Morphofunctional aspects of the adaptation of foreign students to the conditions of the sharply continental climate of the Volgograd region

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Abstract. The problems of monitoring of morphofunctional changes in the process of human adaptation to the changed climatic and geographic conditions of living and study are considered in the article. Various mechanisms of adaptive rearrangements of the organism are described. Changes in the morphofunctional status occur when foreign students adapt to the conditions of the sharply continental climate of the Volgograd region. Those changes cause multidirectional reactions of the cardiovascular system. A satisfactory adaptation response was found in 58.8% of cases: reduction of body weight deficit, load on the myocardium, and increase in the functional capabilities of the cardiovascular system. In a risk group of students with a deficit of body weight, in 30.0% of cases, the reserve potential of the functioning of the cardiovascular system was spent. This corresponds to maladaptation reactions. It is necessary to take into account the obtained results for organizing the measures of conserve and preserve the health of foreign students coming to Russia for higher education.

1. Introduction

According to the International Department and the Centre for Sociological Research, the number of Russian universities where there are full-time foreign citizens is increasing in Russia. Education of foreign students in Russian universities is associated with various aspects of social and linguistic adaptation. Also the students are forced to live in different climatic and geographic regions of Russia, which are differ from their places of permanent residence. It is indisputable that the influence of the climatic and geographic environmental factor affects the human organism.

Monitoring of morphofunctional changes in the process of adaptation of foreign students to the changed living conditions is relevant; it allows assessing the state of physical health and working capacity taking into account the individual characteristics of the organism.

Length and weight of body are genetically determined measures. However, changes in growth and weight indices reflect the influence of external and internal factors on the organism (such as climate, food and water regimes, social and psychological effects), so they characterize individual metabolic processes of the organism [2, 4, 6].

During the process of adaptation, functional systems of various hierarchical levels provide the final useful result of activity. An important role is given to the cardiovascular system, which first reacts to the influence of a disturbing environmental factor with its functional changes [3]. It provides the
oxygen transport cascade, the balance of redox reactions, and the maintenance of homeostasis in various conditions of vital activity of an organism.

The research of the reactions of the cardiovascular system in combination with indicators of morphofunctional status will allow to find out what processes are taking place in the organism of foreign students in the dynamics of their adaptation to the sharply continental climate of the Volgograd region, as well as to reveal the mechanisms of long-term adaptation.

2. Materials and methods
The research has involved foreign students from South and South-West Asia, the Middle East and Africa (young man, 176 people). The average age of the respondents was 20.0 ± 2.9 years. A group of foreign students studying in Volgograd universities took part in the research.

The late arrival of the examined students (in November - December) coincided with the onset of winter colds in the sharply continental climate of the Volgograd region.

The climate of the Volgograd region is arid with sharply expressed continentality according to the report of the Natural Resources and Ecology committee. The average temperature in January is from -8 °C to -12 °C, in July it is from +23 °C to +25 °C. A maximum absolute temperature of +42 to +44 °C is observed usually from July to August and a minimum absolute temperature of −36 to −42 °C is observed from January to February.

Morphofunctional status of foreign students was assessed in the dynamics of two-year residence of respondents in new climatic and geographic conditions in compliance with the principles of informed consent. The research included dynamic observation of the level of physical condition, assessment of the parameters of systemic hemodynamic. A number of indicators such as the length of the body, weight, heart rate, systolic and diastolic arterial pressures were analysed.

The following indices were calculated: body mass index (normal value is 24–27 c.u.), pulse pressure, mean hemodynamic pressure, coefficient of stability of the cardiovascular system (normal value is 16 c.u; the decrease in the value indicates a decrease in the load on the cardiovascular system), coefficient of systolic heart function (CSHF ≥ 96 is low; CSHF = 76-85 is middle; CSHF ≤ 70 is high; the lower the CSHF at rest, the higher the maximum capacity of the individual), adaptation potential [1, 7]. Mathematical processing and analysis of primary data were carried out using a software package «SPSS-17».

3. Results and discussion
Individual processes of growth and physical development influence on the appearance of qualitative differences in the morphological structure of the organism, and, as a consequence, they cause changes in the activity of its functional systems, expanding or narrowing the limits of human adaptive capacity of organism [5, 8].

According to a number of researchers, the use of various indices which characterize physical development is more informative than the absolute values of the dimensional features of physique. Therefore, to assess the physique of foreign students, we used the body mass index. In our studies, it was found that compliance with the norm on the body mass index of foreign students (young men) was determined in 48.4% of cases. In other cases, the deviation of body weight from the norm as a deficit of body weight was noted in 24.5% of cases, an excess of body weight - in 19.1%.

The analysis of dynamics of indicators of morphofunctional status of foreign students (table 1) allowed establishing positive shifts of adaptive reactions of an organism. Foreign students had a decrease in blood pressure (SAP p = 0.021; DAP p = 0.001; HP p = 0.001), which in turn led to an increase in functional reserves of the cardiovascular system (CSHF p = 0.037) with an increase in body mass index due to weight gain (p = 0.047). Normalization of parameters of the cardiovascular system can be regarded as a favourable sign of optimization of adaptation processes.
Table 1. Dynamics of indicators of morphofunctional status of foreign students (Mean ± Standard error, n=176).

|                                    | The first year of study | The second year of study | p     |
|------------------------------------|-------------------------|--------------------------|-------|
| Growth (G), cm                     | 177.7±0.67              |                          | -     |
| Weight (W), kg                     | 70.64±1.17              | 72.82±1.06               | 0.047 |
| Body mass index (BMI), c.u.        | 22.27±0.31              | 22.93±0.26               | -     |
| Heart rate / min (HR)              | 78.82±0.98              | 75.76±0.79               | -     |
| Systolic arterial pressure (SAP), mmHg | 138.1±1.37              | 125.5±0.96               | 0.021 |
| Diastolic arterial pressure (DAP), mmHg | 74.6±0.7                | 62.0±0.69               | -     |
| Pulse pressure (PP), mmHg          | 63.5±1.47               | 63.5±0.69               | -     |
| Mean hemodynamic pressure (HP), mmHg | 95.8±0.73                | 83.1±0.72               | -     |
| Coefficient of stability of the cardiovascular system (CSCS), c.u. | 13.42±0.32               | 12.13±0.17              | -     |
| Coefficient of systolic heart function (CSHF), c.u. | 109.71±1.93              | 95.43±1.39              | -     |
| Adaptation potential (AP), c.u.    | 1.67±0.025              | 1.41±0.024               | -     |

A qualitative assessment of adaptation reactions could be given on the base of calculation of the integral indicator – the value of the adaptation potential. An analysis of the dynamics of this indicator allowed us to note that a decrease in its value (AP \( p = 0.019 \)) in common indicates an increase in the regulatory and adaptive capabilities of the organism of foreign students. However, the realized analysis of the conjugate interaction of integral morphological and functional indicators (table 2) allowed establishing various mechanisms for the adaptation of foreign students to the conditions of the sharply continental climate of the Volgograd region.

Table 2. Conjugation of integral morphofunctional indicators that determine the adaptive reactions of the organism of foreign students.

| Changes in integral morphofunctional indicators | Increase of the functional capacity of the cardiovascular system | Decrease of the functional capacity of the cardiovascular system |
|-----------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|
| Positive shift in adaptive potential          | Decrease in load on the heart                                  | 43.2%                                                         | 38.3%                                                         |
|                                               | Increase in load on the heart                                  | -                                                             | 18.5%                                                         |
| Negative shift in adaptive potential          | Decrease in load on the heart                                  | 8.3%                                                         | 23.3%                                                         |
|                                               | Increase in load on the heart                                  | -                                                             | 68.4%                                                         |
| No shift in adaptive potential                | Decrease in load on the heart                                  | 16.5%                                                        | -                                                             |
|                                               | Increase in load on the heart                                  | 52.3%                                                        | 31.2%                                                         |

Recently, the necessity for an individual approach to the study of adaptive reactions has been emphasized, because important regularities of the response of individuals that differ in morphological and physiological parameters are often “blurred” when calculating the average statistical norms. At the same time, adaptation is understood as the process of development of an optimal mode of purposeful functioning of a person, so it is the process of bringing it under specific conditions to a state where all energy, physical and spiritual forces are directed and spent on fulfilling its main tasks, in this case, on training.

It was found that favourable adaptive reactions which manifested in a positive shift in the adaptive potential, decrease in load on the heart, increase of the functional capabilities of the cardiovascular
system were noted in 43.2%. That group of examined students could be referred to persons with satisfactory adaptation (58.8% of all examined students).

Respondents which had the adaptive potential without changes (11.2% of the total number of those examined) represented a group of potentially adaptable students. At the same time, multidirectional reactions of the organism were noted. We registered increased functionality by reducing the load on the heart in 16.5% of cases; increase in functionality due to increased load was found in 52.3% of cases.

A large percentage of students included in the group with unsatisfactory adaptation (30.0% of the number of all examined) attracted special attention. They were characterized mainly by a negative shift in adaptive potential and multidirectional shifts on the part of the cardiovascular system. In 68.4% of cases in this group there was a decrease in functional capabilities, an increase in load on the heart both of the cardiovascular system in common.

4. Conclusion

An important indicator of health and social well-being is the level of physical development, which reflects the metabolic processes in the organism, and the functionality of various systems. It is an integral component of adaptation. The physical level of health has to be understood as a combination of static (morphological) and dynamic (functional) physical properties of a particular person, which allows him to adapt to the surrounding reality in accordance with age, gender and social role.

It can be concluded basing on the analysis of morphofunctional status data that several variants of adaptive reactions of foreign students in altered living conditions, namely, in the sharply continental climate of the Volgograd region are possible. The variant of reducing the deficit of body weight, decrease in the load on the myocardium, and increase in the functionality of the cardiovascular system as a whole was the most common. The balanced work of the cardiovascular system allowed maintaining the systemic circulation of the blood at an adequate level to the request of the organism. This type of adaptive reactions corresponded to a satisfactory level of adaptation.

The response of the organism to the influence of disturbing environmental factors is carried out by mobilizing and spending of functional reserves, which requires a certain tension of regulatory mechanisms. If the functional reserves (information, energy, metabolic) become higher, then the degree of tension of these mechanisms is lower. It is necessary to adapt to environmental conditions and to maintain homeostasis.

The second variant of adaptive reactions, which can be considered as an unsatisfactory level of adaptation, was less common among foreign students. This variant was unfavourable for the organism, because the functioning of various systems, including the cardiovascular system occurs due to expenditure of reserve capacity. This type of adaptive reactions was characterized by an increase in the load on the heart, a decrease in the functional capabilities of the cardiovascular system accompanied by body weight deficiency. Thus, a group of foreign students with unsatisfactory adaptive reactions is a risk group.

The process of adaptation of foreign students during the development of a professional program at a university took place in parallel with the adaptation to the conditions of a sharply continental climate of the Volgograd region. It had a phase nature and caused complex changes in the students’ organism.

It is necessary to consider the peculiarities of adaptive reactions of foreign students to the conditions of sharply continental climate of Volgograd region for organizing measures to conserve and preserve the health, as well as for valeologization of educational process at the University.

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