

Arctic and North. No. 55. Pp. 134–149.

Original article

UDC 613(985)(045)

DOI: <https://doi.org/10.37482/issn2221-2698.2024.55.161>

Population Health in the Russian Arctic: Problems, Challenges, Solutions

Anna A. Provorova¹, Researcher

Elena V. Smirennikova², Cand. Sci. (Geogr.)

Anna V. Ukhanova³✉, Post-graduate Student, Researcher

^{1,2,3} N. Laverov Federal Center for Integrated Arctic Research, Ural Branch of the Russian Academy of Sciences, pr. Nikolskiy, 20, Arkhangelsk, Russia

¹ aashirikova@mail.ru, ORCID: <https://orcid.org/0000-0002-4573-2761>

² esmirennikova@yandex.ru, ORCID: <https://orcid.org/0000-0001-7733-4285>

³ Karmy-anny@yandex.ru ✉, ORCID: <https://orcid.org/0000-0001-9083-9931>

Abstract. Significant lagging of the Arctic regions of Russia from the all-Russian values of life expectancy and mortality rates of people of working age is noted at the highest state level as one of the main threats to the socio-economic development of the Russian Arctic and ensuring its national security. This lag is largely due to the negative impact of extreme natural and climatic environmental conditions on the health of the population working and living in the Arctic. The presented article is aimed at systematizing the problems and challenges associated with the impact of the harsh natural and climatic conditions of the Arctic on the health of the population living there, as well as finding ways to adapt the public administration system to these challenges. Based on a critical analysis of scientific literature and official statistical information, the paper identifies the health features and the process of adaptation to the natural and climatic conditions of the Arctic for different groups of the Arctic population: indigenous, old-timers and newcomers. The authors have substantiated that the most vulnerable group of the population, whose health is most negatively affected by the extreme natural and climatic conditions of the Arctic, are migrants. On the basis of generalization of problems and peculiarities of public health of the Arctic population and systematization of the experience of previous scientific research, the directions of adaptation of the public administration system of the Arctic regions to the existing challenges have been developed. These directions are based on a differentiated approach to various groups of the Arctic population: indigenous, old-timers and newcomers. According to the authors, the implementation of the directions presented in the article, as well as the creation of the most favorable socio-economic living conditions, can compensate for physiological losses and improve the health indicators of Arctic residents.

Keywords: *population health, Russian Arctic, natural and climatic conditions, public administration*

Acknowledgments and funding


The article was prepared within the framework of research work No. 122011800415-9 “Balanced development of the Arctic socio-ecological-economic systems in the context of transformation of the natural-climatic and socio-economic environment”.

Introduction

The Arctic is a strategically important macro-region for the Russian Federation. Significant reserves of energy, biological, water and other resources necessary to ensure the overall security

* © Provorova A.A., Smirennikova E.V., Ukhanova A.V., 2024

For citation: Provorova A.A., Smirennikova E.V., Ukhanova A.V. Population Health in the Russian Arctic: Problems, Challenges, Solutions. *Arktika i Sever* [Arctic and North], 2024, no. 55, pp. 161–181. DOI: <https://doi.org/10.37482/issn2221-2698.2024.55.161>

 This work is licensed under a CC BY-SA License

system of the country are concentrated here. However, it is important to realize that, along with natural and physical capital, the population makes a significant contribution to the national wealth and security of Russia. According to the Strategy for the Development of the Arctic Zone of the Russian Federation until 2035, one of the main threats that creates risks for the development of the Russian Arctic and ensuring its national security is the lagging in the values of indicators characterizing the quality of life in the Arctic zone from the all-Russian ones, including in terms of life expectancy at birth and mortality of people of working age. This lag is largely caused by the negative impact of the extreme natural conditions of the Arctic on the human body and health. Today, science has accumulated a vast amount of knowledge and information concerning public health issues of the population of the Arctic territories. Therefore, the purpose of this article is to systematize the problems and challenges associated with the impact of the harsh natural and climatic conditions of the Arctic on the health of the population living there, as well as to find ways to adapt the public administration system to these challenges.

Impact of the Arctic's natural and climatic conditions on the health of population

The impact of the severity of Arctic climatic conditions on the human body is dualistic. On the one hand, numerous studies have proven the negative impact on human health of such unfavorable natural and climatic factors in the Arctic as a lack of heat and light, a sharp change in photoperiodicity, increased geomagnetic activity, changes in atmospheric pressure, etc. [1, 2]. A large number of domestic scientific works are devoted to specific reactions of body arising in response to the impact of harsh Arctic climatic conditions: “polar stress syndrome” [3], immunodeficiencies [4], hypovitaminosis [5], arterial hypertension [6], etc. Taken together, the unfavorable natural and climatic factors of the Arctic negatively affect the functional state of the human body, reducing its performance and life expectancy, increasing morbidity and mortality [2].

This is confirmed by official statistical information obtained at the population level. According to Rosstat, in 2021, the level of morbidity of the population in all regions of the Russian Arctic, with the exception of Krasnoyarsk Krai, was higher than the average Russian value (Table 1). In some regions of the Russian Arctic, such as, for example, the Republic of Karelia, Nenets, Yamalo-Nenets and Chukotka Autonomous okrugs, the excess was 40–50% of the Russian average. The sustainable nature of this phenomenon is confirmed by the persistence of the negative trend in hyper morbidity among the population of the Russian Arctic throughout the entire period under review (from 2005 to 2021). It should be noted that even the leader among the Arctic regions — the Krasnoyarsk Krai — was able to demonstrate lower morbidity values in comparison with the Russian average, not due to its decrease in the region, but due to a significant increase in the values of the analyzed indicator in the Russian Federation.

Table 1

Morbidity rate of the population of the Russian Arctic regions (per 1000 people, registered diseases among patients diagnosed for the first time in their lives)¹

	Republic of Karelia	Komi Republic	Arkhangelsk Oblast	Nenets Autonomous Okrug	Murmansk Oblast	Yamalo-Nenets Autonomous Okrug	Krasnoyarsk Krai	Republic of Sakha (Yakutia)	Chukotka Autonomous Okrug	Russian Federation
2005	1 027.1	960.4	903	1 632.4	799.3	1 178	752.7	881.7	1 189.1	743.7
2006	1 046.7	966.3	967.9	1 765.1	844.2	1 171	773	951.8	1 149	760.9
2007	1 027.7	989.1	952.2	1 752	852.4	1 155.8	806.7	933.1	1 117.9	767.3
2008	1 055.2	986.4	983.8	1 746.7	853.1	1 179.7	801.6	978.9	1 110.9	767.7
2009	1 108.3	1 023.1	1 006.4	1 886.8	894.3	1 167.4	835	1 006.7	1 142.9	797.5
2010	1 078.8	1 035.2	1 021.4	1 813.8	891.9	1 151.5	813.3	1 023.4	1 213.5	780
2011	1 100.9	1 047.2	1 036.3	1 750.4	851.2	1 180.7	831.3	1 047.4	1 246.8	796.9
2012	1 076.1	1 053.5	1 042.3	1 752	853.3	1 122.1	825.8	1 066.5	1 172.5	793.9
2013	1 115.4	1 047.4	1 008.6	1 573.1	896.7	1 191.9	807.9	1 107	1 122.8	799.4
2014	1 113.8	1 054.8	991.3	1 436.8	850.3	1 132.1	804.8	1 098.1	1 025.2	787.1
2015	1 114.3	1 072	1 015.9	1 421.4	835.5	1 096.9	784.9	1 026.6	1 076.3	778.2
2016	1 126.2	1 121.2	1 002.2	1 380.7	875.8	1 180.4	783.1	1 043.8	1 289.4	785.3
2017	1 175.1	1 158.5	998.5	1 361	825.3	1 224.4	795.6	1 021.1	1 342.9	778.9
2018	1 173	1 119.8	1 004.9	1 369.8	831.9	1 272	790.6	1 015.3	1 278.3	782.1
2019	1 165.7	1 082	980.2	1 386.1	823.1	1 291.9	773.3	1 032.9	1 149.2	780.2
2020	1 067.7	924.3	945.6	1 179	783.1	1 249.4	776.6	899.6	1 182.2	759.9
2021	1 246.9	1 043.8	1 028	1 188	920.2	1 308.4	852.4	1 053.8	1 189.2	857.1

Another key indicator of public health is life expectancy (LE). As can be seen from Table 2, life expectancy in almost all regions of the Russian Arctic (with the exception of the Yamalo-Nenets Autonomous Okrug) throughout the entire analyzed period from 2005 to 2021 was lower than the Russian average.

Table 2

Life expectancy at birth, years²

	Republic of Karelia	Komi Republic	Arkhangelsk Oblast	Nenets Autonomous Okrug	Murmansk Oblast	Yamalo-Nenets Autonomous Okrug	Krasnoyarsk Krai	Republic of Sakha (Yakutia)	Chukotka Autonomous Okrug	Russian Federation
2005	61.8	62.1	63	63	63.8	67.6	63	64.7	58.5	65.4
2006	63.5	64	64.9	62.3	65.2	68	65.5	65.5	59.6	66.7
2007	64.8	65.6	66.3	61.9	66.8	69.1	66.4	66.1	59.4	67.6
2008	65.1	65.9	67	63.2	66.7	69.1	66.8	65.8	60.3	68
2009	66.2	66.3	67.7	65	67.2	69.8	67.5	66.4	58.8	68.8

¹ Compiled by: Regions of Russia. Social and economic indicators. URL: <https://rosstat.gov.ru/folder/210/document/13204> (accessed 08 June 2023).

² Ibid.

2010	66.4	66.9	67.9	64.9	68.4	70.1	67.6	66.8	57.5	68.9
2011	67.95	67.95	68.84	66.71	68.93	70.16	68.27	67.67	61.58	69.83
2012	68	68.33	69.71	68.21	69.81	70.66	68.42	67.93	60.79	70.24
2013	69.19	69.27	70.27	65.76	70.46	71.23	69.06	69.13	62.11	70.76
2014	69.36	69.05	70.2	70.65	69.97	71.92	69.23	69.81	62.32	70.93
2015	69.16	69.4	70.7	71	70.24	71.7	69.69	70.29	64.16	71.39
2016	69.78	69.45	70.8	71.08	70.94	72.13	70.01	70.84	64.42	71.87
2017	70.65	71.05	71.96	71.52	71.67	73.53	70.61	71.68	66.1	72.7
2018	70.56	71.06	72.09	71.85	71.68	74.07	70.71	72.72	63.58	72.91
2019	71.46	71.3	72.3	73.19	71.75	74.18	71.16	73	68.09	73.34
2020	69.63	70.3	71.39	70.4	69.81	71.91	69.82	71.1	65.82	71.54
2021	67.31	68.32	69.6	69.39	68.29	71.7	68.34	69.98	64.87	70.06

A retrospective analysis of the life expectancy indicator allows concluding that there is a widespread positive trend in the growth of its values in the period from 2005 to 2019. However, in 2020–2021, LE showed a serious decline both in the Arctic regions and in the country as a whole, which is directly related to the COVID-19 pandemic. Losses in life expectancy were highest in some regions of the European Arctic. Thus, life expectancy in the Republic of Karelia in 2021 decreased by more than 4 years relative to 2019, in the Nenets Autonomous Okrug — by 3.8 years, in the Murmansk Oblast — by 3.5 years. In other Arctic regions, life expectancy losses were comparable to or lower than the Russian average. However, the overall reduction in life expectancy in the Russian Federation and its Arctic regions was more than 3 years, which “threw them back” to the values of ten years ago. Thus, in 2021, life expectancy in Russia was 70 years, and in the regions of the Russian Arctic on average it barely exceeded 68.5 years.

Relatively low life expectancy values in the regions of the Russian Arctic are directly related to another feature of the public health: excess mortality in working age. As can be seen from the information presented in Table 3, the working-age mortality rate exceeded the Russian average throughout the entire period under consideration in the vast majority of the regions of the Russian Arctic. The greatest scale of this problem is typical for the Republic of Karelia, where the mortality rate of the population of working age in 2021 was 40% higher than in Russia, as well as for the Komi Republic and the Murmansk Oblast, where the excess ranged from 19 to 24%.

Table 3

*Mortality rate at working age, per 100,000 people of working age*³

	Republic of Karelia	Komi Republic	Arkhangelsk Oblast	Nenets Autonomous Okrug	Murmansk Oblast	Yamalo-Nenets Autonomous Okrug	Krasnoyarsk Krai	Republic of Sakha (Yakutia)	Chukotka Autonomous Okrug	Russian Federation
2005	1154.2	1046.3	899.3	1043.1	896.5	546.5	956.2	776.2	1070.2	826.5

³ Compiled by: UISIS. State statistics. URL: <https://www.fedstat.ru/indicator/59267?ysclid=lioitbhcpw415069823> (accessed 08 June 2023).

2006	1028.3	902.7	955.6	904.8	812.1	495.3	778.5	723.3	1135.3	746.1
2007	926.2	771.3	955.8	793.2	705	494.8	722.7	680.6	1141.1	695.4
2008	907.1	782	972.3	781.5	739.8	475.7	703.4	722.2	1 207.9	685.7
2009	863	794.1	915.8	737.2	710.1	478.8	664.9	725.6	1 227.2	641.7
2010	908	796.6	908.1	766.8	689.6	461.7	700	726	1 328.4	634
2011	789.4	741.2	824.9	709.9	657.7	458.2	668	679	1 010.6	600.9
2012	793.1	721.8	833.2	649.7	602.4	443.1	642.4	649.4	1053.2	575.7
2013	722.9	682.4	739.2	622.9	570.3	420.6	634.9	590.6	987.6	560.9
2014	722.7	700.1	570.6	636	617.6	437.1	631.4	571.2	953.4	565.6
2015	749.7	701.1	590	642.3	635.4	427.7	621.6	552.8	865.8	546.7
2016	684	691.1	576.6	637.5	582.6	424.6	611.6	532.2	827	525.3
2017	638	602.4	604.5	566.9	520.2	381.2	573.5	516.7	822.7	484.5
2018	677.8	607.7	528.9	570.9	547.8	359.9	583.4	468.8	954.6	482.2
2019	618.7	608.3	578.3	560.7	556.2	336	550.8	465.2	801.3	470
2020	744.2	658.3	629.2	630.1	664.1	441	624.4	538.4	853.2	548.2
2021	853.1	748.6	565.4	694.3	719	443.8	686.4	554.8	453.7	604.6

It should be noted that the analysis of official statistical information of the Arctic regions does not allow forming a completely objective picture. Thus, the statistics do not take into account that a significant part of the population, having completed their labor activity in the Arctic, leaves it for permanent residence in the middle and southern latitudes. As a result, diseases accumulated over the years of work in the Arctic manifest themselves in other regions, negatively affecting their statistical indicators. Thus, we can talk not only about the “export of mortality” from the Arctic regions noted by some scientists [7], but also about the “export of morbidity”.

On the other hand, the impact of the harsh natural and climatic conditions of the Arctic on human body triggers the process of adaptation. The representatives of the indigenous population (indigenous small-numbered peoples of the North, as well as indigenous peoples who do not have the status of small-numbered people, for example, Yakuts, Komi, etc.) are the most adapted to living in the Arctic. For them, the extreme conditions of the Arctic can be considered adequate and result in a number of morphological and physiological features, such as:

- increase in heat production due to the increase in the intensity of lipid metabolism and fatty acid content in blood and cell membranes, as well as activation of lipid peroxidation processes;
- intensification of energy processes and intensity of basic metabolism;
- significant development of the thorax, increase in the alveolar surface area and volume of the microcirculatory channel of the lungs;
- shortened inhalation phase and extended exhalation phase;
- hypotonic type of hemodynamics;
- nutritional adaptations: very high protein and fat content and low carbohydrate content in the diet;
- increased content of total protein in blood serum;

- high activity of lipolytic enzymes, increased levels of triglycerides, fatty acids and cholesterol;
- interhemispheric asymmetry, in which there is an increased activity of the right hemisphere with normal function of the left hemisphere of the brain, etc. [8, 9, 10].

These morpho-physiological characteristics of the indigenous population of the Arctic indicate evolutionary adaptation to extreme environmental conditions developed over many generations. At the same time, public health problems are also observed in this group of the Arctic population. Depending on their genesis, they can be subdivided into:

- health problems of the indigenous population of the Arctic associated with the traditional way of life: high level of traumatism (falls from sleds, snowmobiles, etc.); spread of various infectious and parasitic diseases (insufficient compliance with personal hygiene rules due to a nomadic lifestyle; low level of awareness about the ways of spreading diseases; eating raw, unprocessed meat and fish, etc.); high level of infant and child mortality (due to difficult access to medical care);
- health problems of the indigenous population of the Arctic, caused by the “westernization” of their way of life: high prevalence of alcoholism (due to a decrease in population tolerance to alcohol associated with enzyme deficiency [11]) and, as a consequence, high rates of alcohol-related mortality (among for the indigenous population, it is almost twice as high as among the immigrant population [12]); spread of sexually transmitted infections and tuberculosis [13]. The problem of transforming the nutrition of the indigenous population deserves special attention. Traditional nutrition for indigenous peoples involves high consumption of proteins and fats and ensures the maintenance of energy balance in harsh climatic conditions [14]. The change in nutrition from the use of local raw materials of animal and plant origin (venison, meat of wild animals and birds, fatty varieties of fish, various types of berries) to the consumption of fast carbohydrates, which are not typical for the indigenous population, has had an extremely negative impact on their health. Together with the general transformation of lifestyle, this factor provokes the emergence of various diseases that were previously considered uncharacteristic of indigenous peoples, in particular diseases of the circulatory system and diabetes mellitus [12, 15].

Some researchers note a high level of adaptation to the uncomfortable natural and climatic conditions of the Arctic not only among indigenous peoples, but also among the European population living there for four or more generations (old-timers) [16]. There is an extensive series of studies by physiological scientists reflecting the compensatory and adaptive mechanisms of various systems of the human body in the North, in particular the metabolic system [17], autonomic nervous system [18], endocrine [19] and immune systems [20]. However, the adaptive capabilities of the body of the old-time population of the North should not be overestimated. The overwhelming

majority of their compensatory reactions has their limited validity period and over time, as a rule, still turns into pathology.

However, the most vulnerable groups of the population, whose health is most negatively affected by the extreme natural and climatic conditions of the Arctic, are migrants. Data of numerous studies show the high complexity of adaptation processes among the immigrant population in the North [21].

The migrants' bodies are adapted to the complex of environmental factors in which they lived. Moving to unfavorable natural and climatic conditions of the Arctic leads to stress of regulatory systems, disruption of the internal environment constancy and even disruption of adaptation processes; this leads to aggravation of chronic diseases and emergence of new ones. This is a "bio-social payment" for achieving a state of adaptation with great stress, in overload mode, against the background of a restructuring of metabolic processes in the body [22].

The work of L.N. Maslova and co-authors notes that the main cause of mortality from cardiovascular accidents is dyslipidemia, which is developed much more often in the immigrant population living in the Far North for a long time. Among the indigenous population leading a traditional lifestyle, this pathology is much less common, which is apparently explained by the peculiarities of nutrition (frequent consumption of fatty fish) [23]. A number of scientific studies have noted lower morbidity and mortality rates from malignant neoplasms [24], diseases of the circulatory system (coronary heart disease, myocardial infarction, atherosclerosis of the coronary arteries) [25], as well as a lower prevalence of obesity and diabetes mellitus [26] among representatives indigenous nationalities of the North in comparison with the immigrant population.

The process of adaptation of the immigrant population to the extreme conditions of the Arctic is uneven. In certain periods (especially in the first months of life in the Arctic), there is a radical restructuring of the functioning of the physiological systems of the body, which is in a state of severe stress. In addition, researchers identify so-called critical periods of adaptation depending on the length of residence in the North, when, due to biorhythmological patterns, a decrease in the adaptive stability of the human body occurs over a period of about three years, which leads to maladaptive and subsequent pathological disorders [27].

In most cases, after a 10-year period of residence of the immigrant population in the North, the period of organism exhaustion begins, as it no longer has sufficient reserve capacities to function normally in these conditions [28]. This period is critical in making a decision to change a permanent place of residence. Later, remigration and the associated readaptation may have more negative consequences for the body than the decision to stay. Some of the migrants choose the Arctic as their permanent place of residence, which not only significantly increases the risk of premature aging and the development of various pathologies (primarily the cardiovascular and respiratory systems), but can also negatively affect future generations. Thus, according to V.S. Solovyov and co-authors, full adaptation of the newcomer population to the new hypocomforta-

ble, uncomfortable and extreme conditions of the Arctic may not happen even in the fourth generation of immigrants [29].

In recent years, the issue of human body adaptation to the natural and climatic conditions of the Arctic has been complicated by the problem of global climate change. WHO experts note that climate change is currently the main threat to human health. It increases mortality and morbidity due to the growing frequency of extreme weather events, leads to an increase in the number of zoonoses, injuries, intestinal infectious diseases, mental disorders, etc.⁴ In the Arctic, where the rate of climate change is much higher than the global average, the issue of physiological adaptation to these rapid changes is of great importance. The problematic aspect is that the body of the indigenous peoples of the North and the old-time population, who have already adapted to the harsh natural conditions of the Arctic, is forced to spend resources on adaptation again.

Directions for adapting the public administration system to problems and challenges related to the impact of extreme Arctic conditions on public health

Thus, the above-mentioned challenges pose an extremely difficult task for the public health system of the Arctic regions of the Russian Federation to develop a set of adequate management responses and solutions. Having summarized the problems and peculiarities of public health of the Arctic population and systematized the experience of previous scientific research, the team of authors has developed the following most important directions for adapting the public administration system of the Arctic regions to the existing challenges:

1. Formation of a differentiated approach to the implementation of preventive measures and the provision of medical care in relation to various categories of the population of the Arctic regions.

Thus, V.I. Khasnulin and co-authors note that the lack of understanding of the difference in the mechanisms of formation of various diseases in the indigenous and non-indigenous populations of the Arctic, the lack of separation of morbidity and mortality statistics for indigenous and non-indigenous residents and the simple copying of “advanced” Western medical and preventive technologies without their adaptation to the Arctic specifics lead to low effectiveness of medical measures [27].

In our opinion, treatment and preventive measures should be developed separately for each group of the Arctic population: indigenous, old-timers and newcomers.

The most relevant for the indigenous population of the Arctic are:

2. Maximum preservation and maintenance of the traditional way of life of indigenous peoples. Many scientific studies of various directions confirm the higher level of health of the indigenous people leading a traditional way of life, which implies high physical activity and traditional nutrition. In turn, the indigenous population, which has abandoned the traditional way of life, is experiencing processes of maladaptation [30]. The rejection of the traditional type of eco-

⁴ Climate change and health. World Health Organization. URL: <https://www.who.int/ru/news-room/factsheets/detail/climate-change-and-health> (accessed 05 June 2023).

conomic activity entails a mismatch of the body's regulatory systems, as a result of which the conditioned adaptation mechanisms can no longer fully act as protective ones, preventing the formation of diseases [10]. Thus, the preservation of the traditional way of life of indigenous peoples of the North is a guarantee of their health and well-being in the future.

3. Effective organization of medical care for the indigenous peoples of the Arctic in hard-to-reach areas, including:

- development of a system of regular medical examination of the indigenous population living in traditional tundra conditions;
- organization of medical and educational activities among the indigenous peoples of the Arctic. Many diseases among Arctic indigenous people leading a traditional way of life are caused by ignorance and non-compliance with the rules of personal hygiene, sanitary requirements for food processing, and rules for the care and feeding of infants. As a result, helminthic diseases, dental diseases (for example, dental caries was detected in more than 90% of the nomadic population), chronic nutritional disorders, dystrophy and intestinal dysfunction among children are widespread in this group of the Arctic population. Almost a quarter of children die in the first year of life from accidents: mechanical asphyxia, general hypothermia, foreign bodies in the respiratory tract [31]. All these cases of death and morbidity can be prevented by implementing special information and educational activities for the targeted distribution of information related to health problems. As noted by experts, it is most appropriate to conduct dispensary and health-education activities during the celebration of major national holidays (for example, Reindeer Day), when the tundra population gathers in one place. Mobile medical teams, travelling paramedics, as well as the introduction of the position of a sanitary assistant into the staff of reindeer herding brigades have proven to be the best way to implement these activities [31].

The most important issues for the old-timers of the Arctic are:

4. Development of intra-regional and intra-Arctic rotations.

From the point of view of saving financial resources, the use of a rotational method of territory development has a significant advantage. However, the social and cultural aspects, as well as the consequences for the health of employees working on a rotational basis are assessed extremely negatively [32]. According to Ya.A. Korneeva and co-authors, "climatic-geographical, industrial and social factors place impose requirements on the body of a rotational worker that exceed its reserves, which excludes the possibility of full adaptation of the body to these conditions and determines the presence of occupational health risks" [33]. Among these risks, it following should be noted: the negative impact on the body of shift workers of constant acclimatization and re-acclimatization, resulting in an increased level of morbidity and a temporary decrease in working capacity, as well as psychological stress associated with isolation from family, group isolation, inability to have privacy, etc. [33]. Obviously, it is impossible and impractical to completely aban-

don the shift as a method of organizing work. However, it is possible to minimize certain negative impacts on the human body through the development of intra-regional or intra-Arctic rotations. Such types of rotations imply the maximum preservation and optimal use of the labor potential already formed in the Arctic region and / or macro-region (the Russian Arctic), adapted to extreme natural and climatic conditions.

The most pressing issues for the Arctic immigrant population are:

5. Organization of selection of applicants for work in the Arctic conditions.

It is not enough to select healthy (without chronic diseases) people of young age to work in the harsh natural and climatic conditions of the Arctic. Thus, Academician V.P. Kaznacheev noted that in order to successfully adapt to the conditions of the Far North, a person should belong to a certain constitutional type of stayer, i.e. have the ability to withstand workloads for a long time [9]. Another constitutional type is the sprinter; on the contrary, it can withstand very heavy loads, but only for a short period of time. People of this type, according to V.P. Kaznacheev, will not be able to adapt to Arctic conditions even at a young age and in perfect health [9].

6. Continuous medical observation and consultation of the newcomer population.

As noted above, the process of adaptation of the newcomer population to the extreme conditions of the Arctic is uneven. In certain periods, there is a decrease in the adaptive stability of the human body. Therefore, it is important that during these periods a person should be under medical supervision and undergo unscheduled preventive examinations. According to the research of L.V. Anpilogova, the effectiveness of vaccine prophylaxis decreases during these periods [34]. Thus, the immigrant population should have its own schedule of preventive vaccinations.

During the first three years of life in the Arctic, when significant changes occur in the body, doctors do not recommend women to plan a pregnancy, as this may negatively affect baby's healthy development ⁵.

In addition, the problem of the return of migrant populations from the Arctic should be addressed in a timely manner, i.e. before the phase of depletion of the body's adaptation reserves. After 10 years of work in the extreme conditions of the Arctic, medical professionals should inform the newcomer population of the importance of timely return. Consultation should also be given to pensioners who wish to leave the North, since moving to even the most favorable natural and climatic conditions may carry a greater risk for them than a decision to stay in the North. Thus, there is data that the mortality rate among pensioners who left the Far North for the middle zone is several times higher than the Russian average ⁶.

⁵ Vasilyeva A., Konkieva N.A. Adaptatsiya cheloveka k usloviyam Kraynego Severa [Human adaptation to the conditions of the Far North]. In: Materialy VII Mezhdunarodnoy studencheskoy nauchnoy konferentsii «Studencheskiy nauchnyy forum» [Materials of the 7th International Student Scientific Conference "Student Scientific Forum"]. URL: <https://scienceforum.ru/2015/article/2015015574?ysclid=lguwdyden4834186012%22%3Ehttps://scienceforum.ru/2015/article/2015015574?ysclid=lguwdyden4834186012%3C/a%3E> (accessed 08 June 2023).

⁶ Ibid.

It is also important that people who have lived in the Arctic for a long period of time and returned to other regions should be under closer medical attention, since the diseases accumulated during their work in the Arctic will manifest themselves in a new place of residence.

7. Organization of proper nutrition for the newcomer population.

Scientists note the significant role of proper “northern nutrition” based on protein-lipid diets and the use of locally produced products, primarily fatty fish, deer meat, and northern berries, in successful adaptation to the harsh natural conditions of the Arctic. It is very important to reduce the consumption of sugar, salt and carbohydrates⁷. This recommendation is also relevant for the old-timer population.

The relevant issues for both the old-timers and the newcomers are:

8. Organization of opportunities for regular physical education. Scientists note that systematic physical education is one of the most effective means of increasing the body’s resistance to disease and the influence of unfavorable environmental factors [35]. This explains better adaptation to the harsh natural and climatic conditions of the Arctic among manual workers compared to intellectual workers, as well as the fact that regular physical training and vigorous forms of activity make the initial period of adaptation much easier [36]. The relatively low incidence of circulatory system diseases and diabetes mellitus among indigenous minorities is associated not only with dietary habits, but also with a high level of physical activity [26]. Thus, the authorities should pay particular attention to the creation and development of opportunities for physical education and sports for the population of the Arctic.

9. Organization of the educational process taking into account the natural and climatic specifics of the Arctic. Long-term studies by scientists have proven that it is unacceptable to organize the educational process in the North and the Arctic in two shifts. In addition, the training program should include twice as many physical education lessons as in educational institutions of the middle zone⁸.

10. Development of a system of recreation and sanatorium treatment within the Arctic regions. According to experts, moving of Arctic residents for short-term holidays to the middle zone and to the south and equally rapid return may not only have no positive effect on health, but even harm it. Long-term studies of the effectiveness of treatment of northerners at southern resorts show that such treatment is ineffective and often leads to deterioration in health indicators due to a sharp change in climatic conditions and the high body’s adaptation costs. Treatment is most effective in those natural and climatic conditions to which the body has adapted and therefore adjusted its work in an optimal mode⁹. That is why developed intra-regional systems of sanatorium-

⁷ Jos Y.S. Vliyanie usloviy Severa na zdorov'e shkol'nikov [Influence of northern conditions on the health of schoolchildren]. URL: https://narfu.ru/upload/medialibrary/b6e/vliyanie-usloviy-severa-na-zdorove-shkolnikov_dzhos-yu.pdf (accessed 08 June 2023).

⁸ Ibid.

⁹ Vasilyeva A., Konkieva N.A. Adaptatsiya cheloveka k usloviyam Kraynego Severa [Human adaptation to the conditions of the Far North]. In: Materialy VII Mezhdunarodnoy studencheskoy nauchnoy konferentsii «Studencheskiy nauchnyy forum» [Materials of the 7th International Student Scientific Conference “Student Scientific Forum”]. URL:

resort institutions (sanatoriums, sanatorium-preventoriums, balneomudtherapeutic clinics, boarding houses with treatment, sanatorium-type children's camps) and recreation organizations (recreation resorts, rest houses, camping sites, children's health camps) should be created for residents of the Arctic.

11. Active development of telemedicine.

The low population density and the large number of sparsely populated areas, as well as their remoteness and inaccessibility, which are characteristic of the entire territory of the Russian Arctic, cause problems in ensuring the right of the Arctic population to receive affordable and high-quality medical care. The use of telecommunication and electronic information technologies is of particular importance in eliminating this problem. According to A.L. Tsaregorodtsev [37], in the Arctic, when the factor of geographical distance becomes critical, the use of telemedicine can solve the following main problems:

- providing high-quality specialized medical care to remote sparsely populated areas;
- minimizing the cost of providing medical services in remote sparsely populated areas;
- solving the problem of the lack of highly qualified medical personnel in remote sparsely populated areas;
- providing an opportunity for medical workers in sparsely populated areas to quickly consult with colleagues from medical centers in large regional and district cities, which eliminates the problem of professional isolation and minimizes the likelihood of medical error.

In addition, there are studies proving that the introduction of telemedicine technologies can reduce the mortality rate of patients with cardiovascular diseases, reduce the frequency of hospitalizations and requests for emergency medical care, and increase patient satisfaction with the quality of medical services [38].

12. Development of a system for informing the population of the Arctic about existing health risks and opportunities to minimize them. As noted by scientists [22], an extensive set of scientific research and recommendations has been accumulated regarding issues of human adaptation to the extreme conditions of the Arctic. However, there is a huge gap between these recommendations and the awareness of the population of the Arctic regions about them. It is necessary to create an appropriate system of informing and educating the health culture of the population of the Arctic, including the dissemination of knowledge about regional health risk factors and the specific features of a healthy lifestyle in harsh natural and climatic conditions. The implementation of activities within this system involves the participation of both medical professionals, education specialists and the media.

13. Development of northern (Arctic) medicine. As noted above, the organization of treatment and preventive work in the Arctic is carried out according to Western standards without suf-

<https://scienceforum.ru/2015/article/2015015574?ysclid=lguwdyden4834186012%22%3Ehttps://scienceforum.ru/2015/article/2015015574?ysclid=lguwdyden4834186012%3C/a%3E> (accessed 08 June 2023).

ficient consideration of adaptive morpho-functional changes in the human body to the extreme natural conditions of this macro-region. According to Yu.P. Nikitin and co-authors [39], the extensive achievements of science in the field of polar medicine have been perceived by practical public health care in a very limited version. Meanwhile, the results of the study by D.S. Timofeeva [40] showed that the introduction of relevant regional approaches in therapeutic and preventive work in the Arctic reduces the morbidity of the population by more than one third.

It should be emphasized that the training of medical specialists in programs with an extensive regional module that forms understanding of the characteristics of adaptive processes and diseases of the body of both the indigenous inhabitants of the Arctic and the immigrant population is of exceptional importance for the development of Arctic medicine.

Conclusion

Thus, based on a critical analysis of scientific literature and official statistical information, the authors systematized the main problems and challenges associated with the impact of harsh natural and climatic conditions on the health of the population of the Russian Arctic. The dualistic nature of this impact has been determined, which consists, on the one hand, in a decrease in life expectancy, an increase in morbidity and mortality of the Arctic population, and on the other hand, in launching the process of adaptation to the extreme conditions of the Arctic.

The features of the health and process of adaptation to the natural and climatic conditions of the Arctic of various groups of the Arctic population — indigenous, old-timers and newcomers — are highlighted. Thus, the specificity of the public health of the indigenous population includes the presence of morphophysiological characteristics, indicating evolutionary adaptation to extreme environmental conditions over many generations, as well as lower morbidity rates of diseases of the cardiovascular, respiratory and endocrine systems (under the condition of traditional way of life). At the same time, there is a high level of traumatism, infant and child mortality, as well as morbidity from parasitic and some types of infectious diseases among the indigenous population of the Arctic.

The authors have substantiated that the most vulnerable group of the population, whose health is most affected by the extreme natural and climatic conditions of the Arctic, are migrants. This group of the Arctic population is characterized by a higher level of morbidity due to the process of adaptation with a greater stress on the body's regulatory systems.

On the basis of the generalization of problems and peculiarities of public health of the Arctic population and systematization of the experience of previous scientific research, the author's team has developed directions of adaptation of the system of public administration of the Arctic regions to the existing challenges. These directions were based on a differentiated approach to the represented groups of the Arctic population: indigenous, old-timers and newcomers. The main directions include:

- maximum preservation and maintenance of the traditional way of life of indigenous peoples;
- effective organization of medical care for indigenous peoples of the Arctic in hard-to-reach areas;
- development of intra-regional and intra-Arctic rotations;
- organization of the selection of applicants for work in the Arctic;
- continuous medical observation and consultation of the immigrant population;
- organization of the educational process taking into account the natural and climatic specifics of the Arctic;
- development of a system of recreation and sanatorium treatment within the Arctic regions;
- development of telemedicine and northern (Arctic) medicine, etc.

In conclusion, it should be noted that the most important factor in compensating for physiological losses and improving health indicators of Arctic residents is the creation of the most favorable socio-economic living conditions (comfortable housing, high income, opportunities for rest and recreation, a variety of leisure activities, etc.). To compensate for the negative impact of extreme conditions on human health, the level and quality of life in the Arctic regions should be not just higher, but significantly higher than the Russian average. This, along with the implementation of the recommendations proposed by the authors, will make it possible to maximally protect the health of the population working and living in the extreme natural conditions of the Arctic.

References

1. Bogoyavlensky D., Siggner A. Arctic Demography. In: *Arctic Human Development Report*, 2004, Acureyri, pp. 27–41.
2. Solonin Yu.G., Boyko E.R. Medical and Physiological Problems of the Arctic. *Proc. of the Komi Science Centre, Ural Branch, Russian Academy of Sciences*, 2017, no. 4 (32), pp. 33–40.
3. Deputat I.S., Deryabina I.N., Nekhoroshkova A.N., Griбанov A.V. Effect of Climatic and Ecological Conditions of the North on Ageing Processes. *Journal of Medical and Biological Research*, 2017, vol. 5, no. 3, pp. 5–17. DOI: <https://doi.org/10.17238/issn2542-1298.2017.5.3.5>
4. Shchegoleva O.E., Menshikova M.V., Aivazova M.S., Shashkova E.Yu., Mikhailova T.B. The Immunity Homeostasis at Young Men with Clinical Forms of Ecological Immunodeficiency in European North. *Human Ecology*, 2010, no. 5, pp. 35–41.
5. Potolitsyna N.N., Boyko E.R. Vitamin Status in Residents of the European North of Russia and Its Correlation with Geographical Latitude. *Journal of Medical and Biological Research*, 2018, vol. 6, no. 4, pp. 376–386. DOI: <https://doi.org/10.17238/issn2542-1298.2018.6.4.376>
6. Sereda T.V. *Patogeneticheskie osobennosti arterial'noy gipertonii u nekorenogo i korenogo nase-leniya Tyumenskogo Severa: avtoref. dis. dok. med. nauk* [Pathogenetic Features of Arterial Hypertension in Non-Indigenous and Indigenous Populations of the Tyumen North: Dr. Med. Sci. Abs.]. Ekaterinburg, 2017, 47 p. (In Russ.)
7. Zyryanova M.A., Popova L.A. Factor Analysis of Birth Rate Processes in Russian Northern Regions. *The North and the Market: Forming the Economic Order*, 2018, no. 3, pp. 111–121. DOI: <https://doi.org/10.25702/KSC.2220-802X.3.2018.59.111-121>
8. Uvarova T.E., Burtseva T.E., Neustroeva T.S., Savvina M.S. Morphological and Physiological Base for Living Activity of Indigenous Population of the Far North. *Far East Medical Journal*, 2009, no. 2, pp. 114–118.

9. Kaznacheev V.P. *Sovremennye aspekty adaptatsii: monografiya* [Contemporary Aspects of Adaptation]. Novosibirsk, Nauka Publ., 1980, 191 p.
10. Nikiforova V.A., Kudashkin V.A., Kiryutkin S.A. History of Studying the Problem of Adaptation of the Indigenous Small Peoples of the North to Natural Environmental Conditions. *Issues of Social-Economic Development of Siberia*, 2021, no. 1 (43), pp. 139–142. DOI: <https://doi.org/10.18324/2224-1833-2021-1-139-142>
11. Kershengoltz B.M., Chernobrovkina T.V., Kolosova O.N. Ethnogenetic Features of Alcohol Resistance in the People of the North. *Vestnik of the M.K. Ammosov North-Eastern Federal University*, 2012, vol. 9, no. 1, pp. 22–28.
12. Kozlov A.I., Kozlova M.A., Vershubskaya G.G., Shilov A.B. *Zdorov'e korennoy naseleniya Severa RF: na grani vekov i kul'tur: monografiya* [Health of the Indigenous Population of the North of the Russian Federation: on the Edge of Ages and Cultures]. Perm, OT i DO Publ., 2013, 205 p. (In Russ.)
13. Smith H.S., Bjerregaard P., Hing Man Chan, Corriveau A. et al. Research with Arctic People: Unique Research Opportunities in Heart, Lung, Blood and Sleep Disorders. Working Group Summary and Recommendations. *International Journal of Circumpolar Health*, 2006, vol. 65 (1), pp. 79–90. DOI: <https://doi.org/10.3402/ijch.v65i1.17889>
14. Panin L.E. Gomeostaz i pitanie cheloveka v usloviyakh Sibiri i Severa [Homeostasis and Human Nutrition in Siberia and the North]. *Human Ecology*, 1995, no. 2, pp. 75–81.
15. Belova N.I., Lavrinov P.A., Vorobyeva N.A. New Risk Markers for Cardiovascular Pathology in the Nenets Population of the Nenets Autonomous Area. *Journal of Medical and Biological Research*, 2014, no. 2, pp. 12–20.
16. Zapesochaynaya I.L., Avtandilov A.G. *Problema adaptatsii serdechnosudistoy sistemy pri prozhivanii na Kraynem Severe* [The Problem of Adaptation of the Cardiovascular System During Residence in the Far North]. Moscow, Russian Medical Academy of Continuing Professional Education Publ., 2015, 127 p. (In Russ.)
17. Bichkayeva F.A., Volkova N.I., Galstyan D.S., Bichkayev A.A., Lobanov A.A. Study of the Composition of Polyunsaturated Fatty Acids and Their Individual Ratios in Persons of Mature Ageo Different Regions of the North. *Russian Journal of Physiology*, 2020, vol. 106, no. 7, pp. 898–915. DOI: <https://doi.org/10.31857/S0869813920050039>
18. Poskotinova L.V., Demin D.B., Krivonogova E.V., Krivonogova O.V. Simpatikotoniya: risk dezadaptatsii k srede obitaniya ili adaptivnye vozmozhnosti dlya cheloveka v Arktike? [Sympathicotonia: The Risk of Maladaptation to the Environment or Adaptive Opportunities for Humans in the Arctic?]. In: *Medsinskaya fizika, fiziologiya i smezhnye distsipliny v akademicheskoy i vuzovskoy nauke: materialy konferentsii s mezhdunarodnym uchastiem, posvyashchennoy 100-letiyu MGMSU im. A.I. Evdokimova* [Medical Physics, Physiology and Related Disciplines in Academic and University Science: Proceedings of the Conference with International Participation, Dedicated to the 100th Anniversary of A.I. Evdokimov Moscow State Medical and Dental University]. Moscow, A.I. Yevdokimov Moscow State University of Medicine and Dentistry Publ., pp. 406–409. (In Russ.)
19. Tipisova E.V., Molodovskaya I.N., Alikina V.A., Elfimova A.E. Distinctive Features of the Hypothalamic-Pituitarygonadal Axis and the Level of Dopamine in Men of the European and Asian North. *Russian Clinical Laboratory Diagnostics*, 2022, vol. 67, no. 5, pp. 261–266. DOI: <https://doi.org/10.51620/0869-2084-2022-67-5-261-266>
20. Zubatkina O.V., Dobrodeeva L.K., Samodova A.V., Kruglov S.D. Assessment of Metabolic Activity and Energy Supply of Peripheral Blood Lymphocytes. *Human Ecology*, 2022, no. 12, pp. 855–863. DOI: <https://doi.org/10.17816/humeco109363>
21. Bolotin E.I., Lubova V.A. New Approaches to Evaluation of Russian Far East Comfortability for Population's Vital Activity. *Human Ecology*, 2014, no. 1, pp. 20–26.
22. Bagnetova E.A., Malyukova T.I., Bolotov S.V. Adapting the Human Body to Living Conditions in the Northern Region. *Successes of Modern Natural Science*, 2021, no. 4, pp. 111–116. DOI: <https://doi.org/10.17513/use.37616>
23. Maslov L.N., Vychuzhanova E.A., Gorbunov A.S., Tsubulnikov S.Yu. Role of Dyslipidemia in Pathogenesis of Vascular Events among Arctic. *Annals of the Russian Academy of Medical Sciences*, 2014, vol. 69, no. 7/8, pp. 133–136. DOI: <https://doi.org/10.15690/vramn.v69i7-8.1120>

24. Pisareva L.F., Odintsova I.N., Ananina O.A., Malinovskaya E.A. The Morbidity of Mammary Gland Cancer in Indigenous and Outsider Population of Siberia and Far East. *Health Care of the Russian Federation*, 2012, no. 4, pp. 37–41.
25. Gyrkolkau L.A., Shcherbakova L.V., Ivanova M.V. Blood Lipid Levels and Frequency of Dyslipidemia at the Native People of Chukotka. *Bulletin of the East Siberian Scientific Center*, 2011, vol. 31, no. 5, pp. 79–83.
26. Kitaeva Yu.N., Tipisova E.V. Functional Activity of the Pancreatic Gland at Local and Native Wandering Population of the European North. *Izvestia of Samara Scientific Center of the Russian Academy of Sciences*, 2011, vol. 13, no. 1–7, pp. 1714–1716.
27. Hasnuln V.I., Artamonova M.V., Khasnuln P.V. The Real State of Health of Residents of High Latitudes in Adverse Climatic Conditions of the Arctic and Performance of Official Statistics Health. *International Journal of Applied and Fundamental Research*, 2015, no. 9 (part 1), pp. 68–73.
28. Burov I.V. *Matritsy mezhattraktornykh rasstoyaniy v otsenke vliyaniya prirodno-klimaticheskikh faktorov sredy na sostoyanie psikhofiziologicheskikh funktsiy uchashchikhsya Yugry: dis. dok. biol. nauk* [Matrices of Inter-Attractor Distances in Assessing the Influence of Natural and Climatic Environmental Factors on the State of Psychophysiological Functions of Ugra Students: Dr. Biol. Sci. Diss]. Surgut, 2013, 127 p. (In Russ.)
29. Solovyev V.S., Bakieva E.M., Trusevich N.V., Tsertsek T.N. An Integrated Study of Adaptive Features of Adult Women Residing in a Northern City. *Bulletin of Nizhnevartovsk State University*, 2016, no. 2, pp. 66–71.
30. Dorshakova N.V., Karapetyan T.A. Features of Northern Inhabitants Pathology. *Human Ecology*, 2004, no. 6, pp. 48–52.
31. Zubov L.A. Medical-Social Problems and Prospective Lines of Establishment of Medical Care for Indigenous Minorities in Northern Territories Difficult of Access. *Human Ecology*, 2010, no. 1, pp. 61–64.
32. Kozlov A.V., Gutman S.S., Rytova E.V., Zakharov A.N. The Choice of Cultivation Technology for Arctic Territories: Comparative Analysis of Russian and Norwegian Experience. *MIR (Modernization. Innovation. Research)*, 2015, no. 4–1 (24), pp. 19–28.
33. Korneyeva Ya.A., Dubinina N.I., Simonova N.N., Degteva G.N., Fedotov D.M. Risks of Shift Workers in Professional Activity in Far North. *Acta Biomedica Scientifica*, 2013, no. 3–2 (91), pp. 83–88.
34. Anpilogova L.V. *Sostoyanie korevogo postvaksinal'nogo immuniteta u detey, prozhivayushchikh v usloviyakh Kraynego Severa: avtoreferat dis. dok. biol. nauk* [State of Measles Postvaccinal Immunity in Children Living in the Far North: Dr. Biol. Sci. Abs.]. Moscow, 1986, 20 p. (In Russ.)
35. Savin M.N., Ivanov B.A., Korchagin I.V., Okishev M.A. Acclimatization of Military Personnel in the Regions of the Far North and the Arctic by Means of Physical Training. *Uchenye zapiski universiteta im. P. F. Lesgafta* [Scientific Notes of P.F. Lesgaft University], 2018, no. 2 (156), pp. 207–212.
36. Gridin L.A., Shishov A.A., Dvornikov M.V. Features Adaptation Reactions of Human in Far North. *Public Health and Life Environment*, 2014, no. 4, pp. 4–6.
37. Tsaregorodtsev A.L. Efficiency of Telemedicine at the Northern Regions Russian Federation. *The Journal of Telemedicine and E-Health*, 2015, no. 1, pp. 18–22.
38. Baranov A.A., Vishneva E.A., Namazova-Baranova L.S. Telemedicine — Prospects and Difficulties Before a New Development Stage. *Pediatric Pharmacology*, 2013, no. 10 (3), pp. 6–11.
39. Nikitin Yu.P., Khasnuln V.I., Gudkov A.B. Contemporary Problems of Northern Medicine and Researchers' Efforts to Solve Them. *Vestnik of Northern (Arctic) Federal University. Ser.: Medical and Biological Sciences*, 2014, no. 3, pp. 63–72.
40. Timofeev D.S., Timofeeva A.N. K voprosu o severnoy meditsine [On the Subject of Northern Medicine]. *International Journal of Applied and Fundamental Research*, 2013, no. 11–2, pp. 71–72.

*The article was submitted 26.06.2023; approved after reviewing 27.03.2023;
accepted for publication 27.06.2023*

Contribution of the authors: the authors contributed equally to this article

The authors declare no conflicts of interests