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Original article

Assessment of the Impact of Oil Production Processes on the Health of the Population of Oil-Producing Areas of the Irkutsk Region

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Abstract

Introduction. The state of the population health depends on the ecological and hygienic well-being of the territory. In places with developed oil production, there is a long-term impact of pollutants on the human body and, as a result, corresponding diseases develop. This is evidenced by numerous domestic and foreign studies, but the territory of the Irkutsk region is not covered by such studies. Therefore, the work objective is to assess the impact of oil production processes on the incidence of the population of oil-producing regions of the Irkutsk region.

Materials and Methods. The source materials were the statistical indicators of overall and primary disease incidence of the population of the regions of the Irkutsk region for the period from 2016 to 2019, posted on the website of medical statistics of the Irkutsk region. For the calculation of the non-carcinogenic risk, we have used environmental monitoring data from an oil-producing company based on average daily concentrations of pollutants in oil-producing areas.

Results. It is shown that oil-producing areas are characterized by extremely high incidence rates for such groups of diseases as respiratory diseases, diseases of the circulatory system, diseases of the musculoskeletal system, diseases of the digestive system, diseases of the genitourinary system, as well as deviations in pregnancy, childbirth and the postpartum period. Infant mortality rates in these territories are up to 4 times higher than the corresponding average indicators for the Irkutsk region as a whole. The calculation of non-carcinogenic risk showed an excess over the permissible values accepted in Russia.

Discussion and Conclusions. The results of the analysis testify to the unfavorable medical and demographic situation in the territories under discussion. The pronounced excess of the incidence rate for the presented groups of diseases in the oilfield areas in comparison with the territories taken for comparison reflects the possible impact of environmental pollution on the health of the population. A connection between the growth of infant mortality in the territories under consideration and the beginning of the industrial development of hydrocarbon deposits in these places has been revealed. The contribution of oil companies to the socio-economic development of the regions, including co-financing of medical care for the population, could partially offset the negative impact of industrial processes.

Keywords: oil production, public health, overall and primary disease incidence, non-carcinogenic risk.

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Научная статья

Оценка влияния процессов нефтедобычи на здоровье населения нефтедобывающих районов Иркутской области

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Аннотация

Введение. Состояние здоровья населения зависит от эколого-гигиенического благополучия территории. В местах с развитой нефтедобычей происходит длительное воздействие загрязняющих веществ на организм человека, что в итоге влечет за собой возникновение различных заболеваний. Об этом свидетельствуют отечественные и зарубежные исследования. На территории Иркутской области такие исследования не проводились. Поэтому целью данной работы являлась оценка влияния процессов нефтедобычи на заболеваемость населения нефтедобывающих районов Иркутской области.

Материалы и методы. Исходными материалами послужили статистические показатели общей и первичной заболеваемости населения Иркутской области за период с 2016 по 2019 годы, размещенные на сайте медицинской статистики. В расчете неканцерогенного риска использовали данные экологического мониторинга нефтедобывающей компании по среднесуточным концентрациям загрязняющих веществ в районах нефтедобычи.

Результаты исследования. Показано, что районы нефтедобычи отличаются крайне высокими показателями заболеваемости со стороны систем органов дыхания, кровообращения, пищеварения, мочевыделения, костно-мышечной системы, а также по патологиях внутриутробного развития плода, при родах и в послеродовом периоде. Показатели младенческой смертности на данных территориях почти в четыре раза превышают соответствующие средние показатели по Иркутской области. Расчет неканцерогенного риска также показал превышение над принятыми в России допустимыми значениями.

Обсуждение и заключения. Результаты проведенного анализа свидетельствуют о неблагоприятной медико-демографической ситуации на обсуждаемых территориях. Выраженное превышение заболеваемости по представленным группам болезней в районах нефтепромысла, по сравнению с территориями, взятыми для сравнения, отражает возможное влияние загрязненности окружающей среды на здоровье населения. Показана связь роста младенческой смертности с началом промышленного освоения углеводородных месторождений этих мест. Вклад нефтедобывающих компаний в социально-экономическое развитие регионов, включая софинансирование медицинской помощи населению, могло бы частично компенсировать негативное влияние промышленных процессов.

Ключевые слова: нефтедобыча, здоровье населения, общая и первичная заболеваемость, неканцерогенный риск.

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Introduction. The problem of oil production impact on the health of the population is discussed at different levels. A number of studies show the negative environmental impact of oil production, affecting the health of the population [1–6].

As noted in [1], over 4 billion tons of crude oil is produced annually in the world. At each stage (extraction, storage, transportation), the environment is polluted with about 50 million tons of oil and petroleum products. Each process (exploration, drilling, production, gathering, storage, transportation of oil), under appropriate conditions, makes a change in the initial ecological state of the oil-producing area. It is believed, that the greatest environmental pollution occurs during accidental releases and spills [7, 8]. However, the problem is that the issue of using associated petroleum gas remains unresolved. The combustion products of associated petroleum gas are intensively released into the

environment: soot, benz(a)pyrene, ammonia, nitrogen oxides, sulfur dioxide, aromatic hydrocarbons, dioxins, unburned oil. Pollutants enhance their toxic effect with simultaneous action.

Health condition of the population in most cases depends on the ecological and hygienic well-being of the territory. In territories with developed oil production, long-term exposure of the human body to harmful substances occurs and, as a result, corresponding diseases develop, pathologies appear, the risk of childhood morbidity, birth defects, miscarriages, stillbirths, oncological diseases and diseases of the endocrine, pulmonary, and cardiovascular systems increases [9–14].

The work objective is to assess the impact of oil production on the incidence of the population of oil-producing areas of the Irkutsk region. The presented work is a continuation of the authors' research in this field [15].

Materials and Methods. The source materials were statistical indicators of the overall and primary disease incidence of the population of the districts of the Irkutsk region (Katangsky, Kirensky and Ust-Kutsky districts) for the period from 2016 to 2019, posted on the website of medical statistics[1]. For comparison, similar indicators of the Kazachinsko-Lensky district of the Irkutsk region and the Irkutsk region as a whole were used as background indicators. In non-carcinogenic risk calculation, we turned to the environmental monitoring data of the oil company on the average daily concentrations of pollutants in the oil-producing areas[2].

Results. The Irkutsk region is rich in minerals: coal, iron ore, rock and potash salts, hydromineral raw materials, gold, ore raw materials, as well as significant raw hydrocarbon deposits (estimated recoverable oil resources — 2050 million tons[3]).

Hydrocarbon production is in the north of the Irkutsk region — these are the Katangsky, Kirensky and Ust-Kutsky districts. The Verkhnechonskoye oil and gas condensate field is located in the Katangsky district of the Irkutsk region, in the upper reaches of the Chona River, 1100 km from the city of Irkutsk and 420 km from Ust-Kut, is one of the largest deposits in Eastern Siberia[4]. The main fields of the Ust-Kutsky and Kirensky districts are the Yaraktinskoye oil and gas condensate field (OGCF), located 140 kilometers from the city of Ust-Kut[5]; Markovskoye OGCF is named after the nearby village of Markovo, 100 km from Ust-Kut and 60 km from the city of Kirensk; the Ichedinsky oil field occupies the territory of the Kirensky district; the Ayansky licensed subsoil plot is located on the territory of the Ust-Kutsky, Kirensky and Katangsky districts, 40 km from Kirensk[6].

Figure 1 provides population dynamics indicators of the three districts under consideration and demonstrates the situation of demographic decline of the population for the period from 2012 to 2022[7].

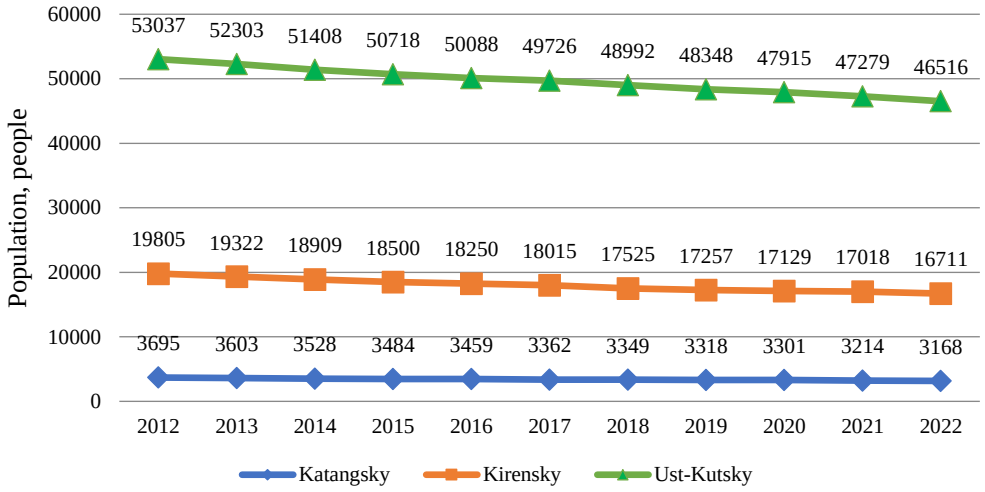

Fig. 1. Population dynamics of the Katangsky, Kirensky and Ust-Kutsky districts of the Irkutsk region

[1] *Medical statistics*. Ministry of Health of the Irkutsk Region. URL: https://miac-io.ru/uslugi-resheniya/meditsinskaya-statistika/ (accessed 25.01.2023). (In Russ.).

[2] *Arkhiv dokumentov dlya uchastiya v reitinge ekologicheskoi otvetstvennosti neftegazovykh kompanii*. URL: https://irkutskoil.ru/sustainable-development/environmental-protection/arkhiv-dokumentov-dlya-uchastiya-v-reytinge/ (accessed 25.01.2023). (In Russ.).

[3] *Otsenka izvlekaemykh resursov nefti*. Ministry of Natural Resources. Irkutsk region. URL: https://www.mnr.gov.ru/activity/regions/irkutskaya_oblast/ (accessed 25.01.2023). (In Russ.).

[4] *Istoriya*. Rosneft. URL: https://vcng.rosneft.ru/about/Glance/OperationalStructure/Dobicha_i_razrabotka/Vostochnaja_Sibir/vcng/ (accessed 25.01.2023). (In Russ.).

[5] *Yarakstinskoe*. Edinyi fond geologicheskoi informatsii o nedrakh. URL: https://efgi.ru/object/17579691?num=1 (accessed 25.01.2023). (In Russ.).

[6] *Glavgosekspertiza odobrila proekt INK po stroitel'stvu neftegazoprovoda na Ichedinskom*. URL: https://irkutskoil.ru/press-center/glavgosekspertiza-odobrila-proekt-ink-po-stroitelstvu-neftegazoprovoda-na-ichedinskom-mestorozhdenii/ (accessed 25.01.2023). (In Russ.).

[7] *Chislennost' postoyannogo naseleniya*. Official website of the Irkutsk region for municipalities. URL: https://irkutskstat.gks.ru/ (accessed 25.01.2023) (In Russ.).

The health of the population is determined by lifestyle and socio-economic, hereditary and genetic factors, the quality of the environment and medical care [16].

To assess the health of the population of the oil-producing areas of the Irkutsk region, the incidence indicators (overall and primary) of the Katangsky, Kirensky, Ust-Kutsky districts were compared with an area close in climate, but without oil-producing facilities the — the Kazachinsko-Lensky district and the indicators of the Irkutsk region as a whole. The Kazachinsko-Lensky district is bordered in the north by the Kirensky district, in the west by the Ust-Kutsky district and the Zhigalovsky district, and in the south by the Kachugsky district. 85 % of the territory of the Kazachinsko-Lensky district is occupied by forest area, which determines the main activities of the population (logging, sawmilling, wood processing).

Initially, groups of diseases with the greatest prevalence in the studied oil-producing areas were identified for the study. To do this, we have studied the indicators of available statistics on overall incidence for the period from 2016 to 2019. Respiratory diseases turned out to be one of the most common types. The highest excess was recorded in the Katangsky district of the overall incidence indicator for this type over the corresponding indicator of the Kazachinsko-Lensky district and the Irkutsk region as a whole. In some cases, the indicators were exceeded several times, for example, in 2016 — almost 5 times, compared with the indicators in the Kazachinsko-Lensky district, and 2.4 times, compared with the indicators of the Irkutsk region as a whole.

Diseases of the circulatory system were in the second place in terms of prevalence. According to them, the overall incidence of the population in 2018 exceeded 2.1–2.4 times in the Katangsky and Ust-Kutsky districts, respectively, the indicators of the Kazachinsko-Lensky district and 1.3 times the indicators for the Irkutsk region as a whole. This is followed by diseases of the musculoskeletal system and digestive organs. The indicators for diseases occurring in the perinatal period and the number of congenital anomalies were also high in importance.

The diagram (Fig. 2) shows the average (for the period under review) indicators of overall incidence in the oil-producing areas of the Irkutsk region and in the districts taken for comparison.

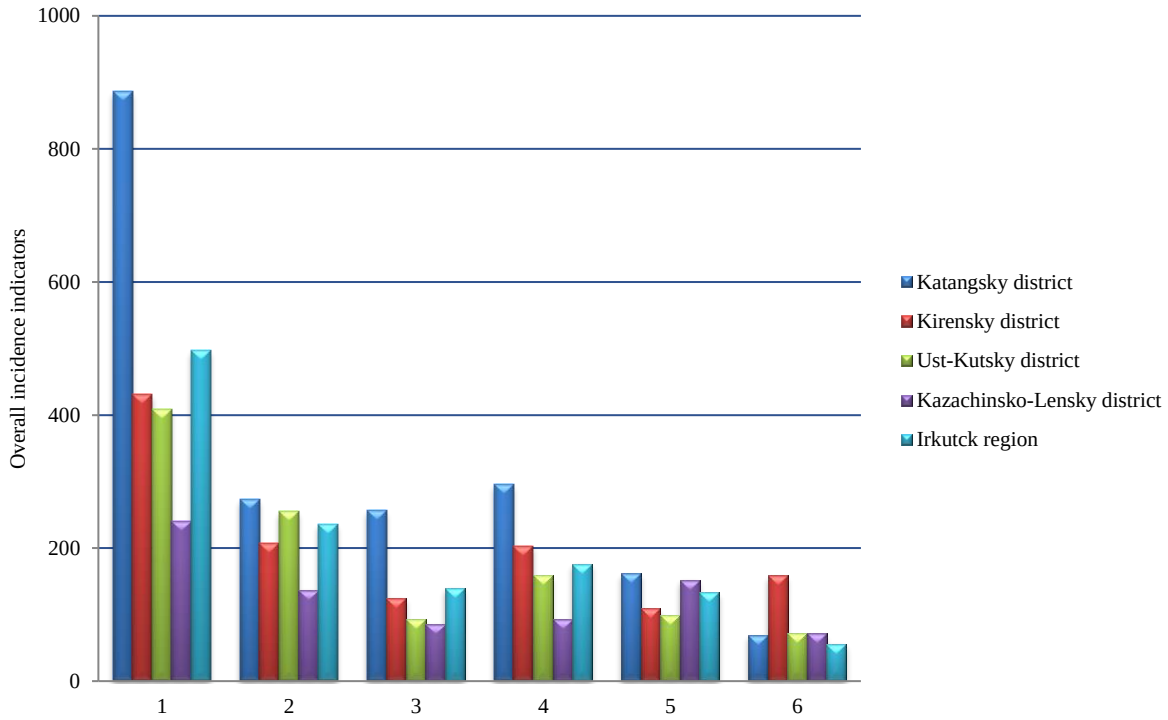

Fig. 2. Average indicators of the overall incidence of the population of the oil-producing areas of the Irkutsk region in comparison with the Kazachinsko-Lensky district and the Irkutsk region as a whole. The following categories of diseases are presented: 1 — respiratory organs; 2 — circulatory system; 3 — digestive organs; 4 — musculoskeletal system; 5 — genitourinary system; 6 — pathology during pregnancy, childbirth and in the postpartum period

From a hygienic point of view, the impact of environmental factors on the residents of the studied areas is manifested mainly in the overall incidence indicator, since the appearance of new cases of diseases is associated with the intensity of exposure to pollutants contained in the habitat of the population.

The comparison of the indicators of overall and primary disease incidence of the population in the selected territories (Fig. 3) indicates a pronounced excess of incidence in the presented groups of diseases in the oilfield areas,

compared to the territories taken for comparison, which is a reflection of the possible impact of environmental pollution on public health.

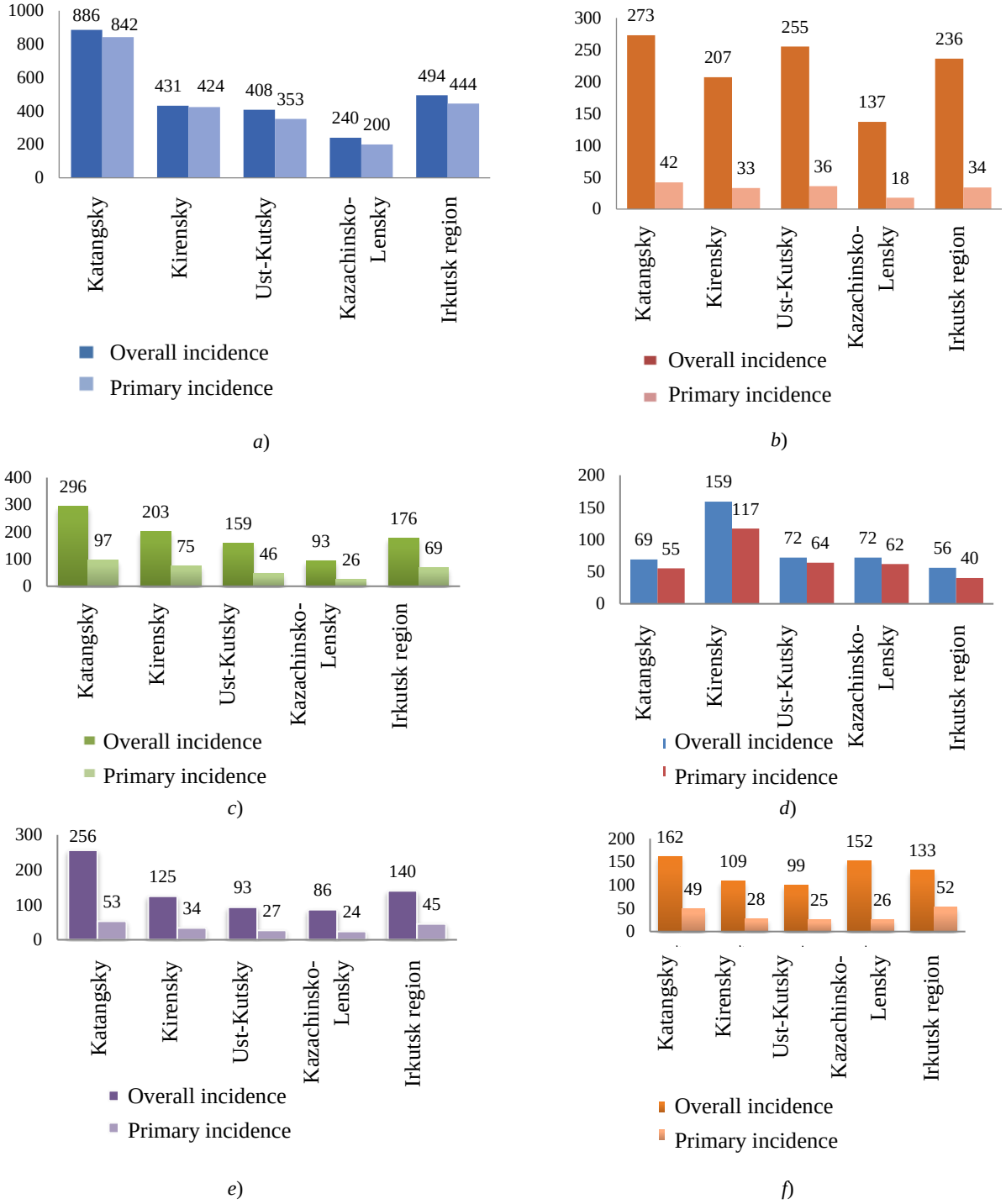

Fig. 3. Comparison of overall and primary disease incidence indicators of the population in municipalities for the following diseases:
a — respiratory organs; *b* — circulatory system; *c* — musculoskeletal system;
d — pathologies during pregnancy, childbirth and the postpartum period;
e — digestive system; *f* — genitourinary system

It is known that infants are extremely sensitive to the quality of the environment [17]. Diseases caused by environmental changes are quite common in infancy. In this regard, the dynamics of infant mortality (the number of dead children under one year per 1000 live births) in the districts of the Irkutsk region was considered. Figure 4 shows the corresponding data[8] for the period from 2001 to 2019.

[8] *Demografiya*. Irkutskstat. URL: https://irkutskstat.gks.ru/ (accessed 25.12.2022). (In Russ.).

According to the presented diagram (Fig. 4), the infant mortality rate in all areas of the oil field exceeds the level of the Irkutsk region as a whole. It should be noted that the indicators of the Ust-Ilimsky, Ziminsky, Bratsky, Bodaybinsky districts, which are also industrial districts of the Irkutsk region, also lie above the line of the Irkutsk region, but their indicators are several times lower than those of the Katangsky district (exceeding the indicators of the Irkutsk region up to 4 times in the period under review). The values of infant mortality indicators of the Kirensky district had been growing since 2011 and by 2013 they were close to the corresponding indicators of the Katangsky district. The diagram also shows the excess of infant mortality rates of the Ust-Kutsky district over the corresponding indicators of the Irkutsk region from 2006 to 2018. In the opinion of the authors, there is an obvious connection between the increase in infant mortality with the beginning of industrial development of hydrocarbon deposits in these areas (Ust-Kutsky — 2003, Katangsky — 2006, Kirensky — 2012).

During the experiment, an assessment of the non-carcinogenic risk to public health in the oil-producing areas of the Irkutsk region was carried out, using the Guidelines[9] and the environmental monitoring results of the oil company in 2018 and 2019 in the territories of the Danilovsky OGCF, Yaraktinsky, Markovsky and Ayan fields as initial data[10].

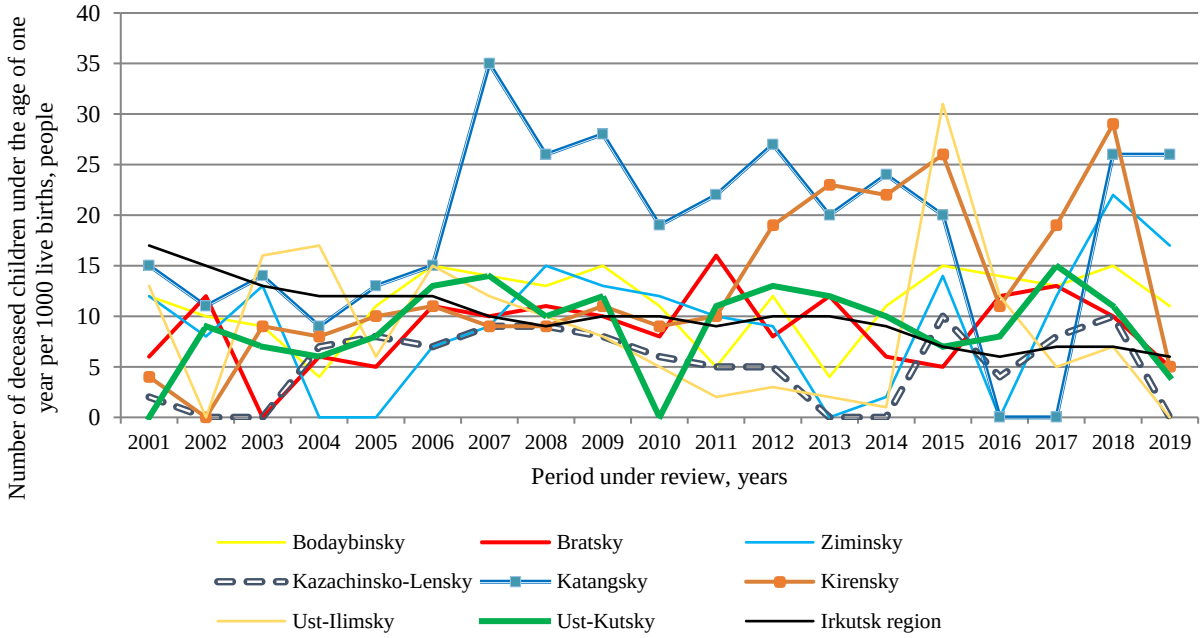

Fig. 4. Dynamics of infant mortality rates in the administrative districts of the Irkutsk region from 2001 to 2019

It should be noted that during the assessment, the average daily concentrations of pollutants averaged over the corresponding year were considered. The risk was calculated based on the fact that pollutants have a long-term effect, therefore, in accordance with the Guidelines, the largest concentration value out of two available ones was used. In accordance with the methodology, it was accepted that the daily air consumption by a person is 20 m^3/day, the average body weight of a person is 70 kg, the life time of a person is 70 years. Table 1 presents the calculation results of the probability of the development of non-carcinogenic effects on the health of the population living in the studied territories.

[9] R 2.1.10.1920-04. *Rukovodstvo po otsenke riska dlya zdorov'ya naseleniya pri vozdeistvii khimicheskikh veshchestv, zagryaznyayushchikh okruzhayushchuyu sredu.* Federal Center of State Sanitary and Epidemiological Supervision of the Ministry of Health of the Russian Federation; 2004. 143 p. (In Russ.).

[10] *Arkhiv*. INK. URL: https://irkutskoil.ru/sustainable-development/environmental-protection/arkhiv-dokumentov-dlya-uchastiya-v-reytinge/ (In Russ.).

Table 1

Assessment results of non-carcinogenic risk to the health of the population of the Katangsky, Kirensky and Ust-Kutsky districts from atmospheric air pollution during oil production

District	Polluting substance			Non-carcinogenic risk assessment				
	Substance	MPC_{cc} (mg/m^3)	Hazard class	RFC*	RfD, (mg/kg·day)	C, (mg/m)	ADD, (mg/kg·day)	INR
Katangsky	NO_2	0.1	3	0.06	0.006	0.01	0.003	0.48
	SO_2	0.05	3	0.05	0.0025	0.05	0.015	6
	H_2S	0.008	2	0.002	0.000016	0.0012	0.00006	0.38
	Saturated hydrocarbons	50	4	0.071	20	2.1	0.63	0.03
	Suspended substances	0.035	–	0.075	0.003	0.23	0.0006	2
	Methanol	0.5	3	4	2	5.5	1.595	0.80
Total 9.69								
Kirensky	NO_2	0.1	3	0.06	0.006	0.009	0.0026	0.43
	SO_2	0.05	3	0.05	0.0025	0.06	0.00174	6.96
	H_2S	0.008	2	0.002	0.000016	0.001	0.00003	1.88
	Saturated hydrocarbons	50	4	0.4	20	2.2	0.638	0.034
	Suspended substances	0.035	–	0.075	0.003	0.54	0.00157	0.52
	Methanol	0.5	3	4	2	3.7	1.1	0.55
Total 10.37								
Ust-Kutsky	NO_2	0.1	3	0.06	0.006	0.007	0.0021	0.35
	SO_2	0.05	3	0.05	0.0025	0.03	0.00017	3.5
	H_2S	0.008	2	0.002	0.000016	0.0002	0.0000058	3.75
	Saturated hydrocarbons	50	4	0.4	20	11	3.2	0.16
	Suspended substances	0.035	–	0.075	0.003	0.51	0.0015	5
	Methanol	0.5	3	4	2	11	2	1
Total 13.76								

* ADD — the average daily dose of the pollutant absorption (mg/kg × day); C — the average concentration of the pollutant in the air (mg/m^3); RfD — the reference dose of MPC (mg/m^3); RFC — reference concentrations for chronic inhalation exposure.

Values of individual non-carcinogenic risk exceeding one, in accordance with the method used, mean the presence of a risk of harm to health with daily inhalation of polluted air. The greatest impact on health is the content of sulfur dioxide, suspended solids, methanol and hydrogen sulfide in the air. A comparative analysis of risks with established incidence indicators in these areas demonstrates the relationship between the content of priority pollutants in the atmospheric air and the incidence pattern of the population in the form of a significant indicator of diseases of the respiratory, circulatory and musculoskeletal systems.

The Irkutsk region is one of the ten most polluted regions of the country. It is believed that the industrial centers — Angarsk, Bratsk, Shelekhov, Zima, Irkutsk — have the greatest negative impact. However, the active development of oil fields in recent years has also begun to have a significant impact, which could not but affect the health of the population of nearby territories.

Discussion and Conclusion. The unfavorable medical and demographic situation in the territories under discussion is shown. The Katangsky district ranks first among all the considered districts and the region as a whole in terms of diseases of the respiratory system, circulatory system, musculoskeletal system, digestive organs, genitourinary system, as well as deviations during pregnancy, childbirth and the postpartum period. The Kirensky district is characterized by extremely high overall and primary indicators of deviations during pregnancy, childbirth and in the postpartum period. In this area, the indicators are exceeded by more than 2 times, compared with the rest of the territories considered. In the Ust-Kutsky district, the indicators of overall and primary incidence of the circulatory system and respiratory diseases exceed the indicators of the territories taken for comparison. There are examples in Russia when the negative impact of industrial production on the health of the population is compensated by the high level of socio-economic development of the region [18]. Perhaps such a solution to the problem would be a solution in these territories if oil-producing companies took part of the costs of financing healthcare, including the costs of attracting highly qualified medical personnel, as well as improving other socio-economic indicators of the production regions themselves.

References

1. Elinskiy VI, Akhmedov RM, Ivanova YuA. The problem of environmental pollution in oil production: topical issue. *Vestnik of Moscow University of the Ministry of Internal Affairs of Russia*. 2020;7:118–122. https://doi.org/10.24411/2073-0454-2020-10397 (In Russ.).

2. Krasnoperova SA. The problem of the utilization of associated petroleum gas on the example of an oil field in the Udmurt republic. *Management of the Technosphere*. 2021;4(1):63–74 https://doi.org/10.34828/UdSU.2021.65.70.007 (In Russ.).

3. Suleymanov RA, Baktybaeva ZB, Valeev TK. Environmental and hygienic environmental characteristics and public health on the territories of crude oil production and transportation. *Ulyanovsk Medico-biological Journal*. 2018;4:124–142 https://doi.org/10.23648/UMBJ.2018.32.22703 (In Russ.).

4. Onyije FM, Hosseini B, Togawa K, et al. Cancer Incidence and Mortality among Petroleum Industry Workers and Residents Living in Oil Producing Communities: A Systematic Review and Meta-Analysis. *Int. J. Environ. Res. Public Health*. 2021;18(8):4343. https://doi.org/10.3390/ijerph18084343

5. Schnatter AR., Chen M, DeVilbiss EA, et al. Systematic Review and Meta-Analysis of Selected Cancers in Petroleum Refinery Workers. *Journal of Occupational and Environmental Medicine*. 2018;60:e329–e342. 10.1097/JOM.0000000000001336

6. Boonhat H, Lin R-T. Association between leukemia incidence and mortality and residential petrochemical exposure: A systematic review and meta-analysis. *Environment International*. 2020;145:106090. https://doi.org/10.1016/j.envint.2020.106090

7. Rustamov ZA, Bryukhova KS. The problem of associated oil gas utilization, analysis and current status. *PNRPU Aerospace Engineering Bulletin*. 2019;58:102–109 https://doi.org/10.15593/2224-9982/2019.58.08 (In Russ.).

8. Orujov RA, Jafarova RA. The peculiarities of the toxic effect of petroleum hydrocarbons on the human organism. *Vestnik Vitebskogo Gosudarstvennogo Meditsinskogo Universiteta*. 2017;16(4):8–5 https://doi.org/10.22263/2312-4156.2017.4.8 (In Russ.).

9. Lin CK, Hung HY, Christiani DC, et al. Lung cancer mortality of residents living near petrochemical industrial complexes: a meta-analysis. *Environmental Health*. 2017;16:101. https://doi.org/10.1186/s12940-017-0309-2

10. Lelieveld J, Pozzer A, Pöschl U, et al. Loss of life expectancy from air pollution compared to other risk factors: a worldwide perspective. *Cardiovascular Research*. 2020;1;116(11):1910–1917. https://doi.org/10.1093/cvr/cvaa025

11. Anwar M, Ridpath A, Berner J, et al. Medical Toxicology and Public Health-Update on Research and Activities at the Centers for Disease Control and Prevention and the Agency for Toxic Substances and Disease Registry:

Environmental Exposures among Arctic Populations: The Maternal Organics Monitoring Study in Alaska. *Journal of Medical Toxicology*. 2016;12(3):315–317. https://doi.org/10.1007/s13181-016-0562-8

12. Isaakova EA. Features of influence of oil and oil products on soil biota. *Colloquium-journal*. 2019;12-1(36):4–6. https://doi.org/10.24411/2520-6990-2019-10325 (In Russ.).

13. Ejike CE, Eferibe CO, Okonkwo FO. Concentrations of some heavy metals in underground water samples from a Nigerian crude oil producing community. *Environmental Science and Pollution Research*. 2017;24(9):8436–8442. https://doi.org/10.1007/s11356-017-8524-5

14. San Sebastián M, Armstrong B, Stephens C. Outcomes of pregnancy among women living in the proximity of oil fields in the Amazon basin of Ecuador. *Int J Occup Environ Health*. 2002;8(4):312–9. https://doi.org/10.1179/107735202800338650

15. Khamidullina EA, Nayanov PA. Impact of the oil and gas production process on the environment and human health. *IOP Conference Series Earth and Environmental Science*. 2022;979(1):012168. https://doi.org/10.1088/1755-1315/979/1/012168

16. Bocharov SS, Vasileva EA. Ecological factors and health of preschool children. *University Science*. 2020;2(10):186–189. (In Russ.).

17. Artemeva AA, Malkova IL. Analiz kharaktera vliianiia neftedobychi na zdorove naseleniia Udmurtii. *Bulletin of Udmurt University. Series Biology. Earth Sciences*. 2006;11:3–14. (In Russ.).

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