THE PECULIARITIES OF SOME INDICES OF PERIPHERAL BLOOD OF FOREIGN STUDENTS

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ABSTRACT — The aim of the research is: to study the morphofunctional characteristics of the peripheral blood cells of healthy young people of the same age group, taking into account the dependence on the ecological and biogeochemical factors of the external environment of the region of residence and to identify the physiological mechanisms underlying adaptation to the external environment.
Materials and methods. there were examined 125 students studied at the North Caucasus Federal University at the age of 18–21. For the quantitative evaluation of peripheral blood cells, 15 laboratory parameters were determined on the MEDONIK M-SERIES hematology analyzer. Leukocyte analysis was performed on the MECOS-C3 hardware-software complex.
Results. The analysis of peripheral blood indices revealed significant shifts in adaptation processes in the direction of tension in the group of Indian students ($P < 0.01$) and less critical changes in the compensatory-adaptive mechanisms of the body in the group of students from Tajikistan ($P < 0.05$).
Conclusion. As a result of the study, new data have been obtained indicating a different spectrum of adaptive reactions of students, which allows the use of peripheral blood as a test system for assessing the influence of damaging environmental factors.

KEYWORDS — Adaptation, uniform elements of peripheral blood, erythrocyte, platelet indices, student hood, youngling, ethnicity belonging.

INTRODUCTION

The problems of the environmental conditions of society in modern conditions have become particularly acute. The ecological security of each individual is the most important characteristic of the sustainable and stable development of society as a whole. It is known that the geographical environment acts on a person not always in direct way but indirectly go through the conditions of his life. The last fact plays a crucial role in the transformation of environmental influences on the human body and its state of health.

The relevance of the problem for this branch of knowledge is that among the problems of modernity, the assessment of the state of public health is becoming more and more relevant. This is due to the adverse effect on human health of environmental, social and economic factors.

Anthropogenic environmental pollution in many regions of the Russian Federation creates a tense environmental situation that represents a potential danger to public health. The transition from health to illness is seen as a process of gradually reducing the body's adaptive abilities. Adequate environmental conditions at the moment correspond to the properties of the biosystem but their boundaries are quite large, changes in the environment within these borders also require the inclusion of adaptive mechanisms. The whole set of adaptive reactions of a certain climatic environment is defined by the concept of an adaptive type which is the norm of a biological response to a complex of environmental conditions, providing a state of equilibrium of populations with this environment and finding external expression in morphofunctional features. One of the urgent problems of modern medicine is the problem of studying the adaptive capacity of the human body as a whole and in particular the Erythrone system, since red blood cells can be considered as a kind of total biopuncture of body tissues, they are among the first to respond to the effects of stimuli, while the first ones either return to the initial level or adapt to the changed conditions of existence. In this regard, there is a need to develop a set of methodological approaches that allow qualitatively and quantitatively assess the severity and intensity of adaptation processes in the erythron system. Improving the quality of health, the adaptive capacity of the population is possible only with the implementation of measures aimed at studying the state of health and analyzing shifts in basic indicators of health.

Youth student is a special social group, united by a certain age and specific working conditions. Adaptation to new social conditions, the ever-increasing intensification of the educational process, significant mental and emotional stresses against the background of a decrease in motor activity cause tension of regulatory-compensatory mechanisms and require a new approach to the development of scientifically based preventive measures at the university.

The scientific substantiation of the processes of adaptation of students to the conditions of study at the university is an actual problem of modern physiological science and practice. Adaptation to student life is a complex and multifaceted process that requires the involvement of all the body's reserves which is not yet fully formed in first-year students [1]. The presence of a high demand for educational and professional activities of young people requires the prediction of the functional state during the period of study at the university to ensure the effectiveness of the adaptation processes of students but the insufficient development of the physiological aspects of adaptation determines the relevance of this study [2]. Thus, the scientific substantiation of the processes of adaptation of students to the conditions of study at the university is an actual problem of modern physiological science and practice.

Clinical analysis of erythrocytes, platelets and peripheral blood leukocytes characterizes a certain moment of dynamic processes: the maturation and release of elements from the bone marrow, the lifetime of the cells, the time of their circulation in the stream. It is rather difficult to identify and correctly assess adaptive hematological reactions to the effect of damaging factors of low intensity. Small changes in the number of blood cells are easily "lost" among physiological fluctuations and limited in their direction [10]. Blood cells are sensitive to changes in the external habitat and the internal state of the human body. Since plasma is the habitat of cells, and intracellular and extracellular fluids are separated by actively functioning semipermeable cell membranes, even small changes in plasma metabolic composition should lead to disruption of cellular homeostasis and according to the laws of isosomolarity of the organism and to the disruption of cell size [2–9].

Stavropol Territory is located in the south of the temperate continental belt. It is located on the border between Europe and Asia; therefore, both European (maritime) and Asian (continental) influences are felt in the climate. The High Caucasus Mountains are located to the south of the Stavropol Territory and they do not allow warm air from Transcaucasia go into its territory and cold air masses coming from the north, on the contrary are trapped by them and spread out over the plains of Stavropol. The ridges of the Western Caucasus isolate the land from air currents coming from the Black Sea. From the east, hot air in summer and cold air in winter plains adjoin the edge, whose influence cannot soften the air from the Caspian Sea. All this makes the climate of Stavropol more continental: with a rather large annual amplitude of temperatures (January: -2, -5° C to -30, -38° C, July: from +19, +24° C to +42, +44° C) and relatively small amount of precipitation [2, 14].

The purpose of this study was to study the morphofunctional characteristics of the peripheral blood cells of healthy young people of the same age group taking into account the dependence on the ecological-biogeochemical factors of the external environment of the region of residence and to identify the physiological mechanisms underlying adaptation to environmental conditions.

MATERIALS AND METHODS

The study was conducted during 2017–2018 on the basis of the NCFU Medical Center in the autumn period during the passage of the annual medical examination. 125 students enrolled at the North Caucasus Federal University in the following fields — Medical Biochemistry, Pharmacy, Biotechnology, Biology at the age of 18–21 students were surveyed. The subjects were found to be clinically healthy, students with acute inflammatory, infectious diseases and endocrine diseases were excluded. In the compared groups, quantitative and morphofunctional parameters of peripheral blood were evaluated. The screening of the survey of persons included: a survey of the subjects using a questionnaire that contained questions about passport data: name, gender, age; and questions about the presence of acute and inflammatory diseases. Laboratory criteria for screening were:

– the normal level of hemoglobin concentration (HB) and the number of red blood cells (ER) in all examined to eliminate anemia [12].

The preanalytical stage of laboratory studies was carried out in accordance with existing orders and recommendations of the Ministry of Health of the Russian Federation on quality control of laboratory studies, as well as established guidelines for physicians "Ways to optimize the quality of laboratory tests in endo-crinological treatment-and-prophylactic institutions" [10]. Blood sampling was carried out in the morning, on an empty stomach. For the quantitative assessment of peripheral blood cells on the hematology analyzer MEDONIK M-SERIES determined 15 laboratory parameters: the number of Erythrocytes (Er or blood cells) (RBC), volume (MCV), anisocytosis Er (RDW), hematocrit value (Ht), hemoglobin

concentration (HGB), average hemoglobin in ER (MCH), average hemoglobin concentration in ER (MCHC), platelet count (PLT), average platelet volume (MPV), platelet anisocytosis (PDW), thrombocrit (PCT), macrothrombocyte (LPCR), leukocytes (WBC), lymphocytes (LYM), granulocytes (GRAN). Measurement of the main parameters in the analyzer is based on the principles of impedance and spectrophotometry, a method of conductometric counting and based on counting the number and determining the nature of the pulses that occur when cells pass through a small-diameter opening (aperture), on both sides of which two isolated electrodes are located. Leukocyte analysis was performed on the MECOS-C3 hardware-software complex (Erythrocytometry, Blood Test, Densitomorpometry programs) (Fig. 1), automatic methods of preparing blood preparations were used for the study, for these purposes a high-quality smear centrifuge was used microscopy, a device for fixing and staining blood smears with built-in programmable four channel timer and drying chamber UFOMK-01 "EMKO-STEINER".

Fig. 1. *Computer cytomorphometry of the uniform elements of hemopoiesis of first-year students*

The results of the experiment were subjected to variational-statistical processing in accordance with the principles set forth in the manual of Lakin GF. (1990). The descriptive statistics of Microsoft Excel were used to create a one-dimensional statistical reference containing information about the central tendency and variability of the input data. The variation series obtained in the experiment were characterized by the following indicators: arithmetic average value (M); standard deviation (σ); the error of the arithmetic mean value or the mean square error (m). Calculating the indicator of significant difference (t) and taking into account the number of measurements according to the Student's t-distribution table, the probability of differences (P) was determined. The difference was considered statistically significant, starting with P values <0.05. In this case, the correctness of the conclusion about the existence of differences in magnitudes can be confirmed in 95% of cases [11, 13].

RESULTS AND DISCUSSION

Analysis of the morphofunctional parameters of erythrocytes of Russian students (table 1) revealed the maximum values of the following parameters: hemoglobin concentration (158.98±1.79 g/l), hematocrit value (45.35±0.73%), erythrocyte anisocytosis (15.29±0.62), the average hemoglobin content in erythrocytes (32.13±1.97) and the average concentration of hemoglobin in erythrocytes (356.11±1.04 g/l) and the minimum number of erythrocytes (5.32±0.085).

The group of Indian students was characterized by the highest values of the number of erythrocytes (7.59 ± 0.351) and the volume of erythrocytes (85.09 ± 1.54). The hemoglobin concentration (150.19 ± 2.01 g / l), the hematocrit value (43.49 ± 0.49%) and the average hemoglobin concentration in the erythrocytes (345.22 ± 1.85 g / l) in this group were the lowest (Table 1).

Tajik students compared with groups of Russian and Indian students had minimal red blood cell anisocytosis (13.55 ± 0.36), red blood cell volume (81.90 ± 1.45) and average hemoglobin red blood cells (28.74 ± 0.61) (Table 1). In general, if we consider the distribution of morphofunctional indicators of erythrocytes of Russian and foreign students we may see that the most similar to the indigenous population of Stavropol are Tajik students, because they are most likely due to the similarity of climatic and geographical conditions of the regions [15].

Statistically the important significant differences were found for all studied morphofunctional parameters of erythrocytes (table 1). Thus, hemoglobin concentration, hematocrit value, erythrocyte anisocytosis and average hemoglobin concentration in erythrocytes among Indian students were significantly lower compared to the same indicators of Russian students. Tajik students also had similar differences - the erythrocyte anisocytosis, the erythrocyte volume, the average hemoglobin content in the erythrocytes and the average hemoglobin concentration in the erythrocytes were significantly lower [16].

The study of morphofunctional parameters of platelets taking into account ethnicity (table 2)

Table 1. *Erythrocyte morphofunctional parameters, (M±m)*

Parameters	Group 1	Group 2	Group 3
HGB g/L	158,98±1,79	150,19±2,01	154,83±3,30
P1		<0,001	>0,10
P2			>0,10
RBC 10*12/L	5,32± 0,085	7,59±0,351	5,41±0,096
P1		<0,001	>0,10
P2			<0,001
HCT %	45,35±0,73	43,49±0,49	43,71±1,05
P1		<0,05	>0,10
P2			>0,10
RDW - SD fL	15,29±0,62	14,08±0,33	13,55±0,36
P1		<0,05	<0,01
P2			>0,10
MCV fL	84,74±0,42	85,09±1,54	81,90±1,45
P1		>0,10	<0,05
P2			>0,10
MCH pg	32,13±1,97	29,43±0,62	28,74±0,61
P1		>0,10	<0,05
P2			>0,10
MCHC g/L	356,11±1,04	345,22±1,85	350,42±2,67
P1		<0,001	<0,05
P2			<0,05

Note: *P1 — significance of differences between morphofunctional indicators of erythrocytes of Russians (group 1) and Indian (group 2) and Tajik (group 3) students; P2 — reliability of differences between morphofunctional indicators of erythrocytes of Indian (group 2) and Tajik (group 3) students*

Table 2. *Morphofunctional parameters of platelets, (M±m)*

Parameters	Group 1	Group 2	Group 3
PLT	213,60±8,13	290,65±11,35	239,83±8,19
P1		<0,001	<0,05
P2			<0,001
PDW	11,63±0,14	12,44±0,29	13,55±0,36
P1		<0,01	<0,001
P2			<0,01
PCT	0,18±0,01	0,30±0,01	0,24±0,01
P1		<0,001	<0,001
P2			<0,001
MPV	8,57±0,15	10,50±0,14	10,20±0,14
P1		<0,001	<0,001
P2			>0,10
LPCR	21,41±0,70	37,09±8,93	26,68±1,12
P1		<0,05	<0,001
P2			>0,10

Note: *P1 — significance of differences between morphofunctional parameters of Russian platelets (group 1) and Indian (group 2) and Tajik (group 3) students; P2 — reliability of differences between morphofunctional indices of platelets of Indian (group 2) and Tajik (group 3) students.*

revealed that Russian students are characterized by minimal platelet count (213.60 ± 8.13), an anisocytosis index of platelets (11.63 ± 0.14), thrombocrit (0.18 ± 0.01), average platelet volume (8.57 ± 0.15) and macrothrombocyte ratio (21.41 ± 0.70).

Indian students had maximum platelet counts (290.65 ± 11.35), thrombocritis (0.30 ± 0.01) and average platelet volume (10.50 ± 0.14) (table 2). In the group of Tajik students the only indicator with the highest value was platelet anisocytosis (13.55 ± 0.36). Also, while analyzing the distribution of morphofunctional platelet indicators of Russian and foreign students, it was found that students from Tajikistan were closest to the indigenous population of Stavropol. We also associate the revealed fact with the similarity of climatic and geographical conditions of these regions.

Statistically the important significant differences were found for all studied morphofunctional parameters of platelets (Table 2). At the same time, they were significantly lower in the group of Russian students compared to the groups of Indian and Tajik students.

Analysis of the white blood cell count of Russian students (table 3) showed the maximum number of granulocytes (61.62 ± 1.52) and the minimum content of the total number of white blood cells (7.19 ± 0.32) and lymphocytes (29.88 ± 1.13). At the same time, all the specified parameters were within the reference values [13, 17].

Indian students were characterized by the opposite distribution of the content of leukocytes (table 3). Thus, the highest values were noted for the total number of leukocytes (7.59 ± 0.35), lymphocytes (34.14 ± 1.42), and the smallest - for the number of granulocytes (52.47 ± 1.51). The group of students from Tajikistan according to the nature of the distribution of the content of leukocytes repeated the trend of Indian students (Table 3). We suppose that of all the peripheral blood indices we analyzed, which reflect a change in the compensatory-adaptive reactions of the organism, is the total content of leukocytes and their separate groups. Since a similar pattern of distribution of these parameters among Indian and Tajik students was revealed [18].

Statistically the important significant differences were found for all studied leukocyte indicators (Table 3). Thus, the total number of leukocytes was significantly higher among Tajik students compared with Russian students. The number of lymphocytes was significantly higher in the group of Indian students

Table 3. *Indicators of the distribution of leukocyte populations among first-year students, (M±m)*

Parameters	Group 1	Group 2	Group 3
WBC	7,19±0,32	7,59±0,35	7,58±0,36
P1		>0,10	<0,05
P2			>0,10
LYM	29,88±1,13	34,14±1,42	31,04±1,32
P1		>0,05	>0,10
P2			>0,10
GRA	61,62±1,52	52,47±1,51	56,45±1,57
P1		<0,001	<0,01
P2			<0,05

Note: *P1 — significance of differences between the content of leukocytes in Russian (group 1) and Indian (group 2) and Tajik (group 3) students; P2 — significance of differences between the content of leukocytes in Indian (group 2) and Tajik (group 3) students.*

compared to Russian students. The quantitative content of granulocytes was significantly higher for both Indian and Tajik students than for Russian students [11, 13, 19].

Thus, the analysis of peripheral blood indices revealed significant shifts in adaptation processes towards tension in the group of Indian students and less critical changes in the compensatory-adaptive mechanisms of the organism in the group of students from Tajikistan. A significant factor shaping a similar range of adaptive reactions of the organism is the complex of climatic and geographical conditions of the Stavropol Territory and in particular of the city of Stavropol, whose climate is close to moderately cold [14, 15, 16, 20].

CONCLUSIONS

A comparative comprehensive assessment of the morphofunctional state of peripheral units of hemopoiesis, including the study of an extended blood test in a practically healthy population of one age group of young people, taking into account ethnic status, has been carried out. A search and development of evaluation and diagnostic signs of trouble among a healthy population contingent, the selection of premorbid conditions using simple, minimally invasive and at the same time most informative methods of monitoring the health of the working-age population and the younger generation. As a result of the study, new data were obtained that indicate the possibility of using peripheral blood as a test system for assessing the influence of damaging environmental factors on the organism of children, adolescents and adults in different regions of residence. The results of the study can be used as normative characteristics of peripheral hemopoiesis and health monitoring at the stage of prenosological diagnosis and during medical examinations, including young people of pre-conscription age. Data on the relationship of the characteristics of uniform indicators of cellular composition with the degree of adaptation will allow identifying the spectrum of adaptive reactions of peripheral blood.

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