UDC: 613.62
IRSTI: 76.33.37
DOI: 10.24412/2790-1289-2025-1-74-92

MORBIDITY AMONG MINING WORKERS

A. Y. Vangay [1*], S. A. Abzaliyeva [1], A. O. Sarsenova[2],
K. B. Abzaliyev [1], M. B. Baurzhan [3]
[1]Al-Farabi Kazakh National University, Kazakhstan, Almaty
[2] LLP «Kazakhstan Medical University «KSPH», Kazakhstan, Almaty
[3]Astana Medical University, Kazakhstan, Astana
[*]*Corresponding author*

Abstract

The paper examines the impact of occupational risk factors in the mining industry on workers' health and recognizes methodologies and tools for mitigating or eliminating these risks. Reducing the harmful impact of the mining industry is being studied and monitored globally. According to the International Organization for Safety and Health at Work, about 2.8 million people die annually as a result of work-related accidents or occupational diseases. Additionally, around 374 million people suffer from various injuries and illnesses at the workplace each year. The issues of occupational diseases and industrial injuries are also relevant to the mining industry in Kazakhstan.

Objective. To study the literature data on the impact of occupational factors on the health of workers in a mining enterprise and the international experience of measures to reduce the harmful effects of the working environment in this industry at the present stage.

Materials and methods. The studies and publications on the study topic were analyzed using sources indexed in electronic databases such as e-Library, Google Academy, PubMed, Web of Science, and Scopus.

Results. An integrated approach to reducing the effects of exposure to harmful factors in the mining industry's production environment yields positive results.

The results of a literature review on studying occupational diseases and injuries among workers in the mining industry are presented. The features of measures to mitigate the risk of hazardous working conditions in different countries are listed.

Conclusions. A comprehensive approach to control and minimize the consequences of harmful occupational factors in the mining industry has shown positive outcomes. According to the latest data, tobacco smoke is one of the deadly risk factors for deaths in the world. This is an additional approach to existing tobacco control measures.

Keywords: *occupational diseases, industrial injuries, mining industry, harmful working conditions, pneumoconiosis.*

Introduction

Mining is one of the main industries that significantly contribute to the economic performance of both developed and developing countries. In Kazakhstan's economy, this sector also holds a leading position. The industry has undergone significant modernization and technological innovations in recent years. However, numerous studies have shown that in mining and processing enterprises, despite the measures taken, the working conditions during mining operations remain extremely difficult and harmful to workers' health [1]. It should be noted that over the past two decades, Kazakhstan has undergone significant technical transformations and reforms in mining production. Many enterprises have created plans for the modernization of production by introducing new high-performance machines and mechanisms.

Published reports indicate the mining industry's impact on the gradual increase in patients with diseases caused by exposure to dust, noise, radioactive materials, other toxic and harmful substances, and other factors [2].

According to the International Organization for Safety and Health at Work, 2.8 million people die annually from work-related accidents and diseases as a result of work accidents or from work-related diseases. Approximately 374 million people a year suffer various types of injuries and diseases in the workplace. Of the 6,300 work-related deaths that occur every day, 5,500 are due to occupational diseases. In addition, the ILO estimates that the number of cases of nonfatal occupational diseases is 160 million per year. In the CIS countries, 12 million people become victims of occupational diseases every year [3; 4].

Results and discussions

Published data indicate that disease types and morbidity trends vary widely from country to country due to different occupational hazards. For example, 27,240 cases of occupational diseases in China were reported in 2010, with 23,812 attributed to exposure to mining dust [5]. In Argentina, there were 22,013 cases of occupational diseases in 2010, with musculoskeletal injuries and respiratory diseases being the most common [6]. In 2011, Japan registered 7,779 cases of occupational diseases, among which lumbar spine injuries and pneumoconiosis prevailed [7], and paid benefits for 325 cases of mental disorders [8]. In the United Kingdom, in 2011, benefits were paid for 5,920 cases of occupational diseases, the most common of which were pneumoconiosis, diffuse mesothelioma, and osteoarthritis [9]. According to the U.S. Bureau of Labor Statistics, 207,500 workers in the United States suffered from nonfatal occupational diseases in 2011, with the three most common problems being skin diseases, hearing loss, and respiratory diseases [10]. One of the fundamental differences between national safety and health regulatory plans and international practice is using a regulatory approach based on prescriptions rather than performance.

S. Davoodi et al. studied important aspects of the operation of registries in ten countries, including Finland, France, Great Britain, Australia, the Czech Republic, Malaysia, the USA, Singapore, Russia and Turkey. The study showed that these countries had built a sufficiently productive system and defined goals in statistics, treatment, and prevention. The necessary minimum information about the patient, his disease, profession, and employer was provided by both doctors and employers [11]. Some countries have specific classification systems for the professions; some use international classification systems such as ICD-10. Since occupational diseases are often preventable but not curable, all countries need to consider prevention and early detection of occupational diseases as the objectives of their medical registration systems. It is also recommended that all countries agree on the global characteristics of occupational disease registries. This allows countries to compare their data internationally.

Monitoring workers' health is linked to workplace environment evaluation, enabling the identification of health risks and the association of specific illnesses with occupational activities. Assessment of working conditions (occupational risks) is a system for analyzing and evaluating workplaces in terms of risks to the health of employees. The latest developments in occupational health risk prevention and mitigation are related to methods for forecasting the risk conditions of employees, the preparation of measures, the implementation of which excludes the impact of hazardous and harmful factors, necessary health measures, and decisions of ecologists. In addition, it helps prevent similar diseases among the rest of the workers. Although the main purpose of health surveillance is the early detection of harmful effects on workers to take timely preventive measures, it also contributes to recognizing occupational diseases with a long latency period. As noted in the Occupational Health Services Convention, 1985 (No. 161), for employers to provide adequate health care for their employees, they need an effective system of health services.

According to the European Occupational Safety and Health Agency (EU-OSHA), over the past 10 years, the number of accidents at work has decreased by 25 %. However, work-related diseases still cause an estimated 2.4 million deaths worldwide each year, and 200,000 of them occur in Europe [4].

The EU and Member States have developed an advanced regulatory system that establishes preventive and protective measures to address occupational health risks to employees [4]. Such a system is based on a three-pronged approach in which workers, employers, and governments are actively involved in developing and implementing these occupational safety and health mea-

sures. The EU legislative framework for occupational health and safety consists of a framework directive and 24 specific directives. The European Framework Directive on Occupational Safety and Health of 1989 is the basis for common principles and minimum standards in the EU. This directive focuses on a culture of risk prevention and establishes employers' obligations to assess risks, take preventive measures, and provide employees with information on occupational safety and health, training, consultation, and balanced participation. Morbidity and risk factors specific to employees in the production sector.

The few most common occupational diseases were mentioned in the EU report:

The first place – is musculoskeletal disorders (MSD), the most common group of diseases associated with the work-related cycle. This group includes pathology of the back, neck, shoulders, upper and lower extremities, and damage or disorders of the joints or other tissue conditions that can lead to disability. Clinically, these range from minor pain to severe conditions that can lead to disability. Scientific evidence shows that in the long term, work-related stress can contribute to musculoskeletal disorders and poor health status, including arterial hypertension and cardiovascular diseases. It can also alter immune function, which in turn can contribute to the development of cancer. They can also alter immune function, which can contribute to cancer. Guidance documents at the EU and national level define diagnostic and exposure criteria for recognizing a given occupational disease as a listed one.

Severe medical accidents among production workers can lead to medical evacuation of the employee for further provision of the necessary medical care. There is no exact data on the number and reasons for the medical evacuation of mining workers. The following agents might cause the evacuation: 1. hazardous substances, such as chemical and biological agents, including carcinogens; 2. radiation, including ionizing radiation and ultraviolet radiation from the sun; 3. physical factors, including vibration, noise, manual lifting and sedentary work, 4. organizational and psychosocial occupational risk factors, such as shift work and stress. So, health promotion programs based on risk assessment are crucial; they address lifestyle issues and rely on long-term worker well-being initiatives.

Continuous assessment of exposure to health hazards at work sites is equally important to manage the health risks of individual employees, as well as the Health Risk Assessment (HRA) process.

As part of industrial hygiene programs, identifying and mitigating health hazards has great value. The program includes the following components: (1) hazard identification, (2) risk assessment relative to exposure to the hazards, (3) hazard monitoring, (4) development of a control plan, (5) employee training and implementation of the control plan, and (6) evaluation of the effectiveness of control measures.

Once occupational exposures have been identified, a risk assessment model and its impact on employee health should be developed and implemented. That will include policies, procedures, recognized methodologies, and tools to address/control these risks [4]. Such a risk assessment system aims to promote and maintain workers' highest level of physical, mental, and social well-being in all professions by preventing ill health, controlling risks, and adapting to working conditions. Such assessments are required and assured by law in many counties worldwide.

The registration process differed from country to country. For example, China has strengthened its health and safety legislation, increasing the number of strict safety requirements for enterprises and introducing multiple safety regulations [12].

«People orientation and attention to the health and safety of employees» is increasingly becoming an important symbol and good image of modern enterprises, which is also the focus of the OHSAS18001 occupational health and safety management system [13]. In July 2016, the «Occupational Disease Prevention Law» was revised to impose mandatory health and safety regulations and standards. OHSAS18001 is a kind of advanced modern safety management method widely adopted by most countries in the world. It mainly emphasizes a systematic approach to occupational health and safety management. The main goal is to control and minimize health and safety risks and reduce occupational accidents and diseases by establishing health and safety mechanisms. Thus, it is very important to develop a system of preventive measures since the later the disease is detected, the worse the therapeutic effect will be.

Diseases of mining workers. Lung diseases.

Worldwide, work in mines is associated with a high incidence of respiratory diseases. Many studies indicate an increase in the risk of silicosis due to exposure to silica dust and pulmonary tuberculosis regardless of the type of mine, for example, coal, copper, gold, or others [14-16]. A study conducted in South Africa found that within a year of ending work in a mine, the mortality risk is higher than in the general population [17]. Even in the U.S., the prevalence of pneumoconiosis among coal mine miners is rising [18], although miners who strictly follow sanitary standards are less likely to report lung disease [19]. Safety and health problems for miners also include hearing loss/problems [20-22], sleep deprivation [23], and cardiac strain [24].

In recent decades, the safety and health of workers have not received adequate attention in sub-Saharan Africa, including Zambia, due to the focus on the control of communicable diseases, including HIV/AIDS, maternal and child health, and reproductive health [25].

Zambia is an example of the mining industry's impact on national economic development and its negative impact on public health. This country's economy significantly depends on extracting natural resources, particularly copper [26]. The trade-offs between economic development and this mining activity's potential positive or negative health and well-being consequences must be considered [27]. Understandably, extracting copper and other metals might significantly contribute to the country's revenue and create significant employment opportunities. At the same time, it negatively impacts the environment and human health, which are equally important resources of a country and should be protected as well [28].

However, the conditions for workers are becoming more complex due to increased investment by the foreign private sector. At that, implementing policies and regulations that ensure safe and healthy working environments lags in low- and middle-income countries, including sub-Saharan Africa. A single copper mine in Zambia can employ up to several thousand workers. For example, only the four largest copper companies hired 56,300 people in 2012 [29]. The country, located in the south of the African continent, is rich in mineral resources, and copper mining is the most important in Zambia's economy. Its econom-ic growth rate was 3.8 % in 2018 [30]. According to data from the International Labor Organization (hereinafter − ILO) published in 2013, 26 % of the 6,000 cases of occupational diseases and injuries recorded be-tween 2003 and 2007 occurred in the mining industry. Poor working conditions and human rights violations cause several health hazards reported among workers. This data is coming from interna-tional human rights organizations [31].

Additionally, HIV-positive results are verified at around 12.4 % of the reproductive population in Zambia [32], which, together with tuberculosis, can potentially have devastating consequences for the country's workforce. Undoubted-ly, miners in Zambia have one of the most stable working environments among their counterparts in sub-Saharan Africa. However, more attention should be paid to investigating their health status and social security needs.

Several studies have been conducted to reveal and mitigate the potential health impacts of communities located close to the project [33-35]. The Health Information Administration (hereinafter − HIA) applied the determinants of the health model, including the social, economic, and physical environ-ment, as well as individual characteristics and be-haviors, to cover the full range of potential direct and indirect public health impacts of the project [36; 37]. The monitoring plan included collect-ing routine health information system data and periodic cross-sectional survey data for indicators considered to be potential determinants of human health per the HIA. The groups were comparable in age (34.0±8.0 years versus 35.9±9.8 years), BMI (23.3±2.6 versus 22.8±3.5), or current smok-ing (68 % versus 55 %). However, miners reported pulmonary tuberculosis more often (11/111) than taxi drivers (2/97). Nasal/ocular symptoms (in-cluding nosebleeds) and lower respiratory tract symptoms were significantly more common in the past 12 months in artisanal miners (75-97 % and 10-96 %, respectively) than among the control group (1-2 % and 1-6 %, respectively).

Thus, even based on the data obtained, it is possible to conclude the negative impact of occupational factors on the health of mining workers and the need to take comprehensive measures to account for and prevent the development of occupational diseases.

In another study [38], D. Mijakoski et al. (Institute of Occupational Health of the Republic of Macedonia, WHO CC, GA2LEN CC, Skopje) studied the prevalence of chronic respiratory symptoms, changes in lung function and chronic obstructive pulmonary disease (hereinafter COPD) in lead-zinc mine miners and determined their predictors. The cross-sectional study included 50 male lead-zinc mine miners (mean age 41.3 ± 6.1 years, me-dian duration of exposure 22.6 ± 7.1 years) and 50 office workers; the groups were matched in gen-der, age, duration of work, and smoking status.

The results showed that occupational exposure in lead-zinc mine miners significantly increased the likelihood of respiratory symptoms, impaired lung function, and COPD.

Little is known about the current health status of U.S. mine and non-mine miners, partly because there are no health surveillance systems for this population. The National Institute for Occupational Safety and Health (hereinafter NIOSH) is develop-ing a program to characterize the disease burden among metal and nonmetal (MNM) miners. This report discusses current knowledge and potential data sources on the health of MNM miners. Recent national studies were analyzed, and the literature relating to the health status of MNM miners was reviewed. No reliable estimates of disease preva-lence have been identified, and national studies have not provided information relevant to MNM miners. As there are significant gaps in under-standing the current health status of MNM min-ers, NIOSH plans to develop a health surveillance program for this population to guide intervention efforts to reduce occupational and personal risks of chronic disease [39].

Kirsten Almberg et al. [40] in his paper showed that in the U.S., miners had significantly increased odds of dying from coal worker's pneumoconiosis (hereinafter CWP), COPD, and lung cancer compared to their counterparts in the general U.S. population. This higher mortality rate has also worsened, as modern miners face more risk than their predecessors. Researchers have given very serious risk indicators of death in Central Appalachian miners born in 1940 or later from a non-cancerous respiratory disease such as black lungs or COPD. Their risk of death exceeded 8 times that of their counterparts in the general population. This eight-fold increase was the highest chance of dying from a non-cancerous respiratory disease in all age groups studied. Progressive massive fibrosis, which is caused only by inhaling dust, was also more common in younger age groups. Thus, inhalation of coal mine dust (in the scientific literature, asbestosis, pneumoconiosis of coal miners is designated – (CWP)) contributes to an increase in the burden of non-malignant respiratory diseases, such as pneumoconiosis (CWP and silicosis) and other chronic diseases of the lower respiratory tract, COPD. This was true for every age group, including almost every age group nationally and in Central Appalachia.

The results highlight the importance of preventing chronic lower respiratory diseases, such as COPD, caused by inhaled coal dust and other factors in miners.

Cardiovascular diseases. Cardiovascular diseases remain the leading cause of death among all noncommunicable diseases despite the measures undertaken. The role of occupational hazards in the mining industry on the development of the cardiovascular diseases is being actively studied, and various data have been obtained and published [41]. Cancer and cardiovascular diseases came out on top of the list of diseases. Cardiovascular disease is now one of the most common health problems for mining workers as well, as it has multifactorial causes. Comprehensive data on deaths or serious events due to medical causes are difficult to obtain.

An interesting study was conducted in the U.S. that demonstrated low odds of coronary heart disease mortality among Central Appalachian miners compared to their white male counterparts in the general population, which is consistent with other studies. This may be because coal miners have better cardiovascular fitness than the general population, the so-called healthy worker effect [40].

However, reports from doctors providing medical services in the mining industry indicate that cardiovascular disease and, increasingly, stroke are one of the main causes of serious illness leading to evacuation [3].

Carcinogenic effect. The effects of carcinogenic factors of various inhaled substances in their work environment, including diesel exhaust, silicon, asbestos, and radon, have been studied in the United States. At the national level, miners were found to have significantly increased their

likelihood of dying from lung cancer in all four age groups compared to the U.S. general population [40].

The increased lung cancer mortality among miners also highlights the importance of providing eligible miners with the opportunity to be screened for lung cancer using low-dose CT scans so that the cancer can be detected in the early stages when treatment produces the best result.

The authors also point to an increase in the incidence of pneumoconiosis among miners, which is only one of the diseases caused by coal dust. This study shows that American miners are also at increased risk of other diseases, including COPD and lung cancer. Preventive measures, including control of exposure to inhaled coal dust, should aim to eliminate all these serious diseases [40].

Intoxication with heavy metals. In Thabeikkyin Township, Mandalay Region, Myanmar, in 2020, Win Thiri Kyaw and co-authors conducted a study to assess the health status of the community [41]. The subjects were divided into two groups: miners and non-miners living in the area. Respiratory status was investigated, and other clinical assessments were conducted. In particular, the participants' hair was analyzed for the presence of heavy metals. The respiratory function of miners was similar to that of non-miners. However, the respiratory function of miners decreased with an increase in the period of employment in the mining industry. Another result is that neurological signs and symptoms of chronic mercury intoxication were revealed in 3 of the 18 miners. There was a statistically significant difference in median mercury concentrations in hair that were significantly higher in miners than in non-miners ($P = 0.01$), and 9 out of 18 miners and 2 out of 11 non-miners had high levels of mercury [41]. The authors declared that there was a correlation between respiratory function weakness and the duration of mining operations, and clinical signs of chronic mercury intoxication were revealed in a minor number of miners with elevated levels in laboratory samples.

Work-related injuries. According to data from previous studies, certain programs in industrial safety and health promotion of workers, including injury prevention and wellness programs in the mining industry, were developed, recommended for implementation, and evaluated. These studies have high importance due to the significant prevalence of injuries and mortality, as well as ad- verse outcomes because of lost working hours [42; 43]. However, the implementation and feasibility of these programs have not been sufficiently guar- anteed. Moreover, the worldwide tendency to- wards using contract labor and extended working days creates additional risks of injury due to long working hours [44]. Previous studies have iden- tified a significant correlation between m usculo- skeletal injuries and ergonomic risk factors such as working with a bent back and grasping objects at underground working activities [45; 46]. A study conducted in Zambia shows that the most common mechanism of injury is the handling of tools and materials, and the hands and fingers are the most often injured parts of the body [47]. According to a US study, the worker's age, work experience, use of mining equipment, electrical injuries, and work in underground mines were predictors of lost time injuries in the mining industry. Mental health conditions as a possible risk factor for the level of work-related injuries had insufficient evidence [48]. A high mortality rate is registered in mining, especially underground mines. Falling rock is the most common cause of underground fatal injuries [47].

A study of the effects of occupational noise on hearing and cardiovascular disease in U.S. industries and occupations found that 25 % of respondents had a history of exposure to occupational noise (14 % had been exposed within the past year), of which 12 % had hearing problems, 24 % had hypertension, and 28% had elevated choles- terol levels [49]. Thus, according to the authors, hypertension, elevated cholesterol, and hearing problems are more common among noise-exposed workers. Reducing noise levels in the workplace is crucial.

Other authors found a higher prevalence of hypertension (aged <55 years), hearing loss, low back pain, leg pain progressing from low back pain, and joint pain among mining workers compared to workers in 5 non-manual occupations. The results were derived from an analysis of publicly available data from the 2007-2018 National Health Survey [50].

Immunopathological conditions. An interesting study that revealed the effect of copper

dust on the development of immunopathological conditions was conducted in India among workers of a copper mine in Malanjkhand [51]. In chronic exposure to copper dust, individuals chronically exposed to copper dust had significantly higher copper content ($P < 0.0001$) and significantly elevated serum IgG and IgA ($P < 0.0001$) compared to office workers and normal controls. In contrast, significant reductions in serum IgM were observed in both groups compared to normal controls ($P < 0.0001$). Serum IgE was more significantly elevated only in miners than in normal controls. Copper showed a significant positive Pearson correlation coefficient with IgE, IgG, and IgA ($r = 0.39$; $r = 0.28$; $r = 0.21$) but a negative correlation ($r = -0.39$) with IgM. The odds ratio analysis confirmed that the increased IgE levels in the miners and the decrease in IgM levels in both groups were indeed affected by the increase in copper levels from normal to abnormal. Miners are prone to diseases such as Diabetes Mellitus type 2 and respiratory discomfort (asthma and hypersensitivity), as an imbalance of IgM and IgE is known to be associated with such diseases. The immunopathy seen in chronically exposed miners can be explained by copper toxicity.

Mental health. The mining environment can also affect mental health, causing symptoms and pathological conditions such as anxiety, job stress, depression, sleep disturbances, mental fatigue, and others. According to José Matamala Pizarro et al. [52], who analyzed 12 years of data on factors such as stress at work, experience of insecurity, poor sleep quality, non-subjective well-being, job dissatisfaction, conflict of social relationships, risk of accidents and injuries, diseases of the musculoskeletal system, substance abuse, hazardous working conditions and demanding work organization, etc. As a result, four important areas were identified: 1) Psychological problems and personal factors (38.2 %); 2) Psychosocial problems and health-related factors (23.6 %); 3) Well-being (21.1 %) and 4) Physical problems and organizational factors (17.1 %) for which the mining industry can expose its workers to serious mental health problems.

Factors influencing health status and increasing susceptibility to diseases that increase feelings of suffering and worsen their quality of life have also been identified, such as psychological demands, shift work, fatigue, anxiety, depression, violence against subcontractors, and worsening living conditions after moving due to silicosis.

In the Republic of Kazakhstan, according to data, there is an increase in workers involved in the mining and quarrying industries, so in the second quarter of 2021, 281.2 thousand people were employed (figure 1) [53].

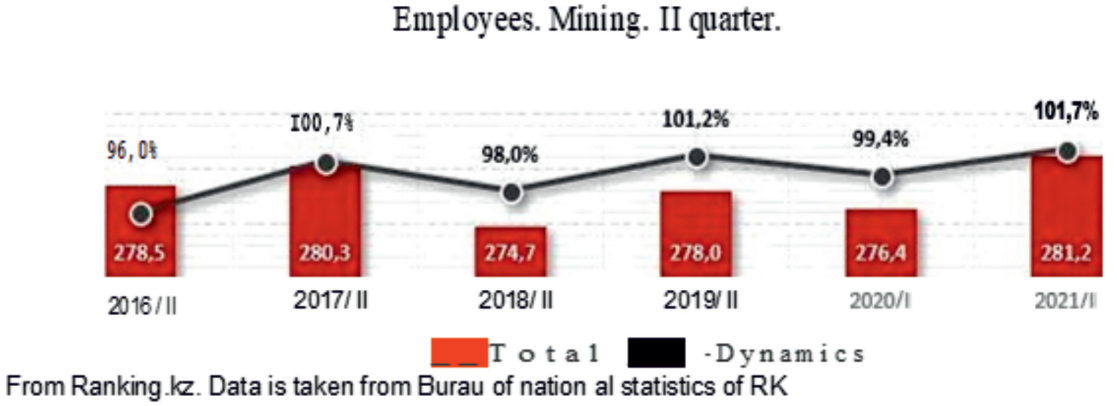

Figure 1. Number of mining workers in Kazakhstan, 2016-2021
Source: Compiled by the authors

According to the Statistics Committee of the Ministry of National Economics of the Republic of Kazakhstan, 2670 accidents were registered in 2023. Of the total number of victims, women accounted for 18.2 %. At the same time, 334 people suffered from group accidents, 662 from occupational diseases, and 97 from poisoning. As a result of the accident, 611 people received closed fractures, 507 – superficial injuries, 276 – concussion injuries and injuries to internal organs, 160 – other fractures (with dislocation, with displacement), 138 – open fractures, and 102 – thermal burns.

If we talk more about the dangers of professions, Kazakhstan's most traumatic profession today is miner's specialty. Many accidents occur in underground work with bolters, blasters, and tunnelers. More than 70% of injuries to miners are injuries to limbs. In the vast majority, these injuries are of light or moderate severity. In occupational morbidity, according to diagnoses among workers in the mining and metallurgical sector, the first place is occupied by diseases caused by inhalation of coal dust, which leads to severe respiratory diseases - pneumoconiosis and dust bronchitis. In second place are diseases associated with physical overload and overload of organs and systems of the body (radiculopathy).

The largest number of workers in unfavorable working conditions in all aspects falls on the country's mining industry. The number of people working on equipment that does not meet safety requirements in the mining industry is 44 % [54]. The most common occupational diseases were pneumoconiosis caused by dust (156 people), intervertebral disc lesions (130), bronchitis and pneumonitis (123), and bilateral sensorineural hearing loss (113).

According to the Committee on Statistics and the IAC IC «Competence research» the number of occupational diseases in Kazakhstan is increasing rapidly [55].

The number of employees working in hazardous conditions in Kazakhstan is more than 300 thousand people, of which 40.9 % work in conditions of increased noise and vibration; increased gas and dust contamination of the working area – 35.1 %; unfavorable temperature regime – 18.1 %; 4.5 % of hard physical labor [56].

According to the data of the Statistics Committee of the Ministry of National Economics of the Republic of Kazakhstan [57], the structure of occupational diseases by industry is as follows (table 1):

Table 1. Distribution of occupational diseases by industry

Type of industry	2016	2017	2018
Mining	51,4 %	69,5 %	61,9 %
Coal	20,6 %	17,5 %	29,3 %
Chemical	6,6 %	5,7 %	4,4 %
Construction	0,3 %	-	0,9 %
Healthcare	3,1 %	1,5 %	1,5 %
Metallurgy	17,5 %	0,8 %	3,1 %
Oil And Gas	0,3 %	-	0,18 %

Source: compiled by the authors

According to subparagraph 2) of paragraph 2 of Article 182 of the Labor Code of the Republic of Kazakhstan, the employer must follow several requirements to control the state of safety and health of employees at the enterprise.

However, not all occupational health and safety measures provided for in this Labor Code article are mandatory for all employers. This applies, for example, to the certification of production facilities (carried out under the Rules for Mandatory Periodic Certification of Production Facilities for Working Conditions dated December 28, 2015, No 1057 (amended on 08/28/2020), the introduction of an occupational health and safety management system, and the conduct of mandatory medical examinations.

Medical examinations are conducted according to the current legislation. Par. 2, Order No. KR DSM-131/2020 regulates the procedure of mandatory periodic medical examinations.

The scope of work for health, safety, and environment (hereinafter – HSE) departments in organizations with more than fifty employees is regulated by the Standard Regulations on HSE Departments in the Organization, approved by order of the Minister of Health and Social Development of the Repub-lic of Kazakhstan dated December 25, 2015, No. 1020 (as amended on 12.08.2022).

Studies on the incidence of temporary disability on industrial sites related to occupational activities and occupational injuries in 4,294 workers of the mining industry of Central Kazakhstan

(Kazakhmys Corporation) revealed the list of most common diseases [58]. The first place is occupied by diseases of the respiratory system (41 % of the total number of cases in the reporting year), diseases of the musculoskeletal system in cases and days of disability remain in second place for many years, the third place in the nomenclature is occupied by diseases of the gastrointestinal tract, namely gastritis, and duodenitis, as prevailing diagnoses. Of the registered cases of CVD, 81 % were cases diagnosed with arterial hypertension. Researchers have found a direct correlation between morbidity and temporary disability and data on workers' working conditions.

An analysis of industrial injuries and occupational morbidity in the Republic of Kazakhstan over 10 years and data on industries with unfavorable and harmful working conditions showed that industrial injuries in all regions of the republic generally tend to decrease [57]. Thus, according to the authors, when comparing the indicators for 2008 and 2018, the following is observed: in the Karaganda region - a decrease of 54.2 %; in the East Kazakhstan region - a decrease of 43.6 %; in the Pavlodar region - a decrease of 43.6 %. At the same time, as noted in the review of the experience of conducting periodic assessments of working conditions at mining enterprises of the Republic of Kazakhstan, 44 % of employees work on equipment that does not meet safety requirements in the mining industry [58].

To date, during the period of progressive technical changes and the emergence of new high-performance equipment, the level of occupational trauma and diseases, except for some sectors of the industry, remains high in the mining industry of Kazakhstan. Despite the development of various programs and procedures to minimize health risks, rates of workplace injuries and occupational diseases are still alarmingly high. Many health issues directly affect workers in the workplace, including work environment, work practices, and workers' physical and mental state.

Conclusion

There is a definitive link between hazardous working conditions in the mining industry and the development and progression of various diseases, including respiratory diseases, musculoskeletal disorders, cancers, cardiovascular conditions, skin diseases, and mental health issues. Although the etiology of all these diseases is complex (multifactorial), the adverse effect of occupational hazards on miners' health can never be excluded. Several factors are significantly associated with risk factors for and the progression of these conditions.

Hence, exposure to occupational risks and their consequent effects should be a top priority. Special focus should be on sobriety and implementing comprehensive measures to monitor and prevent occupational diseases.

References

1. Чеботарёв А. Г., Пфаф В. Ф., Гибадулина И. Ю. Состояние условий труда, профессиональной заболеваемости и совершенствование медико-профилактического обеспечения работников горнодобывающих предприятий // Горная промышленность. – 2021. – №3. –С. 139-143. – DOI: 10.30686/1609-9192-2021-3-139-143.

2. Jiangdong Bao, Jan Johansson, Jingdong Zhang. An Occupational Disease Assessment of the Mining Industry's Occupational Health and Safety Management System Based on FMEA and an Improved AHP Model // Sustainability. – 2017. – Vol. 9(1). – P. 94. – DOI: https://doi.org/10.3390/su9010094

3. Convention № 155 of the International Labour Organization «On Occupational Safety, Health, and the Working Environment» (adopted in Geneva on 22.06.1981 at the 67th session of the ILO General Conference) [Electronic source] // United Nations Treaty Collection [Website]. – URL: https://treaties.un.org/Pages/showDetails.aspx?objid=08000002800dbe0a (Accessed on: 18.10.2024).

4. Commission Regulation (EU) 2022/2294 of November 23 2022 implementing Regulation (EC) No 1338/2008 of the European Parliament and of the Council as regards statistics on healthcare facilities, healthcare human resources and healthcare utilization. Official Journal of the European Union L 304. – 2022. – Vol. 65. – P.42-52.

5. Zhang X., Wang Z. & Li T. The current status of occupational health in China // Environ Health Prev Med. – 2010. – Vol. 15. – P. 263-270. – DOI: https://doi.org/10.1007/s12199-010-0145-2.

6. Superintendencia de Riesgos del Trabajo [Electronic source] // Argentina.gob.ar. [Website]. –

URL: https://www.argentina.gob.ar/normativa/nacional/disposici%C3%B3n-46-2009-157874 (Accessed: 18.10.2024).
7. Survey of Work-Related Diseases. [Electronic source] // Ministry of Health, Labour and Welfare, Japan [Website]. – URL: https://www.mhlw.go.jp/english/wp/wp-hw3/dl/appendix-5.pdf (accessed on 18.10.2024).
8. Occupational Disease Recognition of Mental Disorders [Electronic source] // Ministry of Health, Labour and Welfare, Japan [Website]. – URL: http://www.mhlw.go.jp/bunya/roudoukijun/gyomu.html (Accessed on 18.10.2024).
9. Industrial Injury first diagnosed prescribed diseases all assessments resulting in payment by type of disease [Electronic source] // Department for Work and Pension, United Kingdom 2012 [Website]. – URL: https://www.gov.uk/government/statistics/industrial-injuries-disablement-benefit-quarterly-statistics-march-2012 (Accessed on 10.09.2024).
10. Number, annualized incidence rate, and median days of nonfatal occupational injuries and illnesses with days away from work (DAFW) by selected industry and source types, private industry, 2021-22 [Electronic source] // Bureau of Labor Statistics, United States Department of Labor 2023 [Website]. – URL: https://www.bls.gov/news.release/osh.t06.htm.
11. Davoodi S., Haghigi K. S., Kalhori S. R., Hosseini N. S., Mohammadzadeh Z., Safdari R. Registers of occupational diseases - characteristics and experience // Acta Inform Med. – 2017. – Vol. 25(2). – P. 136-140. – DOI: 10.5455/aim.2017.25.136-140.
12. Bao J., Johansson J., Zhang J. An Occupational Disease Assessment of the Mining Industry's Occupational Health and Safety Management System Based on FMEA and an Improved AHP Model // Sustainability. – 2017. –Vol. 9. – P. 94. – DOI: https://doi.org/10.3390/su9010094.
13. Occupational health and safety management systems. Requirements [Electronic source] // National Standards of People's Republic of China [Website]. – 2011. – URL: https://www.chinesestandard.net/PDF/English.aspx/GBT28001-2011 (Accessed: 07.09.2024).
14. Naidoo R. N., Robins T. G., Murray J. Respiratory outcomes among South African coal miners at autopsy // Am J Ind Med. – 2005. – Vol. 48(3). – P.217-224. – DOI: 10.1002/ajim.20207.
15. Stuckler D., Basu S., McKee M., Lurie M. Mining and risk of tuberculosis in sub-Saharan Africa // Am J Public Health. – 2011. – Vol. 101(3). – P.524-530. – DOI: 10.2105/AJPH.2009.175646.
16. Ngosa K., Naidoo R. N. The risk of pulmonary tuberculosis in underground copper miners in Zambia exposed to respirable silica: a cross-sectional study // BMC Public Health. – 2016. – Vol. 16. – P. 855. – DOI: https://doi.org/10.1186/s12889-016-3547-2.
17. Bloch K., Johnson L. F., Nkosi M., Ehrlich R. Precarious transition: a mortality study of South African ex-miners // BMC Public Health. – 2018. – Vol. 18(1). – P. 862. – DOI: 10.1186/s12889-018-5749-2.
18. Blackley D. J., Halldin C. N., Laney A. S. Continued Increase in Prevalence of Coal Workers' Pneumoconiosis in the United States, 1970-2017 // Am J Public Health. – 2018. – Vol. 108(9). – P. 1220-1222. – DOI: 10.2105/AJPH.2018.304517.
19. Yorio P. L., Laney A. S., Halldin C. N., Blackley D. J., Moore S. M., Wizner K., Radonovich L. J., Greenawald L. A. Interstitial Lung Diseases in the U.S. Mining Industry: Using MSHA Data to Examine Trends and the Prevention Effects of Compliance with Health Regulations, 1996-2015 // Risk Anal. – 2018. – Vol. 38(9). – P. 1962-1971. – DOI: 10.1111/risa.13000.
20. Jiménez-Forero C. P., Zabala I. T., Idrovo Á. J. Work conditions and morbidity among coal miners in Guachetá, Colombia: The miners' perspective // Biomedica. – 2015. – Vol. 35 Spec. – P. 77-89. – DOI: 10.1590/S0120-41572015000500009.
21. Masterson E. A., Tak S., Themann C. L., Wall D. K., Groenewold M. R., Deddens J. A., Calvert G. M. Prevalence of hearing loss in the United States by industry // Am J Ind Med. – 2013. – Vol. 56(6). – P. 670-681. – DOI: 10.1002/ajim.22082.
22. Musiba Z. The prevalence of noise-induced hearing loss among Tanzanian miners // Occup Med (Lond). – 2015. – Vol. 65(5). – P. 386-390. – DOI: 10.1093/occmed/kqv046.
23. Legault G., Clement A., Kenny G. P., Hardcastle S., Keller N. Cognitive consequences of sleep deprivation, shiftwork, and heat exposure for underground miners // Appl Ergon. – 2017. – Vol. 58. – P. 144-150. – DOI: 10.1016/j.apergo.2016.06.007.
24. Lutz E. A., Reed R. J., Turner D., Littau S.

R. Occupational heat strain in a hot underground metal mine // J Occup Environ Med. – 2014. – Vol. 56(4). – P. 388-396. – DOI: 10.1097/JOM.0000000000000107.
25. Key Health challenges for Zambia. London: ACCA [Electronic source] // The Association of Chartered Certified Accountants (ACCA) [Website]. – 2013. URL: https://www.accaglobal.com/content/dam/acca/global/PDF-technical/health-sector/tech-tp-khcz.pdf. (Accessed: 11.10.2024).
26. Sikamo J., Mwanza A., Mweemba C. Copper mining in Zambia - history and future // J. S. Afr. Inst. Min. Metall. – 2016. – Vol. 116(6). – P .491-496. – DOI: https://doi.org/10.17159/2411-9717/2016/v116n6a1
27. Making Mining Work for Zambia: The Economic, Health, and Environmental Nexus of Zambia's Copper Mining Industry [Electronic source] // World Bank Group [Website]. – 2015. – URL: https://www.worldbank.org/en/news/press-release/2015/06/17/making-mining-work-for-zambia
28. Williams B., Campbell C. Creating alliances for disease management in industrial settings: a case study of HIV/AIDS in workers in South African gold mines // Int J Occup Environ Health. – 1998. – Vol. 4(4). – P. 257-264. – DOI: 10.1179/oeh.1998.4.4.257.
29. ILO supports a partnership approach in the Zambian mining sector to create jobs and stimulate inclusive growth [Electronic source] // International Labour Organization [Website]. – URL: https://www.ilo.org/projects-and-partnerships/projects/ilo-supports-partnership-approach-zambian-mining-sector-create-jobs-and (Accessed: 17.10.2024).
30. World Bank Open Data. GDPgrowth-Zambia [Electronic source] // World Bank [Website]. URL: https:// data.worldbank.org/indicator/NY.GDP.MKTP. KD. ZG. ZM (2019). (Accessed: 17.10.2024).
31. Human Right Watch. You will be fired if you refuse – labour abuses in Zambian's Chinese state-owned copper mines [Electronic source] // New York: Human Right Watch.2011 [Website]. – URL: https://www.hrw.org/sites/default/files/reports/zambia1111ForWebUpload.pdf (Accessed October 17 2024).
32. Zambia HIV Country Profile: 2016 [Electronic source] // World Health Organizaion [Website]. – URL: https://www.who.int/hiv/data/Country_profile_Zambia.pdf (2017). (Accessed: 17.09.2024)
33. Divall M. J., Barnes D., Knoblauch A. M. First Quantum Minerals Limited: Health Impact Assessment Scoping Study Trident Project; NewFields LLC: Denver, Colorado. – 2010.
34. Knoblauch A. M., Divall M. J., Owuor M., Archer C., Nduna K., Ng'uni H., Musunka G., Pascall A., Utzinger J., Winkler M. S. Monitoring of selected health indicators in children living in a copper mine development area in northwestern Zambia // Int. J. Environ. Res. Public Health. – 2017. – Vol. 14. – P. 315. – DOI: https://doi.org/10.3390/ijerph14030315
35. Knoblauch A.M., Divall M. J., Owuor M., Musunka G., Pascall A., Nduna K., Ng'uni H., Utzinger J., Winkler M. S. Selected indicators and determinants of women's health in the vicinity of a copper mine development in northwestern Zambia // BMC Womens Health. – 2018. – Vol. 18. – P. 62. – DOI: 10.1186/s12905-018-0547-7.
36. IFC. Introduction to Health Impact Assessment [Electronic source] // International Finance Corporation: Washington, DC, USA, 2009 [Website]. – URL: https://www.ifc.org/content/dam/ifc/doc/mgrt/healthimpact.pdf (Accessed: 17.09.2024).
37. Winkler M. & Viliani F. & Knoblauch A. & Cave B. & Divall M. & Ramesh G. & Harris-Roxas B. & Furu P. Health impact assessment international best practice principles // International Association for Impact Assessment. – 2021. – Vol. 5. – 8 p.
38. Mijakoski D., Karadzinska-Bislimovska J., Stoleski S., Minov J., Bislimovska D., & Atanasovska A.. Respiratory symptoms, lung function changes, and COPD in lead-zinc miners // European Respiratory Journal. – 2019. –Vol. 54. – P. PA2825. – DOI: 10.1183/13993003. congress-2019. PA2825
39. Yeoman K. M., Halldin C. N., Wood J., Storey E., Johns D., Laney A. S. Current knowledge of US metal and nonmetal miner health: Current and potential data sources for analysis of miner health status // Arch Environ Occup Health. –2016. – Vol. 71(2). – P. 119-126. – DOI: 10.1080/19338244.2014.998330.
40. Kirsten Almberg, Robert Cohen. Modern Coal Miners Have Higher Death Rates From Lung Diseases Than Their Predecessors [Electronic source] // Niosh Sscience Blog [Website]. – 2023.

– URL: https://blogs.cdc.gov/niosh-science-blog/2023/02/27/mining-lung-disease/ (Accessed: 11.09.2024).
41. Kyaw W. T., Kuang X., Sakakibara M. Health Impact Assessment of Artisanal and Small-Scale Gold Mining Area in Myanmar, Mandalay Region: Preliminary Research // Int J Environ Res Public Health. – 2020. – Vol. 17(18). – P. 6757. – CMB
42. Berriault C. J., Lightfoot N. E., Seilkop S. K., Conard B. R. Injury mortality in a cohort of mining, smelting, and refining workers in Ontario // Arch Environ Occup Health. – 2017. – Vol. 72(4). – P. 220-230. – DOI: 10.1080/19338244.2016.1265479.
43. Tong R., Zhang Y., Yang Y., Jia Q., Ma X., Shao G. Evaluating Targeted Intervention on Coal Miners' Unsafe Behavior // Int J Environ Res Public Health. – 2019. – Vol. 16(3). – P. 422. – DOI: 10.3390/ijerph16030422.
44. Friedman L. S., Almberg K. S., Cohen R. A. Injuries associated with long working hours among employees in the US mining industry: risk factors and adverse outcomes // Occup Environ Med. – 2019. – Vol. 76(6). – P.389-395.
45. Kunda R., Frantz J., Karachi F. Prevalence and ergonomic risk factors of work-related musculoskeletal injuries amongst underground mine workers in Zambia // J Occup Health. – 2013. – Vol. 55(3). – P.211-217.
46. Jiménez-Forero C. P., Zabala I. T., Idrovo Á. J. Work conditions and morbidity among coal miners in Guachetá, Colombia: The miners' perspective // Biomedica. – 2015. – Vol. 35 Spec. – P.77-89. – DOI: 10.1590/S0120-41572015000500009.
47. Michelo P., Bråtveit M., Moen B.E. Occupational injuries and fatalities in copper mining in Zambia // Occup Med. – 2009. – Vol. 59(3). – P. 191-194.
48. Nowrouzi-Kia B., Sharma B., Dignard C., Kerekes Z., Dumond J., Li A. et al. Systematic review: lost-time injuries in the US mining industry // Occup Med. – 2017. – Vol. 67(6). – P. 442-447.
49. Kerns E., Masterson E. A., Themann C. L., Calvert G. M. Cardiovascular conditions, hearing difficulty, and occupational noise exposure within US industries and occupations // Am J Ind Med. – 2018. – Vol. 61(6). – P. 477-491. – DOI: 10.1002/ajim.22833.
50. Robinson T., Sussell A., Scott K., Poplin G. Health conditions among male workers in mining and other industries reliant on manual labor occupations: National Health Interview Survey, 2007-2018 // Am J Ind Med. – 2023. – Vol. 66(8). – P. 692-704. – DOI: 10.1002/ajim.23483.
51. Tumane R. G., Nath N., Khan A. Risk Assessment in Mining-Based Industrial Workers by Immunological Parameters as Copper Toxicity Markers // Indian J Occup Environ Med. – 2019. – Vol. 23(1). – P. 21-27. – DOI: 10.4103/ijoem.IJOEM_116_18.
52. Matamala Pizarro J., Aguayo Fuenzalida F. Mental health in mine workers: a literature review // Ind Health. – 2021. – Vol. 59(6). – P. 343-370. – DOI: 10.2486/indhealth.2020-0178.
53. В горнодобывающей промышленности занято более 281 тысячи человек [Электронный ресурс] // Kapital.kz [Web-сайт]. – URL: https://kapital.kz/economic/99016/v-gornodobyvayushchey-promyshlennosti-zanyato-boleye-281-tysyachi-chelovek.html (Дата обращения: 20.09.2024).
54. Малашкина В. А. Обзор опыта проведения периодической оценки условий труда на горнодобывающих предприятиях Республики Казахстан // Горный информационно-аналитический бюллетень. – 2019. – №5. – С. 209-216.
55. Гусев О. Частота профессиональных заболеваний в Казахстане в 23,4 раза ниже, чем в США [Электронный ресурс] // Inbusiness.kz [Web-сайт]. – URL: https://inbusiness.kz/ru/news/chastota-professionalnyh-zabolevanij-v-kazahstane-v-23-4-raza-nizhe-chem-v-ssha (Дата обращения: 18.09.2024).
56. Абитаев Д. С., Ердесов Н. Ж., Жумалиев В. С., Машина Т. Ф., Серик Б., Калишев М. Г., Шинтаева Н., Жакенова С. Р. Профессиональные риски и состояние здоровья лиц, работающих в горнодобывающей промышленности Центрального Казахстана // Медицина и экология. – 2020. – №2. – С. 41-45.
57. Ердесов Н. Ж., Сраубаев Е. Н., Серик Б. Произведенный травматизм и профессиональная заболеваемость в Республике Казахстан // Медицина и экология. – 2020. – №4. – С.38-45.
58. Малашкина В., Копылова А. Рекомендации по разработке мероприятий с целью улучшения условий труда по результатам периодической аттестации производственных объектов по условиям труда в Республике Казахстан // Горный информационно-аналитический бюл-

летень. – 2020. – № 6-1. – С. 154-162. – DOI: 10.25018/0236-1493-2020-61-0-154-162.

References

1. Chebotarjov, A. G., Pfaf, V. F., Gibadulina, I. Ju. (2021). Sostojanie uslovij truda, professional'noj zabolevaemosti i sovershenstvovanie mediko-profilakticheskogo obespechenija rabotnikov gornodobyvajushhih predprijatij. Gornaja promyshlennost', 3, 139-143. DOI: 10.30686/1609-9192-2021-3-139-143.
2. Jiangdong, Bao, Jan, Johansson, Jingdong, Zhang (2017). An Occupational Disease Assessment of the Mining Industry's Occupational Health and Safety Management System Based on FMEA and an Improved AHP Model. Sustainability, 9(1), 94. DOI: https://doi.org/10.3390/su9010094
3. Convention № 155 of the International Labour Organization «On Occupational Safety, Health, and the Working Environment» (adopted in Geneva on 22.06.1981 at the 67th session of the ILO General Conference). United Nations Treaty Collection [Website]. Retrieved October 18 2024, from https://treaties.un.org/Pages/showDetails.aspx?objid=08000002800dbe0a.
4. European Commission (2022). Commission Regulation (EU) 2022/2294 of November 23 2022 implementing Regulation (EC) No 1338/2008 of the European Parliament and of the Council as regards statistics on healthcare facilities, healthcare human resources and healthcare utilization. Official Journal of the European Union, L 304, 65, 42-52.
5. Zhang, X., Wang, Z., Li, T. (2010). The current status of occupational health in China. Environmental Health and Preventive Medicine, 15, 263-270.
6. Superintendencia de Riesgos del Trabajo. Argentina.gob.ar. Retrieved October 18, 2024, from https://www.argentina.gob.ar/normativa/nacional/disposici%C3%B3n-46-2009-157874.
7. Ministry of Health, Labour and Welfare, Japan (2009). Survey of work-related diseases. Retrieved October 18, 2024, from https://www.mhlw.go.jp/english/wp/wp-hw3/dl/appendix-5.pdf.
8. Ministry of Health, Labour and Welfare, Japan. (n.d.). Occupational disease recognition of mental disorders. Retrieved October 18, 2024, from http://www.mhlw.go.jp/bunya/roudoukijun/gyomu.html.
9. Department for Work and Pensions, United Kingdom (2012). Industrial injury first diagnosed prescribed diseases: All assessments resulting in payment by type of disease. Retrieved September 10, 2024, from https://www.gov.uk/government/statistics/industrial-injuries-disablement-benefit-quarterly-statistics-march-2012.
10. Bureau of Labor Statistics, United States Department of Labor. (2023). Number, annualized incidence rate, and median days of nonfatal occupational injuries and illnesses with days away from work (DAFW) by selected industry and source types, private industry, 2021-22. Retrieved from https://www.bls.gov/news.release/osh.t06.htm.
11. Davoodi, S., Haghigi, K. S., Kalhori, S. R., Hosseini, N. S., Mohammadzadeh, Z., Safdari, R. (2017). Registers of occupational diseases – Characteristics and experience. Acta Informatica Medica, 25(2), 136-140. DOI: https://doi.org/10.5455/aim.2017.25.136-140.
12. Bao, J., Johansson, J., Zhang, J. (2017). An occupational disease assessment of the mining industry's occupational health and safety management system based on FMEA and an improved AHP model. Sustainability, 9(1), 94. DOI: https://doi.org/10.3390/su9010094.
13. National Standards of the People's Republic of China (2011). Occupational health and safety management systems: Requirements. Retrieved September 7, 2024, from https://www.chinesestandard.net/PDF/English.aspx/GBT28001-2011.
14. Naidoo, R. N., Robins, T. G., Murray, J. (2005). Respiratory outcomes among South African coal miners at autopsy. American Journal of Industrial Medicine, 48(3), 217-224. DOI: https://doi.org/10.1002/ajim.20207.
15. Stuckler, D., Basu, S., McKee, M., Lurie, M. (2011). Mining and risk of tuberculosis in sub-Saharan Africa. American Journal of Public Health, 101(3), 524-530. DOI: https://doi.org/10.2105/AJPH.2009.175646.
16. Ngosa, K., Naidoo, R. N. (2016). The risk of pulmonary tuberculosis in underground copper miners in Zambia exposed to respirable silica: A cross-sectional study. BMC Public Health, 16, 855. DOI: https://doi.org/10.1186/s12889-016-3547-2
17. Bloch, K., Johnson, L. F., Nkosi, M., Ehrlich, R. (2018). Precarious transition: A mortality study

of South African ex-miners. BMC Public Health, 18(1), 862. DOI: https://doi.org/10.1186/s12889-018-5749-2
18. Blackley D. J., Halldin C. N., Laney A. S. (2018). Continued Increase in Prevalence of Coal Workers' Pneumoconiosis in the United States, 1970-2017. Am J Public Health, 108(9),1220-1222. DOI: 10.2105/AJPH.2018.304517.
19. Yorio, P. L., Laney, A. S., Halldin, C. N., Blackley, D. J., Moore, S. M., Wizner, K., Radonovich, L. J., Greenawald, L. A. (2018). Interstitial lung diseases in the U.S. mining industry: Using MSHA data to examine trends and the prevention effects of compliance with health regulations, 1996-2015. Risk Analysis, 38(9), 1962-1971. DOI: https://doi.org/10.1111/risa.13000.
20. Jiménez-Forero, C. P., Zabala, I. T., Idrovo, Á. J. (2015). Work conditions and morbidity among coal miners in Guachetá, Colombia: The miners' perspective. Biomédica, 35(Spec.), 77-89. DOI: https://doi.org/10.1590/S0120-41572015000500009
21. Masterson, E. A., Tak, S., Themann, C. L., Wall, D. K., Groenewold, M. R., Deddens, J. A., Calvert, G. M. (2013). Prevalence of hearing loss in the United States by industry. American Journal of Industrial Medicine, 56(6), 670-681. DOI: https://doi.org/10.1002/ajim.22082.
22. Musiba, Z. (2015). The prevalence of noise-induced hearing loss among Tanzanian miners. Occupational Medicine (London), 65(5), 386-390. DOI: https://doi.org/10.1093/occmed/kqv046.
23. Legault, G., Clement, A., Kenny, G. P., Hardcastle, S.,Keller, N. (2017). Cognitive consequences of sleep deprivation, shiftwork, and heat exposure for underground miners. Applied Ergonomics, 58, 144-150. DOI: https://doi.org/10.1016/j.apergo.2016.06.007.
24. Lutz, E. A., Reed, R. J., Turner, D., Littau, S. R. (2014). Occupational heat strain in a hot underground metal mine. Journal of Occupational and Environmental Medicine, 56(4), 388-396. DOI: https://doi.org/10.1097/JOM.0000000000000107.
25. Key health challenges for Zambia (2013). The Association of Chartered Certified Accountants (ACCA) [Website]. Retrieved October 11, 2024, from https://www.accaglobal.com/content/dam/acca/global/PDF-technical/health-sector/tech-tp-khcz.pdf.
26. Sikamo, J., Mwanza, A., Mweemba, C. (2016). Copper mining in Zambia–history and future. Journal of the Southern African Institute of Mining and Metallurgy, 116(6), 491-496. DOI: https://doi.org/10.17159/2411-9717/2016/v116n6a1.
27. Making mining work for Zambia: The economic, health, and environmental nexus of Zambia's copper mining industry (2015). World Bank Group [Website]. Retrieved from https://www.worldbank.org/en/news/press-release/2015/06/17/making-mining-work-for-zambia.
28. Williams, B., Campbell, C. (1998). Creating alliances for disease management in industrial settings: A case study of HIV/AIDS in workers in South African gold mines. International Journal of Occupational and Environmental Health, 4(4), 257-264. DOI: https://doi.org/10.1179/oeh.1998.4.4.257.
29. ILO supports a partnership approach in the Zambian mining sector to create jobs and stimulate inclusive growth (n.d.). International Labour Organization [Website]. Retrieved October 17, 2024, from https://www.ilo.org/projects-and-partnerships/projects/ilo-supports-partnership-approach-zambian-mining-sector-create-jobs-and.
30. World Bank Open Data: GDP growth – Zambia (2019). World Bank [Website]. Retrieved October 17, 2024, from https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG.ZM.
31. «You will be fired if you refuse» – Labour abuses in Zambia's Chinese state-owned copper mines (2011). Human Rights Watch. Retrieved October 17, 2024, from https://www.hrw.org/sites/default/files/reports/zambia1111ForWebUpload.pdf.
32. Zambia HIV country profile: 2016. (2017). World Health Organization [Website]. Retrieved September 17, 2024, from https://www.who.int/hiv/data/Country_profile_Zambia.pdf.
33. Divall, M. J., Barnes, D., Knoblauch, A. M. (2010). First Quantum Minerals Limited: Health impact assessment scoping study, Trident Project. NewFields LLC.
34. Knoblauch, A. M., Divall, M. J., Owuor, M., Archer, C., Nduna, K., Ng'uni, H., Musunka, G., Pascall, A., Utzinger, J., Winkler, M. S. (2017). Monitoring of selected health indicators in children living in a copper mine development area in northwestern Zambia. International Journal of Environmental Research and Public Health, 14, 315. DOI: https://doi.org/10.3390/ijerph14030315.

35. Knoblauch, A. M., Divall, M. J., Owuor, M., Musunka, G., Pascall, A., Nduna, K., Ng'uni, H., Utzinger, J., Winkler, M. S. (2018). Selected indicators and determinants of women's health in the vicinity of a copper mine development in northwestern Zambia. BMC Women's Health, 18, 62. DOI: https://doi.org/10.1186/s12905-018-0547-7.
36. International Finance Corporation (IFC). (2009). Introduction to health impact assessment. Retrieved September 17, 2024, from https://www.ifc.org/content/dam/ifc/doc/mgrt/healthimpact.pdf.
37. Winkler, M., Viliani, F., Knoblauch, A., Cave, B., Divall, M., Ramesh, G., Harris-Roxas, B., Furu, P. (2021). Health impact assessment international best practice principles. International Association for Impact Assessment, 5, 8.
38. Mijakoski, D., Karadzinska-Bislimovska, J., Stoleski, S., Minov, J., Bislimovska, D., Atanasovska, A. (2019). Respiratory symptoms, lung function changes, and COPD in lead-zinc miners. European Respiratory Journal, 54, PA2825. DOI: https://doi.org/10.1183/13993003.congress-2019.PA2825.
39. Yeoman, K. M., Halldin, C. N., Wood, J., Storey, E., Johns, D., & Laney, A. S. (2016). Current knowledge of US metal and nonmetal miner health: Current and potential data sources for analysis of miner health status. Archives of Environmental. Occupational Health, 71(2), 119-126. DOI: https://doi.org/10.1080/19338244.2014.998330.
40. Almberg, K., Cohen, R. (2023). Modern coal miners have higher death rates from lung diseases than their predecessors. NIOSH Science Blog. Retrieved September 11, 2024, https://blogs.cdc.gov/niosh-science-blog/2023/02/27/mining-lung-disease/.
41. Kyaw, W. T., Kuang, X., Sakakibara, M. (2020). Health impact assessment of artisanal and small-scale gold mining area in Myanmar, Mandalay Region: Preliminary research. International Journal of Environmental Research and Public Health, 17(18), 6757. DOI: https://doi.org/10.3390/ijerph17186757.
42. Berriault, C. J., Lightfoot, N. E., Seilkop, S. K., & Conard, B. R. (2017). Injury mortality in a cohort of mining, smelting, and refining workers in Ontario. Archives of Environmental Occupational Health, 72(4), 220-230. DOI: https://doi.org/10.1080/19338244.2016.1265479.
43. Tong, R., Zhang, Y., Yang, Y., Jia, Q., Ma, X., Shao, G. (2019). Evaluating targeted intervention on coal miners' unsafe behavior. International Journal of Environmental Research and Public Health, 16(3), 422. DOI: https://doi.org/10.3390/ijerph16030422.
44. Friedman, L. S., Almberg, K. S., Cohen, R. A. (2019). Injuries associated with long working hours among employees in the US mining industry: Risk factors and adverse outcomes. Occupational and Environmental Medicine, 76(6), 389-395.
45. Kunda, R., Frantz, J., Karachi, F. (2013). Prevalence and ergonomic risk factors of work-related musculoskeletal injuries amongst underground mine workers in Zambia. Journal of Occupational Health, 55(3), 211-217.
46. Jiménez-Forero, C. P., Zabala, I. T., Idrovo, Á. J. (2015). Work conditions and morbidity among coal miners in Guachetá, Colombia: The miners' perspective. Biomedica, 35(Spec.), 77-89. https://doi.org/10.1590/S0120-41572015000500009
47. Michelo, P., Bråtveit, M., Moen, B. E. (2009). Occupational injuries and fatalities in copper mining in Zambia. Occupational Medicine, 59(3), 191-194.
48. Nowrouzi-Kia, B., Sharma, B., Dignard, C., Kerekes, Z., Dumond, J., Li, A., et al. (2017). Systematic review: Lost-time injuries in the US mining industry. Occupational Medicine, 67(6), 442-447.
49. Kerns, E., Masterson, E. A., Themann, C. L.,Calvert, G. M. (2018). Cardiovascular conditions, hearing difficulty, and occupational noise exposure within US industries and occupations. American Journal of Industrial Medicine, 61(6), 477-491. DOI: https://doi.org/10.1002/ajim.22833.
50. Robinson, T., Sussell, A., Scott, K., Poplin, G. (2023). Health conditions among male workers in mining and other industries reliant on manual labor occupations: National Health Interview Survey, 2007-2018. American Journal of Industrial Medicine, 66(8), 692-704. DOI: https://doi.org/10.1002/ajim.23483.
51. Tumane, R. G., Nath, N., Khan, A. (2019). Risk assessment in mining-based industrial workers by immunological parameters as copper toxicity markers. Indian Journal of Occupational and Environmental Medicine, 23(1), 21-27. https://doi.org/10.4103/ijoem.IJOEM_116_18.
52. Matamala Pizarro, J., Aguayo Fuenzalida, F. (2021). Mental health in mine workers: A literature

review. Industrial Health, 59(6), 343-370. DOI: https://doi.org/10.2486/indhealth.2020-0178.
53. V gornodobyvajushhej promyshlennosti zanjato bolee 281 tysjachi chelovek. Kapital.kz [Website]. Retrieved September 9, 2024, from https://kapital.kz/economic/99016/v-gornodobyvayushchey-promyshlennosti-zanyato-boleye-281-tysyachi-chelovek.html. (In Russian).
54. Malashkina, V. A. (2019). Obzor opyta provedenija periodicheskoj ocenki uslovij truda na gornodobyvajushhih predprijatijah Respublikik Kazahstanju. Mining information and analytical bulletin, 5, 209-216. (In Russian).
55. Gusev, O. Chastota professional'nyh zabolevanij v Kazahstane v 23,4 raza nizhe, chem v SShA. Inbusiness.kz [Website]. Retrieved September 9, 2024, from https://inbusiness.kz/ru/news/chastota-professionalnyh-zabolevanij-v-kazahstane-v-23-4-raza-nizhe-chem-v-ssha. (In Russian).
56. Abitaev, D. S., Erdesov, N. Zh., Zhumaliev, V. S., Mashina, T. F., Serik, B., Kalishev, M. G., Shintaeva, N., Zhakenova, S. R. (2020). Professional'nye riski i sostojanie zdorov'ja lic, rabotajushhih v gornodobyvajushhej promyshlennosti Central'nogo Kazahstana. Medicine and ecology, 2, 41-45. (In Russian).
57. Erdesov, N. Zh., Sraubaev, E. N., Serik, B. (2020). Proizvedennyj travmatizm i professional'naja zabolevaemost' v Respublike Kazahstan. Medicine and ecology, 4, 38-45. (In Russian).
58. Malashkina, V., Kopylova, A. (2020). Rekomendacii po razrabotke meroprijatij s cel'ju uluchshenija uslovij truda po rezul'tatam periodicheskoj attestacii proizvodstvennyh objektov po uslovijam truda v Respublike Kazahstan. Mining information and analytical bulletin, 154-162. DOI: 10.25018/0236-1493-2020-61-0-154-162. (In Russian).

ЗАБОЛЕВАЕМОСТЬ РАБОТНИКОВ ГОРНОДОБЫВАЮЩИХ ОТРАСЛЕЙ ПРОМЫШЛЕННОСТИ

А. Ю. Вангай [1*], С. А. Абзалиева [1], А. О. Сарсенова[2], К. Б. Абзалиев [1], М. Б. Бауржан [3]
[1]КазНУ им. Аль - Фараби, Казахстан, Алматы
[2]ТОО «Казахстанский медицинский университет «ВШОЗ»», Казахстан, Алматы
[3]Медицинский университет Астаны, Казахстан, Астана
[*]*Корреспондирующий автор*

Аннотация

В работе исследуются вопросы влияния факторов риска рабочей среды горнодобывающей отраслей промышленности на здоровье работников, и признанные методики и инструменты для устранения/контроля данных рисков. Концепция снижения вредного воздействия промышленности горнодобывающего производства исследуются и контролируется во всех странах. По данным Международной организации охраны труда, ежегодно погибает около 2,8 млн человек в результате несчастных случаев на работе или от болезней, связанных с производством. Примерно 374 млн человек в год получают разного рода травмы и заболевания на рабочем месте. Вопросы профессиональных заболеваний и производственного травматизма также актуальны для горнодобывающей промышленности Казахстана.

Цель. Изучить литературные данные по влиянию производственных факторов на состояние здоровья работников горнодобывающего предприятия и международный опыт мероприятий по снижению вредного воздействия рабочей среды этой отрасли на современном этапе.

Материалы и методы. Проведен анализ исследований и публикаций по теме исследования с использованием источников, индексируемых в базах данных электронной библиотеки e-Library, Google Академия, PubMed, Web of Science и Scopus. Представлены результаты литературного обзора, направленного на изучение профессиональных заболеваний и производственного травматизма у работников горнодобывающей отрасти и особенностей организации мероприятий по снижение риска вредных условий труда в разных странах.

Результаты исследования. Комплексный подход к снижению последствий воздействия вредных факторов производственной среды горнодобывающей промышленности дает положительные результаты.

Выводы. По последним данным, табачный дым является одним из смертельных фактором риска смертей в мире. это дополнительный подход к существующим мерам борьбы против табака.

Ключевые слова: *профессиональные заболевания, производственный травматизм, горнодобывающая промышленность, вредные условия труда, пневмокониоз.*

ТАУ- КЕН ӨНДІРУ ӨНДІРІСІНДЕГІ ҚЫЗМЕТКЕРЛЕРДІҢ АУРУЛАРЫ

А. Ю. Вангай [1*], С. А. Абзалиева [1], А. О. Сарсенова[2],
К. Б. Абзалиев [1], М. Б. Бауржан [3]

[1]Әл-Фараби атындағы ҚазҰУ, Қазақстан, Алматы
[2] «ҚДСЖМ» Қазақстандық медициналық университеті» ЖШС, Қазақстан, Алматы
[3] Астана медициналық университеті, Қазақстан, Астана
[*]*Корреспондент автор*

Аңдатпа

Жұмыста тау-кен өнеркәсібінің жұмыс ортасындағы қауіп факторларының жұмысшылардың денсаулығына әсері және осы тәуекелдерді жою/бақылау үшін танылған әдістер мен құралдар зерттеледі. Тау-кен өнеркәсібінің зиянды әсерін азайту тұжырымдамасы барлық елдерде зерттеліп, мониторинг жүргізілуде. Халықаралық еңбек қауіпсіздігі және еңбекті қорғау ұйымының мәліметі бойынша, жыл сайын өндірістегі жазатайым оқиғалардың немесе жұмысқа байланысты аурулардың салдарынан шамамен 2,8 миллион адам қайтыс болады. Жылына шамамен 374 миллион адам жұмыс орнында әртүрлі жарақаттар мен аурулардан зардап шегеді. Кәсіби аурулар мен өндірістік жарақаттану мәселелері Қазақстанның тау-кен өнеркәсібі үшін де өзекті болып табылады.

Мақсаты. Тау-кен кәсіпорындарында өндірістік факторлардың жұмысшылардың денсаулығына әсері туралы әдебиеттік деректерді және қазіргі кезеңде осы саладағы өндірістік ортаның зиянды әсерін азайту шараларының халықаралық тәжірибесін зерттеу.

Материалдар мен әдістер. Зерттеу тақырыбы бойынша зерттеулер мен жарияланымдарға талдау электронды кітапхананың e-Library, Google Scholar, PubMed, Web of Science және Scopus деректер қорында индекстелген дереккөздер арқылы жүргізілді. Мақалада тау-кен өнеркәсібіндегі жұмысшылар арасындағы кәсіптік аурулар мен өндірістік жарақаттарды зерттеуге бағытталған әдебиеттерге шолу нәтижелері және әртүрлі елдердегі зиянды еңбек жағдайларының қаупін төмендету бойынша шараларды ұйымдастыру ерекшеліктері берілген.

Зерттеу нәтижелері. Тау-кен өнеркәсібінің өндірістік ортасына тигізетін зиянды факторлардың әсерін азайтудың кешенді тәсілі оң нәтиже береді.

Қорытындылар. Соңғы мәліметтерге сәйкес, темекі түтіні әлемдегі өлімге әкелетін қауіпті факторлардың бірі болып табылады. Бұл темекіге қарсы күрестің қолданыстағы шараларына қосымша тәсіл.

Түйін сөздер: *кәсіптік аурулар, өндірістік жарақаттар, тау-кен өнеркәсібі, зиянды еңбек жағдайлары, пневмокониоздар.*

АВТОРЛАР ТУРАЛЫ

Вангай Александра Юрьевна – қоғамдық денсаулық сақтау магистрі, Әл-Фараби атындағы ҚазҰУ ішкі медицина кафедрасының аға оқытушысы, медицина және денсаулық сақтау факультеті; e-mail: alexandra.vangay@gmail.com; телефон: 87772945599; ORCID: https://orcid.org/0009-0004-9613-047.

Абзалиева Сымбат Абулхаировна – медицина ғылымдарының кандидаты, Әл-Фараби атындағы ҚазҰУ жасанды интеллект және Big Data кафедрасының аға оқытушының міндетін атқарушысы, Ақпараттық технологиялар факультеті; e-mail: abzaliyeva.symbat@gmail.com; телефон: 87772322978; ORCID: https://orcid.org/0009-0004-9802-0129.
Сарсенова Айман Онласбековна – қоғамдық денсаулық сақтау магистрі, «Медикер» медициналық орталығы, e-mail: sarsenova.a@mediker.kz; телефон: 87017011177; ORCID: https://orcid.org/0000- 0002-8432-6184
Абзалиев Куат Баяндыевич – медицина ғылымдарының докторы, Әл-Фараби атындағы ҚазҰУ клиникалық мамандықтар кафедрасының профессоры; e-mail: abzaliev_kuat@mail.ru; телефон: 87012212211; ORCID: https://orcid.org/0000-0003-2452-854X.
Бауржан Мадина Бауржанқызы – «Медицина» мамандығы бойынша философия докторы PhD, Қазақстан Республикасының Денсаулық сақтау министрлігі ШЖҚ «Қоршаған орта мен медициналық реабилитация ғылыми-зерттеу институты» МКК ғылыми-зерттеу басқармасының жетекшісі, Астана медициналық университетінің медициналық реабилитация және спорттық медицина кафедрасының доценті; e-mail: Madina_baurzhan@mail.ru; телефон: 87772375738; ORCID: https://orcid.org/0000-0003-1244-8673.

ОБ АВТОРАХ

Вангай Александра Юрьевна – магистр общественного здравоохранения, старший преподаватель кафедры внутренней медицины, факультет медицины и здравоохранения НАО «КазНУ им Аль-Фараби»; e-mail: alexandra.vangay@gmail.com; телефон: 87772945599; ORCID: https://orcid.org/0009-0004-9613-0471.
Абзалиева Сымбат Абулхаировна – кандидат медицинских наук, и.о. доцента, кафедры Искусственного интеллекта и Big Data, Факультета Информационных Технологий НАО «КазНУ им аль-Фараби»; e-mail: abzaliyeva.symbat@gmail.com; телефон: 87772322978; ORCID: https://orcid.org/0009-0004-9802-0129.
Сарсенова Айман Онласбековна – магистр общественного здравоохранения, Медицинский центр «Медикер» , e-mail: sarsenova.a@mediker.kz; телефон: 87017011177; ORCID: https://orcid.org/0000-0002-8432-6184.
Абзалиев Куат Баяндыевич – доктор медицинских наук, профессор кафедры клинических специальностей НАО «КазНУ им Аль-Фараби» e-mail: abzaliev_kuat@mail.ru; телефон: 87012212211; ORCID: https://orcid.org/0000-0003-2452-854X.
Бауржан Мадина Бауржановна – доктор философии PhD по специальности «Медицина» Руководитель научно-исследовательского управления РГП на ПХВ «Научно-исследовательский институт курортологии и медицинской реабилитации» МЗ РК, доцент кафедры медицинской реабилитации и спортивной медицины НАО «Медицинский университет Астана»; e-mail: Madina_baurzhan@mail.ru; телефон: 87772375738; ORCID: https://orcid.org/0000-0003-1244-8673.

ABOUT AUTHORS

Vangay Alexandra – Master of Public Health Senior Lecturer, Department of Internal Medicine Faculty of Medicine and Health Care Al-Farabi Kazakh National University; e-mail: alexandra.vangay@gmail.com; telephone: +7 777 294 5599; ORCID: https://orcid.org/0009-0004-9613-0471.
Abzalieva Symbat – PhD in Medicine, Acting Associate Professor, Department of Artificial Intelligence and Big Data Faculty of Information Technologies Al-Farabi Kazakh National University; e-mail: abzaliyeva.symbat@gmail.com; telephone: +7 777 232 2978 ORCID: https://orcid.org/0009-0004-9802-0129.
Sarsenova Aiman – Master of Public Health, Medical Center «Mediker», e-mail: sarsenova.a@mediker.kz; telephone: +7 701 701 1177; ORCID: https://orcid. org/0000-0002-8432-6184.
Abzaliyev Kuat – Doctor of Medical Sciences, Professor, Department of Clinical Specialties Al-Farabi Kazakh National University; e-mail: abzaliev_kuat@mail.ru; telephone: +7 701 221 2211; ORCID: https://orcid.org/0000-0003-2452-854X.

Baurzhan Madina – PhD in Medicine Head of the Research Department, Associate Professor, Department of Medical Rehabilitation and Sports Medicine «Research Institute of Resortology and Medical Rehabilitation» Ministry of Health of the Republic of Kazakhstan Al-Farabi Kazakh National University; e-mail: Madina_baurzhan@mail.ru; telephone: +7 777 237 5738; ORCID: https://orcid.org/0000-0003-1244-8673.

Written informed consent was obtained from the patient for publication of this manuscript and accompanying images. A copy of the written consent is available for review by the First Author of this report.
Conflict of interest. *All authors declare that there is no potential conflict of interest that requires disclosure in this article.*
Authors' contributions. *All authors contributed equally to the development of the concept, implementation, processing of results and writing of the article.*
We declare that this material has not been previously published and is not under consideration by other publishers.
Funding. *None.*

Article submitted: 26.02.2025 year
Accepted for publication: 20.03.2025 year