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FEATURES OF OCCUPATIONAL MORBIDITY OF URANIUM MINING WORKERS

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Introduction. Preservation of the health and professional longevity of people of working age is a priority task of the Russian healthcare system. In this regard, it is extremely important to study the structure and dynamics of occupational pathology for the scientific justification and development of measures aimed at managing the risks to the health of workers in enterprises with extremely dangerous working conditions and to prevent the development of occupational diseases.

Objective. To study specific features in the structure of occupational morbidity of workers of a uranium mining enterprise over a 50-year period.

Materials and methods. The work was performed on the model of a large uranium mining enterprise within the Rosatom State Corporation in Russia with extremely dangerous working conditions. Cases of occupational diseases detected in workers from the beginning of the operation of the company from 1970 to 2019 were analyzed. The structure of occupational diseases was characterized, and the share contribution of the main nosological forms over 5-year periods was analyzed.

Results. The main nosological forms of occupational diseases in underground miners of a uranium ore mining enterprise were identified. A steady trend towards an increase in the total number of cases of diseases was noted. There was a gradual increase in the proportion of diseases of the musculoskeletal system and peripheral nervous system, a decrease in the proportion of "dust" pathology, an increase and subsequent decrease in the proportion of sensorineural hearing loss, as well as a stable contribution to the structure of occupational pathology of malignant neoplasms.

Conclusion. Indicators of a priori occupational health and safety risk of uranium mining workers reflect the levels of their occupational morbidity. Musculoskeletal system disorders and occupational malignancies dominate in the structure of occupational diseases. This morbidity is many times higher than the national average.

Keywords: occupational pathology structure; occupational risk; diseases of the musculoskeletal system; occupational malignancies

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ОСОБЕННОСТИ ПРОФЕССИОНАЛЬНОЙ ЗАБОЛЕВАЕМОСТИ РАБОТНИКОВ УРАНОДОБЫВАЮЩИХ ПРОИЗВОДСТВ

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Введение. Одной из приоритетных задач здравоохранения Российской Федерации является сохранение здоровья и профессионального долголетия лиц трудоспособного возраста. В связи с этим крайне актуально изучение структуры и динамики профессиональной патологии для научного обоснования и разработки мероприятий по управлению рисками для здоровья работников предприятий с особо опасными условиями труда и профилактике развития профессиональных заболеваний.

Цель. Изучение особенностей структуры профессиональной заболеваемости работников уранодобывающего предприятия за 50-летний период.

Материалы и методы. Работа выполнена на модели крупного уранодобывающего предприятия России с особо опасными условиями труда ГК «Росатом».

Проведен анализ случаев профессиональных заболеваний, выявляемых у работников от начала работы предприятия за период с 1970 по 2019 гг. Охарактеризована структура профессиональных заболеваний, в динамике по 5-летним периодам проанализирован долевой вклад основных нозологических форм.

Результаты. Выявлены приоритетные нозологические формы профессиональных заболеваний у подземных горнорабочих предприятия по добыче урановых руд. Отмечена устойчивая тенденция к увеличению общего числа случаев заболеваний с постепенным увеличением доли заболеваний опорно-двигательного аппарата и периферической нервной системы, снижению доли «пылевой» патологии, росту и последующему снижению доли нейросенсорной тугоухости; стабильный вклад в структуру профессиональной патологии злокачественных новообразований.

Заключение. Показатели априорного профессионального риска работников уранодобывающего предприятия отражают уровни их профессиональной заболеваемости. В структуре профессиональных заболеваний преобладают заболевания костно-мышечной системы и профессиональные злокачественные новообразования, многократно превышающие среднероссийские показатели.

Ключевые слова: структура профессиональной патологии; профессиональный риск; заболевания костно-мышечной системы; профессиональные злокачественные новообразования

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INTRODUCTION

Ensuring the medical component of industrial safety, preserving the health and professional longevity of people of working age comprise priority tasks of the healthcare of the Russian Federation. Strategically important industries need highly qualified personnel, whose training requires significant time and material resources. In this regard, the health of workers in certain industries with particularly dangerous working conditions is of great medical, social, and economic significance [1–2].

The importance of this area was emphasized by M.V. Mishustin, the Chairman of the Government of the Russian Federation, at the opening of the All-Russian Week of Occupational Safety — 2021. He emphasized that the rapidly changing world poses new challenges, which lead to previously unknown risks associated with occupational diseases arise. Therefore, timely identification of signs of the initial development of a possible occupational disease is an urgent task.

According to the definition by the WHO, occupational risk is the prognostic probability of the frequency and severity of adverse reactions to exposure to harmful factors of the working environment and the work process. Production factors (noise, vibration, severity of the labor process) that exceed sanitary and hygienic standards have a negative impact on the body of workers. They can cause a risk of developing occupational diseases, exacerbate the course of a number of common diseases, and determine disability and the onset of disability [3–5].

It is difficult to overestimate the importance of nuclear energy in Russia. Currently, nuclear power plants here generate about 20% of the total electricity amount. Power generation at nuclear power plants, extraction of raw materials, and enrichment of nuclear fuel are carried out at the enterprises of the Rosatom State Corporation, one of the largest producers of natural uranium in the world [6–7].

The majority of studies into the health status of uranium mining workers in Russia were carried out in the late twentieth and early twenty-first centuries. They recorded the presence of such priority factors of working conditions as industrial aerosols, intense noise, local and general transport, technological vibration, physical overload, functional overstrain of the musculoskeletal system, and ionizing radiation [8–12]. The main forms of occupational diseases of workers at that time were pathologies of the respiratory system (silicosis, pneumoconiosis), vibration disease, and occupational hearing loss [13–18].

Therefore, research aimed at studying the features of occupational health disorders of workers exposed to harmful production factors during the extraction of uranium ore and the development of measures to manage the risks of their development are both justified and relevant.

In this paper, we study the structure of occupational morbidity of workers of a uranium mining enterprise over a 50-year period.

MATERIALS AND METHODS

The work was performed based on a model of a large uranium mining enterprise within Rosatom State Corporation in Russia with extremely dangerous working conditions.

Cases of occupational diseases detected in workers from the beginning of the company's work for the period 1970–2019 were analyzed. The structure of occupational diseases was characterized, and the contribution of the main nosological forms (silicosis, vibration disease, sensorineural hearing loss, chronic dust bronchitis, pathology of the musculoskeletal system and peripheral nervous system, malignant neoplasms) was analyzed over 5-year periods [19–20].

RESULTS AND DISCUSSION

The conducted research established that at the workplaces of the uranium mining enterprise studied here, the current main occupational health risk factors are intense noise, local and general vibration, as well as physical overload

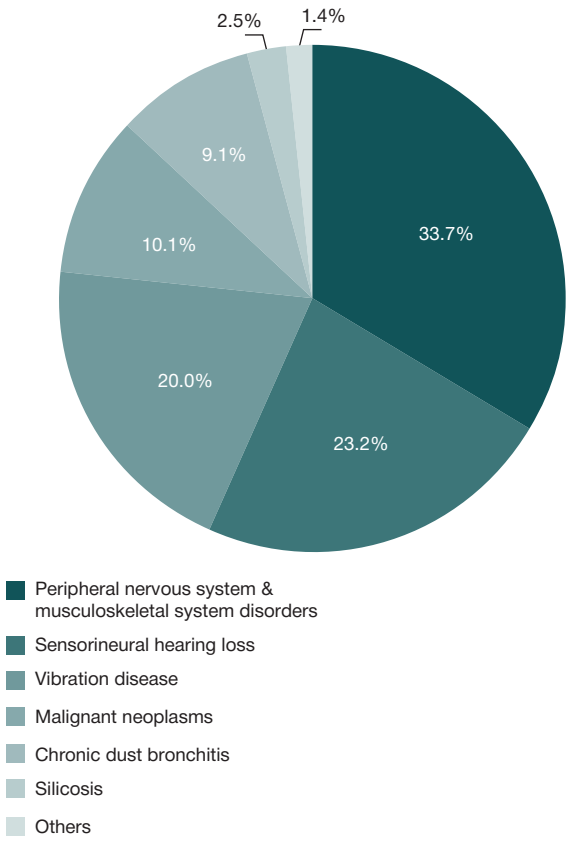

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Fig. 1. The structure of nosological forms of occupational pathology identified in uranium mining workers for the period 1970–2019 (number of cases, %)

and functional overstrain of the musculoskeletal system due to insufficient mechanization of the labor process and the high prevalence of manual labor among workers of the main professions. Radiation factors (gamma radiation, radon and its short-lived daughter decay products, long-lived alpha-nuclides of a number of natural uranium) have an additional negative impact on the health of miners. The data obtained is comparable with the information available in previously published literature sources [21–23].

Currently, industrial aerosols have an insignificant impact on the occupational risk structure of miners of the uranium mining enterprise, largely due to the use of various dust suppression methods.

The results of a retrospective analysis of cases of occupational diseases based on archived data from the results of preventive medical examinations for the period 1970–2019 are presented in Table 1.

In total, from 1970 to 2019, 1134 cases of occupational diseases were recorded among workers of the uranium mining enterprise. There was a fairly steady increase in the number of occupational diseases, with more than half of all cases (53.9%) detected in the past 10 years, in the 2010–2019 period.

Occupational morbidity is characterized by the following priority groups of pathology: diseases of the peripheral nervous system (PNS) and musculoskeletal system (MSS), formed mainly due to overstrain of organs and systems in the process of performing work functions (33.7%); sensorineural hearing loss (SNHL) caused by noise exceeding the maximum permitted level (23.2%); vibration disease (VD) due to exposure of local and/or general vibration (20.0%); respiratory diseases due to exposure of industrial aerosols (11.6%), among which cases of silicosis (2.5%) and chronic dust bronchitis (CDB) (9.1%) were isolated; malignant neoplasms (MNs) — 10.1% of cases (Fig. 1).

The conducted analysis allowed us to establish specific features in the dynamics of the development of occupational pathology in workers of the enterprise studied herein (Figs. 2–6).

Thus, in the period from 1970 to 1989, more than half of the cases of occupational diseases (up to 62.5%) were due to respiratory pathology, silicosis, and chronic dust

Table 1. Cases of occupational diseases over 5-year periods in 1970–2019 (absolute values)

Cases	VD	MNs	SNHL	PNS & MSS	Silicosis	CDB	Others	Total
1970–1974	2		1		5		0	8
1975–1979	8	2	10		14	6	0	40
1980–1984		2	4		5	1	1	13
1985–1989		7	5		1	27	5	45
1990–1994	4	5	56	8	1	25	2	101
1995–1999	7	25	27	4	1	19	1	84
2000–2004	9	28	23	11		2	0	73
2005–2009	57	9	59	27	1	4	2	159
2010–2014	85	20	51	162		13	2	333
2015–2019	55	17	27	170		6	3	278
Total in 1970–2019	227	115	263	382	28	103	16	1134

The table was prepared by the authors based on archival data

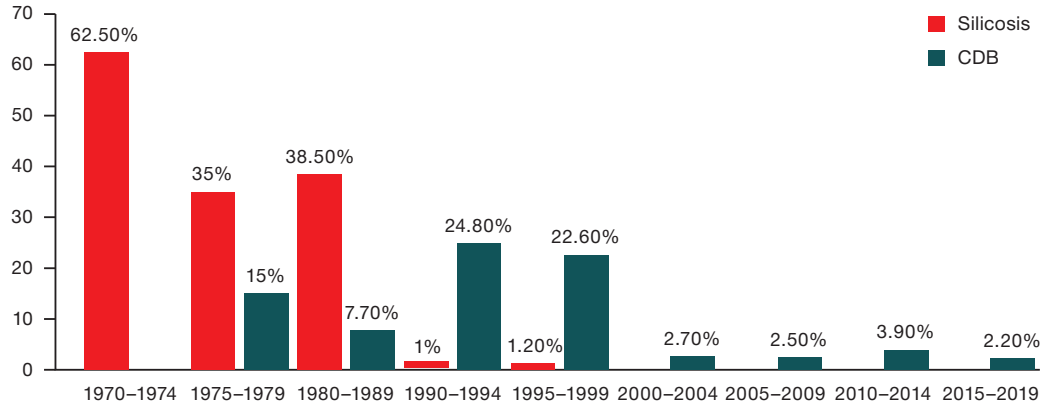

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Fig. 2. Dynamics of the proportion of silicosis and chronic dust bronchitis in the structure of occupational diseases detected in uranium mining workers during the 1970–2019 period

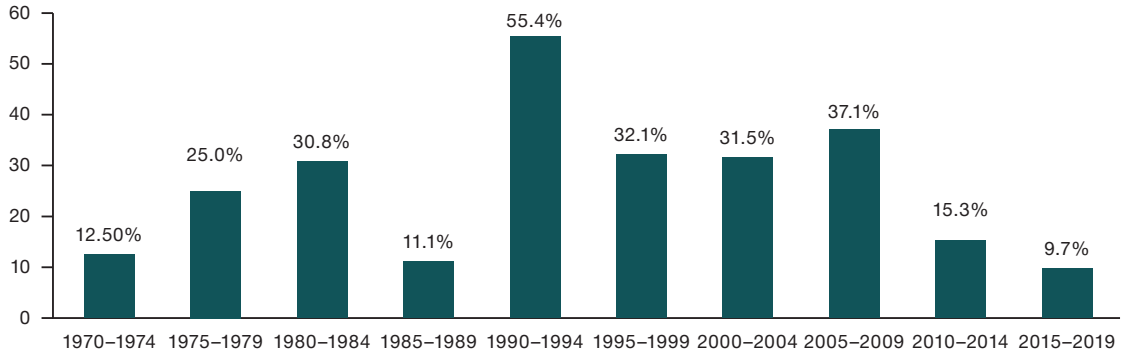

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Fig. 3. Dynamics of the proportion of sensorineural hearing loss in the structure of occupational diseases detected in workers of a uranium mining enterprise during the 1970–2019 period

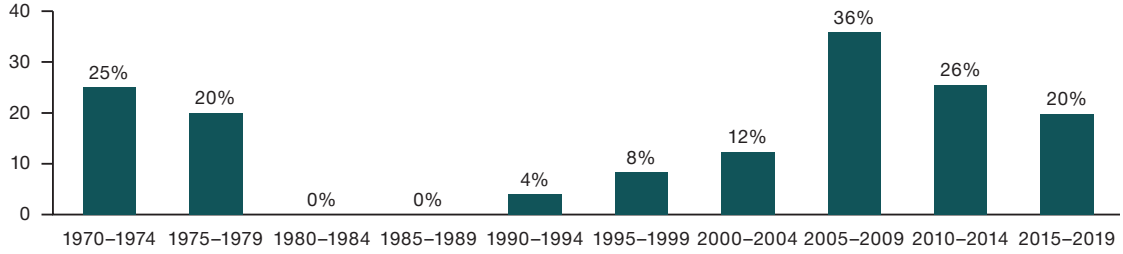

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Fig. 4. Dynamics of the proportion of vibration disease in the structure of occupational diseases detected in workers of a uranium mining enterprise during the 1970–2019 period

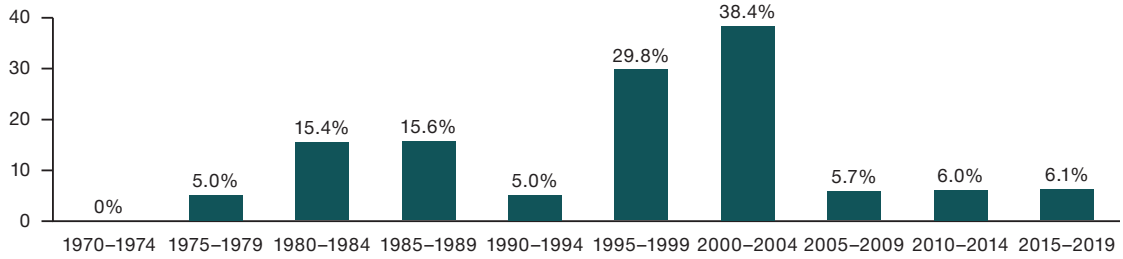

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Fig. 5. Dynamics of the proportion of malignant neoplasms in the structure of occupational diseases detected in workers of a uranium mining enterprise during the 1970–2019 period

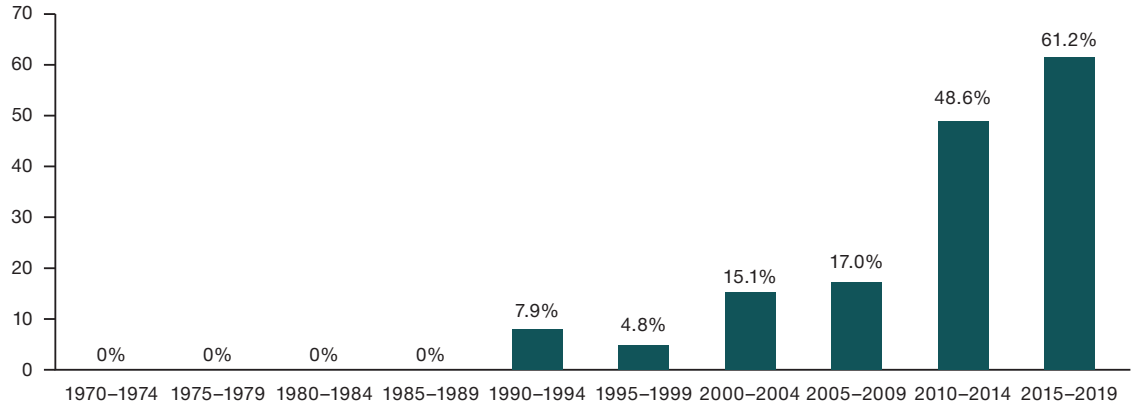

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Fig. 6. Dynamics of the proportion of diseases of the peripheral nervous system and musculoskeletal system in the structure of occupational diseases detected in workers of a uranium mining enterprise during the 1970–2019 period

bronchitis (CDB). Prior to 1984, silicosis prevailed among occupational diseases of the respiratory system; however, since 1985, chronic dust bronchitis has become the priority form of pathology with up to 60% of all cases of occupational diseases (OD). Silicosis was detected only in isolated cases.

Cases of silicosis have not been detected since 2000. CDB accounted for 2.7% to 3.9% of cases of all occupational diseases. It is important to note that cases of silicosis were found in those workers who, prior to starting work in the divisions of a uranium mining enterprise, had already had a history of work experience in «dusty» professions at other mining enterprises.

The proportion of sensorineural hearing loss in the structure of occupational pathology fluctuated over a wide range: the maximum (55.4% of cases) in the period from 1990 to 1994 with a fairly significant decrease in indicators to 9.7–15.3% in the period from 2010 to 2019. The proportion of vibration disease (VB) in the structure of occupational diseases was 20–25% from 1970 to 1979. In the period from 1980 to 1989, cases of VB were not recorded. Since 1990, an increase in the incidence of VB was noted: from 4% in 1990–1994 to 35.8% in 2005–2009. Over the following 10 years, i.e., 2010–2019, the proportion of cases of VB returned to the level of 19.8–25.5%.

It is important to note that in the structure of the occupational pathology of workers of a uranium mining enterprise, cases of malignant neoplasms (MNs) were regularly detected (with the exception of 1970–1974). Respiratory pathology prevailed among MNs (lung cancer — most of all).

The proportion of MNs was no more than 0.6% of cases in the structure of occupational pathology in the Russian Federation over the past 15–20 years. However, in the case of uranium miners, MNs was at least 5–6%. In some periods, this figure reached 29.8–38.4% of cases (1995–2004). Malignant neoplasms are mainly represented by cases of lung cancer (94 cases, 81.7%) and some variants of hemoblastosis (21 cases, 18.3%).

Between 1989 and 2019, in the Russian Federation, slightly over 1000 cases of occupational cancer were detected. The data obtained indicates that cases of occupational cancer detected in uranium enterprise workers account for almost 10% of all cases of occupational cancer in the entire country.

Since 2005, there has been an increase in the incidence of diseases of the musculoskeletal system and peripheral nervous system: the most frequently recorded since 2010. In 2019, this figure reached more than 60%.

Intensive morbidity rates (the number of cases per 10,000 workers) demonstrated a fairly significant increase in the number of cases (56.3% of cases per 10,000 workers in harmful working conditions). A significant spread of occupational morbidity indicators has been established over the years. The highest number emerges in the last 10 years, which can be attributed to increased knowledge of medical professionals and improved diagnosis of various forms of occupational pathology. The occupational disease detection rate is currently the highest (66.6–69.5% of cases per year). A feature of the morbidity rate of uranium mining workers is the almost threefold increase in cases of vibration disease, MSS and PNS disorders, reaching 60%, in the period of 2005–2019.

The data from the retrospective analysis of the structure of occupational morbidity of uranium mining workers demonstrates their features in comparison with the general structure of occupational morbidity of workers in the Russian Federation [24]. More than a third of all cases are occupational diseases of the peripheral nervous system and musculoskeletal system. Almost a quarter are sensorineural hearing loss. One fifth consists of vibration disease which is comparable with previously available information in the literature [25]. However, the frequency of development and detection of respiratory diseases is insignificant when compared to previously available data (more than 10% of cases) [26].

In addition, a feature of the dynamics of the development of certain nosological forms of occupational

pathology among uranium mining workers during the first 10-year period analyzed was the predominance of the number of cases of occupational respiratory diseases (silicosis and chronic dust bronchitis with a predominance of silicosis). Currently, dust bronchitis due to exposure to industrial dust is the predominant form of occupational respiratory disease. The predominance of cases of respiratory pathology among workers in the first decades of the operation of the enterprise can be explained by the fact that in the initial period a significant proportion of workers, including underground miners, had previously worked in underground mining facilities in other regions of the country. As our own qualified personnel were trained, the proportion of workers exposed to fibrogenic dust at other enterprises significantly decreased. This led to a change in the structure of occupational respiratory pathology.

The proportion of malignant neoplasms is rather high (for 50 years it amounted to 10.1% of cases), being significantly higher than the national average [24]. Regular detection of cases of malignant neoplasms (mainly of the respiratory system with a predominance of lung cancer) deserves special attention. These figures significantly exceed the national data and account for almost 10% of all cases of occupational cancer in the whole country. This is an alarming fact and requires special attention from industry management, enterprises, and medical professionals. At the same time, the high detection of oncological pathology can be attributed to the orientation of the occupational pathology service towards the significance of a priori risk in workers engaged in underground mining of uranium ore. This deserves a positive assessment of the work of the medical service [27].

Currently, the share of professional hearing loss among uranium mining workers has significantly decreased. This is probably due to an increase in the effectiveness of noise-canceling measures.

CONCLUSION

The specifics of the working conditions of uranium mining workers at the present stage (features of a priori occupational risk) are reflected in the indicators of occupational morbidity of this contingent. Occupational diseases of the musculoskeletal system prevail, and the levels of occupational diseases are many times higher than the national average.

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