39	0.273
LF/HF	0.92±0.21	1.24±0.27	0.749	0.4±0.25	1±0.18	0.149
Index of vegetative equilibrium	132.43±45.92	195.33±32.68	0.184	45.23±8.05*	176.1±25.12*	0.026*
Vegetative rhythm indicator	2.89±0.99	4.14±0.8	0.506	1.9±0.2	3.41±0.59	0.638
An indicator of the adequacy of regulatory processes	41.5±7.31	53.32±5.86	0.375	24.17±0.97*	49.27±4.22*	0.022*
Well-being	5.76±0.26*	3.81±0.24*	0.0003*	6±0.64*	4.06±0.18*	0.033*
Activity	5.09±0.32*	3.71±0.17*	0.001*	5.47±0.47*	3.89±0.13*	0.009*
Mood	6.37±0.13*	4.27±0.27	0.0001*	6.33±0.18*	4.64±0.23*	0.03*
Vitamin D	17.34±3.78	9±1.86	0.057	22.27±5.38*	9.2±1.64*	0.049*
Cortisol	519.73±34.42	569.43±13.86	0.805	543.5±25.3	565.33±27.72	0.933

*– significantly significant differences.

the quantitative determination of 25-OH vitamin D in serum and plasma "25-OH Vitamin D (total) ELISA" ("DRG Instruments", Marburg, Germany) was used.

Statistical processing of the results was performed using the software package "Microsoft Excel 2007" (Microsoft company), software "Statistica 10.0" (TIBCO company) and is represented by the arithmetic mean (M), standard error (± m). The difference indicators were calculated using the Mann-Whitney U–test and were considered statistically significant at the $p<0.05$ level.

Results and discussion. A comparative analysis of the indicators of the psychophysiological state of the body of students was carried out by ranking the results of the study by the level of anxiety and OMC using an anonymous questionnaire, selected techniques and cardiohemodynamics (HRV) data. To do this, the students were divided into groups: low SA and PA (group 1), medium SA and PA (group 2) and high SA and PA (group 3) and mixed type (low SA and high PA; high SA and low PA), as well as by FMC: group 1–follicular phase (FF), group 2 –luteal phase (LF). Since no significant differences were found in the groups with mixed SA and PA indicators, they were excluded for further comparative analysis.

A posteriori comparisons of intergroup indicators of HRV and psycho-emotional state showed the following results. Significant differences between groups 1 and 2 in the SA category are noted only by the WAM method, in the categories of well-being ($U = 79.5$, $p = 0.016$) and mood ($U = 69.5$, $p = 0.007$). This suggests that in group 1 with low SA indicators, subjective feelings of well-being and mood, which is characterized by unaccountability and low severity, the comfort of the physiological and psychological state was assessed higher than in group 2 [15]. Also, significant differences between these groups were found in the level of vitamin D ($U = 49.0$, $p = 0.037$), higher data were noted in group 1. This suggests that in group 2, the subjects have a predisposition to a potentially significant risk factor for the development of diseases associated with a reduced concentration of vitamin D in the blood [16-21]. Statistical analysis of HRV indicators, when compared in the

Table 3

Indicators of HRV, well-being, activity, mood, vitamin D and cortisol levels at medium and high levels of anxiety

	Situational anxiety		p-уров.	Personal anxiety		p-уров.
Level	31-44 (n=37)	>45 (n=19)		31-44 (n=37)	>45 (n=19)	
HR (b/pm)	70,83±1,86*	78,29±2,44*	0,02*	72,62±2,12	74,79±1,75	0,363
RRNN (ms)	864,49±22,26	799,44±23,67	0,079	847,24±24,15	822,17±16,6	0,506
R-R min (ms)	696,39±17,11	677,79±17,45	0,359	688,81±17,74	681,79±16,55	1,000
R-R max (ms)	1043,59±33,42	955,53±33,37	0,103	1026,5±38,96	989,76±23,8	0,568
SI	119,87±22,69	150,48±29,94	0,249	138,47±28,04	128,34±19,89	0,563
RMSSD (ms)	78,48±10,87	50,96±6,88	0,166	69,29±10,5	65,27±9,71	0,953
pNN50 (%)	37,48±4,28	27,65±5,27	0,194	32,68±4,55	33,29±4,55	0,953
SDNN (ms)	69,45±7,09	52,17±5,67	0,179	65,27±7,25	60,71±6,51	0,723
CV (%)	7,81±0,69	6,39±0,57	0,311	7,42±0,66	7,25±0,69	0,817
AMo (%)	37,27±2,58	39,98±3,68	0,597	38,78±2,89	37,99±2,9	0,670
TP (ms^2)	4557,48±697,15	2919,91±635,34	0,161	4613,56±811,69	3353,92±542,84	0,493
HF (ms^2)	2446,13±514,72	1210,01±328,26	0,150	2415,58±600,83	1463,35±281,92	0,659
LF (ms^2)	1096,54±158,52	874,65±215,91	0,291	1193,77±211,32	895,89±156,2	0,502
VLF (ms^2)	1014,67±157,19	835,04±167,45	0,533	1004,13±157,28	994,47±198,73	0,598
%HF	43,95±3,45	36,17±3,79	0,158	40,33±3,59	41,1±3,43	0,761
%LF	26,95±1,54	30,41±2,35	0,291	29,08±1,75	27,33±1,8	0,323
%VLF	29,13±2,67	33,48±3,83	0,341	30,63±2,74	31,61±3,39	1,000
LF/HF	1,06±0,18	1,24±0,27	0,203	1,22±0,2	1±0,18	0,497
Index of vegetative equilibrium	165,25±25,68	195,33±32,68	0,283	177,51±29,64	176,1±25,12	0,723
Vegetative rhythm indicator	3,59±0,51	4,14±0,8	0,659	4,18±0,58	3,41±0,59	0,220
An indicator of the adequacy of regulatory processes	46,08±4,09	53,32±5,86	0,279	48,73±4,79	49,27±4,22	0,795
Well-being	4,77±0,17*	3,81±0,24*	0,002*	5,02±0,19*	4,06±0,18*	0,0003*
Activity	4,41±0,13*	3,71±0,17*	0,002*	4,57±0,17*	3,89±0,13*	0,002*
Mood	5,42±0,16*	4,27±0,27*	0,0007*	5,65±0,16*	4,64±0,23*	0,001*
Vitamin D	9,32±1,49	9±1,86	0,611	9,9±1,6	9,2±1,64	0,641
Cortisol	519,73±34,42	535,03±23,8	0,673	524,81±25,46	543,5±25,3	0,534

*Статистически значимые различия.

PA category, by changes in the duration of consecutive intervals showed significant differences in the following temporal characteristics of heart rate: RRNN (ms) (U = 13.0, p = 0.045), R-R max (ms) (U = 12.0, p = 0.038), RMSSD (ms) (U = 12.0, p = 0.038) and pNN50 (%) (U = 5.0, p = 0.012), where higher rates were noted in group 1 (see Table 1). This suggests that in group 1, the modulation of the heart rate is determined by high-frequency fluctuations of the heart rhythm with the predominant influence of the parasympathetic division of the autonomic nervous system (ANS) [22].

When comparing the indicators between groups 1 and 3, significant differences in the SA category are noted in the WAM test: well-being (U=11.5, p=0.0003), activity (U=20.0, p=0.001), mood (U=6.5, p=0.0001), where the indicators are higher in group 1. This suggests that in the group with low SA, the qualitative characteristic of the subjective state is indicated to be more comfortable both psychologically and physiologically. Statistical analysis of HRV data, when compared in the PA category, by changes in the duration of consecutive intervals showed significant differences in the following heart rate characteristics (by time indicators): HR (beats/min) (U=2.00, p=0.007) with the reverse sign, RRNN (ms) (U=4.00, p=0.001), R-R max (ms) (U=3.00, p=0.009), SI (U=4.00,p=0.001), RMSSD (ms) (U=9.00,p=0.026), pNN50 (%) (U=5.00, p=0.013), SDNN (ms) (U=9.00, p=0.026); (by frequency characteristics): TR (ms2) (U=13.00, p=0.048), HF (ms2) (U=9.00, p=0.026); (according to secondary indicators of variational heart rate monitoring): Hebrew (U=9.00, p=0.026) and PAPR (U=8.00, p=0.022) with the opposite sign. HRV data show that in group 1, the temporal characteristics of the heart rate are mainly due to the influence of the parasympathetic department of the ANS, which in turn indicates a more energy-efficient way of heart rate modulation. The voltage index of regulatory systems is more pronounced in group 2, which indicates the predominant activity of sympathetic regulation mechanisms and a more energy-consuming behavior of the state of the central circuit [22]. Frequency analysis of HRV showed that the data of the total power spectrum (TP) and high-frequency oscillations (HF) of the wave structure of heart rate variability predominate in group 1, which suggests that the total neurohumoral activity is influenced by the activation of vagal heart rate control with a predominant predominance of the parasympathetic department of the ANS. Secondary indicators of variational heart rate monitoring are more pronounced in the group with high PA (group 2), which also indicates the modulating effect of the sympathetic department of the ANS on heart rate indicators [22]. In the PA category, during the intergroup comparison, significant differences are also shown in the results according to the WAM method: well-being (U=10.5, p=0.033), activity (U=3.00, p=0.009), mood (U=10.00, p=0.030). These data show that the subjective assessment of the functional state in group 1 is higher than in group 3, which indicates a more comfortable state in the group with low LT indicators. Significant differences between these groups were also found in serum vitamin D levels (U=9.00, p=0.049), higher data were also found in group 1 (see Table 2). Low vitamin D levels in the group with high PA indicate short-term or long-term possibilities for the development of infectious diseases, diseases with metabolic disorders and others [23-25].

Analysis of HRV data in comparison between groups 2 and 3 showed significant differences in HR rhythm characteristics (beats/min.) (U=217.00, p=0.020). Although the heart rate values in the studied groups are in the zone of reference values for their age period, nevertheless, in group 3, the indicators are close to the upper limit of the norm. Significant differences in the WAM technique are also shown, both in the SA category: well-being (U=179.50, p=0.002), activity (U=177.50, p=0.002), mood (U=157.00, p=0.0007) and in the PA category: well-being (U=217.00, p=0.0003), activity (U=258.50, p=0.002), mood (U=240.00, p=0.001) (see Table 3). This indicates that in group 2, the subjective assessment of the functional state exceeds the indicators of group 3 in both SA and PA and corresponds to a more comfortable psychological and physiological state of the subjects.

The state of the HPAS, depending on the level of anxiety, was assessed by the concentration of cortisol in the blood. The average cortisol level in the study groups was (535.25±16.9 nmol/L). Cortisol indices did not exceed the reference values for SA in group 1 (519.73±34.42nmol/L), group 2 (535.03±23.8 nmol/L) and in group 3 (569.43±13.86 nmol/L), for LT in group 1 (543.5±25.3 nmol/L), group 2 (524.81±25.46 nmol/L) and in group 3 (565.33±27.72 nmol/L). No significant differences in the background concentration of the hormone were found. In an intergroup comparison, depending on the stage of the ovarian-menstrual cycle (OMC), significant differences were revealed. In the group of subjects in the follicular phase of OMC, the cortisol level is significantly higher (589.30±6.77 nmol/L) than in the group of girls in the luteal phase of OMC (369.61±34.31 nmol/L), which is confirmed by literature data [26-30]. Thus, at the time of the study, the level of cortisol is reflected by the HPAS only depending on the stage of OMC.

The prevalence of vitamin D deficiency, depending on the level of anxiety, was determined by a quantitative determination test in serum and plasma. The average value of vitamin D in the study groups was 10.33±1.18ng/ml. The indicators are significantly lower than the reference values, which indicates a significant deficiency of vitamin D in all the study groups. At the same time, in group 1, the vitamin D index was (17.34±3.78ng/ml), in group 2 (9.32±1.49ng/ml) and in group 3 (9±1.86ng/ml), respectively. Significant differences in the concentration of vitamin D in the blood were found between group 1 and 3. This suggests that vitamin D deficiency may indirectly affect the level of situational and personal anxiety [31,32]. During the intergroup comparison, depending on the stage of the ovarian-menstrual cycle (OMC), significant differences were also revealed. In the group of subjects in the follicular phase of OMC, the vitamin D level is significantly higher (11.47±1.35 ng/ml) than in the group of girls in the luteal phase of OMC (5.48±1.74 nmol/L), which corresponds to ambiguous literature data and requires further study [33-35].

Conclusions. A differentiated analysis of the psychophysiological state of the body of students in the "high latitudes" revealed a number of features characteristic of certain levels of anxiety. According to SA indicators, the subjective assessment of well-being, activity and mood varies depending on the level of anxiety. With an increase in SA, the emotional background, psychological comfort, the volume of interaction with the physical and social environment decreases. No changes were found at the level of regulation of the cardiovascular system. According to PA indicators, changes were found at the level of functioning of the cardiovascular system, manifested in changes in the mechanisms of regulation of heart rhythm. With an increase in the level of anxiety, the temporal and frequency characteristics of HRV change, the influence of the mechanisms of the sympathetic nervous system in the modulation of the heart rhythm and the energy-consuming state of the central regulation circuit prevail. The level of SA and PA does not have a significant impact on the

performance of the HPAS, while it is reflected in the stages of the ovarian-menstrual cycle. A significant deficiency of vitamin D is present in all study groups and requires correction in accordance with individual and practical recommendations of medical specialists.

Ethical standards. All studies were conducted in accordance with the principles of biomedical ethics formulated in the Helsinki Declaration of 1964 and its subsequent updates, and approved by the local Ethics Committee at the Research Center for Biomedical Problems of Human Adaptation in the Arctic - a branch of the Federal State Budgetary Institution of Science of the Federal Research Center "Kola Scientific Center of the Russian Academy of Sciences" (Apatity).

Informed consent. Each participant of the study submitted a voluntary written informed consent signed by him after explaining to him the potential risks and benefits, as well as the nature of the upcoming study.

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Reference

1. Avcyn A.P. Vvedenie v geograficheskuyu patologii [Introduction to geographical pathology.] M.: Medgiz, 1972; 328 (In Russ.).]

2. Baevskiy R.M., Ivanov G.G., Chirejkin L.V. Metodicheskie rekomendacii po analizu VSR pri ispol'zovanii razlichnyh elektrokardiograficheskih system [Methodological recommendations for HRV analysis using various electrocardiographic systems.] Vestnik aritmologii [Bulletin of Arrhythmology. 2001; 24: 65-87 (In Russ.).]

3. Fedina R.G., [et al.]. Vliyanie faz menstrual'nogo cikla na sostoyanie gipotalamo-gipofizarno-nadpochechnikovoj sistemy u prakticheski zdorovyh zhenshchin goroda Novosibirska [Influence of menstrual cycle phases on the state of the hypothalamic-pituitary-adrenal system in practically healthy women of Novosibirsk. Journal of Siberian Medical Sciences, 2011; (6): 15 (In Russ.).]

4. Bojko E.R. Fiziologo-biohimicheskie osnovy zhiznedeyatel'nosti cheloveka na Severe [Physiological and biochemical foundations of human life in the North]. Yekaterinburg: Ural Branch of the Russian Academy of Sciences, 2005; 192 (In Russ.).]

5. Diatroptov M.E., Simonova E.YU., Diatroptova M.A. Infradiannye ritmy izmeneniya urovnya kortizola i gormonov shchitovidnoj zhelezy u zhenshchin reproduktivnogo vozrasta [Infradian rhythms of changes in the level of cortisol and thyroid hormones in women of reproductive age]. Rossijskij mediko-biologicheskij vestnik im. akademika I.P. Pavlova. [I.P. Pavlov Russian Medico-Biological Bulletin. 2013; 21(3) :107-113 (In Russ.).] doi:10.17816/PAVLOVJ20133107-113

6. Eliseev O.P. Praktikum po psihologii lichnosti [Practicum on personality psychology: 2nd ed., ispr. and reprinted in St. Petersburg: Peter, 2002. 512 p. (In Russ.).]

7. Kadochnikova N.I., Khlybova S.V. Sostoyanie menstrual'noj funkcii, uroven' somaticheskogo i reproduktivnogo zdorov'ya devushek 17-19 let s raznoj dlitel'nost'yu menstrual'nogo cikla [The state of menstrual function, the level of somatic and reproductive health of girls aged 17-19 years with different duration of the menstrual cycle. Medical Almanac, 2008; (4): 89-92 (In Russ.).]

8. Kaznacheev V.P. Problemy adaptacii i konstitucii cheloveka na Severe [Issues of adaptation and human constitution in the North]. Institut klinicheskoj i eksperimental'noj mediciny SO AMN SSSR [Institute of Clinical and Experimental Medicine of the SB Academy of Medical Sciences of the USSR, Novosibirsk. 1984; 4 (1): 95-99.

9. Kaznacheev V.P. Problemy adaptacii i konstitucii cheloveka na Severe [Problems of adaptation and human constitution in the North]. Ekologicheskie problemy cheloveka na Krajnem Severe [Human environmental problems in the Far North. Novosibirsk, 1980; 208 (In Russ.).]

10. Korolenko Ts.P. Psihofiziologiya cheloveka v ekstremal'nyh usloviyah [Human psychophysiology in extreme conditions. M.: Medicine, 1978; 272 (In Russ.).]

11. Mikhailov V.M. Variabel'nost' ritma serdca (novyj vzglyad na staruyu paradigm [Heart rate variability (a new look at the old paradigm. Ivanovo: LLC "Neurosoft", 2017; 516 (In Russ.).]

12. Avtsyn A.P., Zhavaronkov A.A., Marachev A.G., Milovanov A.P. Patologiya cheloveka na Severe [Human pathology in the North. M.: Medicine. 1985; 416 (In Russ.).]

13. Rean A.A., Averin V.A., Dandarova Zh.K. Psihologiya cheloveka ot rozhdeniya do smerti [Human psychology from birth to death. Edited by A.A. Rean. St. Petersburg: Prime - EUROZNAK, 2003; 656 (In Russ).]

14. Baranov A.A. [et al.] Rezul'taty profilakticheskih medicinskih osmotrov nesovershennoletnih v Rossijskoj Federacii [Results of preventive medical examinations of minors in the Russian Federation]. Rossijskij pediatricheskij zhurnal [Russian Pediatric Journal. 2016; 19 (5): 287-293 (In Russ.).]

15. Doskin V.A., Lavrentieva N.A., Miroshnikov M.P., Sharai V.B. Test differencirovannoj samoocenki funkcional'nogo sostoyaniya [Test of differentiated self-assessment of functional state]. Voprosy psihologii [Issues of psychology. 1973; 6:141-145 (In Russ.).]

16. Tyukalova M.A., Rechkalov A.V. Uroven' kortizola v syvorotke krovi v pokoe i pri fizicheskoj nagruzke v raznye fazy ovarial'no-menstrual'nogo cikla [The level of cortisol in blood serum at rest and during exercise in different phases of the ovarian-menstrual cycle]. Vestnik Kurganskogo gosudarstvennogo universiteta [Bulletin of Kurgan State University, 2017; 3 (46): 18-19 (In Russ.).]

17. Khasnulin V.I. Sindrom polyarnogo napryazheniya [Polar stress syndrome]. Mediko–ekologicheskie osnovy formirovaniya, lecheniya i profilaktiki zabolevanij u korennogo naseleniya Hanty–Mansijskogo avtonomnogo okruga [Medical and ecological foundations of the formation, treatment and prevention of diseases in the indigenous population of the Khanty–Mansi Autonomous Okrug. Novosibirsk, 2004: 24-35 (In Russ.).]

18. Khasnulin V.I., Khasnulin P.V. Sovremennye predstavleniya o mekhanizmah formirovaniya severnogo stressa u cheloveka v vysokih shirotah [Contemporary ideas about the mechanisms of formation of northern stress in humans at high latitudes]. Ekologiya cheloveka [Human Ecology, 2012; 1: 3-11 (In Russ.).] https://doi.org/10.33396/1728-0869-2012-1-3-11

19. Chibisov S.M., Rappoport S.I., Blagonravov M.L. Hronobiologiya i hronomedicina: monografiya [Chronobiology and chronomedicine : monograph]. People's Friendship University. 2018; 828 (In Russ.).]

20. Tsaregorodtsev N.A., Ivanova O.V., Dianov O.A. Sostoyanie sistemy gemostaza u detej s metabolicheskim sindromom [The state of the hemostasis system in children with metabolic syndrome]. Byulleten' sibirskoj mediciny [Bulletin of Siberian Medicine, 2015; 14 (5): 100-105 (In Russ.).]

21. Boucher B.J. Is vitamin D status relevant to metabolic syndrome? Dermato-Endocrinology 2012: 4(2): 212–224. https://doi.org/10.4161/derm.20012

22. Wang L. [et al.]. Circulating 25-hydroxy-vitamin D and risk of cardiovascular disease: Ameta-analysis of prospective studies Circ Cardiovasc Qual Outcomes, 2012; 1(5): 819–829. https://doi.org/10.1161/circoutcomes.112.967604

23. Hewison M. Vitamin D and immune function: autocrine, paracrine or endocrine? Scand J Clin Lab Invest (Suppl.) 2012; 243: 92–102. https://doi.org/10.3109/00365513.2012.682862

24. Łagowska K. The Relationship between Vitamin D Status and the Menstrual Cycle in Young Women: A Preliminary Study. Nutrients, 2018. 10(11):1729. doi: 10.3390/nu10111729.

25. Littorin B., Blom P., Schölin A. [et al.]. Lower levels of plasma 25-hydroxyvitamin D among young adults at diagnosis of autoimmune type 1 diabetes compared with control subjects: results from the nationwide. Diabetes Incidence Study in Sweden (DISS). Diabetology. 2006; 49: 2847–2852. https://doi.org/10.1007/s00125-006-0426-x

26. Santos E.F., [et al.]. Multifactorial explanatory model of depression in patients with rheumatoid arthritis: a structural equation approachю Clin. Exp.Rheumatol, 2019; 37(4): 641-648.

27. Pu D., Luo J., Wang Y. Prevalence of depression and anxiety in rheumatoid arthritis patients and their associations with serum vitamin D level. Clin.Rheumatol, 2018; 37(1): 179-184. DOI:10.1007/s10067-017-3874-4

28. Raghuwanshi A., Joshi S.S., Christakos S. Vitamin D and multiple sclerosis. J Cell Biochem, 2008; 105: 338–343. https://doi.org/10.1002/jcb.21858

29. Anderson J.L. [et al.]. Relation of vitamin D deficiency to cardiovascular risk factors, disease status, and incident events in a general healthcare population. Am J Cardiol 2010; 106: 963–968. doi:10.1016/j.amjcard.2010.05.027

30. Subramanian A., Gernand A.D. Vitamin D metabolites across the menstrual cycle: a systematic review. BMC Women's Health 19, 19 (2019). https://doi.org/10.1186/s12905-019-0721-6

31. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. Heart Rate Variability. Standards of Measurement, Physiological Interpretation and Clinical Use. Circulation. 1996; 93:1043–1065.

32. Harmon Q. E., [et al.]. Vitamin D and Reproductive Hormones Across the Menstru-