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ASSESSMENT OF THE IMMUNE STATUS IN MEN OF THE SUBRACTIC AND SEMI-ARID REGIONS USING FACTOR ANALYSIS

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Functional systems, including the immune system in humans, adapt depending on the influencing environmental factors. Factor analysis is considered an important method for identifying latent operating parameters and their contribution to the overall process. The aim of this work is to assess the immune status of men aged 20-60 years old living in the subarctic and semi-arid regions using factor analysis. After determining the concentration of leukocytes by standard methods, and the concentration of lymphoid subpopulations by the method of indirect immunoperoxidase reaction using monoclonal antibodies, factor analysis was carried out by the method of the main component with the determination of coefficient scores of indicators to calculate the contribution of different stages of the immune reaction in the formation of the immune response. The processes of lymphoproliferation and apoptosis play a controlling role over other processes, regardless of the place of residence. The activity of the phagocytosis process increases under semi-arid conditions. The activities of the processes of differentiation and the acquired cellular response are intensified in the subarctic region. At the same time, the balance between the processes of proliferation and apoptosis is disturbed to a greater extent in the subarctic region. Thus, the formation of an adaptive immune response in men of the subarctic region is accompanied by excessive use of the reserve capabilities of immune homeostasis. In men of the semi-arid region, the adaptive immune response is formed more fluently, which contributes to the preservation of reserve capabilities of immune homeostasis and is the most optimal (beneficial) for the body.

Keywords: immune system, factor analysis, phagocytosis, apoptosis, lymphoproliferation, subarctic region, semi-arid region.

Introduction: The impacts of living in different climatic, environmental and technogenic conditions can lead to adaptive functional and systematic changes, including the immune system, The body's reserve capabilities may subsequently be exhausted as a result, which may lead to the development of chronic pathology of a regional nature [1,6].

The air temperature, daylight and solar irradiation, UV index, and air quality index are all different in the subarctic and semi-arid regions. The average temperature in the subarctic region is 16°C lower than in the semi-arid region, and the semi-arid region has 3 hours more sunshine than the subarctic region. The UV index is 2.5 times higher on average in the semi-arid region. The air quality index in the subarctic region (AQI=23) is higher than in the semi-arid region (AQI=41), because the concentration of pollutants, particularly particulate matter (2.5 and 10 microns), is 25 times higher in the semi-arid region than in the subarctic region [9,12].

The evaluation of the functions of the human immune system is based on the development new methods and is important for determining the internal relationship of immunological parameters and the mechanisms of their functioning [11]. At present, the quantitative determination of immunocompetent cells, including cytotoxic, T-helper, B-lymphocytes and natural killers, by microscopic or flow cytometry method gives a good idea of the state of the body's immune homeostasis, normal ranges of cell content, and is also considered an important indicator in the norm. and in pathology [2,3].

Since these parameters are frequently involved in complex variable immu-

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nological mechanisms, the processes of substantiating the results obtained, the mechanisms of action in normal and pathological conditions, and predicting the possibility of developing environmentally dependent diseases are becoming more difficult [5,13]. The factor loadings for each variable within the components can be interpreted as measures of correlation between the observed variable and the underlying unobserved component, which is a feature of factor analysis. Factor analysis can be used in immunological studies to extract information not only about the role of each parameter, but also about the role of the underlying mechanism [5]. Therefore, a comprehensive study of these parameters is necessary in order to build an overall picture that reflects the specificity of the immune status.

The aim of work is to assess the immune status of men aged 20-60 living in the subarctic and semi-arid regions using factor analysis.

Materials and methods: We analyzed the examination results of 63 men aged 20-60 years, 33 people living in the subarctic region (Arkhangelsk, Arkhangelsk region of the Russian Federation) and 30 people living in the semi-arid region (Aleppo, Syria). Participation in the examination was on a voluntary basis; at the time of venous blood sampling, the voluntaries had neither acute nor chronic diseases according to the conclusion of a local clinic doctor. The primary analysis of peripheral venous blood for immune status of Aleppo, Syria residents was conducted in the University of Aleppo's biochemistry laboratory. In the peripheral blood, the number of leukocytes in the Goryaev's chamber, the leukocyte formula in the stained blood smear according to Romanovsky-Giemsa were determined. The lymphocytic subpopulation ($CD3^+$, $CD4^+$, $CD5^+$, $CD8^+$, $CD10^+$, $CD16^+$, $CD20^+$, $CD71^+$, $CD95^+$, $HLA\text{-}DR^+$) were determined by the method of indirect immunoperoxidase reaction using monoclonal antibodies on preparations of lymphocytes of the "dried drop" type using a peroxidase conjugate and staining with a chromogen solution for analysis in immersion microscopy.

Determined parameters are conditionally divided into different stages of the immune response: 1- Phagocytosis (neutrophils, monocytes and eosinophils), 2- Congenital cellular response (natural killers CD16), 3- lymphoproliferation (CD10 and CD71), 4- Differentiation (CD5 and CD3), 5- Adaptive cellular response (CD4, CD8 and HLA-DR), 6- Humoral response (CD20 and HLA-DR), 7- Apoptosis (CD95).

The work was carried out in the Laboratory of Physiology of Immunocompetent Cells of the Institute of Physiology of Natural Adaptations of N. Laverov Federal Center for Integrated Arctic Research of the Ural Branch of the Russian Academy of Sciences, Arkhangelsk, Russia within the State Assignment № 122011700267-5 "Physiological significance of the features of immune homeostasis, functional and receptor activity of immunocompetent cells in people in extremely changing environmental conditions, considering professional status and socially significant diseases among residents of the Arctic region"

The results were statistically processed using Microsoft Excel 2010 and SPSS 20.0 for Windows. Kaiser's statistical test was used to determine the number of significant factor sets for factor analysis. The Bartlett test was used to determine the acceptability of factor analysis. The principal component method was used to select the factors. The factor loadings were rotated using the Varimax method to maximize the correlation coefficients in the factor sets. To identify the contribution of each stage of the immune reaction in the formation of the immune response, the weight value of the immunological parameters of the stages was calculated using the coefficient score of the parameter (K_n), the percentage of intrinsic variance (σ_n) and the total percentage of variance (σ) obtained from the results of factor analysis using the following formula [7,4]:

$$\omega = \frac{X \sum_{n=1}^{u} \sigma_n K_n}{\sigma},$$

where ω is the weight value of the parameter , X is the concentration of the parameter.

The percentage of the contribution of the stage is equal to the total weighted value of all parameters of the stage multiplied by one hundred and divided by the total weighted value of all stages.

The assessment of the significance of differences for paired independent samples between groups was carried out using the Mann-Whitney test, the threshold level of significance was taken as $p<0.05$.

Results and discussion: The Kaiser-Meyer-Olkin (KMO) criterion shows acceptable and satisfactory adequacy in the subarctic and semi-arid regions, respectively, and the Bartlett sphericity criterion confirms that the data are acceptable for factor analysis (Table 1).

Using the principal component method, 3 factors in the subarctic region and 4 factors in the semi-arid region were identified (Table 2). These factors explain 75.32% and 78.11% of the variance in immunological status parameters in men living in the subarctic and semi-arid regions, respectively.

By determining the parameters that represent each factor (Table 3), it was found that in men in the subarctic climatic

Table 1

Acceptability and adequacy of data for factor analysis in men aged 20-60 living in the subarctic and semi-arid regions

		Subarctic	Semi-arid
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		**0.744**	**0.659**
Bartlett's Test of sphericity	χ^2	340.522	256.782
	df	78	78
	P	**< 0.001**	**< 0.001**

Table 2

Explained cumulative variance of the immunological status parameters of men aged 20-60 living in the semi-arid and subarctic regions

Living region	Factor	Eigenvalue	% variance	Total %
Subarctic	1	5.58	**42.93**	42.93
	2	2.96	22.74	65.67
	3	1.26	9.66	**75.32**
Semi-arid	1	5.11	**39.32**	39.32
	2	1.94	14.93	54.25
	3	1.62	12.48	66.73
	4	1.48	11.38	**78.11**

region, the highest loads in the first factor correspond to parameter that reflect humoral immune response activation (activated lymphocytes (HLA-DR$^+$) and B-lymphocytes (CD20$^+$)), lymphoproliferation and mitosis of lymphocytes due to increased expression of transferrin receptors (CD71$^+$), apoptosis of lymphocytes due to marker expression (CD95$^+$), and innate immune response (natural killers (CD16$^+$)). The composition of the 2nd factor includes parameters that reflect the activity of the cellular immune response (cytotoxic T-lymphocytes (CD8$^+$), T-helpers (CD4$^+$)), lymphocyte proliferation due to the expression of the marker of lymphocyte precursors (CD10$^+$), and differentiation of common T- and B-1 lymphocytes (CD5$^+$). The composition of the 3rd factor includes cells that reflect the level of phagocytosis (eosinophils and, to a lesser extent, neutrophils, monocytes) and the maturation of lymphocytes (CD3$^+$).

The analysis showed that in men in the semi-arid climatic region, the greatest loads as part of the first factor correspond to the parameters of the humoral immune response, mainly B-lymphocytes (CD20$^+$), the process of lymphoproliferation due to the transferrin receptor (CD71$^+$) and the process of apoptosis (CD95$^+$). The 2nd factor includes markers that reflect the level of differentiation and maturation mainly (CD3$^+$), cellular immune response (CD8$^+$, CD4$^+$) and, to a lesser extent, innate cellular immune response (CD16$^+$). The third factor includes markers that reflect the level of lymphoproliferation mainly (CD10$^+$), differentiation and maturation due to CD5$^+$, and the level of activation of the immune response (HLA-DR$^+$). And the composition of the 4th factor includes parameters of phagocytosis, mainly eosinophils, monocytes and, to a lesser extent, neutrophils.

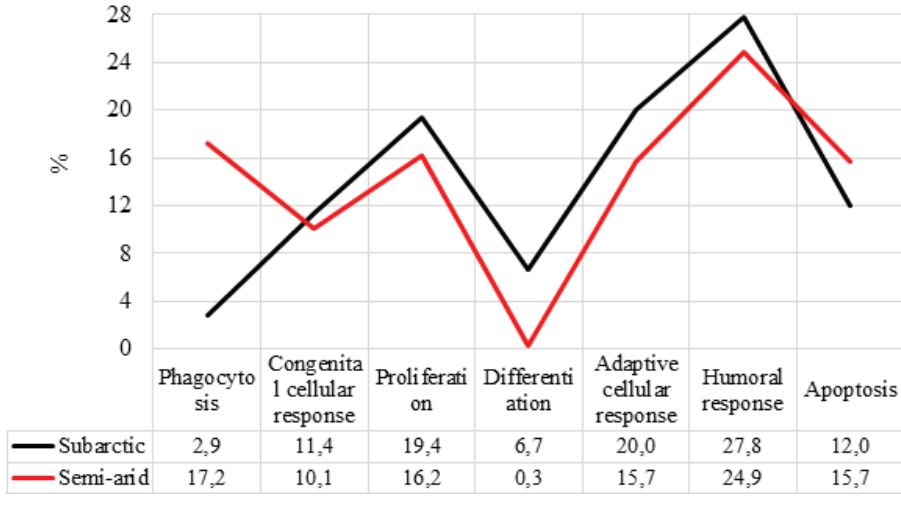
Determining the percentage contribution of different stages of the immune response using the coefficients scores for assessing the variables, a significant difference was revealed (Figure 1) at the stages of phagocytosis, differentiation, cellular reaction and apoptosis ($p<0.01$). In subarctic conditions, the contribution of phagocytosis, as well as apoptosis, to the formation the immune response is almost 6.0 times and 1.3 times lower than in men of the semi-arid region, respectively, which may be explained by a decrease in air temperature and UV index [8,10]. The contribution of the processes of differentiation and cellular acquired reaction is 22.0 and 1.3 times higher than their contribution in men of the semi-arid region, respectively. Thus, it can be assumed that cold weather, photoperiods, and UV radiation deficiency contribute to an increase in the activity of T-lymphocyte differentiation, which in turn enhances the cellular acquired response. The contribution of the process of lymphoproliferation in men of the subarctic region is 1.6 times higher than the contribution of the process of apoptosis, in contrast to the men of the semi-arid region, in which both contributions are practically equal, which reflects the distinctive features of the functioning of the immune system depending on the place of residence of a person and can contribute to the development of secondary ecologically dependent immune imbalances, including autoimmune diseases, oncopathology, etc.

Moreover, determining the percentage contribution of different stages of the im-

Table 3

Structure of factor variables and coefficient scores of immunological status parameters in men aged 20-60 living in semiarid (1) and subarctic (2) regions

Parameter	Region	Rotated Component Matrix				Coefficient scores			
		Factor				Factor			
		1	2	3	4	1	2	3	4
CD20$^+$	1	**0.94**	0.18	-0.03	0.02	0.367	-0.035	-0.085	-0.09
	2	**0.93**	0.09	0.14		0.233	-0.004	-0.092	
CD71$^+$	1	**0.91**	0.12	0.26	0.01	0.347	-0.090	0.071	-0.106
	2	**0.93**	0.04	0.19		0.221	-0.026	-0.046	
CD95$^+$	1	**0.86**	0.11	0.08	0.24	0.319	-0.097	-0.039	0.051
	2	**0.91**	0.10	0.22		0.212	-0.01	-0.033	
CD3$^+$	1	-0.01	**0.90**	0.08	-0.02	-0.123	0.425	-0.054	-0.122
	2	0.26	0.33	0.54		-0.037	0.041	0.289	
CD8$^+$	1	0.16	**0.87**	0.21	0.20	-0.072	0.349	-0.011	-0.017
	2	-0.04	**0.92**	0.21		-0.069	0.286	0.044	
CD4$^+$	1	0.32	**0.85**	0.22	0.22	-0.006	0.315	-0.015	-0.014
	2	0.05	**0.90**	0.02		-0.006	0.298	-0.104	
CD16$^+$	1	0.53	0.58	0.03	0.28	0.120	0.173	-0.099	0.052
	2	**0.88**	0.06	0.29		0.189	-0.031	0.031	
CD10$^+$	1	0.05	0.07	**0.89**	0.19	-0.055	-0.090	0.427	0.027
	2	0.20	**0.90**	0.05		0.028	0.290	-0.106	
CD5$^+$	1	-0.03	0.16	**0.89**	0.01	-0.081	-0.016	0.433	-0.083
	2	0.07	**0.82**	0.16		-0.026	0.255	-0.001	
HLA-DR$^+$	1	0.28	0.18	**0.69**	0.04	0.054	-0.032	0.312	-0.078
	2	**0.94**	0.08	0.08		0.246	0.000	-0.134	
Eosinophils	1	0.02	0.21	0.03	**0.89**	-0.101	-0.009	-0.083	0.506
	2	0.03	0.02	**0.86**		-0.156	-0.094	0.593	
Monocytes	1	0.26	0.05	0.29	**0.79**	0.018	-0.133	0.062	0.421
	2	0.44	0.12	0.55		0.014	-0.034	0.291	
Neutrophils	1	0.04	0.07	0.00	0.58	-0.042	-0.042	-0.058	0.336
	2	0.19	0.08	0.57		-0.058	-0.044	0.354	



Percentage contribution of immune response stages in men aged 20-60 living in the subarctic and semi-arid regions

mune response will help in assessing the immune status of the population, and will also be useful for predicting possible deviations, manifested by the development of possible pathologies that may appear in the future. In addition to the above, we suggest that the line presented in Figure 1 should have a reference form that should be determined for optimal assessment and interpretation of the immune status of the population.

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BIOCHEMICAL PARAMETERS OF BLOOD OF MAS WRESTLER STUDENTS DURING THE TRAINING PERIOD

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The purpose of this work was to evaluate the biochemical parameters of blood in the mass-wrestler students during the training period. 28 students of the NEFU named after M.K. Ammosov, indigenous nationality of the Republic of Sakha (Yakutia), including 17 athletes - wrestlers, took part in the survey on the basis of informed voluntary consent. The biochemical parameters of blood aspartate aminotransferase (AST), alanine aminotransferase (ALT), lactate dehydrogenase (LDH), creatine kinase, alkaline phosphatase, gamma-glutamyltransferase (GGT), glucose, total cholesterol, HDL cholesterol, LDL cholesterol, VLDL cholesterol, triglycerides, uric acid, urea, creatinine, total protein, albumin by enzymatic method. Calculated indicators were determined: the de Ritis coefficient (AST/ALT), the index of muscle tissue damage (CPK/AST) and the atherogenicity coefficient. According to the results of the study, the excess of normal indicators of CPK, SCHF and the muscle damage index (CPK/AST) of more than 10 units was revealed.

Keywords: mass wrestlers, biochemical parameters, CPK, AST, ALT.

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Introduction. The ability to accurately quantify the physiological effects of exercise on the human body is crucial to understanding recovery needs and to ensure adequate rest before re-training. The use of biomarkers can improve the ability of trainers to assess the recovery period after training and to establish the intensity of subsequent training in the most effective way [6]. The study of the effect of physical exertion on the activity of intracellular enzymatic profiles specific to certain tissues and organs provides additional information not only about the condition of muscles, but also about its biochemical adaptation to the training process of athletes [5]. Analyzing the dynamics of enzymes under the influence of physical exertion, it is possible to vary exercises of different nature and intensity in such a way as not to cause destructive changes in the body systems [5]. In mas-wrestling, athletes, as a rule, perform exercises for a large number of repetitions to develop strength and muscular endurance of the arms, while often using the "to failure" method. However, the inept use of this method leads to excessive local acidification of the muscles of the hands, which ultimately negatively affects the development of strength and muscular endurance of the hands [2].

The aim of the study was to evaluate the biochemical parameters of the blood of the mass–wrestlers during the training period.

Materials and methods. The survey was conducted on the basis of in-