The impact of the ecological state of the region of birth on the functional state of health

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Abstract. The paper considers the problem of the impact of a complex of environmental factors and their impact on the health of young people. Young people aged 18 to 21 years old, who lived up to 18 years old in different environmental conditions, were examined in order to assess the general functional state of their body. The study used a developed non-invasive optical method for assessing the oxygen status of tissues and general functional state, as well as an independent biomedical study. The results of the experiment revealed the significance of the influence of the ecological factors of the region of birth on the functional state of health of the young generation.

1. Introduction
At present, the need for a comprehensive study of the influence of environmental factors on the health of the younger generation is obvious [1-12]. This problem is of particular relevance in areas of increased anthropotechnogenic impact, which include megalopolises, industrial centers of the country, large agricultural centers [10-19]. Anthropotechnogenic factors include pollution of air, soil, city water, high noise level, electromagnetic radiation, which are a direct product of industrialization [19-33]. As you know, the quality of the ecology of the environment is the main factor in the healthy coexistence of inanimate nature and the community of various living organisms, their well-being and life expectancy, including humans [11-19, 34-39]. The high rates of urbanization observed in recent years, an increase in vehicles, poor-quality operation of treatment facilities, an increase in the volume of various waste, annual environmental accidents and disasters, etc. [40-46] clearly identified the problem of environmental impact on the health of the population. Many studies show that an increase in the concentration of toxic, chemical ingredients in the environment leads to a significant deviation from the norm of the general functional state of the body in the population of the country, which characterizes the adaptive and functional capabilities of the cardiorespiratory system, the state of the main internal organs of a person and the body as a whole [47- 50]. This process is especially dangerous for the younger generation due to the active phase of development and formation of the organism in the childhood and adolescent stages of postnatal ontogenesis.
Therefore, the study of the influence of environmental factors in the region on the functional state of the cardiovascular and respiratory systems of the body, as well as the general functional state of health of young people is an urgent task.

2. Method
To study the functional state of the cardiorespiratory system and the general functional state of young people who were born and lived up to 18 years in different regions of the country with different environmental conditions, a methodological approach was proposed, which was released by creating an experimental base in the form of an instrumental-software complex for studying the oxygen status of tissues and the general functional state of a person [47-50].

The instrumental-software complex is represented by a developed diagnostic non-invasive optical system for monitoring the oxygen status of tissues based on a multichannel analyzer of visible spectra using various methods of multivariate data mining [51]. The optical method used is based on the ability of blood hemoglobin to absorb light of various wavelengths emitted from the LED, which is scattered, reflected by tissues and blood and reaches the photodetector. The result of measuring the developed diagnostic optical system is an individual digital oxygen image of human tissue, which is the numerical readings of six optical sensors, which are recorded at different periods of time when performing a functional load. The obtained data is processed using mathematical methods of data mining and machine learning, in particular, using algorithms for cluster analysis and visualization of multidimensional data, by reducing the dimension of the feature space from multidimensional to two-dimensional with minimal loss of useful information about the objects under study.

The survey involved 31 young males aged 18 to 21. Young people were born in and grew up in different regions of the country: in large cities, in which the atmosphere is polluted mainly with harmful substances from car emissions, in cities near large and medium-sized industrial facilities, as well as in rural, ecologically clean, areas.

Before the experiment, all young people underwent a special medical examination, which did not reveal in young people chronic pathologies of the main functional systems of the body. To assess the oxygen supply of the body, the resistance of the cardiorespiratory system to hypoxic conditions and to determine the general functional state of the organism in the method as a functional load, we chose the maximum breath holding on inhalation in a sitting position. Measurements were recorded on the right hand cyst. In addition, an independent biomedical study of each subject was carried out aimed at obtaining general information about the state of the cardiovascular and respiratory systems of the body, as well as the general functional state of the body.

3. Results
As a result of examining young people using the developed diagnostic optical system, individual digital oxygen images were obtained, which are multidimensional data and reflect the dynamics of changes in the oxygen status of tissues during different periods of measurements: at rest, with a short-term hypoxic effect on the body (breath holding) and during the recovery thereafter.

Further, the obtained digital oxygen images were analyzed by methods of intelligent data analysis for clustering and visualization of multidimensional digital images in a Cartesian coordinate system. One of the classical clustering methods, PAM (Partitioning Around Medoids), was chosen as the cluster analysis algorithm.

As a result of the cluster analysis of digital oxygen images of the subjects, the survey participants were divided into 2 clusters depending on the dynamics of the oxygen status during the functional load, which reflects the body's adaptive response to short-term hypoxia. The first cluster includes 20 subjects, the second cluster - 10 subjects, and 1 subject did not fall into any cluster. At the same time, the second cluster included subjects with good dynamics of the digital oxygen image during the exercise and, accordingly, with high resistance to hypoxia. The first cluster included subjects with
both sufficient and unsatisfactory resistance of the organism to hypoxic exposure. The results obtained correlate with biomedical research.

The result of clustering digital oxygen images of the examined young people is shown in Figure 1. The numbers of the clusters are labeled on the graph.

After analyzing the information obtained about the functional state of each subject and comparing it with the regions of birth of the survey participants, in which they lived until the age of 18, the following results were obtained: 87.5% of the subjects who were diagnosed with an unsatisfactory functional state by an independent medical and biological study and who were included in the group with unsatisfactory hypoxia resistance (Fig. 1, left cluster), were born and raised either in ecologically dirty regions with industrial facilities that are powerful sources of pollution, or in large cities, where the main air pollution is caused by harmful emissions from cars.

![Cluster plot](image.png)

**Figure 1.** The result of clustering 31 oxygen digital images in a two-dimensional coordinate system. ... Images of the oxygen status of the test subjects in the space found by 6 variables for 31 subjects. Variables are the numerical readings of each of the six sensors 4 minutes after the functional load, normalized to readings obtained at state of rest. Each participant in the examination is indicated on the graph by a dot with a number.

The percentage of subjects born in ecologically favorable regions, who showed a good functional state and who are distinguished by a high resistance of the organism to hypoxia (Fig. 1, right cluster) was 67%. Thus, the preliminary results of this study confirm the importance of environmental factors in shaping the health of the younger generation.

4. **Conclusion**

The results of our research indicate a significant influence of the environmental factors of the birth region on the functional state of the body of the younger generation, as well as the need for further research and a more complete factor analysis of the influence of the ecology of the birth region on the health of adolescents.
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