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Morbidity and mortality patterns in extreme climatic conditions of Oymyakonsky district of Yakutia

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Abstract. This study is devoted to the analysis of long-term dynamics morbidity and mortality in the Oymyakon region of Yakutia (2000-2023) in order to justify the need to include the ulus in the Arctic zone. Republic of Sakha (Yakutia).

Materials and methods of research. The work was carried out on the basis of statistical materials provided by the State Budgetary Institution of the Republic of Sakha (Yakutia) "Yakutsk Republican Medical Information and Analytical Center" for 2000-2023 and data from the All-Russian Population Censuses for 2002 and 2020.

Results and discussion. As the analysis showed, the current situation The morbidity and mortality rate of the Oymyakon Ulus population requires special attention not only from the healthcare system but also reflects the population's quality of life. Studies have revealed a number of serious problems, including a high prevalence of HIV infection due to intensive migration due to industrial activity in the district. The incidence of sexually transmitted infections (STIs), parenteral viral hepatitis, and mental disorders is underestimated due to insufficient population screening, a lack of proper diagnostics, and a shortage of qualified medical personnel. It has been noted that since 2020, the incidence of community-acquired pneumonia has increased significantly in the district. These cases are caused by unfavorable environmental or social factors, poor lifestyle practices, and a weakened immune system, including due to the COVID-19 pandemic. Mortality rates from circulatory diseases and external causes in the Oymyakon Ulus have been found to be significantly higher than similar data for the Republic of Sakha (Yakutia).

Conclusion. Considering established situation, due to demographic aging and logistical challenges, comprehensive measures to improve the accessibility and quality of medical care are needed in the Oymyakon district. Development of a mechanism for effective and mutually beneficial cooperation between the district's central hospital and mining companies, large-scale screening diagnosis of socially significant diseases and strengthening preventive measures will improve both qualitative and quantitative statistics. To increase the attractiveness of living in the ulus and attract additional funding from the federal budget, it is advisable to include the Oymyakon ulus in the list of Arctic regions of the Sakha Republic (Yakutia).

Keywords: socially significant diseases, HIV infection, morbidity and mortality in Oymyakon, Arctic zone

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Introduction. The problem of outflow of people from remote and hard-to-reach areas is becoming increasingly relevant in Russia every year. This is especially true for Yakutia, a constituent entity of the Russian Federation characterized primarily by extreme natural and climatic conditions and a vast territory with poorly developed transportation infrastructure. For example, since 2000, the population of the Yakut Arctic has declined by more than 26%. Moreover, it is typically the economically active population that is leaving their former places of residence. However, it is important to note that on August 14, 2020, a decree from the head of the region approved the Strategy for the Socioeconomic Development of the Arctic Zone of the Republic of Sakha (Yakutia) (AZ RS(Y)) until 2035, the primary goal of which is the preservation of human capital. Therefore, it is clear that the strategy places special emphasis on the development of Arctic medicine.

Thanks to this, the "Oncodesant" project was implemented in the region in 2020, multidisciplinary mobile medical teams were created in 2023, the material and technical base of medical institutions in the Arctic uluses is being improved, certain attention is being paid to scientific projects related to the health of northerners, etc. All of this should gradually increase the level of satisfaction of the population of the Arctic Zone of the Republic of Sakha (Yakutia) with the quality of medical care, which in turn will contribute to a decrease in the rate of outflow. Indeed, according to our previously obtained data, dissatisfaction with the quality of medical services is one of the main predictors of population decline [1]. We conducted the studies we mentioned in 2023 in the Oymyakonsky District, the question of its inclusion in the Arctic zone remains unclear, although in recent years, works by scientists from a wide range of specialties have been published

substantiating the possibility of including this ulus in the Arctic Zone of the Republic of Sakha (Yakutia) [2-4]. It's important to remember that the population of the Oymyakon District, according to official data alone, decreased by 45.7% between 2000 and 2023. The actual figure is even higher, as a certain portion of the registered population actually resides in Central Yakutia, primarily in Yakutsk.

In connection with the above, the aim of the work is to analyze the long-term morbidity and mortality structure of the population of the Oymyakon district of Yakutia in order to develop a medical and social justification for the inclusion of this ulus in the Arctic zone of Yakutia.

Materials and methods. A comparative analysis was conducted Statistical data on morbidity and mortality in the Oymyakon Ulus from 2000 to 2023, provided by the State Budgetary Institution of the Republic of Sakha (Yakutia) "Yakutsk Republican Medical Information and An-

alytical Center" (YARMIAC). The study also used data from the All-Russian Population Censuses (ARPC) for 2002 and 2020. Morbidity and mortality rates are presented graphically using two-year intervals, the data for which were obtained by averaging.

Results and discussion. Among the socially significant diseases, Of the registered cases in the Oymyakon ulus, HIV infection is of particular concern. Due to increased migration in the ulus associated with industrial activity, the HIV incidence rate in the Oymyakon district has significantly exceeded the national average for decades (Figure 1). Between 2005 and 2024, 73 new cases of HIV infection were registered in the ulus, representing 3.6% of the total number of cases in the region during the same period. By comparison, the proportion of residents of the Oymyakon ulus does not exceed 0.8% of the republic's total population.

It is well known that there is a direct link between HIV infection and sexually transmitted infections (STIs) and parenteral viral hepatitis [5, 6]. However, according to official data, the STI incidence rate in the region is relatively calm (for example, from 2000 to the present, not a single case of gonorrhea, chlamydia, or trichomoniasis has been reported). However, this is clearly the result of insufficient population screening, a lack of proper diagnostics, and a shortage of qualified medical personnel. It is highly likely that residents of this small ulus who contract STIs receive medical care anonymously or self-medicate due to a lack of trust in medical confidentiality and subsequent stigma, which also contributes to a distorted picture. For a similar reason, the data on viral hepatitis are incomplete. For example, data on primary incidence of chronic hepatitis B is missing for 2000-2003, 2013, 2016, and 2019-2021, and the available figures vary significantly. However, according to the Yakutia viral hepatitis patient registry, in 2025, a total of 141 people were registered for outpatient care in the Oymyakon District, including 74 (52.5%) with hepatitis C, 65 (46%) with hepatitis B, and 2 (1.5%) with hepatitis D.

The data on the primary incidence of mental disorders in the population also raises doubts. Thus, if from 2000 to 2017 this indicator in the ulus consistently exceeded the Russian average by 64.7%, and the national average by 198.7%, then from 2018 to 2023, on the contrary, it became lower by 68.3 and 38.2%, respectively. Here it is necessary to note that people suffering from mental disorders are prone to suicide [7, 8]. However,

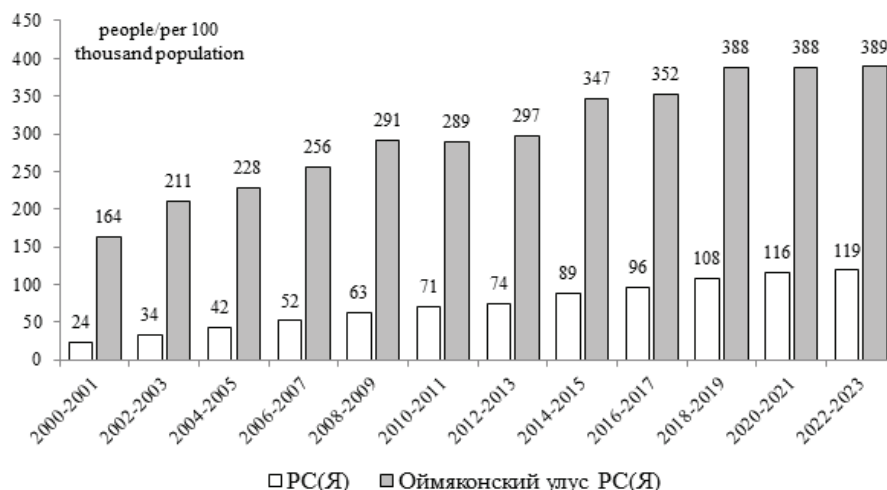


Fig. 1. Dynamics of the overall incidence of HIV infection in the Republic of Sakha (Yakutia) and the Oymyakonsky ulus of the Republic of Sakha (Yakutia) in the period from 2000 to 2023.

no trend towards a decrease in mortality from suicide in the Oymyakon ulus has been noted over the recent period. On average, from 2000 to 2023, 4.3 ± 2.3 people died from suicide annually in the district.

Over the past few years, the incidence of so-called community-acquired pneumonia (CAP) has increased significantly in the ulus. Possible causes include unfavorable environmental or social factors (e.g., violation of sanitary and hygienic requirements in rotational camps), failure to adhere to healthy lifestyle principles, and a weakened human immune system, including due to the emergence of the SARS-CoV-2 virus in society. As Figure 2 shows, in 2020-2021, the incidence of CAP in the ulus was 5.6 times higher than the regional average, and 2.5 times higher in 2022-2023 (Figure 2). A similar situation was observed for tuberculosis: from 2018 to 2021, its prevalence in the

ulus was 1.7-2 times higher than the national average.

A comparative analysis of the primary and overall incidence rates of cardiovascular diseases (CVD) in the Oymyakon Ulus revealed no significant differences from regional data. However, a study of the mortality structure revealed that in some years (e.g., 2010-2011, 2014-2015, 2020-2021), the CVD mortality rate in the ulus exceeded regional rates by more than 90% (Figure 3). This is primarily due to a significant increase in the proportion of people of retirement age, who are typically more likely to die from cardiovascular diseases. According to the All-Russian Population Censuses (ARPC) their proportion in the Oymyakon Ulus was 8.6% ($n = 1,221$) in 2002 and 18.6% ($n = 1,440$) in 2020. Secondly, the district faces challenges with accessibility and timeliness of medical care that meets modern standards. Nearly 40% of

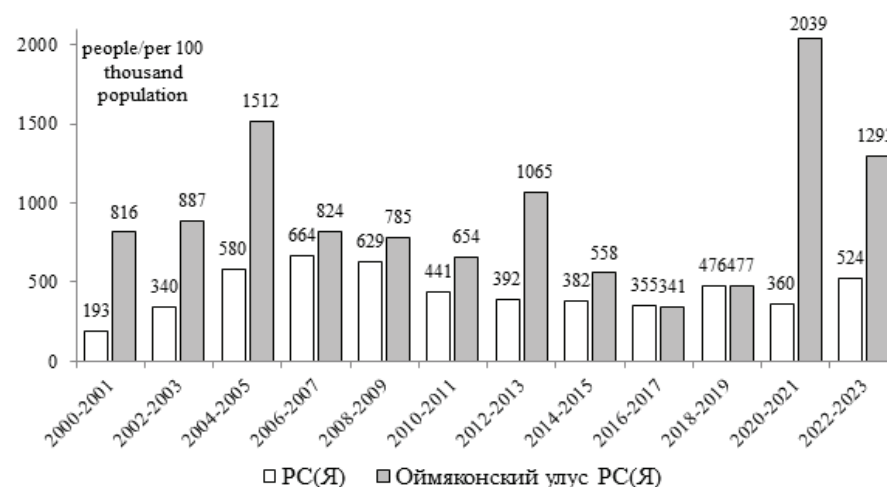


Fig. 2. Dynamics of incidence of community-acquired pneumonia in the Republic of Sakha (Yakutia) and Oymyakonsky ulus of the Republic of Sakha (Yakutia) in the period from 2000 to 2023

the ulus's population lives 340-450 km from the central district hospital. Most of the gold mines are also located at a considerable distance from Ust-Nera. During the Soviet era, this problem was solved by air travel, but currently, travel within the district is exclusively by land, creating significant challenges for both ordinary residents and healthcare workers.

Another obvious indicator of social distress among the population of the Oymyakon ulus is the increase in the external cause mortality rate (ECMR). As a rule, ECMR is often associated with alcohol abuse, psychological factors, crime, and failure to observe safety precautions in extreme climatic conditions. During the period under review, 581 people died in the region, mainly people of working age (Fig. 4). Incidentally, it is also cause for considerable concern that the number of people in this age group decreased 2.3 times between 2002 and 2020, from 10,295 to 4,561, or from 70.2% to 59.0% of the total population of the region.

Conclusion: Population decline affects the quality of healthcare, which in turn is one of the factors contributing to population migration from their places of residence, creating a vicious circle. However, it is important to remember that preserving and increasing human capital should be an integral part of any state's policy. Given this indisputable truth, special attention should be paid to health care issues and the health status of people living in the coldest place in the Northern Hemisphere. Moreover, in the near future, morbidity rates among residents of the Oymyakon may deteriorate in the near future, both due to existing demographic trends and as a result of the 2025 flood, which damaged residential buildings and infrastructure in all settlements.

The multifaceted nature of the problem requires a fundamental review of issues related to improving people's quality of life. Given the presence of a significant number of profitable mining enterprises in the ulus, which pose a constant risk in both epidemiological and environmental terms, the ulus leadership, with the support of the Ministry of Health of the Republic of Sakha (Yakutia), needs to develop a mechanism for effective and mutually beneficial cooperation between the central district hospital of the ulus and subsoil users without involving intermediaries.

In order to reduce morbidity and mortality among the population, as well as to foster a culture of health among the people, the role of preventive measures in all institutions in the district, regardless of their specific activities, should be sig-

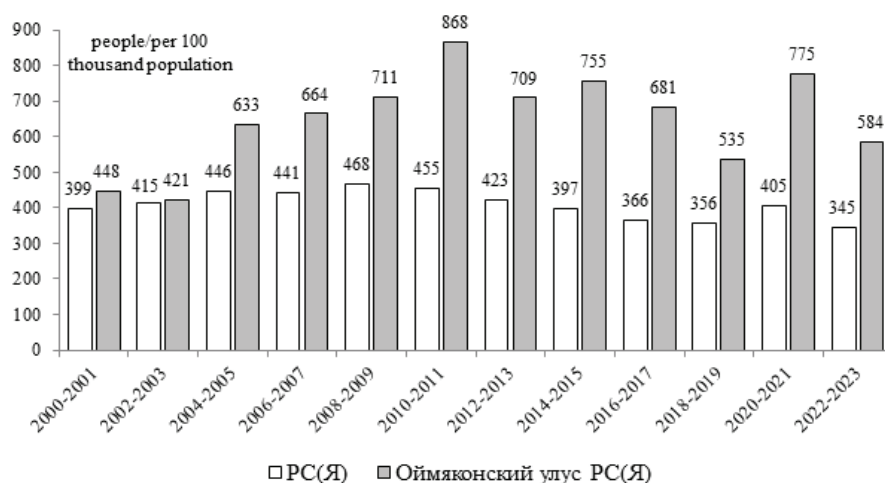


Fig. 3. Mortality rates from circulatory system diseases among the population of the Republic of Sakha (Yakutia) and the Oymyakon Ulus of the Republic of Sakha (Yakutia)

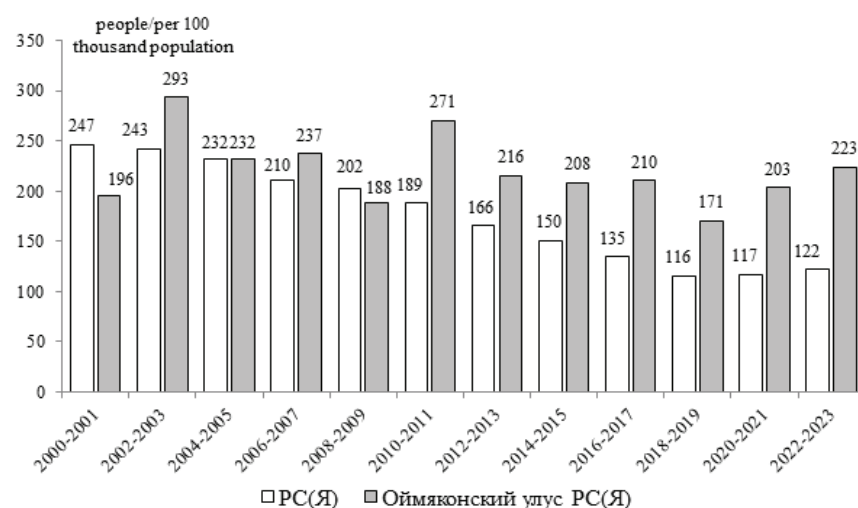


Fig. 4. Dynamics of mortality among the population of the Republic of Sakha (Yakutia) and the Oymyakon Ulus of the Republic of Sakha (Yakutia) from external causes

nificantly strengthened, and large-scale screening for the diagnosis of socially significant diseases should be carried out.

In order to increase the attractiveness of living in the Oymyakon region and attract additional funding from the federal budget, the republic's leadership needs to initiate amendments to Decree of the President of the Russian Federation No. 296 of May 2, 2014 "On the Land Territories of the Arctic Zone of the Russian Federation" and add the Oymyakon ulus to the list of Arctic regions of the Yakut Arctic.

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Genetic diagnostic technologies in modern medicine: from classical molecular genetic methods to high-performance genome analysis platforms

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Abstract. The review examines the development of genetic diagnostic technologies, from classical molecular methods to modern high-performance platforms, including NGS, microchip technologies, and AI-based analysis algorithms. Special attention is paid to the possibilities of modern approaches in the early detection of hereditary and multifactorial diseases, as well as an assessment of their limitations and prospects for further implementation in clinical practice. The presented data summarize key trends in the evolution of genetic methods and demonstrate the importance of digitalization, bioinformatics, and machine learning for improving the accuracy and standardization of genomic diagnostics. The material will be useful to specialists in the field of molecular medicine, clinical geneticists, bioinformatics and researchers working on the development of personalized healthcare technologies. The review highlights the importance of an integrated approach to assessing the diagnostic potential of modern genetic methods and their role in shaping future standards of medical care.

Keywords: genetic diagnostics; new generation sequencing (NGS); high-performance platforms; bioinformatics; artificial intelligence; molecular methods; personalized medicine.

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