**INVESTIGATION OF MALIGNANT NEOPLASMS MORBIDITY OF THE OVARIES IN WOMEN DEPENDING ON ENVIRONMENTAL CONDITIONS OF RESIDENCE**

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We used the data of official state statistics for 2000–2020 to test the hypothesis about the effect of environmental conditions – radioactive (following the Chernobyl disaster) and chemical pollutants on the incidence of ovarian malignant neoplasms in the female population of the Bryansk region. A variety of statistical approaches were used to estimate the incidence of ovarian malignancies, including the Shapiro-Wilk test, Mann-Whitney U-test, Spearman's rank correlation test, and linear regression. We did not establish statistically significant differences in the frequency of primary morbidity of women with malignant neoplasms of the ovaries, regardless of the environmental conditions of residence. Our forecast of the frequency of newly diagnosed malignant neoplasms of the ovaries on average in the Bryansk region shows an increase of 12.4% in 2020 in comparison with the real data for 2020, while the largest increase in predicted values ​​is recorded in the territories of radioactive contamination (by 79.6%), and the least –in the combined territories (by 6.9%).

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**Background**

According to the latest estimates of the International Agency for Research on Cancer and the World Health Organization GLOBOCAN 2020 [1], the incidence of malignant neoplasms in the world has increased to 19.3 million new cases and 10.0 million deaths from them in 2020. According to the Russian National Medical Research Center for Oncology named after N.N. Blokhin ovarian malignancies in the structure of oncological morbidity in Russia is second only to endometrial cancer and cervical cancer in frequency of occurrence [2].A number of studies reveal a significant relationship between the risk of malignant neoplasms of the female reproductive system with an increase in the level of technogenic radioactive [3-12] and chemical pollution [13-16] of the environment.

There are currently 316,000 people spread across 749 settlements living in radioactively contaminated areas of the Bryansk region *(Decree of the Government of the Russian Federation of 10.08.2015 No. 1074)* [17]. According to official data *(On the state and environmental protection of the Russian Federation in 2019)* [18], in recent years in the Bryansk region there has been an increase in the emission of air pollutants, mostly volatile organic compounds (VOCs) and nitrogen oxides (NOx), as well as solid household and industrial waste.

In this regard, the study of the health status of the female population living in ecologically unfavorable conditions is highly relevant. Therefore, we carried out a comparative assessment of the frequency of malignant neoplasms of the ovaries in the female population of the Bryansk region living in conditions of radioactive, chemical and combined contamination during 2000-2020.

**Methods**

We conducted an ecological and hygienic assessment of the state of the environment and the level of primary morbidity of the female population with malignant neoplasms of the ovaries in the Bryansk region, namely, in 4 cities and 27 districts in terms of radiation (as a result of the Chernobyl accident), chemical (due to atmospheric air pollution) and combined radiation and chemical contamination over a twenty-year period (2000-2019).

We have isolated the main pollutants that pollute the atmospheric air: carbon monoxide, sulfur dioxide, nitrogen oxides and volatile organic compounds – VOCs (including benz (a) pyrene, benzene, styrene, pyridine, vinyl chloride, formaldehyde, acrolein, and phenol).

The primary morbidity of the female population with malignant neoplasms of the ovaries in the Bryansk region was analyzed according to [19].

**Results**

As a result of the ecological and hygienic analysis of the condition of the environment in cities and districts of the Bryansk region over a twenty-year study period (2000-2019), we ranked the territories depending on the level of chemical pollution of the atmospheric air by the amount of gross emissions of gaseous pollutants (VOCs, SO2, CO and NOx) on the area of ​​the district, the density of radioactive contamination by137Cs and 90Sr due to the Chernobyl accident and the primary morbidity of women ovarian malignancies (Table 1).

As Table 1 indicates, the data on the density of radioactive contamination by 137Cs and 90Sr and the level of chemical pollution by leading gaseous pollutants vary within wide limits. For 137Cs – from 4.4 to 460.6 kBq/m2, for 90Sr – from 0.4 to 16.3 kBq/m2. In terms of gross emissions of gaseous pollutants into the air per area (g/m2) – from 12 to 32191, of which: for carbon monoxide – from 7 to 5217, nitrogen oxides – from 6 to 10886, sulfur dioxide – from 0 to 2617 and VOCs – from 0 to 13470.

It should be noted that 35 years after the Chernobyl accident, the average annual effective dose from the Chernobyl component in settlements in the group of ecologically safe areas and areas of chemical pollution does not exceed 0.3 mSv per year, while in the group of radioactive and combined contamination the maximum values reach 5.5 mSv per year [20].

We have identified 4 groups of territories of the Bryansk region according to the degree of ecological unfavorable of the environment (Table 1): 1) ecologically safe areas; 2) areas of chemical pollution; 3) areas of radioactive contamination; 4) areas of combined radiation and chemical contamination.

Correlation analysis of the primary incidence of ovarian malignant neoplasms in cities and districts of the Bryansk region with the level of radiation contamination and chemical pollution of the environment (Table 1) did not reveal significant links between the incidence of primary ovarian malignant neoplasms as with the level by137Cs contamination(ρ=-0.19, p=0.31) and 90Sr (ρ=0.02, p=0.92), as well as air pollution by VOCs (ρ=0,19, р=0,32), CO (ρ=0.09, p=0.61), NOx (ρ=0.22, p=0.23) and SO2 (ρ=0.27, p=0.14).

We revealed an increase in the long-term trend in the frequency of malignant neoplasms of the ovaries in ecologically safe areas and in areas of chemical pollution and radioactive contamination and a slight decrease in areas of combined contamination. However, a statistically significant increase was found only in the group of territories of chemical pollution (p=0.02) – Figure 1.

Our forecast of the frequency (based on 2000-2019 data) of newly diagnosed malignant ovarian neoplasms on average in all cities and districts of the Bryansk region shows an increase of 12.4% in 2020 in comparison with real data for 2020. The reason for this, in all probability, is a reorientation of the healthcare system in connection with the COVID-19 pandemic.

Table 1.

Correlation analysis of the primary morbidity of ovarian malignancies of the female population in cities and districts of the Bryansk region with the level of radiation and chemical contamination of the environment (2000-2019)

|  |  |  |  |
| --- | --- | --- | --- |
| Cities and districts of the Bryansk region | Main gaseous air pollutants | Contamination density, kBq/m2 | Primary morbidity of ovarian malignancies (per 100,000) |
| Total | Of them: |
| VOCs | NOx | SO2 | CO | 137Cs | 90Sr |
| Gross emissions of gaseous pollutants per area, g/m2 |
| **Ecologically safe areas (control)** |
| Rognedinsky | 12 | 0 | 6 | 0 | 7 | 21,7 | 0,8 | 25,8 |
| Suzemsky | 27 | 5 | 9 | 1 | 13 | 18,6 | 2,5 | 26,3 |
| Mglinsky | 31 | 6 | 6 | 2 | 17 | 6,6 | 0,6 | 17,5 |
| Kletnyansky | 47 | 27 | 5 | 5 | 10 | 5,4 | 0,5 | 21,6 |
| Navlinsky | 53 | 12 | 13 | 4 | 25 | 18,9 | 0,8 | 18,7 |
| Dubrovsky | 56 | 13 | 17 | 0,4 | 26 | 7,2 | 0,4 | 19,4 |
| Brasovsky | 64 | 10 | 19 | 6 | 29 | 25,2 | 0,4 | 20,0 |
| Sevsky | 68 | 20 | 10 | 24 | 14 | 18,9 | 1,4 | 19,4 |
| Komarichsky | 99 | 25 | 19 | 9 | 46 | 27,1 | 1,0 | 15,1 |
| Karachevsky | 115 | 29 | 34 | 1 | 51 | 13,9 | 0,8 | 25,6 |
| Surazhsky | 128 | 35 | 35 | 6 | 52 | 8,2 | 0,4 | 17,9 |
| **Areas of chemical pollution** |
| Pogarsky | 123 | 65 | 22 | 4 | 32 | 29,9 | 1,1 | 29,3 |
| Zhiryatinsky | 155 | 104 | 16 | 1 | 35 | 5,4 | 0,8 | 18,1 |
| Zhukovsky | 196 | 22 | 53 | 40 | 80 | 6,6 | 0,8 | 19,9 |
| Trubchevsky | 275 | 88 | 27 | 2 | 158 | 23,6 | 0,8 | 16,0 |
| Pochepsky | 364 | 223 | 33 | 3 | 106 | 5,4 | 0,5 | 19,5 |
| Unechsky | 559 | 292 | 58 | 32 | 177 | 7,2 | 0,8 | 24,1 |
| Vygonichsky | 857 | 749 | 37 | 2 | 70 | 9,5 | 0,4 | 12,7 |
| Bryansky | 959 | 813 | 47 | 13 | 86 | 5,7 | 0,4 | 23,8 |
| Town Seltso | 5208 | 773 | 2405 | 97 | 1934 | 4,4 | 0,8 | 23,4 |
| Dyatkovsky | 8045 | 339 | 3760 | 1139 | 2807 | 38,4 | 1,1 | 22,0 |
| City Bryansk | 32191 | 5217 | 10886 | 2617 | 13470 | 8,8 | 5,9 | 23,7 |
| **Areas of radioactive contamination** |
| Krasnogorsky | 16 | 1 | 5 | 0 | 9 | 303,4 | 9,3 | 18,8 |
| Gordeevsky | 29 | 2 | 11 | 0,2 | 15 | 328,6 | 5,0 | 11,0 |
| Zlynkovsky | 37 | 5 | 11 | 4 | 18 | 412,4 | 16,3 | 18,3 |
| Novozybkovsky | 51 | 10 | 0 | 0 | 41 | 460,6 | 8,4 | 14,6 |
| Klimovsky | 72 | 16 | 8 | 15 | 33 | 139,6 | 6,4 | 21,2 |
| Klintsovsky | 169 | 17 | 70 | 2 | 80 | 194,4 | 4,7 | 20,0 |
| **Areas of combined radiation-chemical contamination** |
| Starodubsky | 392 | 316 | 24 | 9 | 43 | 45,4 | 1,4 | 20,9 |
| City Klintsy | 7264 | 2059 | 2616 | 139 | 2450 | 195,6 | 3,0 | 17,4 |
| SityNovozybkov | 7422 | 1778 | 2159 | 406 | 3079 | 456,5 | 9,7 | 24,0 |
| Correlation coefficients *(ρ)* and levels of their statistical significance *(p)* |
| - | **ρ=0.17****р=0.37** | **ρ=0,19****р=0,32** | **ρ=0.22****р=0.23** | **ρ=0.27****р=0.14** | **ρ=0.09****р=0.61** | **ρ=-0.19****р=0.31** | **ρ=0.02****р=0.92** | - |

Besides the increase in predicted values ​​in comparison with real data is uneven. Thus, the greatest increase in newly diagnosed malignant neoplasms of the ovaries is recorded in areas of radioactive contamination – by 79.6% (28.2 forecast for 2020, 15.7 real values ​​for 2020), and a less pronounced increase was found in ecologically safe areas – by 18,8% (forecast 25.3, real result 21.3), in areas of chemical pollution – by 11.9% (30.2 versus 27.0), and combined contamination – by 6.9% (19.9 versus 18.6) – Figure 1.

Figure 1.Dynamics of the frequency of primary incidence of ovarian malignancies in chemically contaminated territories of the Bryansk region with the lines of a multi-year trend over three years in the period 2000-2019 and forecast for 2020 (in terms of 100,000).

**Conclusions**

1. We have not found statistically significant differences in the frequency of primary morbidity with malignant neoplasms of the ovaries in women, regardless of the environmental conditions of residence.

2. We have not found significant correlations between the frequency of primary morbidity of malignant neoplasms of the ovaries, both with the level of pollution by Cesium-137 and Strontium-90, and air pollution with volatile organic compounds, carbon monoxide, sulfur dioxide and nitrogen oxides.

3. We found a significant increase in the long-term trend in the frequency of malignant neoplasms of the ovaries in areas of chemical pollution (p=0.02), however, in other areas, no statistically significant regularities were established.

4. Our forecast for the frequency of newly diagnosed malignant neoplasms of the ovaries on average in the Bryansk region indicate shows an increase of 12.4% in 2020 in comparison with real data for 2020, while the largest increase in predicted values is recorded in the territories of radioactive contamination (by 79.6%), and the least – in the combined territories (by 6.9%).

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**ИССЛЕДОВАНИЕ ЗАБОЛЕВАЕМОСТИ ЗЛОКАЧЕСТВЕННЫМИ НОВООБРАЗОВАНИЯМИ ЯИЧНИКОВ У ЖЕНЩИН В ЗАВИСИМОСТИ ОТ ЭКОЛОГИЧЕСКИХ УСЛОВИЙ ПРОЖИВАНИЯ**

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Нами использованы данные официальной государственной статистики за 2000–2020 гг. для проверки гипотезы о влиянии экологических условий окружающей среды – радиоактивных (после Чернобыльской катастрофы) и химических загрязнителей на заболеваемость злокачественными новообразованиями яичников у женского населения Брянской области. Для оценки частоты злокачественных новообразований яичников использовались различные статистические подходы, включая тест Шапиро-Уилка, U-критерий Манна-Уитни, тест ранговой корреляции Спирмена и линейную регрессию. Не установлено статистически значимых различий в частоте первичной заболеваемости женщин злокачественными новообразованиями яичников вне зависимости от экологических условий проживания. Прогноз частоты впервые выявленных злокачественных новообразований яичников в среднем по Брянской области показывает рост на 12,4% в 2020 году по сравнению с реальными данными на 2020 год, при этом наибольший рост прогнозируемых значений зафиксирован на территориях радиоактивного загрязнения (на 79,6%), а наименьший – на территориях сочетанного загрязнения (на 6,9%).

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