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THE INFLUENCE OF GEO-ECOLOGICAL CHARACTERISTICS ON THE BODY CONDITION OF THE INDIGENOUS YAMAL POPULATION

ABSTRACT. Geological features of northern territories are considered in the aspect of their influence on the organism of the native populations of Yamal. The present article offers a comparative and correlative analysis of the ecological, climatic and cryosolic characteristics of Ustpurovsky-Tazovsky and Purovsky geo-cryological regions and their influence on the health of aboriginals.

It was stated that the total volume of sewage thrown in the surface water objects and the content of iron chlorides and ammonium nitrogen is bigger in Purovsky geocryological region, however, the given contaminations do not exceed the tolerance limit concentrations (LTC). It is necessary to consider the geocryological peculiarities of the territory, as the superficial permanently frozen ground can entrap different substances and accumulate them. Thus, LTC for northern territories must be considerably lower.

Examination of the contaminating substances showed excess of LTC in hard substances (dust, soot, ash, etc.), and carbon oxide in the atmosphere of Purovsky geocryological region and nitrogen oxides both in Purovsky and Ustpurovsky-Tazovsky geocryological regions. The abovementioned microscopic solid particles are capable of accumulating in human bodies, thereby damaging human health. Apart from the ecological characteristics, the influence of climate indexes of the reviewed territories (air temperature and humidity, wind direction and speed, quantity of precipitation) on the immune system of the tundra nenets was studied.

In conclusion, complex influence of extreme climate, ecological, and cryological conditions of the northern regions essentially affects human organisms creating a basis for developing of pathological processes.

KEY WORDS. Human health, immune system, environmental contamination, geo-ecological features.

Intensive industrial development of the northern territories calls for the study of the physiological basics of regulation of the anthropogenic impact on the healthcare processes regarding the population of the region as multifactor and labile extreme climatic and ecological influences of the Far North condition a different character and longevity of the influence of the environmental factors and human adaptation reactions as compared to the Central Russia [1-3].

The specificity of adjustment of the indigenous population has been developing for many centuries and presents in itself an adaptive optimum which is adequate to the given environment [4]. In the era of rapid technological progress reaching into the northern territories there is a great interest exactly in the indigenous population

of the given ecological niche which can serve as a 'model population' for the study of the mechanisms of interaction between man and the unfavorable environment [5]. This explains the necessity to explore the complex ecological, climatic and cryological factors of the Far North and estimate their combined impact on the health of the indigenous peoples inhabiting the region.

The aim of the research: study of the influence of the geo-ecological parameters on the health condition of the indigenous Yamal population.

Materials and methods. We have studied the settlements of Samburg and Tarko-Sale of Purovskiy district of the Yamalo-Nenetz Autonomous Region (YNAR). According to E. D. Ershov's "Geocryology of the USSR. Western Siberia", judging by their geo-cryological characteristics, these settlements belong to the Northern zone of the Kharasavey-Novourengoy subzone of the Ustpurovsko-Tazovskaya region and Central zone of the Igarko-Numtinskiy subzone of the Purovskaya region correspondingly [6].

In this work we present a comparative and correlation analysis of the ecological, climatic and permafrost parameters of the Ustpurovsko-Tazovskaya and Purovskaya geo-cryological regions and their influence on the health condition of Yamal indigenous population.

The official statistical ecological data obtained in [7] and [8] have been applied. In particular we have carried out estimation of the quality of the environment by the following parameters: atmospheric discharge; discharges to water basins; amount of the companies producing discharges and the number of the sources of contaminating emissions.

The climatic data were obtained from the Climatological reference books and the Institute of the Earth Cryosphere of SB RAS [9-13] as well as the site www.meteo.infospase.ru. To define the cryological characteristics of the thickness and humidity of the seasonal-thaw layer of Nadym station we used the data from the Institute of the Earth Cryosphere of SB RAS [13].

Detection of immune pathologies and risks of development of immune pathological conditions was carried out in two stages:

I stage – questioning of the test groups with the help of specially designed questionnaires including the elements of survey and data collection, medical cards of patients;

II stage – laboratory assessment of immunity.

At the moment of the laboratory test the persons in question were clinically healthy; did not have any signs of acute inflammatory disease for two months; the generally accepted laboratory values of activity index were within the norm.

The received data have been processed with IBM/PC using standard statistical software "SPSS 11.5 for Windows" (average value, dispersion of average values, parametric comparison using Student's criterion, Spearman correlation coefficient with rank-order correlation, frequency analysis and multifactor regressive analysis).

Research findings. Investigation of the chemical composition of the discharge waters in the surface water basins revealed the following (table 1).

Table 1

Characteristics of the sewage waters discharged into the surface water basins in different geo-cryological regions

Name	Ustpurovsko-Tazovskaya	Purovskaya
Synthetic surface-active substances, tons	0,04 ± 0,01	0,07 ± 0,02
Total phosphor, tons	0,25 ± 0,05	0,37 ± 0,09
Ferrum, tons	0,37 ± 0,11	1,57 ± 0,17**
Sulfates, thousand tons	0,01 ± 0,001	0,02 ± 0,01
Chlorides, thousand tons	0,01 ± 0,002	0,02 ± 0,004*
Ammonia-N, tons	1,01 ± 0,17	10,89 ± 1,66**
Nitrates, tons	7,55 ± 2,13	5,22 ± 2,55
Nitrites, tons	0,11 ± 0,02	0,77 ± 0,45

- statistical significance of the differences ($p<0.05$; **$p<0.001$)

We have stated that the sewage water discharge into the surface water basins in the Purovskaya geo-cryological region is bigger than in the Ustpurovsko-Tazovskaya geo-cryological region: discharge of Ferrum (1,57 ± 0,17 tons and 0,37 ± 0,11 tons correspondingly at $p<0.001$), chlorides 0,02 ± 0,004 thous. tons and 0,01 ± 0,002 thous. tons correspondingly at $p<0,05$), Ammonia-N (10,89 ± 1,66 tons and 1,01 ± 0,17 tons correspondingly at $p<0.001$). No statistical significance of the differences concerning the other discharged contaminants was detected.

According to the maximum permissible sewage water discharges (MPD) calculation methodology we have calculated the concentration of each contaminant at the control point (mg/l) and then compared it with the maximum permissible concentration (MPC), table 2.

Table 2

Concentration of contaminants in the water at the control point in different geo-cryological regions and MPC, mg/l

Name	Ustpurovsko-Tazovskaya	Purovskaya	MPC
Synthetic surface-active substances	0,000001409	0,000003963	0,5
Total phosphor	0,000008808	0,000020951	0,0001
Ferrum	0,000013036	0,0000889	0,3
Sulfates	0,000352331	0,001132492	500
Chlorides	0,00035	0,00113	350
Ammonia-N	0,000035585	0,000616642	2,0
Nitrates	0,000266009	0,00029558	45
Nitrites	0,000003875	0,0000436	3,3

Thus, the total amount of sewage waters discharged into the surface water basins and the amount of each discharged contaminating substance (ferrum, chlorides and

ammonia-N) in the Purovskaya geo-cryological region is bigger, however not exceeding MPC. It is necessary to take into account the geo-cryological features of the region. Since the surface permafrost formation (PF) is capable of catching and accumulating various contaminants. Therefore MPC for the northern territories with PF should be much lower.

The study of the atmospheric discharges let us calculate the maximum values of the ground level concentrations of contaminants (C_m, mg/m^3) and compare them with MPC (table 3).

Table 3

Maximum values of ground level concentrations of contaminants C_m in atmosphere in different geo-cryological regions and MPC, mg/m^3

Name	Ustpurovsko-Tazovskaya	Purovskaya	MPC
Solids	0,13260	0,67906	0,50
Gaseous and liquid			
Sulfur dioxide	0,104847	0,04442	0,50
Carbon oxide	5,105509	10,29763	5,0
Nitrogen oxides	1,692765	1,13704	0,085

Analysis of Table 3 shows MPC excess in the atmosphere for solids (dust, soot, ash, etc.), carbon oxide in the Purovskaya geo-cryological region and nitrogen oxides both in the Purovskaya and Ustpurovsko-Tazovskaya geo-cryological regions. The most harmful for people's health are microscopic dust particles (suspended) capable of accumulation in human bodies and with time deteriorate the immune system.

The next source of atmospheric contamination is carbon oxide (hazard class 4) which results from fuel combustion and changes the ambient temperature. We have detected double excess of the MPC for this substance in the Purovskaya geo-cryological region. Climates changes cause exacerbation of cardiovascular, respiratory and other diseases.

Another atmospheric contaminant is nitrogen oxides (MPC = 0.085mg/m3), hazard class 2 – highly hazardous. The MPC excess for this substance in the Ustpurovsko-Tazovskaya geo-cryological region is 20-fold; in the Purovskaya region 13-fold. The interaction of nitrogen oxides and sulfur with water can later form nitric acid (HNO_3) and sulfuric acid (H_2SO_4).

Apart from the ecological factors the regional climatic parameters, such as air temperature and humidity, wind speed and direction, amount of precipitation etc., also influence on the people's health. They in turn depend on the permafrost characteristics.

The correlation analysis between the ecological and climatic characteristics of the territories under study shows that the given amount of precipitation promotes positive influence on the environmental quality. There is an inversely proportional correlation between the amount of precipitation and the sewage waters discharged into the surface

water basins; the correlation coefficient (CC) is (CC=-0.610 at $p<0.01$) which reduces the amount of contaminants in the sewage waters. Similar results of the correlation analysis exist for the interrelation of the precipitation amount and contaminants emission (KK=-0.570; $p<0.05$), including gaseous and liquid (KK=0.570; $p<0.05$), that is carbon oxides (KK=-0.530; $P<0.05$) and nitric acid (KK=0.53; $p<0.05$).

The correlation analysis regarding the climatic and cryological (permafrost) parameters has revealed that there is a direct link with a high correlation coefficient (KK=0.999; $p<0.001$) between the average monthly air temperature in winter and weight moisture content of the seasonally thawed layer for the natural (without anthropogenic impact) and damaged permafrost formations. At the depths of 0.6 and 0.85 m the damaged permafrost soil still display the correlation unlike the natural soils. Another peculiarity of the damaged soils is that correlation can be traced down to 1.1 m depth. The presence of correlations at a depth of over 0.85 m in the damaged soils probably means that permafrost layers thaw deeper than the natural soils.

It is well known that the ecological, climatic and cryological characteristics of the territory can influence on the health condition of Yamal indigenous population. Therefore we have conducted a comparative analysis of the laboratory-immune characteristics (immune competent cells of peripheral blood) in the geo-cryological regions under study (table 4).

Table 4

Cell content in the peripheral blood in the Ustpurovsko-Tazovskaya and Purovskaya regions

Name	Geo-cryological region	
	Ustpurovsko-Tazovskaya	Purovskaya region
Leukocytes, thous./mm^3	7,01 ± 0,19	8,16 ± 0,29**
Eosinophils, %	2,39 ± 0,31	1,84 ± 0,33
Basophils, %	0,13 ± 0,05	1,43 ± 0,27***
Band neutrophils, %	1,98 ± 0,95	0,68 ± 0,13
Segmented neutrophils, %	47,63 ± 1,07	56,29 ± 0,97***
Monocytes, %	6,24 ± 0,26	5,39 ± 0,21*
Lymphocytes, %	43,43 ± 1,03	33,50 ± 1,08***

- statistical significance of the differences ($p<0.05$; **$p<0.01$; ***$p<0.001$)

Besides we have obtained results of the correlation analysis between the climatic and immune parameters and found out that the further to the north the thicker the permafrost layer, the bigger the wind speed, the lower the temperature and amount of precipitation. Some parameters of the immune system also change: decrease in the absolute level of leukocytes and relative level of neutrophils which is compensated by the increase in the relative level of monocytes and lymphocytes.

Thus the complex influence of the extreme climatic, ecological and cryological conditions of the northern regions significantly influence on the human organism causing a clearly expressed tension of the immune mechanisms and creating a foundation for the pathological processes development.

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