

ACTUAL TOPIC

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INCIDENCE OF MALIGNANT NEOPLASMS IN THE POPULATION OF THE TERRITORIES OF THE REPUBLIC OF SAKHA (YAKUTIA) FOR THE PERIOD 2010-2019

The article presents data on the study of the current situation of the incidence of malignant neoplasms in the population of the territories of the Republic of Sakha (Yakutia), assessments of its relationship with the amount of pollutant emissions and ethnicity. It has been revealed that the age-standardized incidence rate of cancer of all localizations (C00-96) for the period 2010-2019 in the Republic of Sakha (Yakutia) is lower than in the whole of the Russian Federation, both in men and women, and has a similar growth trend. Higher average long-term incidence rates of cancer of all localizations (C00-96) have been observed in men and women living in the city of the republican significance Yakutsk and in industrial zones, and the lowest rates have been revealed for agricultural zones. No statistically significant correlations have been found between atmospheric pollution from stationary sources and the incidence of cancer, while a negative association with the number of indigenous people living in the municipality has been revealed. It is assumed that the increase in the incidence of cancer is associated with improvements in early detection of cancer that is common for both the Republic of Sakha (Yakutia), and the Russian Federation, and with the variety of physical and chemical factors harmful to humans in municipalities.

Keywords: malignant neoplasms, cancer incidence, standardized indicators, zoning of territories, environmental factors.

Introduction. Despite advances in technological development of early diagnosis and treatment methods, oncological diseases continue to grow steadily. According to the World Health Organization (WHO), the global cancer burden and cancer deaths are expected to increase to 54 million and to 16 million per year, correspondingly by 2050 [5]. As reported by the Global Burden of Disease Cancer Collaboration, in 2007-2017, the global cancer burden increased by 33%, and the cancer DALYs, being in the 6th place earlier, reached the 2nd place in the ranking, following cardiovascular diseases [4]. However, an introduction of updated and more effective methods of early cancer diagnosis, treatment and prevention contribute to a decrease in mortality rates and an increase in the life expectancy in high-income countries. Thus, in the United States from 1991 to 2017, a continuous decrease of the cancer death rates led to an overall decrease in mortality by 29% [3].

The Republic of Sakha (Yakutia) is the largest subject of the Russian Federation (3 million sq. km) with the population of 972 000 people, as of 2020, (the population density is 0.31 people per sq. km). According to the 2010 All-Russian Population Census, representatives of 126 peoples live in the Sakha Republic (Yakutia), with the largest groups represented by the Yakuts (45.5%), Russians

(41.2%), and Ukrainians (3.6%). In accordance with the administrative-territorial division, 34 municipal districts and 2 urban districts make the Sakha Republic (Yakutia), significantly differing in their population density, climatic and socio-economic living conditions, ethnic and age composition. These differences significantly affect the rates of population morbidity and mortality. Although Yakutia is not among Russian regions with highest incidence of malignant neoplasms (MNO), recently, there has been a steady rise in the cancer burden. According to Rosstat, there is 31.3% increase in cancer incidence in 2010- 2019 (from 213.8 to 280.7 per 100.000 population), while more significant dynamics has been found among females (33.9%), as compared with males (28.3%).

Aim of the study: to characterize the current state of the malignant neoplasm burden among the population of the Sakha Republic (Yakutia), to assess cancer associations with the amount of pollutant emissions and ethnicity.

Materials and research methods

Data from the State Medical Statistics on cancer in 2010- 2019, published by the P. Herzen Moscow Oncological Research Institute - a branch of the National Medical Research Radiological Centre of the Ministry of Health of the Russian Federation, and data from the State Budgetary Institution of the Republic of Sakha

(Yakutia) "Yakutsk Republican Oncological Dispensary" (forms 7, 35) have been used in the study.

The malignant neoplasm incidence rates in the Sakha Republic (Yakutia) and the Russian Federation have been calculated based on the age-standardized rates (SR) per 100 000 population (world standard population) for the period between 2010 and 2019, as well as average long-term values for the entire observation period with 95 % confidence interval.

The system of zoning into 5 social-territorial zones, proposed by M.A. Tyrylgin [2] has been applied for zoning the territory of the Sakha Republic (Yakutia). Standardized indicators of the malignant neoplasms incidence for all localizations (C00-96) have been calculated by the method of direct standardization. The age structure of the population of the Sakha Republic (Yakutia) differs from the structure of the European population and the standard of the structure of the world population due to the positive natural growth and low life expectancy. In this regard, the age structure of the population of the Sakha Republic (Yakutia), according to the 2010 All-Russian Population Census, has been adopted as a standard.

Data from the 2010 All-Russian Population Census have been used to describe the ethnic composition of the territories. Indicators of pollutant emissions from stationary sources into the atmosphere (tons) have been selected to assess the degree of environmental pollution. The average level of the indicator for the period between 2005 and 2019 for each municipality (MO) has been calculated. The grouping of municipalities with similar age-standardized rates (SR) of cancer incidence rates of all localizations (C00-96) in 2015-2019 has been conducted using the method of two-stage cluster analysis (IBM SPSS Statistics 22). The search for possible links between incidence rates, environmental pollution, and an ethnic composition has been undertaken using the Spearman correlation and private correlation analyses.

Results and discussion. An analysis of mean values of age-standardized incidence rates for a 10-year period with the boundaries of 95% CI showed that, in general, the incidence of malignant neoplasms in the Sakha Republic (Yakutia) was lower than the average for the Russian Federation, both among males (by 10.4%) and females (by 13.6%). Since 2010 there has been an increase in the cancer incidence by 3.9 and 11.3%, respectively (in the Russian Federation -

by 2.6 and 12.2%, respectively) among males and females in the Republic of Sakha (Yakutia), as well as in the Russian Federation, as a whole, with the cancer burden 32.1% higher among males (in the Russian Federation - by 27.2%), as compared with females (Fig. 1).

Comparison of the SP incidence of malignant neoplasms of all localizations (C00-96) per 100,000 population in the socio-territorial zones of the Republic of Sakha (Yakutia) in 2015-2019 (Fig. 2) has shown higher incidence rates of malignant neoplasms in men and women living in Yakutsk, the capital of Sakha (295.1 and 240.0), and the industrial zone (284.2 and 225.8), while the lowest rates have been observed in the agricultural zone (216.7 and 171.9 per 100,000 of the corresponding population). The levels of malignant neoplasm incidence rates in men and women in Yakutsk are 1.4 times higher than those in the agricultural zone. In all social-territorial zones, the cancer incidence in men is 1.2-1.3 times higher than in women. Differences between the indicators of mixed and industrial, agricultural and industrial, Arctic and agricultural zones are statistically significant ($p < 0.05$).

The analysis of prevalence of cancer incidence SP (C00-96) in 35 municipalities of the Republic of Sakha (Yakutia) has showed significant differences, which remain with time interval extension. Thus, in 2015-2019, the SP incidence of cancer among men varied from 170 to 351, among women from 116 to 287 per 100,000 of population.

The existing differences require detailed analysis to find the reasons for their occurrence. In the course of the cluster analysis of SP incidence rates, three clusters were formed (Tables 1 and 2):

- among the male population, cluster 1 with lower rates of cancer incidence included 14 (9 agricultural, 3 Arctic and 2 mixed zones); cluster 2 - 8 municipalities (3 Arctic, 2 industrial, 2 mixed and 1 agricultural zones), and cluster 3 - 13 municipalities (3 industrial, 5 Arctic, 1 agricultural and 3 mixed zones, and Yakutsk);

- among the female population, cluster 1 includes 12 municipalities (2 Arctic, 7 agricultural and 3 mixed zones); cluster 2 - 10 municipalities (4 Arctic, 3 agricultural and 3 mixed zones), cluster 3 - 13 municipalities (5 industrial, 5 Arctic, 1 agricultural and 1 mixed zones, and Yakutsk).

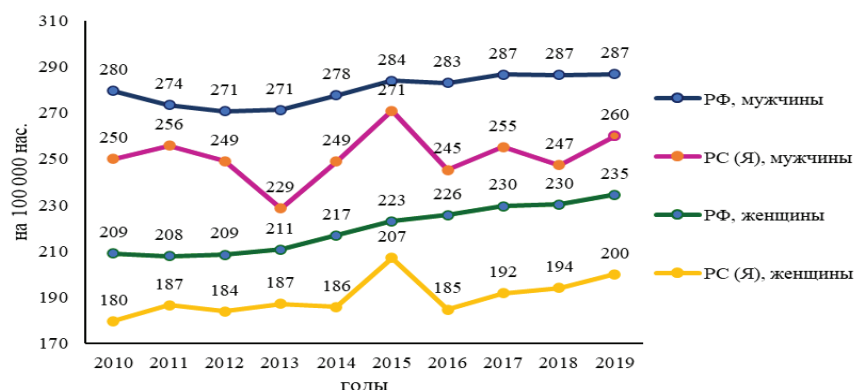


Fig. 1. Comparison of standardized cancer incidence rates for men and women in the Russian Federation and the Republic of Sakha (Yakutia) for 2010-2019, all localizations (C00-96), per 100,000 of the corresponding population (world population standard)

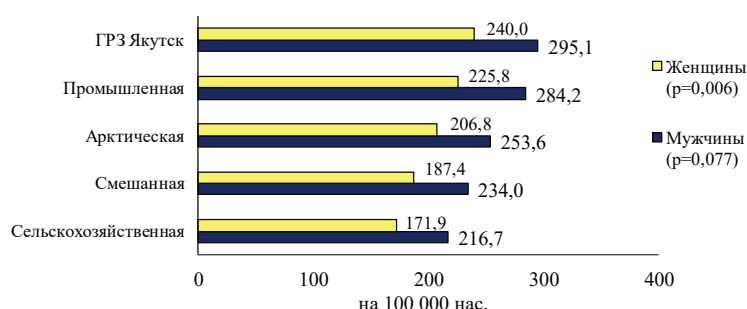


Fig. 2. Comparison of the standardized indicators of the incidence of cancer of all localizations (C00-96) in men and women in social-territorial zones of the Republic of Sakha (Yakutia) for 2015-2019 (the standard is the population of the Republic of Sakha (Yakutia)) in comparison of mixed and industrial zone $p=0.016$, rural and industrial $p=0.001$, Arctic and rural areas $p=0.017$

Significant differences between the male and female population in the levels of indicators, both between, and within municipalities affect the distribution of municipalities into clusters. Nevertheless, the prevalence of municipalities of the Arctic and industrial zones of the Sakha republic in cluster 3, and the prevalence of agricultural zones in cluster 1 is observed among both men, and women.

The above data suggest possible effects of unfavorable environmental factors and the ethnic composition of the population on cancer incidence rates. Moreover, both of these factors can be inter-related due to a higher share of the non-indigenous population in industrial regions (uluses) of Sakha. According to the Census, the share of the indigenous population, including the Yakuts and indigenous peoples of the North, vary in municipalities from 4 to 99.4%.

Correlation analysis according to Spearman revealed that the amount of pollutant emissions into the atmosphere from stationary sources has a moderate negative correlation with the share of the indigenous population in municipalities ($r = -0.59$, $p < 0.001$), which correlates with a smaller number of indigenous people living in industrial uluses.

A search for potential correlations between levels of morbidity and environmental pollution, i.e. between the variables "pollution emissions" and the SP of the cancer incidence has not revealed any statistically significant correlations ($r = 0.25$, $p = 0.193$). A negative correlation has been found between the variables "a share of the indigenous population" and the SP incidence of cancer (C00-96) both among males ($r = -0.42$, $p = 0.012$), and females ($r = -0.43$, $p = 0.011$). Application of the method of private correlation analysis with "the share of the indigenous population" as a "control" variable making it possible to alleviate effects of the factor "ethnicity", has not revealed any statistically significant links between the variables "pollutant emissions" and the SP of cancer incidence ($r = 0.18$, $p = 0.311$).

Conclusions. The study of the current situation of morbidity from malignant neoplasms of all localizations (C00-96) among the population of the Republic of Sakha (Yakutia) has revealed the following:

–standardized incidence rates of malignant neoplasms of all localizations (C00-96) among males and females, according to the world population standard, in the Republic of Sakha (Yakutia) are lower as compared with the Russian Federation. However, in 2010-2019, a

similar trend towards an increase in the cancer incidence among the male and female population has been observed in the Republic of Sakha (Yakutia), as in the whole of the Russian Federation, while the cancer incidence among men is higher as compared with women;

– within social-territorial zones of the Republic of Sakha (Yakutia), higher average long-term indicators of cancer incidence of all localizations (C00-96),

standardized by the age composition of the Republic of Sakha (Yakutia), have been observed in men and women living in Yakutsk and in industrial zones, while the lowest indicators have been found for agricultural areas. And, the difference between values of average long-term indicators (2015-2019) in industrial and agricultural zones is 1.4 times;

– despite significant differences in levels of SP incidence of cancer (C00-96)

Table 1

Distribution of municipalities of the RS (Y) by clusters according to levels of SP incidence of cancer (C00-96) in 2015-2019, males

Municipality	SP per 100000 population	Social-territorial zone
Cluster 1 n=14 196 (95% CI 185-206)		
Tattinsky ulus	169.8	Agricultural
Kobyaisky ulus (region)	170.1	Mixed
Bulunsky ulus (region)	174.7	Arctic
Olekminsky region	177.7	Mixed
Suntarsky ulus (region)	181.0	Agricultural
Anabarsky National (Dolgan-Evenki) ulus (region)	191.1	Arctic
Verkhnevilyusky ulus (region)	194.3	Agricultural
Ust-Aldansky ulus (region)	204.7	Agricultural
Amginsky ulus (region)	205.2	Agricultural
Oleneksky Evenkiysky National region	206.3	Arctic
Vilyuskiy ulus (region)	210.5	Agricultural
Namsky ulus	215.1	Agricultural
Gornyy ulus	217.2	Agricultural
Churapchinsky ulus (region)	220.1	Agricultural
Cluster 2 n=8 241 (95% CI 235-248)		
Lensky region	233.6	Industrial
Oimyakonsky ulus (region)	234.0	Industrial
Momsky region	236.5	Arctic
Allaikhovky ulus (region)	237.7	Arctic
Nyurbinsky region	240.0	Agricultural
Abyisky (region)	244.8	Arctic
Verkhnekolymsky ulus (region)	250.0	Mixed
Verkhoyansky region	254.1	Mixed
Cluster 3 n=13 292 (95% CI 277-306)		
Ust-Maysky ulus (region)	264.8	Mixed
Ust-Yansky ulus (region)	268.2	Arctic
Khangalassky улус	270.3	Mixed
Tomponsky region	273.3	Mixed
Aldansky region	278.4	Industrial
Even-Bytantaisky National ulus (region)	281.3	Arctic
Megino-Kangalassky ulus	288.2	Agricultural
Yakutsk (city of the republican significance) (CRS)	295.1	CRS
Mirinsky region	303.9	Industrial
Nizhnekolymsky region	304.0	Arctic
Neryunginsky region	305.8	Industrial
Srednekolymsky ulus (region)	306.8	Arctic
Zhigansky National Evenkisky region	351.3	Arctic

Note: Data are presented as mean and 95% CI.

Table 2

Distribution of MD of the RS (Y) by clusters depending on the level of SP incidence of cancer (C00-96) in 2015-2019, females

Municipality	SP per 100000 population	Social-territorial zone
Cluster 1 n=12 154 (95% CI 142-166)		
Even-Bytantsky National ulus (region)	116.0	Arctic
Amginsky ulus (region)	127.8	Agricultural
Gorny ulus	141.8	Agricultural
Kobyaisky ulus (region))	142.2	Mixed
Churapchinsky ulus (region)	149.0	Agricultural
Verkhnekolymsky ulus (region)	157.0	Mixed
Vilyuskiy ulus (region)	162.1	Agricultural
Suntarsky ulus (region)	165.6	Agricultural
Tomponsky region	166.5	Mixed
Nyurbinsky region	168.3	Agricultural
Namsky ulus (region)	170.5	Agricultural
Abyisky (region)	177.7	Arctic
Cluster 2 n=10 195 (95% CI 188-203)		
Allaikhovky ulus (region)	180.7	Arctic
Verkhoyansky region	182.2	Mixed
Megino-Kangalassky ulus (region)	187.7	Agricultural
Olekminsky region	191.8	Mixed
Tattinsky ulus (region)	191.9	Agricultural
Nizhnekolymsky region	192.3	Arctic
Ust-Aldansky ulus (region)	200.9	Agricultural
Khangalassky улус (region)	206.0	Mixed
Bulunsky ulus (region)	208.5	Arctic
Momsky region	210.5	Arctic
Cluster 3 n=13 232 (95% CI 217-246)		
Verkhnevilyusky ulus (region)	213.5	Agricultural
Mirninsky region	213.5	Industrial
Lensky region	214.3	Industrial
Ust-Yansky ulus (region)	214.3	Arctic
Srednekolymsky ulus (region)	214.8	Arctic
Zhigansky National Evenkisky region	216.1	Arctic
Neryungrinsky region	217.1	Industrial
Ust-Maysky ulus (region)	224.2	Mixed
Yakutsk (city of the republican significance) (CRS)	240.0	CRS
Oimaykonsky ulus (region)	246.3	Industrial
Oleneksky Evenkiysky National region	248.2	Arctic
Aldansky region	258.5	Industrial
Anabarsky National (Dolgan-Evenki) ulus (region)	289.6	Arctic

in 35 municipalities of the Republic of Sakha (Yakutia), remaining with extension of time intervals, and, respectively, in the three clusters formed according to the intensity of the indicators among males and females, the highest rates in the Arctic and in industrial zones, and the lowest rates in agricultural zones are common for all the clusters;

- no statistically significant associations have been established between atmospheric pollution from stationary sources and cancer incidence.

Thus, the search for causes of morbidity in individual localizations of malignant neoplasms, and indicators of environmental pollution to assess impacts of environmental factors on

development of malignant neoplasms in the Republic of Sakha (Yakutia) should be continued. The increase in the cancer incidence could be due to early cancer detection, common for the Republic of Sakha (Yakutia) and the Russian Federation, associated with modernization of the oncological service within the framework of the National Project "Health", and differences in physical and chemical factors in the Sakha Republic municipalities. A correlation between the proportion of the indigenous population and the cancer incidence requires additional research, including genetic study.

Reference

1. Злокачественные новообразования в России в 2007-2019 годах (заболеваемость и смертность). – М.: МНИОИ им. П.А. Герцена – филиал ФГБУ «НМИЦ радиологии» Минздрава России. - 2007-2019 гг. [Malignant neoplasms in Russia in 2007-2019 (morbidity and mortality). M.: P. Herzen MNIIOI - Branch of the Federal State Budgetary Institution "National Medical Research Center of Radiology", Ministry of Health, Russia (In Russ.).]
2. Тырылгин М. А. Проблемы охраны здоровья населения Крайнего Севера / М.А. Тырылгин. – Новосибирск: Наука, 2008. – 302 с. [Tyrylgin M.A. Problems of health protection of the population of the Far North. Novosibirsk: Nauka. 2008: 302 (In Russ.).]
3. Cancer statistic, 2020. NCHS, <https://doi.org/10.3322/caac.21590>
4. Oncology Global, Regional, and National Cancer Incidence, Mortality, Years of Life Lost, Years Lived With Disability-Adjusted Life-Years for 29 Cancer Groups, 1990 to 2017: A systematic Analysis for Global Burden of Diseases Study. Global Burden of Diseases Cancer Collaboration. *JAMA Oncol.* 2019; 5(12):1749-1768. doi: 10.1001/jamaoncol.2019.2996
5. World Cancer Report. World Health Organization, International Agency for Research on Cancer; eds.: B.W. Stewart, P. Kleihues. – Lion: IARC Press, 2003; 351.
6. Malignant neoplasms in Russia in 2007-2019 (morbidity and mortality). - M.: P. Herzen MNIIOI -a branch of the Federal State Budgetary Institution "National Medical Research Center of Radiology", Ministry of Health, Russia.
7. Tyrylgin, M.A. Problems of health protection of the population of the Far North / M.A. Tyrylgin. - Novosibirsk: Nauka, 2008. - 302 p.
8. Cancer statistic, 2020. NCHS, <https://doi.org/10.3322/caac.21590>
9. Oncology Global, Regional, and National Cancer Incidence, Mortality, Years of Life Lost, Years Lived With Disability-Adjusted Life-Years for 29 Cancer Groups, 1990 to 2017: A systematic Analysis for Global Burden of Diseases Study / Global Burden of Diseases Cancer Collaboration // *JAMA Oncol.* 2019; 5(12):1749-1768. doi: 10.1001/jamaoncol.2019.2996
10. World Cancer Report/ World Health Organization, International Agency for Research on Cancer; eds.: B.W. Stewart, P. Kleihues. – Lion: IARC Press, 2003. -351 p.