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HEALTHY LIFESTYLE. PREVENTION

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SCIENTIFICALLY BASED EDUCATIONAL PROGRAM ON HEALTHY DIET: FEATURES OF NUTRITION TO MINIMIZE HARM TO HEALTH CAUSED BY ADVERSE (EXTREME) NATURAL AND CLIMATIC CONDITIONS

A scientifically based nutrition education programme has been developed covering nutrition peculiarities for people living on territories with extreme natural and climatic conditions. Adequate and balanced diet that takes aforementioned peculiarities into account makes a significant contribution to preserving health of both indigenous people and newcomers. Systemic informing and teaching provided for people regarding principles of healthy diet seems a promising trend in activities implemented within the 'Demography" National project.

Keywords: education programme, nutrition, natural and climatic conditions, Far North, Arctic zone.

Introduction. Climate is a long-term weather pattern that is typical for a given territory. In the Russian Federation there are several climatic zones including arctic, sub-arctic, moderate, and sub-tropic one. A big part of the country territory is located in the Far North (or areas that are considered similar to it); natural and climatic conditions there are adverse (extreme) [15,16]. These territories include Murmansk region, Arkhangelsk region, Tyumen region, Irkutsk region, Kamchatka, Magadan region, Sakhalin, Komi Republic, Karelia, Tyva, Sakha (Yakut Republic), Krasnoyarsk region, Khabarovsk region, Khanti-Mansi Autonomous Area, and Chukotka. All these RF regions are conditionally divided into Asian North and European North. Some of them are included into the Arctic zone [8]. Population is made up of various groups: natives from various ethnic groups; indigenous Caucasians (the second or older generation); migrants or newcomers who have been living in the zone for rather a short time (the 1st or the 2nd generation); shift workers who have been working there in shifts for a year or several years [16].

Both indigenous people and newcomers can preserve their health to a larger extent due to adequate and balanced diet, certain peculiarities taken into account. But still, data available in scientific literature indicate that actual nutrition consumed by indigenous people does not conform to principles of healthy diet and doesn't take climatic peculiarities into account. Thus, though food rations consumed by pre-school and school children contain fats and carbohydrates in sufficient quantities, some components are in deficiency, such as proteins, including animal ones (11-20%), vitamin C (20-36%) and A (22-89%), calcium, iodine (up to 75%) and other essential ones [23]. Rations consumed by young males (aged 17-21) who lived in the north-eastern regions in Russia (Magadan and Chukotka) tended to have low quantities of proteins and fats including polyunsaturated fatty acids and, on the contrary, high quantities of carbohydrates (up to 68%); dietary fiber was almost absent. Vitamin-mineral profile of consumed food products is apparently poor [1]. Moreover, basic rations consumed by sportsmen who live and train in the Far North can't satisfy daily energy needs and provide optimal macronutrient ratio; it should be noted that such rations should take into account not only overall dietary principles but also a specific kind of sport, a season, physical loads intensity and stages in a training process [5].

Products with high biological values do not occur frequently enough in food rations consumed by adult people [4,23]. For example, milk is daily consumed only by 47% respondents; fresh vegetables, greenery, and fruit, by not more than 16%; and fish, only by 3% (49% respondents consume it 1-2 times a week). On the contrary, sugar is consumed too often since it occurs in daily rations of 77% respondents [29]. Comparative analysis of

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actual daily food products consumption and recommended levels reveals deficiency of milk products, vegetables, potato, and fruit, and excessive quantities of confectionary [20,23,27]. Although local population consume meat in relatively significant quantities (owing to deer-raising products and hunting season), average annual quantity is 240 g/day and it is lower than in other RF regions [26]. Indigenous people, as opposed to newcomers, consume sour milk products, milk, and cheese in much smaller quantities and it results in lower calcium contents and its improper ratio with phosphor. Vegetable products deficiency leads to the body being poorly provided with water-soluble vitamins, first of all, vitamin C [20].

A share of carbohydrates reaches 60% in the structure of energy value, proteins and fats account for 20% each [13]. Some researchers state that nutrition becomes carbohydrate-lipid and carbohydrate in its essence with refined products being consumed in large quantities but low contents of vitamins, minerals, and dietary fiber [9,16,23]. This trend occurred more than 20 years ago when a share of products brought to the Far North from other regions started to grow [10,19].

Therefore, even native people tend to consume food rations that are close to conventional Caucasian ones; such rations are unable to satisfy all physiological needs of people who live under adverse (extreme) natural and climatic conditions. The existing situation requires intense activities aimed at raising people's awareness about principles of healthy diet and implementing up-to-date tools for spreading scientific knowledge including peculiarities of nutrition typical for a relevant ethnic group.

To implement activities within the "Demography" National project regarding "Population health improvement", the Federal Service for Surveillance over Consumer Rights Protection and Human Wellbeing (Rospotrebnadzor) developed the Concept for creating teaching (educational) programs on healthy diet. According to the Concept, eight scientifically substantiated programs are to be developed. Among them there is a program on healthy diet for people living on territories with peculiar exposures to environmental factors (macro- and micronutrient deficiency, climatic conditions).

Our research goal was to develop a scientifically substantiated teaching program on healthy diet covering nutrition peculiarities for people living on territories with extreme natural and climatic conditions.

Data and methods.A section in the teaching program on nutrition peculiarities to minimize health hazards caused by adverse (extreme) climatic conditions consists of two theoretical elements. The first one dwells on peculiarities of extreme climate and its influence on the body. The second one covers principles of healthy diet and its peculiarities for a relevant population group. Practical work is accomplished to strengthen knowledge and acquire relevant skills and abilities (Table 1).

To create theoretical sections in the teaching program, we analyzed research papers with results of fundamental and applied scientific research that were available in conventional citation databases (CyberLeninka, eLibrary, Google Scholar, Web of Science, Scopus, RSCI, Higher Attestation Commission etc.) and were considered relevant to the topic.

When implementing the teaching program, it is advisable to stick to a conventional algorithm that involves creating a multi-level system for continuous education provided for population (with participating medical and non-medical organizations) [7].

Results and discussion. *Peculiarities of extreme climate at high latitudes (the Far North).* Climate at high latitudes is influenced by three basic interacting factors; they are radiation, that is, solar heat income and consumption on the earth surface and in the atmosphere; circulation, that is, movement of air masses (either sea or continental ones); heat and moisture moving vertically in the atmosphere and over underlying surfaces (topsoil, plant cover, top water, snow cover, ice cover over the sea etc.) [8].

As a result, climate in the Far North is characterized with certain adverse conditions (Table 2). They include a set of non-specific meteorological factors (low temperature, high relative and low absolute humidity, and high air mobility) that tend to fluctuate drastically [8,28,30]. Apart from these meteorological factors, there are other specific exposures in the Far North such as peculiar photoperiodicity (polar days and nights) and differential air pressure. Additionally, the body is influenced by intense natural electromagnetic background created by both earth and cosmic factors. Thus, the geomagnetic field is by 25% higher than in the central European part of the country; still, since this field has weaker protective capabilities than at middle and low latitudes, alternating currents from ion- and magnetosphere produce significant effects related to solar activity [24]. Low mineralization of drinking water is another peculiarity in the Far North owing to the existing microelement structure of soils and dilution with melted snow [8,11,30]. Another adverse factor is that settlements are located far from each other in this zone and therefore transport communications are scarce and irregular between them.

All the aforementioned natural and climatic conditions are adverse and even extreme as per certain parameters

Table 1

Structure of the section in the teaching program on healthy diet regarding its peculiarities for people living on territories with extreme natural and climatic conditions

Program elements	Expected results		
	Instant		Prospect
	knowledge	skills and abilities	
Peculiarities of extreme climate and its influence on the body	- peculiarities of extreme climate - influence exerted by extreme climate on the body	- to assess whether it is necessary to correct one's food ration - to correct a food ration if necessary - to develop rational eating habits	- decreasing prevalence of alimentary-dependent diseases - decreasing prevalence of micronutrient deficiency - growing healthy life expectancy, - growing number of people who pursue healthy lifestyle
Principles of healthy diet and its peculiarities	- peculiarities of diet under extreme climatic conditions at high latitudes		
Practice	- drilling		

making higher demands to functional systems in the body even if it is adapted to them; influence on health is hardly avoidable. It is well-known that morbidity among population (both overall and primary) is higher among population living in the Far North than on average in Russia; many diseases occur at younger ages, their clinical course in non-specific and involves a lot of complications; there is also premature ageing and a decrease in life expectancy by 10-15 years [15,16]. Vitamin D deficiency and alimentary-dependent diseases (obesity, type 2 diabetes, and cardiovascular pathology) are more widely spread in the Far North than in other regions [10,20]. It is advisable to use approaches that involve hazard identification to quantitatively assess health risks [31].

When people live permanently (indigenous natives from various ethnic groups and indigenous Caucasians) on territories with extreme (and sub-extreme) cold climate, their bodies are usually well-adapted (Figure). Adaptation mechanisms are fixed by evolution in their genotype and become apparent in ontogenesis [2]. Key components in adaptation are aimed at preserving heat balance due to greater heat production under cold stress. These components are, first of all, an increase in basal metabolism determined by hyperfunction of the thyroid gland and changes in all types of metabolism including protein, fat, carbohydrate, vitamin, macro- and microelements. Vasodilatation induced by cold also helps the body to preserve heat [13,14,25]. Basal metabolic rate (BMR) corresponds to energy costs necessary to maintain vital activities (functioning of the cardiovascular, respiratory, excretory and other systems as well as heat production) when the body is at relative rest. BMR is by 10-15% higher for people living at high latitudes than for their counterparts who live at middle and low latitudes [22,17,18]; according to some other authors, the difference can reach 30% [16,25]. However, there are studies revealing that the value has already decreased down to 5% due to, among other things, changes in diets [14].

Energy metabolism switching from carbohydrate to lipid one is the most characteristic change in metabolism; thus, a so called "polar metabolic type" is created [21,22,25]. Prevalence of lipid metabolism is necessary for heat formation and heat exchange maintenance since the body prefers to oxidize fatty acids due to them having higher caloric coefficient (1 gram provides 9 kilocalories) thus preventing proteins from being spent on energy needs [13,22]. Besides, lipids participate in changing viscosity of cell membranes which is also important for adaptation to low temperatures [12].

This metabolic type results in elevated contents of very low density lipoproteins (VLDLP) and low density lipoproteins (LDLP) in blood of an adapted person. By the way, they have certain atherogenic properties. However, atherosclerosis doesn't occur since high density lipoproteins (HDLP) are also contained in blood in elevated quantities and it creates a balance between atherogenic and anti-atherogenic lipid fractions. Besides, elevated quantities of VLDLP and LDLP that contain apolilipoprotein B with contrinsular effects lead to a decrease in dextrose absorption by body tissues and lower reabsorption threshold in the kidneys. Under such conditions gluconeogenesis in the liver involving dextrose formation out of proteins and fats becomes the primary source of carbohydrates necessary for tissue nutrition. Physiological standards (homeostasis levels) are significantly different from those in the central European part of the country. Dextrose concentration in blood goes down to a value corresponding to the bottom limit of the physiological standards against lower concentrations of insulin [22].

Since lipoprotein metabolism is significantly higher under extreme climatic conditions, it creates great loads on liver macrophages. Bearing in mind that primary function of these cells is to create an immune response, we can assume that inhibited functioning of key cells in the immunity makes people living in the Far North more susceptible to communicable diseases [21,22].

Given changes in lifestyle and socio-economic structures including diet transformations, there is failure in adaptation to traditional living conditions of indigenous people. Occurring dyslipidemia and depleting functional and receptor activity of β-cells in the pancreas determine further metabolic disorders and chronic non-communicable diseases (obesity, type 2 diabetes, ischemic heart diseases, primary hypertension, and others); prevalence of such diseases has grown over the last decade [6,13].

Newcomers have to face significant loads on their adaptation system since it requires complicated structural changes in regulatory, physiological, and metabolic processes, and so called "the winter-over syndrome" occurs [15]. The circulatory system is among the fastest to react. Peripheral vascular spasm is necessary to prevent heat loss but it can also cause primary hypertension occurrence. Morphofunctional changes in the pulmonary circulation are considered to underlie chronic non-specific lung diseases ('Magadan pneumopathy"). The respiratory system is under significant functional strain that is related, among other things, to the necessity to preserve temperature homeostasis in respiratory sections [28]. Cold air with absolute humidity requires more secretion to moisten mucosa and it makes for greater moisture losses, up to 1.500 ml per day (instead of 500 ml typical for the central European part of the country), with exhaled air [30]. Moisture also evaporates on skin surface and it results in its weakened protective capabilities and changes in the overall heat exchange of the body. When liquid is excreted via extra-renal way, it results in more intense external breathing and oc-

Table 2

Natural and climatic peculiarities in the Far North

Factors that determine natural and climatic peculiarities in the Far North	Natural and climatic peculiarities in the Far North	
	non-specific	specific
Solar radiation (solar heat income and consumption on the earth surface and in the atmosphere)	- low temperature (-40-70 0C) - high relative humidity (65-95%) - low absolute humidity (1-3 g/m3) - significant air mobility (up to 40 m/sec)	- changes in photoperiodicity (polar night lasts up to 125 days; polar day, up to 140 days) - intense electromagnetic (geomagnetic and cosmic) field - air pressure differential (70-80 gPa in winter, 40-60 gPa in summer) - low mineralization of drinking water (selenium, fluorine, and calcium deficiency)
Movement of air masses		
Heat and moisture moving vertically in the atmosphere and over underlying surfaces		

currence of “polar shortness of breath” (it can occur due to strong wind combined with frost). Changes in external breathing involve greater respiratory minute volume, respiratory volume, respiratory rate, oxygen consumption; lower vital capacity of lungs, inhalation and exhalation reserve volumes, and maximum lung ventilation; large bronchial tubes widen but there is spasm in the middle-sized and small ones. Similar changes occur in external breathing when hands and to a greater extent feet are cold [28].

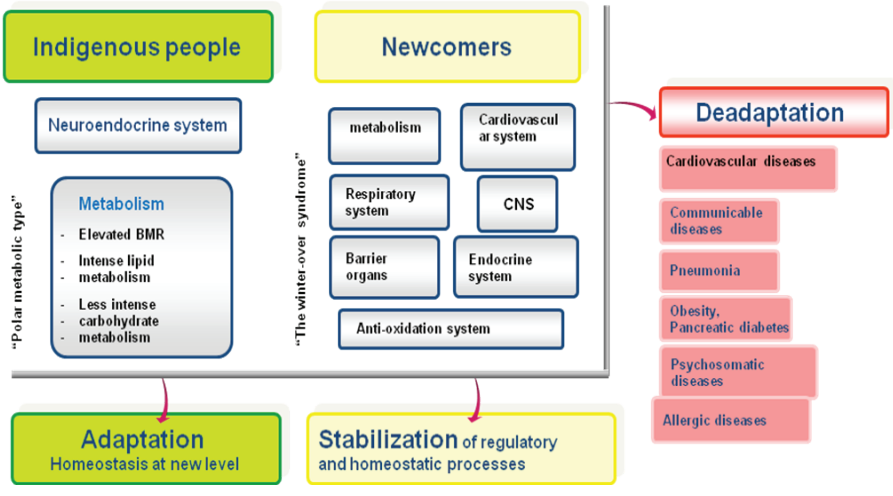
Drastic rises and drops in air pressure (10 times higher than threshold values) result in similar drastic fluctuations in partial density of oxygen (an actual quantity of oxygen molecules in inhaled air) and developing hypoxia [28,30]. All these changes undoubtedly influence metabolism. Hypoxia stimulates more intensive lipid peroxidation and it exerts negative membrane-tropic impacts. Exposure to cold leads to stronger oxidation of deposited fats and glycogen but dextrose contents in blood go down (by 40-45%). The latter results in an increase in renal “carbohydrate barrier” and functional disorders in the pancreas [9].

Basal metabolism increases by 13-17% at an early stage in adaptation during the whole polar day. Newcomers’ long staying in these new conditions, polar nights, as well as shorter periods of time spent outside in the frost lead to a decrease in BMR by 10% [22]. These changes occur owing to endocrine-metabolic shifts including activation of the sympathetic system, greater production of glucocorticoids, high contents of free fatty acids, LDLP and VLDLP, that is, atherogenic forms [21].

Insufficient UV-radiation due to the Sun standing low over the horizon and changes in spectrum of solar radiation lead to “ultraviolet hunger”, vitamin D deficiency, and disorders in phosphor-calcium metabolism. Strained electromagnetic field (direct and alternating) creates changes in tissue respiration caused by slower transfer of electrons along the respiratory chain and natural decrease in ATP synthesis (energy substrate in the body) [30].

In case an outcome is favorable, regulatory and homeostatic processes stabilize and synchronize but this, by the way, can take as long as 10 years [25]. Probably due to it hereditary adaptation mechanisms of newcomers’ children can’t ensure long preservation of their health [15].

When reserve capabilities are depleted and overall adaptation costs are higher than functional and morphological



Scheme showing influence exerted on the body by natural and climatic conditions at high latitudes

limits, it results in deadaptation which can be considered a borderline state between health and illness or a disease itself [3]. Its basic components are oxidation stress, insufficient detoxification and barrier organs failure, disorders of polar metabolic type, northern tissue hypoxia, immune deficiency, blood hypercoagulation, polyendocrine disorders, regenerating and plastic deficiency, electromagnetic homeostasis disorders, functional dissymmetry of intrahemispheric relations, desynchronosis, psychoemotional strain, and meteopathy [15]. Cardiovascular diseases, diseases of the nervous and respiratory system, and communicable diseases occupy leading places in the structure of morbidity [9,28]. Chronic non-communicable diseases occur and develop in large measure due to the alimentary factor, that is, excessive consumption of carbohydrate food, refined sugar, and products rich with saturated fatty acids; vitamin and mineral deficiency as well as deficiency of essential amino acids. We should note that technogenic and anthropogenic environmental contamination in the Far North deteriorates adaptation capabilities and additionally makes for occurrence of multiple diseases including allergies and immune pathologies [9].

Basic principles of healthy diet

- Rations should be energy-adequate, that is, their energy value should correspond to energy costs borne by the body.

- Basic food products should be consumed in quantities within physiologically adequate ranges and ratios between them.

- Food rations should include variable food products: bakery and grocery (flour, bread, cereals, beans, and macaroni), milk and milk products, meat and meat products, fish and fish products, vegetables, potato, fruit, eggs, vegetable oil, as well as sugar and confectionary.

- Nutrition regime should be optimal.

Nutrition peculiarities under adverse (extreme) natural and climatic conditions at high latitudes

- Energy value of a ration should be by 10-15% higher than in other climatic zones [17,18,22]. The reason is that people living in the Far North tend to spend more energy in general since it is necessary to both increase heat production (due to BMR) and to cope with additional physical loads (walking on snow in heavy winter clothing, resisting winds, etc). The farther from the equator, the greater are energy costs on doing the same work [9].

- Protein and fat components should appear in food in sufficient quantities due to energy metabolism switching from carbohydrates to lipids. Recommended ratio of proteins, fats, and carbohydrates is 1:1:3, that is, a share of proteins should not be lower 15%; fats, 35-36%; carbohydrates, 46-50% [23]. Animal proteins should account for not less than 60% of the overall quantity, and animal fats, not less than 60-90%.

It is extremely important to use locally manufactured food when creating rations for indigenous people. Priority products include reindeer meat and fat; meat of Yakut horses, elk, and hare; bird game (partridge, heath-cock, wood-goose, wild duck, and wild goose); codfish and whitefish (Siberian salmon, grayling, navaga, red salmon, sterlet, burbot, herring, pike, perch, etc.); as well as meat of sea animals (walrus, seal, or whale). These products are rich with irreplaceable amino acids, polyunsaturated fatty acids, fat-soluble vitamins, and antioxidants [9,16,26].

- Simple carbohydrates should be con-

sumed in smaller quantities since carbohydrate metabolism changes and tissues consume dextrose in smaller quantities. Dextrose income is provided due to gluconeogenesis in case proteins and fats are consumed in sufficient quantities.

- Vitamins should be consumed in sufficient quantities. Less intensive carbohydrate metabolism decreases (but doesn't eliminate) body needs in water-soluble vitamins. Use of low-mineralized water leads to lower assimilation of not only minerals but also vitamins and to developing vitamin deficiency. Therefore, there is almost twice as high need in various vitamins [9]. More intense lipid metabolism increases demand for fat-soluble vitamins.

A food ration should necessarily include vegetables, fruit, local wild plants (wild sorrel, wild garlic, Iceland moss) and berries (cowberries, cloudberries, cranberries, blackberries, blueberries, honeysuckle, rose hips, etc.).

- There should be additional macro- and microelements intake. Mineral deficiency occurs in the body mainly due to low mineralization of water in local rivers and selenium and fluorine deficiency. Radiation exposure results to radioactive strontium accumulation in bones. A food ration should include products rich with calcium that makes for strontium elimination [9]. Zinc and copper should also be consumed in sufficient quantities since they are necessary for functioning of cytochrome chain enzymes, anti-oxidation system, and neuroendocrine regulation [26].

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HYGIENE, SANITATION, EPIDEMIOLOGY AND MEDICAL ECOLOGYAND MEDICAL ECOLOGY

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OPTIMIZATION OF THE SYSTEM OF PLANNING MEASURES FOR EPIDEMIOLOGICAL CONTROL OF THE INCIDENCE OF TICK-BORNE ENCEPHALITIS AND SIBERIAN TICK TYPHUS IN REGIONS WITH COMBINED FOCI OF THESE INFECTIONS

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The article presents the results of the multidimensional factor analysis, with the help of which the leading factors influencing epidemic processes of tick-borne viral encephalitis and Siberian tick-borne typhus in the territories of Altai Krai with combined foci of these natural focal infections in the period from 2000 to 2019 were determined. The relationships between individual predictors have been established, allowing them to make a significant contribution to the formation of the incidence rate as a single factor. The degree of influence of each of the leading factors on the morbidity level according to these nosologies in the studied territories was identified. The results of multiple and dual regression are presented carried out for the purpose of estimating the perspective value of the analyzed controlled factors necessary for the subsequent optimization of the planning system for the measures of epidemiological control of morbidity of tick-borne viral encephalitis and Siberian tick-borne typhus in the studied territory, which will also allow to form a planned trend of morbidity dynamics towards a decrease in its indicators.

Keywords: combined foci, natural focal infections, tick-borne viral encephalitis, Siberian tick-borne typhus, endemic territories, determination of leading factors, multidimensional factor analysis.

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Introduction. The incidence of Siberian tick-borne typhus (STT) and tick-borne viral encephalitis (TVE), as well as other tick-borne infections, is currently high and depends on multiple influence of a large number of factors characterizing epidemic processes of these vector-borne natural focal infections [1, 2, 3, 9, 10]. Such factors may be expressed as an independent phenomenon beyond the control of others or may consist of a different number of predictors forming a general, meaningful impact on the epidemic process of these infections [5, 6, 7, 11].

The multidimensional factor analysis of the effects of various predictors on the TVE and STT incidence will allow inducing the “latent” relationship between individual predictors acting as a single factor, while the effect of each predictor individually on the resulting trait was considered as statistically insignificant [4, 8, 12]. Identification of leading factors with determination of predictors in their structure allowed assessing each factor by its contribution to formation of incidence rate of these infections in the territory of the endemic region by means of the multidimensional factor analysis [13, 14, 15].

The **aim of the study** was to optimize the system for planning measures of epidemiological control of tick-borne viral encephalitis and Siberian tick-borne typhus incidence in regions with combined foci of these infections.

Materials and methods. The study was conducted using the data of the of-