ASSESSMENT OF THE RISKS OF MALIGNANT NEOPLASMS IN THE POPULATION WHEN REUSING MINE WATER

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Summary

Introduction. Extraction of iron ore is accompanied by the formation of significant volumes of mine waters, which are characterized by high mineralization. In the process of draining mine waters into surface reservoirs without their proper purification from pollutants and demineralization, it poses a significant environmental hazard and a threat to human health. The high incidence of malignant neoplasms in the population of Ukraine requires new approaches to the development of ways and methods of prevention, taking into account all determinants, including environmental factors.

Aim. Establishing the risk of developing malignant neoplasms in the population when re-using mine water.

Materials and methods. The methodological approach to the comprehensive assessment of the state of mine waters of the Kryvyi Rih iron ore basin involved the use of a complex of hygienic, experimental, epidemiological and medical-statistical research methods.

Results. We found that the concentrations of chemical substances exceed the maximum permissible levels for total mineralization by 22-25 times, by chloride content by 31-37 times, by suspended substances by 140-156 times, by iron by 4,4-4,9 times, and leads to changes in smell, colour, taste and increased aggressiveness of water to metals. Mine water of the Kryvyi Rih iron ore basin belongs to brines and is characterized as chloride-sulfate. The level of biochemical oxygen demand exceeds the maximum allowable standards by 2,64-2,76 times, and chemical oxygen consumption by 10-11 times, which can lead to a decrease in the oxygen content in natural reservoirs and create unsuitable conditions for the life of living organisms. The probability of developing malignant neoplasms for residents of the city of Kryvyi Rih is 0,05935, which is 15,71-23,62 times higher than the similar indicator for residents of the Dnipropetrovsk and Chernivtsi regions respectively. The additional (attributable risk) caused by environmental pollution is 0,05683 for residents of the city of Kryvyi Rih, while this indicator for residents of the Dnipropetrovsk region is 0,001264, which is 44,96 times lower. The need for a comprehensive approach to risk management is proven, which is based on a probabilistic assessment of the negative consequences of the impact of environmental factors on health and consists of certain stages: data collection and evaluation, impact and hazard assessment, environmental risk characterization.

Conclusions. Taking into consideration the indicators of the content of chemicals in mine water and the analysis of the levels of morbidity of the population with malignant neoplasms, the need for mandatory cleaning and demineralization of mine water when it is reused is scientifically substantiated.

Keywords: surface water bodies, underground waters, harmful chemicals, primary morbidity, prevalence of diseases, risk of malignant neoplasms
INTRODUCTION

Iron ore extraction processes are accompanied by the formation of significant volumes of mine waters, which, depending on the composition of the aquifer rocks, as well as the activity of water exchange, are characterized by increased (up to 3g/dm³) and high (> 3g/dm³) mineralization. In the process of draining mine waters into surface reservoirs without their proper purification from pollutants and demineralization, it poses a significant environmental hazard and a threat to human health.

Annually, the active mining enterprises of the Kryvyi Rih iron ore basin and those operating in hydroprotection mode pump up to 40 million m³ of groundwater (mines, quarries), among which 16-17 million m³ are highly mineralized mine waters.

The systematic discharge of highly mineralized mine waters by mining enterprises leads to the deterioration of water quality in water sources, affects the state of ecological safety of water bodies, the amount of costs for water treatment and the state of health of the population [1].

The analysis of information on the state of surface and underground waters of Ukraine as well as on existing mine water treatment technologies shows that currently the majority of mine waters have high mineralization and are contaminated with other harmful impurities that do not allow them to be discharged into surface water bodies without deep cleaning. Existing treatment plants do not provide a comprehensive solution to the problem of discharging such water, since treatment is accompanied by the generation of a significant amount of waste [2-3].

Morbidity of the population occupies a special place in the complex of medical and social indicators, because it is the main cause of mortality, as well as temporary and permanent loss of working capacity of the population, which in turn leads to significant economic losses of society, negatively affects the health of future generations and a decrease in population people. According to the State Statistics Service of Ukraine, over the past 20 years, the rate of cancer among men has increased by 47 %, among women by 35 % [4].

The most vulnerable age group in terms of the occurrence of malignant neoplasms in 2017 were women aged 18 to 54 and men aged 18 to 59. During 1995-2017, the number of patients registered in medical institutions in Ukraine increased from 1434,2 to 2258.3 persons per 100,000 population [5, 6].

As of 2019, the cumulative risk of developing cancer was 28 % for men and 18 % for women, meaning that one in three to four men and one in five women are likely to develop a malignancy in their lifetime [4].

The implementation of a healthy lifestyle program, improving public awareness of oncology issues, monitoring the state of the environment and the ecological situation in Ukraine should be key in the prevention of cancer incidence [7].

The high incidence of malignant neoplasms in the population of Ukraine and the high share of this pathology in the mortality structure of the population require new approaches to the development of ways and methods of prevention (due to research on known carcinogens and little-studied oncogenic environmental factors), early diagnosis and effective treatment. At the same time, all determinants should be taken into account, including environmental factors and an unfavourable ecological situation, which contribute to the emergence of malignant neoplasms and methods of their elimination [9-10].

AIM

To establish the risk of development of malignant neoplasms of the population during the repeated use of mine water.

MATERIALS AND METHODS

The mine water research was carried out at the enterprise of the mining and metallurgical industry of Ukraine, which is engaged in underground mining of iron ore in the Kryvyi Rih iron ore basin and in the laboratories of the State Enterprise «Ukrainian Research Institute of Industrial Medicine.» The water intake was carried out at 20 points of the main mine horizons and the laboratory studies were carried out according to the following indicators: soluble oxygen, hydrogen indicator, biochemical oxygen consumption for 5 days, chemical oxygen consumption, ammonium nitrogen, nitrites, nitrates, phosphates, phenols, total iron, suspended substances, petroleum products, chlorides, sulfates, dry residue. 43 protocols of similar studies for 2018-2023 were also analyzed. The assessment was carried out in accordance with the Order of the Ministry of Health of Ukraine dated February 05, 2022 No. 721 «Hygienic Water Quality Standards of Water bodies to meet drinking, household and other needs of the population» («Order»).

The incidence of malignant neoplasms in the population of the city of Kryvyi Rih was studied through a retrospective epidemiological analysis of statistical reports of medical and preventive institutions of the city of Kryvyi Rih (Form No. 12, approved by the Order No. 378 of the Ministry of Health of Ukraine dated July 10, 2007 No. 378 (with changes and additions introduced by the order of the Ministry of Health dated June 17, 2013 No. 511) for 2018-2022. The analysis of the demographic indicators of the residents of the city of Kryvyi Rih for 2005-2019 was based on information provided by the Executive Committee of the Kryvyi Rih City Council (Letter No. 9/19/1275 dated June 11, 2020). The population of the city of Kryvyi Rih is included in the
main group, and the population of Ternopil and Chernivtsi regions is included in the control group.

Risk assessment was carried out according to international methods [11, 12] in accordance with which AR, RR, OR, CI 95 %, EF were determined.

Statistical processing of the obtained results was carried out using the procedures of descriptive epidemiology (descriptive analysis) with the determination of average arithmetic values and their errors. M was defined as the (arithmetic) mean of the sample; m (SEM) is the standard error of the mean; SD – standard (mean square) deviation; p – is the level of statistical significance reached. The Student’s t-test was used to assess the probability of the obtained data with a normal distribution of signs, the critical level of significance when testing statistical hypotheses was taken as equal to 0,05. The results of the research, which were obtained during the execution of a fragment of the research work, were processed using the standard package of Microsoft Office Excel 2003 programs (№ HK9TK–GB4KD-3936D-8R6C8–DJTHD) та STATISTICA 6.0. (№ 31415–9265–35897).

RESULTS AND DISCUSSION

According to the results of laboratory studies, we analyzed the chemical composition of mine water (table 1). The results obtained were compared with the hygienic standards for water bodies used for household and other needs of the population, in order to assess the possibility of using mine water for the specified purposes.

The content of dissolved oxygen, hydrogen index, ammonium nitrogen, nitrates, nitrites, phosphates, phenols, petroleum products are within the permissible standards, and in the case of reuse of mine water will not have a negative impact on natural reservoirs, the environment and the health of the population.

### Table 1

<table>
<thead>
<tr>
<th>№</th>
<th>Water quality indicators</th>
<th>General mine water (water reservoir on the horizon 475 m) mg/dm³, n=63</th>
<th>Normative levels according to the Order of the Ministry of Health of Ukraine No. 721 dated February 05, 2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dissolved oxygen, mg/dm³</td>
<td>7,68±0,04</td>
<td>≥ 4</td>
</tr>
<tr>
<td>2</td>
<td>Hydrogen index (pH), pH unit</td>
<td>7,74±0,17</td>
<td>6,50–8,50</td>
</tr>
<tr>
<td>3</td>
<td>BOD₅, mg/dm³</td>
<td>8,10±0,18*</td>
<td>3,00</td>
</tr>
<tr>
<td>4</td>
<td>COD, mg/dm³</td>
<td>318,95±12,09*</td>
<td>30,00</td>
</tr>
<tr>
<td>5</td>
<td>Ammonium nitrogen, mg/dm³</td>
<td>0,89±0,07</td>
<td>2,00</td>
</tr>
<tr>
<td>6</td>
<td>Nitrites, mg/dm³</td>
<td>0,32±0,02</td>
<td>3,30</td>
</tr>
<tr>
<td>7</td>
<td>Nitrates, mg/dm³</td>
<td>9,70±0,24</td>
<td>45,00</td>
</tr>
<tr>
<td>8</td>
<td>Common iron, mg/dm³</td>
<td>1,41±0,08*</td>
<td>0,30</td>
</tr>
<tr>
<td>9</td>
<td>Suspended solids, mg/dm³</td>
<td>111,29±5,61*</td>
<td>0,75</td>
</tr>
<tr>
<td>10</td>
<td>Oil products, mg/dm³</td>
<td>0,40±0,01</td>
<td>0,30</td>
</tr>
<tr>
<td>11</td>
<td>Chlorides, mg/dm³</td>
<td>11983,70±858,26*</td>
<td>350,00</td>
</tr>
<tr>
<td>12</td>
<td>Sulphates, mg/dm³</td>
<td>936,84±24,14*</td>
<td>500,00</td>
</tr>
<tr>
<td>13</td>
<td>Dry residue, mg/dm³</td>
<td>24172,57±1473,50*</td>
<td>1000,00</td>
</tr>
</tbody>
</table>

* – exceed the threshold limit values

General mineralization is one of the most important indicators of the chemical composition of natural waters. During the study of mine water, it was determined at the level of 24172,57±1473,50 mg/m³, which is 22–25 times higher than the normative levels and refers to brines (> 50 g/dm³). According to the analysis of the mineral composition of the water, the water is characterized as chloride-sulphate. The content of microelements in mine waters is determined by their quantity in the underground waters of the mine workings and the processes associated with the migration of elements from the mining rocks into the mine waters. Mineral impurities in mine waters are in a dissolved and suspended state. The amount of mineral substances changes quite significantly, but it makes it possible to characterize the corresponding interval of such changes.

It was established that the studied water contains a significant amount of chlorides in its composition, namely 11983,70±858,26 mg/dm³, which is 31–37 times higher than the threshold limit values. The level of sulphates in mine water is 936,84±24,14 mg/dm³, which is 1,8–1,9 times higher than the threshold limit values. Such values affect the taste, smell and colour of water, lead to corrosion of metals and negatively affect water sources.

The concentration of suspended substances is 111,29±5,61 mg/dm³, which is 140–156 times that can significantly affect the depth of sunlight penetration.
impair the vital activity of hydrobionts, lead to siltation of water bodies, causing their ecological aging.

The iron content in the water is 1.42±0.08 mg/dm^3, and it exceeds the permissible standards by 4.4-4.9 times, which leads to a change in the taste and an increase in the aggressiveness of water in relation to metals.

The degree of contamination of mine waters with organic substances is estimated by the following indicators: BOD_5—an important ecological indicator of the state of natural water bodies. The level of BOD_5 is 8.10±0.18 mg O_2 per l, which is 2.64-2.76 higher than the norm and can cause a decrease in the content of dissolved oxygen, create hypoxic conditions and the death of certain types of hydrobionts. The chemical consumption of oxygen is 10-11 times higher than the normative values and is 318.95±12.09 mg/dm^3, which can lead to a decrease in the oxygen content in natural reservoirs and create unsuitable conditions for life of living organisms.

The mine water monitoring data show that concentrations of sulphates and chlorides in drainage waters vary significantly at different sampling points. Thus, the concentration of sulphates differs by 3 times, and chlorides by 80 times from the well to the bed of the Saksagan River. With an average sulphate concentration of 825±138 mg/dm^3, the 95 % uncertainty interval is 549-1101 mg/dm^3. With an average chloride concentration of 18580±6042 mg/dm^3, the 95 % uncertainty interval is 6496-30664 mg/dm^3. And even at one sampling point, a horizon of 475 meters, this dispersion of the result is 20 % for sulphates (936±28 mg/dm^3), and the 95 % uncertainty interval is 880-992 mg/dm^3. For chlorides (11147±791 mg/dm^3) – 5 %, and the 95 % uncertainty interval is 9564-12728 mg/dm^3. Fluctuations over months and years are superimposed on this uncertainty. Thus, the level of sulphates and chlorides changes 7 times during five years of observation, then it becomes obvious that it does not make sense to associate the level of general morbidity of the population, which also has a significant interval of uncertainty due to its internal reasons with these indicators. In this case, more information is provided by the assessment of excess risk arising from the discharge of this water into sediments, rivers and soil. The impact of pollutants on the health of the population can be combined, both directly and indirectly through soil, food products, etc.

It is not possible to establish statistically reliable dependencies of the impact on the general morbidity due to lack of evidence of a cause-and-effect relationship, so we propose to evaluate the impact of pollution on the level of malignant neoplasms among the population.

The study and analysis of the primary morbidity and prevalence of malignant neoplasms in the population of the city of Kryvyi Rih was conducted taking into consideration the age structure of the population and is presented in table 2.

<table>
<thead>
<tr>
<th>Morbidity</th>
<th>Age</th>
<th>Primary morbidity</th>
<th>Prevalence of morbidity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>children 0-14 y.o., M±m</td>
<td>8.87±2.62</td>
<td>61.51±25.20</td>
</tr>
<tr>
<td></td>
<td>adolescents 15-17 y.o., M±m</td>
<td>7.30±3.48</td>
<td>36.70±9.66</td>
</tr>
<tr>
<td></td>
<td>adults 18 y.o. and older, M±m</td>
<td>171.67±25.58</td>
<td>264.38±33.25</td>
</tr>
</tbody>
</table>

In order to determine the increase in the incidence of malignant neoplasms among the population of the city of Kryvyi Rih, we analyzed the primary incidence, i.e. that which occurred for the first time in the current year. Thus, according to the presented statistics, the average level of primary incidence of malignant neoplasms is the highest among the adult population and is 171.67±25.8 % of cases per 10,000 population (p<0.05). The lowest level is observed among adolescents aged 15-17 and is 36.70±9.66 cases per 10,000 population (p<0.05).

The prevalence rate of malignant neoplasms among the three age categories is the highest in the age group of 18 years and older and is from 264.38±33.25 cases per 10,000 population (p<0.05). In second place are children under the age of 14, in whom the prevalence of malignant neoplasms is 61.51±25.2 cases per 10,000 population (p<0.05). The lowest level is observed among adolescents aged 15-17 and is 36.70±9.66 cases per 10,000 population (p<0.05).

Thus, when analyzing the primary morbidity and prevalence of malignant neoplasms, the highest level is observed among the adult population, but for a final statement about the situation, it is necessary to focus not on the adult population, which moves within the city and is more stable in terms of age, but on the incidence of children and adolescents, as the most sensitive and vulnerable contingent. The most informative indicator that proves the presence of additional risk from adverse environmental factors for these categories of the population is the analysis of attribute risk, which will be calculated and analyzed at the next stage.

For an objective assessment of the impact of the environment on the level and structure of the incidence of malignant neoplasms and to establish a cause-and-
effect relationship, it is more appropriate to compare the incidence of the city of Kryvyi Rih with the incidence of malignant neoplasms in other regions of Ukraine, in which the minimum number of industrial enterprises is located, which is environmental pollutants and achieved the lowest levels of environmental pollution, to maximally exclude the influence of other risk factors. Today, such regions are Ternopil region and Chernivtsi region, as well as the closest geographically – Poltava region and Chernihiv region. Thus, the population risk of malignant neoplasms (C00-D48) in the city of Kryvyi Rih is 0.009 (90 per 10,000 population), and in the comparison group – 0.006 (60 per 10,000) [13].

Based on the analysis of the level of prevalence and incidence of malignant neoplasms among the population of the city of Kryvyi Rih of different ages and in relation to individual administrative districts, the group risk of malignant neoplasms in the population of the city of Kryvyi Rih was determined.

Group, attributable risk caused by environmental factors is presented in table 3.

### Table 3

<table>
<thead>
<tr>
<th>Age</th>
<th>AR* 10,000</th>
<th>0-14 y.o.</th>
<th>15-17 y.o.</th>
<th>adults 18 y.o. and older</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children</td>
<td>14.26</td>
<td>19.06</td>
<td>87.4</td>
<td></td>
</tr>
<tr>
<td>Adolescents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

According to the results of our research, it was established that children and adolescents are the most vulnerable to the state of the environment and the influence of environmental factors.

It was established that the lowest risk of malignant neoplasms occurs in children under the age of 14, 14.26 per 10,000 population, and the highest in adults (18 years and older) 87.4 per 10,000 population. Thus, in order to exclude the influence of other factors and to establish an objective cause-and-effect relationship with environmental factors, we conducted a comparison of cases of neoplasms caused by environmental pollution in certain areas of the city in relation to other regions of Ukraine, which is shown in table 4:

### Table 4

<table>
<thead>
<tr>
<th>Age</th>
<th>AR*10,000</th>
<th>Poltava and Chernihiv regions</th>
<th>Ternopil and Chernivtsi regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children</td>
<td>169.38</td>
<td>199.38</td>
<td></td>
</tr>
<tr>
<td>Adolescents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thus, when comparing cases of neoplasms caused by environmental factors, it was found that it is 169.38, and when comparing with Ternopil and Chernivtsi regions, the additional risk is 199.38.

Thus, the high risk of developing malignant neoplasms in the population of the city of Kryvyi Rih and a significant percentage of neoplasms suggests that environmental factors play a leading role in their occurrence.

In previous studies, we [13] calculated risk indicators for the development of malignant neoplasms for the population of the city of Kryvyi Rih and compared them with similar indicators calculated for the population of the Dnipropetrovsk and Chernivtsi regions (table 5).

### Table 5

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Research region</th>
</tr>
</thead>
<tbody>
<tr>
<td>The probability of getting a malignant neoplasm, p</td>
<td>Chernivtsi region</td>
</tr>
<tr>
<td>Attributable risk (additional risk caused by pollution), AR</td>
<td>0.002512</td>
</tr>
<tr>
<td>A chance to find a risk factor in the residents of the region</td>
<td>0.004</td>
</tr>
<tr>
<td>Odds ratio, (OR±m)</td>
<td>1.505±0.023</td>
</tr>
<tr>
<td>Confidence interval, CI 95 %</td>
<td>1.439-1.574</td>
</tr>
</tbody>
</table>

When analyzing risk indicators in the population of the city of Kryvyi Rih, it was established that the probability of developing a malignant neoplasm for residents of the city of Kryvyi Rih is 0.05935, which in comparison with a similar indicator for residents of the Dnipropetrovsk and Chernivtsi regions, is 15.71-23.62 times higher, respectively. The additional (attributable risk) caused by environmental pollution is 0.05683 for residents of the city of Kryvyi Rih, while this indicator for residents of the Dnipropetrovsk region is 0.001264, which is 44.96 times lower. The odd ratio of developing malignant neoplasms for the population of the city of Kryvyi Rih is 25.054±0.022 with a CI of...
95% (24,012-26,141), and for residents of the region it is 1,505±0,023 with a CI of 95% (1,439-1,574).

Thus, research has established that in the city of Kryvyi Rih there is an increase in the incidence of malignant neoplasms in comparison with other cities of Ukraine, and the risk of developing malignant neoplasms from environmental pollution, including natural water bodies, belongs to the category of high risk and requires constant water quality monitoring and cancer prevention among the population.

The presence of high levels of salts and high mineralization of mine waters contributes to the pollution of water bodies, deteriorates the quality of water, and often makes them unsuitable for economic and industrial purposes. The use of such water in agriculture leads to salinization of soils and makes them unsuitable for growing crops.

Therefore, with the repeated use of non-demineralized mine water, a high risk of water pollution is related to a high level of morbidity and is one of the leading etiological factors of the incidence of malignant neoplasms.

CONCLUSIONS

1. During the analysis of data from a laboratory study of mine water, it was established that the concentrations of substances exceed the maximum permissible levels for total mineralization by 22-25 times, by chloride content by 31-37 times, by suspended substances by 140-156 times, by iron by 4,4-4,9 times, and leads to changes in smell, colour, taste and increased aggressiveness of water to metals. Mine water belongs to brines and is characterized as chloride-sulphate.

2. The level of biochemical oxygen demand exceeds the maximum permissible standards by 2,64-2,76 times, and chemical oxygen consumption by 10-11 times, which can lead to a decrease in the oxygen content in natural reservoirs and create unsuitable conditions for the life of living organisms.

3. The probability of developing malignant neoplasms for residents of the city of Kryvyi Rih is 0,05935, which is 15,71-23,62 times higher than the similar indicator for residents of the Dnipropetrovsk and Chernivtsi regions, respectively. The additional (attributable risk) caused by environmental pollution is 0,05683 for residents of the city of Kryvyi Rih, while this indicator for residents of the Dnipropetrovsk region is 0,001264, which is 44,96 times lower.

4. The need for a comprehensive approach to risk management is proven, which is based on a probabilistic assessment of the negative consequences of the impact of environmental factors on health and consists of certain stages: data collection and evaluation, impact and hazard assessment, environmental risk characterization.

5. Taking into account the indicators of the content of chemicals in mine water and the analysis of the levels of morbidity of the population with malignant neoplasms, the need for mandatory cleaning and demineralization of mine water when it is reused is scientifically substantiated.

Prospects for further research. The results that can be obtained during the analysis of malignant neoplasms of the population can be considered as initial data and allow monitoring of the qualitative and quantitative state of mine waters and the state of human health. The obtained results will become the basis for determining the excess risk that occurs when using mine water and determining the risk categories of carcinogenic and non-carcinogenic effects, as well as the search for effective technologies for cleaning and de-mineralization of mine water.

FUNDING AND CONFLICT OF INTEREST

The authors declare no competing interests. The information on the connection of funding by certain institutions, foundations, organizations, grants: the article is part of a research work «Conducting Scientific Research and Searching for Comprehensive Environmentally Acceptable Solutions for Systems of Consistent and Repeated Use of Water, Including Water Coming from Other Enterprises.»

COMPLIANCE WITH ETHICAL REQUIREMENTS

The study did not require ethics committee approval. No humans or animals were involved, no personal data were used, and no informed consent was required.

LITERATURE

2. Вилкул Ю. Г., Ступник Н. И., Бровко Д. В., Кириченко П. С. Пути снижения техногенного влияния шахтных и карьерных вод на пресноводные объек- ты Кривбаса. Матеріали міжнар. наук.-практ. конф., 5-8 жовтня 2016 р. Дніпро, 2016. Т. 2. С. 138-144.


REFERENCES


12. Орехова О., Павленко О. Професійні ризики здоров’ю працюючих як сучасна концепція медицини праці. Український журнал з проблем медицини праці. 2017. № 3 (52). С. 77-87.

Резюме

ОЦІНКА РИЗИКІВ ВИНИКНЕННЯ ЗЛОЯКІСНИХ НОВОУТВОРЕНЬ У НАСЕЛЕННЯ ПРИ ПОВТОРНОМУ ВИКОРИСТАННІ ШАХТНИХ ВОД

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Вступ. Видобування залізної руди супроводжується утворенням значних об'ємів шахтних вод, які характеризуються високою мінералізацією. В процесі відведення шахтних вод в поверхневі водойми без належного їх очищення від забруднюючих речовин та демінералізації становить значну екологічну небезпеку та загрозу здоров'ю людей. Високий рівень захворюваності на злоякісні новоутворення населення України вимагає нових підходів до розробки способів та методів профілактики з урахуванням всіх детермінант, в тому числі і факторів довкілля.

Мета. Встановлення ризику розвитку злоякісних новоутворень населення при повторному використанні шахтної води.

Матеріали та методи. Методологічний підхід до комплексної оцінки стану шахтних вод Криворізького залізорудного басейну передбачав застосування комплексу гігієнічних, експериментальних, епідеміологічних та медико-статистичних методів дослідження.

Результати. Нами встановлено, що концентрація хімічних речовин перевищує гранично допустимі рівні по загальній мінералізації у 22-25 разів, за вмістом хлоридів у 31-37 разів, по завислих речовинах у 140-156 разів, по залізу у 4,4-4,9 разів, та призводить до зміни запаху, кольору, смаку та підвищення агресивності води до металів. Шахтна вода Криворізького залізорудного басейну відноситься до розсолів і характеризується як хлоридно-сульфатна. Рівень біохімічної потреби кисню перевищує гранично допустимі нормативи у 2,64-2,76 разів, а хімічне споживання кисню у 10-11 разів, що може призводити до зниження вмісту кисню у природних водоймах та створювати непридатні умови для життя живих організмів. Ймовірність захворіти на злоякісні новоутворення для мешканців м. Кривий Ріг становить 0,05935, що в порівнянні з аналогічним показником для мешканців Дніпропетровської та Чернівецької областей перевищує у 15,71-23,62 разів. Додатковий (атрибутивний) ризик, спричинений захворюванням на злоякісні новоутворення, становить для мешканців м. Кривий Ріг 0,05683, в той час, коли цей показник для мешканців Дніпропетровської області становить 0,001264, що у 44,96 разів нижчий. До багатьох негативних наслідків впливу шахтної води на здоров'я тяжко складається з певних етапів: збрізка, утрати, небезпеки, характеризують ризик екологічного ризику.

Висновки. Враховуючи показники вмісту хімічних речовин у шахтній воді та аналіз рівнів захворюваності населення злоякісними новоутвореннями науково обґрунтовано необхідність обов'язкового очищення та демінералізації шахтної води при її повторному використанні.

Ключові слова: поверхневі водойми, підземні води, шкідливі хімічні речовини, первинна захворюваність, поширеність захворювань, ризик злоякісних новоутворень