O.A. Ananina, L.D. Zhuikova, L.A. Kolomiets, G.A. Kononova, L.V. Pikalova

DOI 10.25789/YMJ.2025.90.20

UDC 618.1-006.04(571.16):338.14

SOCIAL AND ECONOMIC DAMAGE (DALY) FROM MALIGNANT NEOPLASMS OF FEMALE GENITAL ORGANS IN THE TOMSK REGION

The purpose of the study is to assess direct and indirect economic damage from cervical, uterine, and ovarian cancer in the Tomsk region.

Material and methods. Data from Rosstat for the Tomsk region covering the period from 2013 to 2023 were utilized, including population size, life expectancy, gross regional product per capita, and reporting forms C51 "Distribution of deaths by gender, age groups, and causes of death." Additionally, information on the costs of examination and treatment for genital cancer under compulsory medical insurance and high-tech medical care in rubles for 2016-2020 was analyzed. The losses of DALYs (person-years) and economic damage (rubles) were calculated according to WHO guidelines, using the segmented regression method.

Results. The maximum loss of DALY values for cervical cancer was in the range of 35–49 years, for uterine cancer and ovarian cancer in the range of 55–69 years. The highest expenditure was allocated to the treatment of ovarian cancer (325.24 million rubles), followed by lower amounts for uterine cancer (205.5 million rubles) and cervical cancer (189.8 million rubles). The total economic impact (including direct and indirect costs) amounted to 3.9 billion rubles for cervical cancer, 2.8 billion rubles for ovarian cancer, and 2.3 billion rubles for uterine cancer.

Conclusion. The findings of the study, quantified in monetary terms, are recommended for use in optimizing the allocation of budget funds under current conditions.

Keywords: economic burden, DALY, cancer, cervical cancer, uterine cancer, ovarian cancer, Tomsk region

For citation: Ananina O.A., Zhuikova L.D., Kolomiets L.A., Kononova G.A., Pikalova L.V. Social and economic damage (DALY) from malignant neoplasms of female genital organs in the Tomsk region. Yakut Medical Journal. 2025; 90(2): 81-84. https://doi.org/10.25789/YMJ.2025.90.20

Introduction. In 2020, out of 9.23 million new cancer cases among women worldwide, more than 1.39 million (15.1%) were related to gynecological malignancies. Among the 4.4 million women who died from cancer that year, 14.8% of deaths were caused by cancers of the female reproductive organs. According to WHO statistics, by 2035, the number of cancer-related deaths is expected to rise to 7 million, with gynecological cancers accounting for 12.0% of these cases [9].

Cancer Research Institute, Tomsk National Research Medical Center, Russian Academy of Sciences: **ANANINA Olga A.** – MD, PhD, Senior Researcher, Laboratory of Epidemiology, ORCID: 0000-0001-8002-3189, ananina.olga@bk.ru; **ZHUIKOVA Lilia D.** – MD, Head of the Laboratory of Epidemiology, ORCID: 0000-0003-3536-8473, zhuikovalili@mail.ru; **KOLOMIETS Larisa A.** – MD, Head of the Gynecology Department of Cancer Research Institute, Tomsk National Research Medical Center RAS, Professor of the Department of Oncology, Siberian State Medical University, Ministry of Health of the Russian Federation, ORCID: 0000-0002-6854-8940, kolomietsla@oncology.tomsk.ru; **KONONOVA Galina A.** – junior researcher, Laboratory of Epidemiology, ORCID: 0000-0001-6010-6462, kononova-ga@onco.tnimc.ru; **PIKALOVA Lidiya V.** – PhD, researcher of the Laboratory of Epidemiology, ORCID: 0000-0003-1453-2254, e-mail: l.v.pikalova@tomonco.ru.

In the Tomsk region, the age-standardized incidence rate (ASR) of cervical cancer was 16.9 per 100,000 population (compared to 13.7 in the Russian Federation, RF), endometrial cancer-18.9 (RF-16.4), and ovarian cancer-10.1 (RF-10.2). In the structure of cancer incidence among the female population, these malignancies ranked fifth (5.2%), fourth (7.4%), and ninth (3.7%), respectively, collectively accounting for 16.3% of all female reproductive organ tumors. The age-standardized mortality rates for cervical cancer were 5.7 (RF-4.8), endometrial cancer-3.9 (RF-3.8), and ovarian cancer-3.8 (RF-4.8) per 100,000 population. In the structure of cancer mortality, these malignancies ranked eighth (4.6%), ninth (4.1%), and tenth (4.0%), respectively, with gynecological cancers accounting for 12.8% of all cancer-related deaths [1, 3].

According to estimates by researchers from the Heidelberg Institute of Global Health (Germany), the Chinese Academy of Medical Sciences, and the Peking Union Medical College (China), the global economic cost of cancer from 2020 to 2050 will amount to 25.2 trillion US dollars (inconstant 2017 prices) , averaging 0.84 trillion per year. This is equivalent to an annual tax of 0.55% on global GDP. However, cancers of the female reproductive system are not among the top ten most costly malignancies: cervical cancer (CC) ranks 11th (estimated cost: $ 682 billion), ovarian cancer (OC) ranks 15th ($ 519 billion), and endometrial cancer (EC) ranks 24th ($193 billion) [8].

The mortality rate serves as a key indicator for evaluating the effectiveness of cancer control measures, as it directly depends on timely diagnosis and treatment efficacy.

According to WHO data [10], among non-communicable diseases in Russia in 2020, the burden of gynecological diseases across all age groups resulted in 973.7 disability-adjusted life years (DALYs) lost per 100,000 population, ranking fifth in the DALY structure-after ischemic heart disease, stroke, "low back and neck pain," and diabetes. The Global Burden of Disease (GBD) database [11] does not provide region-specific data for Russian federal subjects, including the Tomsk region. Due to frequent methodological changes in DALY calculations (the latest revision was in May 2024) [14] and the lack of standardization in calculation approaches, it is currently difficult to compare previous studies from Siberia and the Russian Far East with GBD data [4, 5].

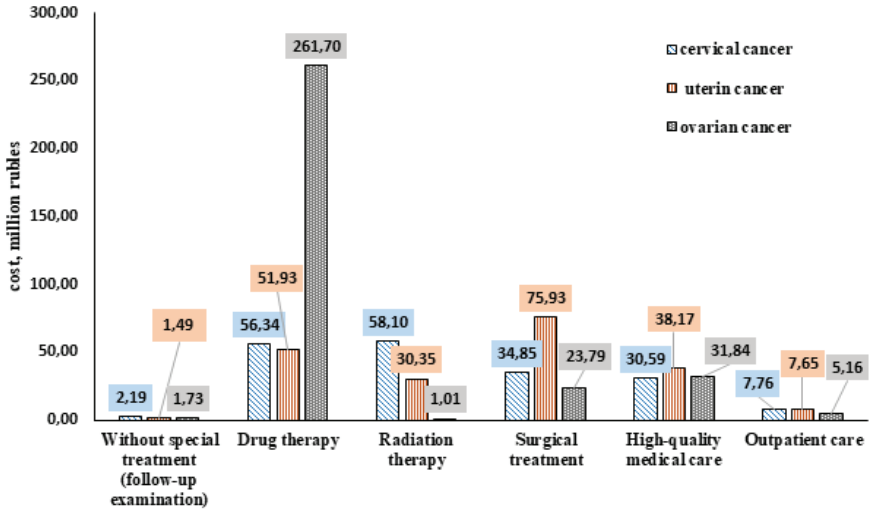
The government allocates substantial funds to provide medical care, including significant expenditures for supporting disabled citizens. Even greater financial losses stem from the premature mortality of cancer patients. All these economic costs can be quantified in monetary terms

to enable rational budget reallocation when planning cancer control measures. Therefore, conducting an analysis of both direct and indirect economic burdens caused by gynecological malignancies in the Tomsk region is particularly relevant.

Research Objective: To assess the direct and indirect economic burden caused by cervical, endometrial, and ovarian cancers in the Tomsk region.

Materials and Methods. The study included data from 2013-2023 for the Tomsk region, provided by the Territorial Office of State Statistics and Rosstat: demographic distribution by sex and age, life expectancy, gross regional product (GRP) per capita, mortality statistics (Form C51: "Distribution of deaths by sex, age groups, and causes of death"). Economic losses from malignancies consist of direct costs (10–20%) and indirect costs (80–90%). Direct costs include: prevention, diagnosis, treatment, rehabilitation, and social support for patients. Data sources included reimbursement records from the Territorial Compulsory Health Insurance Fund (CHI) for 2016–2020 and the hospital registry of the Tomsk Cancer Research Institute for high-tech medical care (HTMC). Additional reference was made to HTMC tariffs listed in the State Guarantees Program for Free Medical Care (Section II).

Indirect costs include: lost national income due to disability (5%) or premature death (75%) [2, 4]. These were calculated using the DALY method (disability-adjusted life years) multiplying DALY values by GRP per capita [7]. DALY losses (person-years) and economic damage (rubles) were computed using the "Onco DALY" software [6], developed by the Epidemiology Laboratory of the Tomsk Cancer Research Institute based on WHO guidelines [14].Trend analysis was performed using segmented regression [12] in JASP software.



Direct costs (million rubles) by types of medical care provided cervical cancer, uterine cancer, ovarian cancer in the Tomsk region, 2016-2020

Results: *Direct costs of female reproductive cancers in the Tomsk Region.* An assessment of the treatment costs for malignant neoplasms (MN) of the reproductive organs in the female population of the Tomsk region was conducted based on the data from payment registers for medical care provided under the territorial and federal compulsory health insurance (CHI) funds. The evaluation took into account the type of medical care provided in hospitals and outpatient clinics, including follow-up examinations, drug therapy, radiation therapy, surgical

Table 1

Indirect economic damage (thousand rubles) and DALY losses (person-years) of cervical cancer, uterine cancer, ovarian cancer in the Tomsk region in 2013-2023

years	GRP per capita, rubles	DALY Losses			Economic damage, rubles		
		cervical cancer	uterine cancer	ovarian cancer	cervical cancer	uterine cancer	ovarian cancer
2013	403 575,20 ₽	1628	819	1075	657 020 426 ₽	330 528 089 ₽	433 843 340 ₽
2014	430 138,20 ₽	1687	541	827	725 643 143 ₽	232 704 766 ₽	355 724 291 ₽
2015	520 296,60 ₽	1751	856	810	911 039 347 ₽	445 373 890 ₽	421 440 246 ₽
2016	484 654,70 ₽	1573	871	683	762 361 843 ₽	422 134 244 ₽	331 019 160 ₽
2017	515 560,30 ₽	1571	558	1072	809 945 231 ₽	287 682 647 ₽	552 680 642 ₽
2018	570 191,30 ₽	1279	882	1047	729 274 673 ₽	502 908 727 ₽	596 990 291 ₽
2019	575 297,10 ₽	1276	759	993	734 079 100 ₽	436 650 499 ₽	571 270 020 ₽
2020	517 023,00 ₽	1227	825	776	634 387 221 ₽	426 543 975 ₽	401 209 848 ₽
2021	679 724,80 ₽	1185	791	1138	805 473 888 ₽	537 662 317 ₽	773 526 822 ₽
2022	769 028,80 ₽	988	668	773	759 800 454 ₽	513 711 238 ₽	594 459 262 ₽
2023	870 868,90 ₽	987	696	730	859 547 604 ₽	606 124 754 ₽	635 734 297 ₽
period, average annual change over the period, level p		2015-2013, -94.60*; p=0.001	2013-2023, -1.75; p=0.888	2013-2023, -7.73; p=0.646	2013-2023, +4.5 млн руб.; p=0.585	2013-2023, +26.7* млн руб.; p=0.004	2013-2023, +28.9* млн руб.; p=0.016

Note: *– statistical significance of the differences ($p < 0.05$) was estimated using segmented regression.

Table 2

Direct and indirect economic damage (million rubles) of cervical cancer, uterine cancer, ovarian cancer in the Tomsk region in 2016-2020

	cervical cancer		uterine cancer		ovarian cancer	
	million rubles	%	million rubles	%	million rubles	%
Indirect economic damage	3 670.05 ₽	95.08	2 075.92 ₽	90.99	2 453.17 ₽	88.29
Direct economic damage	189.83 ₽	4.92	205.52 ₽	9.01	325.24 ₽	11.71
Total	3 859.88 ₽	100	2 281.44 ₽	100	2 778.41 ₽	100

treatment, and outpatient care. (Figure):

The highest costs were associated with antitumor drug therapy for ovarian cancer (OC) (36.3% of all expenses for gynecological cancer care), surgical treatment for uterine cancer (UC) (10.5%), and radiation therapy for cervical cancer (CC) (8.1%). The lowest expenditures were on diagnostic/follow-up examinations for diagnosis establishment and clarification (0.2–0.3% for each cancer type) and outpatient care for women with this pathology (0.7–1.1%). The most funded treatment was for OC (325.24 million RUB), followed by UC (205.5 million RUB) and CC (189.8 million RUB). When assessing annual direct medical costs for gynecological cancer patients, the lowest expenditure level was recorded in 2018 (91.84 million RUB), while the highest was in 2020 (196.71 million RUB). This trend can be explained by increases in compulsory health insurance (CHI) tariffs and high-tech medical care (HTMC) costs. Over the five-year period, no statistically significant cost growth was observed for OC (p=0.079), CC (p=0.059), or UC (p=0.123). However, a clear increase in costs was noted for all studied malignant neoplasms (MN) in the most recent years (2016 and 2020), averaging 80.6%: CC showed a growth rate of 63.9%, UC-26.7%, and OC-121.8%.

Indirect costs of female reproductive organs malignant neoplasms in the Tomsk region. During 2016-2020, DALY losses amounted to: 6,957.71 for cervical cancer; 3,911.66 for uterine cancer; 4,588.89 for ovarian cancer (in person-years). The highest DALY losses for cervical cancer occurred in the working-age groups of 35-39, 40-44, and 45-49 years (821.1, 1,159.0, and 817.4 DALY person-years, respectively). For uterine and ovarian cancers, peak losses were observed in post-working-age cohorts (55-59, 60-64, and 65-69 years): UC: 574.3, 764.5, and 696.5 person-years; OC: 1,060.2, 781.5, and 587.2 person-years. The time trend analysis using segmented regression (Table 1) revealed a statistically significant decrease in DALYs for cervical cancer (CC) during 2013-2015, with an average annual reduction rate of 94.8 person-years (p = 0.001). While the economic burden showed an increasing trend during this period, the change was not statistically significant (p = 0.585). For uterine cancer (UC) and ovarian cancer (OC), no significant changes in DALY losses were observed during the study period. However, the overall economic burden increased significantly for both cancers: for UC at an average annual rate of 26.7 million RUB (p=0.004), and for OC at 28.9 million RUB (p=0.016).

Direct and indirect costs of female reproductive cancers in the Tomsk region. During 2016-2020, the highest total direct and indirect economic burden was associated with cervical cancer treatment (3.9 billion RUB), followed by ovarian cancer (2.8 billion RUB) and uterine cancer (2.3 billion RUB) (Table 2).

Discussion: Currently, for data spanning 2000–2021, the methodology for calculating DALY employs the maximum healthy life expectancy at birth from World Population Prospects 2024 [13], projected to reach 90.6 years by 2050 (previously, the 2013 benchmark of 87.1 years was used). Following the COVID-19 pandemic, global life expectancy at birth has resumed growth, reaching 73.3 years in 2024 an increase of 8.4 years since 1995 [13]. This trend is expected to drive higher cancer incidence and, consequently, increased healthcare expenditures.

The persistently high economic burden of gynecological cancers, further exacerbated by annual growth in GDP per capita, could be mitigated by reducing mortality among the working-age population. Thus, it is critical to prioritize greater funding for preventive and rehabilitative anti-cancer programs. Such initiatives should aim to: promote women's proactive health management; enable early detection and treatment of precancerous conditions, and facilitate the rapid reintegration of radically treated patients into society and the workforce.

Conclusion. In the current era of rising cancer incidence, addressing the multifaceted challenges of reducing cancer mortality as outlined in the federal project "Combating Oncological Diseases" requires a comprehensive analysis of direct and indirect economic losses. This analysis is critical for healthcare policymakers to prioritize interventions, including: primary cancer prevention, patient rehabilitation. To evaluate the efficiency of healthcare expenditures, it is essential to compare the costs of medical care for gynecological cancer patients against the economic losses attributable to female mortality.

The authors declare no conflict of interest in the submitted article.

References

1. Zlokachestvennye novoobrazovaniya v Rossii v 2021 godu (zabolevaemost' i smertnost') [Malignant neoplasms in Russia in 2021 (morbidity and mortality)].
2. Ed. By Kaprin A.D., Starinsky V.V., Shakhzadova A.O. Moscow: P.A. Herzen Moscow State Medical Research Institute — branch of the FSBI SMRC of Radiology» of the Ministry of Health of Russia, 2022 (In Russ.).]
3. Zhuikova L.D., Ananina O.A., Sirotina A.S., et al. Ocenka poteryannyh let zhizni (DALY) i ekonomicheskij ushcherb ot prezhdevremennoj smertnosti po prichine zlokachestvennyh novoobrazovanij shejki matki, tela matki i yaichnikov naseleniya Tomskoj oblasti [Disability-Adjusted Life Year (DALY) assessment and economic damage from premature death of cervical uterine and ovarian cancers in the Tomsk Region]. Sovremennaya Onkologiya [Journal of Modern Oncology. 2022; 24 (4): 494–498 (In Russ.).] doi: 10.26442/18151434.2022.4.201709.
4. Zhuikova L.D., Chojnzonov E.L., Ananina O.A., et al. Kartograficheskij analiz zabolevaemosti zlokachestvennymi novoobrazova¬niyami naseleniya regiona Sibiri i Dal'nego Vostoka v 1993−2022 gg. [Cartographic analysis of malignant neoplasms incidence in the population of the Siberia and the Russian]. Voprosy onkologii [Problems in Oncology. 2024; 70 (3): 481-492 (In Russ.).] https://doi.org/10.37469/0507-3758-2024-70-3-481-492
5. Ilyasova A.R. Osnovy ekonomiki zdravoohraneniya: uchebnoe posobie [Fundamentals of Healthcare Economics: Textbook. Kazan: Kazan University Publishing House, 2019 (In Russ.).]
6. Kobyakova O.S., Deev I.A., Kulikov E.S., et al. Primenenie indeksa DALY dlya ocenki sostoyaniya zdorov'ya naseleniya: monografiya [Application of the DALY index to assess the health status of the population. Tomsk: Publishing house of the Siberian State Medical University, 2020. 100 p. (In Russ.).]
7. Ananina O.A., Zhuykova L.D., Luneva E.E. et al. Svidetel'stvo o gosudarstvennoj registracii programmy EVM № 2022664458 "ONCO DALY" ot 29 iyulya 2022 g. [Certificate of state registration of the computer program № 2022664458 "ONCO DALY" dated July 29, 2022 (In Russ.).] URL: https://www.elibrary.ru/download/elibrary_49322445_95157449.PDF.

8. Bencina G., Chami N., Hughes R., et al. Breast cancer-related mortality in Central and Eastern Europe: years of life lost and productivity costs. Journal of Medical Economics 2023; 26 (1): 254–261. https://doi.org/10.1080/13696998.2023.2169497.

9. Chen S., Cao Zh., Prettner K., et al. Estimates and Projections of the Global Economic Cost of 29 Cancers in 204 Countries and Territories From 2020 to 2050. JAMA Oncol. 2023; 9 (4): 465-472. https://doi.org/10.1001/jamaoncol.2022.7826

10. Global cancer statistics 2020: Globocan estimates of incidence and mortality worldwide for 36 cancers in 185 countries. Accessed January 15, 2025. https://gco.iarc.fr/.

11. Global health estimates: Leading causes of DALYs. Accessed January 15, 2025. https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/global-health-estimates-leading-causes-of-dalys

12. Institute for Health Metrics and Evaluation. Accessed January 31, 2025. https://vizhub.healthdata.org/gbd-results/

13. Joinpoint Trend Analysis Software. Accessed January 15, 2025. https://surveillance.cancer.gov/joinpoint/

14. United Nations (2024). World Population Prospects 2024: Summary of Results. New York: United Nations. Accessed January 14, 2025. https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/files/documents/2024/Jul/wpp2024_summary_of_results_final_web.pdf

15. WHO methods and data sources for global burden of disease estimates 2000-2021 (Global Health Estimates Technical Paper WHO/ DDI/DNA/GHE/2024.3). Accessed January 15, 2025. https://cdn.who.int/media/docs/default-source/gho-documents/global-health-estimates/ghe2021_daly_methods.pdf?sfvrsn=690b16c3_1

ARCTIC MEDICINE

T.B. Gretskaya, F.A. Bichkaeva, O.S. Vlasova, A.V. Strelkova, E.V. Nesterova, B.A. Shengof, V.A. Zhenikhov

DOI 10.25789/YMJ.2025.90.21

UDC [612.015.32:577.175.7:612.018.2] (98)

LEVELS OF GLUCOSE AND ITS METABOLITES, PANCREATIC HORMONES, AND ADIPONECTIN IN THE ARCTIC POPULATION

The search for the causes underlying changes in carbohydrate metabolism remains relevant due to the lifestyle of the Arctic population and its changes in the indigenous population, which leads to a change in the "northern" hormonal and metabolic profile and the development of metabolically related diseases, including diabetes mellitus. The aim of the study was to identify the characteristics of carbohydrate metabolism, pancreatic hormones, and adiponectin in an almost healthy Arctic population, depending on their ethnicity and lifestyle. Materials and methods. A cross-sectional study of the population of the local Caucasian population and the aborigines of the Arctic (Nenets) aged 18 to 74 years was conducted. The levels of proinsulin, insulin, and adiponectin in blood serum were studied by enzyme immunoassay, and glucose, lactate, and pyruvate were studied by spectrophotometric analysis. The HOMA, Caro, lactate/pyruvate, and Proinsulin/Insulin indices were calculated. Results and discussion. The analysis of glucose levels showed that a statistically significantly high glucose content was found in the local Caucasian population relative to nomadic and sedentary aborigines. At the same time, 21.9% of nomadic aborigines, 17.8% of settled Aborigines and 28.9% of the local Caucasian population had excess glucose levels and 7.1%, 8.8% and 10.0% had prediabetic blood levels. Lactate levels, lactate/pyruvate values, and insulin in the groups were highest in sedentary Aborigines ($p=0.001$, $p<0.001$, $p=0.046$), while in nomadic aborigines and the local Caucasian population, insulin levels were minimal ($p=0.046$), and proinsulin levels and proinsulin/insulin values ($p<0.001$), on the contrary, is higher in the absence of significant differences in the level of pyruvate. A significantly low content of adiponectin was observed in sedentary aborigines, both relatively nomadic and the local Caucasian population ($p<0.001$). Conclusion. The lowest levels of glucose and insulin found in nomads against the background of increased proinsulin and adiponectin may indicate a decrease in the secretory activity of pancreatic beta cells and an improvement in insulin resistance; in sedentary aborigines, the predominance of anaerobic processes over aerobic ones is associated with a restriction of proinsulin production and is associated with an increase in insulin resistance with low levels of adiponectin, while in the local Caucasian population, insulin levels increase slightly while maintaining a higher level, which leads to an increased load on beta cells of the pancreas, causing an increase in adiponectin synthesis.

Key words: glucose, lactate, pyruvate, insulin, proinsulin, insulin resistance, adiponectin, Arctic population.

For citation: T.B. Gretskaya, F.A. Bichkaeva, O.S. Vlasova, A.V. Strelkova, E.V. Nesterova, B.A. Shengof, V.A. Zhenikhov. Levels of glucose and its metabolites, pancreatic hormones and adiponectin in the Arctic population. Yakut Medical Journal. 2025; 90(2): 84-87. https://doi.org/10.25789/YMJ.2025.90.21

N. Laverov Federal Center for Integrated Arctic Research of the Ural Branch of the Russian Academy of Sciences: **GRETSKAYA Tatyana B.** – Cand. Sc. (Biology), researcher, tatyana-rab@yandex.ru, https://orcid.org/0000-0002-8513-1848; **BICHKAEVA Fatima A.** – Doctor in Biology, chief researcher, fatima@fciarctic.ru, https://orcid.org/0000-0003-0727-3071; **VLASOVA Olga S.** – Cand. Sc. (Biology), chief researcher, olgawlassova@mail.ru, https://orcid.org/ 0000-0002-6956-6905; **STRELKOVA Alexandra V.** – PhD, al.strelkova@yandex.ru, https://orcid.org/ 0000-0002-9077-889X; **NESTEROVA Ekaterina V.** – researcher, ekaterina29reg@mail.ru, https://orcid.org/ 0000-0001-8467-2514; **SHENGOF Boris A.** – researcher, b-shengof@yandex.ru, https://orcid.org/ 0000-0002-3776-1474; **ZHENIKHOV Vlad A.** – Senior Lab Assistant, vlad.zhenixov1@mail.ru, 89502545271, https://orcid.org/0009-0008-6527-3903

Introduction. Trends in the spread of diabetes mellitus 2 (DM 2) persist among the indigenous population of the Arctic (about 20% of cases) [3]. In this regard, it is of interest to evaluate the metabolic mechanisms underlying its development in the practically healthy population of the Arctic. At the same time, such rearrangements occur in different directions for each indicator and lead to the formation of a specific "northern" hormonal and metabolic profile of the body, characterized by minimizing the carbohydrate component of metabolism against the background of intensification of lipid (L.E. concept Panina, 1978), resulting in a completely different structure of metabolic relationships [6]. Perhaps one of the reasons for the decrease in glycemia among the indigenous inhabitants of the Arctic of the last century may be the type, intake regime and amount of