

PUBLIC HEALTH

## Environment Features and Human Health in the North

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### Abstract

There is a perspective approach to assessing the effect of environmental changes on the population health. It is quite clear that the possibility of a standardized assessment in the level of the population health in specific ecological zone, taking into account the effect of extreme environmental factors, is one of the most important conditions for the implementation of environmental impact assessment and environmental health monitoring.

**Keywords:** *health; ecology; environmental factors.*

### State of the Problem

Russian Far North regions occupy 11 million km<sup>2</sup> or nearly two-thirds of the country. In these areas, a total of 10.7 million people live permanently, comprising 7.4% of the country's population, including representatives of about 30 indigenous minorities.

The need of state policy development in the North is determined by the exclusively important value of this region in social and economic development, in defense capabilities, in the geopolitical and strategic interests of all Russia, and in the special conditions of economic functionality and life of the population caused by extreme climatic factors and remoteness from the central developed areas of Russia. In addition, specific high latitude features, also known as the so-called helio-geophysical electromagnetic factors, corpuscular flows of different origin and intensity invade the atmosphere of northern territories.

Changes of biochemical and biophysical process in the membrane of cells cause the development of "Polar" symptoms in humans: dyspnea, asthenia, psycho-emotional instability and an increase of blood oxygen debt as the manifestation of peculiar hypoxia.

In the second part of the twentieth century, the discomfort of life in the North was aggravated by the anthropogenic pressure of rapid technological revolution. Technological processes used in the mining industry were

accompanied by pollution of the surrounding environment by chemical elements of different origins and degrees of toxicity. These toxic substances, polluting soil and river water, negatively affect the population health of reclaimed industrial regions through biota, vegetation, and drinking water. The worst thing is that we are talking primarily about the health of the younger generation. A healthy younger generation is an essential condition for the prosperity and development of any society. All of the above shows that children in the North are in the most difficult ecological, hygienic, and socioeconomic conditions.

Among children of 13–16 years, only 10–15% can be considered relatively healthy; the infant mortality rate in some areas of the North is two to three times higher than the national average. Morbidity among northerners is three to five times higher than the national average, and the incidence of tuberculosis in some regions is six to seventeen times higher. Oncopathology, respiratory and circulatory diseases are twice as high among northerners. The high mortality of males is also connected with intensive alcoholism.

Thus, the ecological problem in the North comes to the fore because of the close connection with threats to physical and mental development, and even the survival, of the people inhabiting this amazing and rich region.

At the same time, in the northwest parts of the Sakha Republic (Yakutia), the diamond mining industry and hydropower have progressed. Summary data about the environmental state in the Viluy River watershed are reflected in known monographs ("Ecology of the Viluy River watershed: industrial pollution", "Ecology of the Viluy River: environment state and human health", "Ecology of

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the Viluy River: environment state evaluation”, and “Ecology, adaptation and health” “Gray Viluy”), as well as in materials of the scientific and practical conference “Applied Ecology of the North: the problems and prospects “ and in numerous publications of the scientists of the republic. Starting from the end of the 1980s, by insistence of public and scientific institutions of the Republic, complex biomedical monitoring surveys of the environment and the health status of the population in villages and towns along the Viluy River were performed.

Scientific research has been carried out by scientists of the Institute of the North and by practical physicians. Long-term studies have confirmed the negative effect of ongoing processes on the state of demographics and health of the Viluy region population (Myrminsky, Suntarsky, Nyurbinsky, Upper-Vilyuisky, and Vilyuisky districts).

High morbidity associated with diseases of the gastrointestinal tract, cardiovascular system, musculoskeletal apparatus, high frequency of tumors and congenital anomalies, pregnancy pathology and delivery all confirmed the negative effect on health of subtoxic doses of accumulated industrial poisons and chemical pollutants.

The study of the adaptation processes in indigenous populations led to understanding the fact that the evolution of adaptive mechanisms among indigenous residents took a peculiar path and developed an adaptive reaction different from that among the newcomer population.

However, currently, these reactions under impact of rapid environmental changes are inadequate, and as a result there has been a development of de-adaptation among the indigenous population. Thus, significant abnormalities have developed in the immune system among residents of disadvantaged regions, more pronounced with the approach to the source of pollution.

In light of these facts, ongoing research in diamond mining provinces is directed toward the study of intimate mechanisms developing in bodies exposed to individual or complex environmental factors. Study of the physiological and biochemical reactions to ecotoxins is a no less important problem. Along with the analysis of health and demographic indicators, the need for the study of complex pathophysiological processes occurring in the body has resulted in identification of the following areas of our research.

### **I. Morphological and functional features of the body affected by ecological conditions (together with the Krasnoyarsk State Medical Academy)**

Study of northern ethnoses and population living permanently in extreme geoclimatic conditions is of interest in terms of human adaptation to severe northern conditions and development of standards for an ecological portrait of population. Studies of constitutional features of more than 4,000 residents of the republic [1], which were conducted for PhD research, leads us to the following conclusions:

- Assessment of physical and somatic-typical parameters of the Yakutia population showed the existing features depending on ethnic factors.

- The bone mass index of the Yakutia population is significantly higher compared to this index in the inhabitants

of other Siberian regions (Novosibirsk area, Krasnoyarsk region), regardless of ethnic factors.

- Choreography school students from Yakutia differ from students from other regions of Siberia by body size and body component composition (the proportion of fat and bone components is significantly lower in all age groups of students from Krasnoyarsk region,  $P < 0.001$ ).

- We have identified how the training process (choreography) influences both age-dependent changes in body size and its component composition, and the dynamics of puberty in students of the choreography school.

Obtained results allowed creating the Republican database of anthropometric indicators of physical development of the Yakutia population for further development of health interventions. For the first time, for men and women of the republic, normative parameters of body size and soma component composition that depend on ethnic and constitutional properties were created.

Based on received materials, we developed recommendations, which are applied in the selection program of professional students training in the choreography school. Currently, research in integrative anthropology is continuing.

### **II. Study of ecological and physiological features of elemental status in the Yakutia population (together with the Center for Biotic Medicine, Moscow)**

In the PhD research of U.D. Antipina, S.V. Markov, N.V. Borisova, and G.A. Egorova [2, 3], the prevalence of macro- and micronutrient imbalances in children of Yakutia is analyzed.

For the first time, diagnostic screening of the republic's child population was conducted. Typical features in the elemental status of children living in rural surroundings and in Yakutsk were identified. In addition, risk groups were formed of those children with a deficit and excess of macro- and micronutrients with the help of multielement hair analysis. For the first time, the influence of the chemical composition of food and drinking water on the elemental status of children and its features in children with endemic goiters were studied. In children, living in rural encampments of diamond province, the role of water in excessive intake of chemical elements (Fe and Mn, particularly) was discovered. We discovered that endemic goiter, widespread among children of the republic, has a heterogeneous nature of origin and is caused by a complex of natural (deficit of the essential elements), artificial (toxic elements excess), and social (supply balance) factors. Based on received materials, we developed the recommendation to create the elemental mapping of regions of the republic, as well as preventive and remedial actions for risk groups (adolescents and children of primary school age) to prevent endemic goiter based on iodine in combination with other vital micronutrients such as zinc and selenium.

### **III. Study of the immune disorders, including allergic diseases, which are widespread among children of the North**

Within the framework of “Global strategy of treatment and prevention of bronchial asthma (2104)”, “ISAAC” and “ISAAC-2” programs, risk factors for asthma were identified and the health state of 6340 children was studied. The

analysis of allergic diseases in children of the Nyurbinsky and Viliuisky districts revealed a multifactorial type of the body's sensitization with a significant role of immune mechanisms (viral infections, drug and epidermal allergies, etc.) [4,5]. The immune status of children with bronchial asthma is characterized by a decrease in CD3+, CD4+, CD8+, CD16+, IgA, and IgG levels and an increase in CIC and IL-13 levels in adolescents.

The identified immune disorders in adolescents with asthma characterize the functional immune deficiency and immune dysregulation due to climatic and geographical features and environmental degradation [6,7].

**IV. Study of cardiovascular diseases depending on solar and geophysical disturbance (together with Yu.G. Shafer Institute of Cosmophysical Research and Aeronomy of the Siberian Branch of the RAS)**

V.I.Hasnulina and F.G.Zhdanovoy found a clear association between the heart's electrical activity and the level of geomagnetic activity in high latitudes, where perturbations of geomagnetic and electric fields are largest.

Studies conducted in the Institute revealed a number of characteristic data [8,9]:

- Increased incidence of high blood pressure and hypertensive crises in the year of maximum solar activity (1992) compared with the year of lowest solar activity (1998). Similar results were observed in Tiksi and in Yakutsk.

- Cases of cerebral stroke and acute myocardial infarction were recorded most often during periods of increased geomagnetic disturbance. The greatest number of named pathologies was registered in winter-spring (December-April) and fall (September-October) periods.

- Analysis of mortality from cerebral stroke and acute myocardial infarction shows that the greatest number of deaths is registered in the winter and fall months. As is known, these seasons are characterized by increased activity of geophysical factors that also testifies to the relationship between stroke and myocardial infarction, and geophysical perturbations.

- Solar activity and geomagnetic perturbations affect the development and course of stroke and AMI, depending on gender: the frequency of acute myocardial infarction is observed to be ten times greater in men aged 30 to 50 years than in women of same age. Risk of myocardial infarction in men over 50 years old has tended to decline; but in women of same age the risk increases by a factor of 1.5 to 2. This increase is probably related to a deficit of hormones during menopause.

In sum, ecologo-medical studies conducted by the Institute in recent decades show that extremely vulnerable climatic features of the North combined with technogenic contamination lead to a serious violation of structure and land biocenosis, degradation of forest arrays, depletion of freshwater and fish stocks in reservoirs and, as a consequence, deterioration of population health.

Consequently, the main objectives for health care in the

North should be the following:

- Extension of prenological diagnosis and actions directed toward clinical examination of the population as the main form of diseases prevention

- Formation of the population health registers, including information about the social-medical status of citizens

- Creation of technological systems providing diagnostic and curative medical assistance for residents in remote territories based on the formation of exit teams, expeditions and telemedicine technologies

- Formation of healthy lifestyles, promotion of physical culture and sports, the development of voluntary incremental health insurance

- Development of regional standards for the population health and the nutrition standards in the North, including support for the production of traditional food development of local bio-pharmaceutical industry and correction of technogenic factors.

### Competing interests

The authors declare that they have no competing interests.

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