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CARDIOVASCULAR SYSTEM ASSESSMENT IN WORKERS OF MINING INDUSTRY

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ABSTRACT

We conducted a medical examination of 649 male workers employed at the underground sites of the Razvedochnaya, Kairagach, Semguron, and Samarchuk mines within the Angren Ore Management Group, as well as 80 administrative staff members to assess the impact of occupational environmental factors on their health. Among those examined, 42% were found to have cardiovascular pathologies. These included hypertension in 30% of the subjects and ischemic heart disease in 12%. An evaluation of the cardiovascular condition of both the primary and control groups revealed several changes in the functional status of various systems and an unfavorable trend in indicators associated with increased work experience. For workers with 5-10 or more years of service, this indicator was 2.5 times higher compared to surface workers, and the prevalence of individuals with vegetovascular dystonia was 7.2 times greater. Cardiovascular pathologies were twice as common among tunneling workers, underground machine operators, support installers, and drill operators.

Key words: underground mines, major occupations, cardiovascular system, length of service, risk factors.

INTRODUCTION

In the overall pathological profile of workers in the mining industry, particularly those engaged in underground operations, cardiovascular diseases occupy a prominent position [3, 6]. Given their prevalence, severity, and potential for serious complications, these disorders represent a major cause of disability, long-term incapacitation, and premature mortality among working-age males [1].

Research has indicated that there is a rising incidence of cardiovascular diseases among individuals involved in physically demanding occupations [5]. This can be attributed to a combination of adverse workplace factors, including strenuous physical labor, awkward postures, heavy lifting, high temperatures, vibrational stress, and excessive noise levels [2].

At present, the pathogenic mechanisms and predictive implications of cardiovascular diseases resulting from exposure to hazardous occupational conditions remain inadequately explored [7]. The investigation into interorgan interactions in the context of certain pathologies continues to hold importance. Although numerous studies address this issue, the specific causal links between industrial environmental factors and the onset of cardiovascular pathology in mineworkers still require further elucidation [10].

One pressing challenge today involves developing preventative strategies focused on averting the emergence of cardiovascular abnormalities in employees exposed to dust-laden environments in coal and mining enterprises [8]. Beyond sanitary and hygiene measures, medically-oriented preventive actions, such as early identification of cardiovascular dysfunction during initial and periodic health screenings, appropriate therapeutic interventions, and rehabilitation programs, offer promising approaches to safeguard worker health [4, 9].

Purpose of the study: Studying the state of cardiovascular system and assessing the risk of disease development in workers of mining industry.

Material and methods of research: The comprehensive assessment of workers' health, aimed at evaluating the impact of environmental factors, was conducted through an in-depth medical examination of 649 male workers from underground sites and a control group consisting of 80 administrative personnel. This study was undertaken by the Laboratory of Diagnosis, Treatment, and Prevention of Occupational Diseases of the Research Institute of Sanitation, Hygiene, and Occupational Diseases under the Ministry of Health of Uzbekistan, in collaboration with the Angren City Medical Association. A total of 433 workers from hazardous professions were selected for diagnostic evaluations focusing on the cardiovascular system.

The comprehensive clinical and laboratory-diagnostic examination encompassed the following procedures:

Assessment of the cardiovascular system by specialists, including a cardiologist and a therapist. Clinical examinations were performed by experts from the dispensary department of the Research Institute of Cardiovascular Diseases under the Ministry of Health of Uzbekistan.

Functional assessments of the cardiovascular system were conducted using a high-grade 12-channel electrocardiograph, model SM1200V COMEN, manufactured in China.

Arterial blood pressure measurements were taken using a mechanical sphygmomanometer, model Adjutor IAD-01-1.

Results and discussion. We conducted a comprehensive medical examination of 1103 employees from the mines Razvedochnaya, Kairagach, Semguron, and Samarchuk of the AGMK JSC, which included 710 workers from underground sites.

To thoroughly evaluate the influence of environmental factors on workers' health, we performed detailed medical examinations on 649 male workers from underground sites and a control group of 80 administrative workers. This study was organized by the Laboratory of Diagnosis, Treatment, and Prevention of Occupational Diseases of the Research Institute of Sanitation, Hygiene, and Occupational Diseases under the Ministry of Health of Uzbekistan, in conjunction with the Angren City Medical Association. Out of the main group, 433 workers from hazardous professions were chosen for diagnosing cardiovascular system functionality.

The majority of the surveyed workers from key professions (513 individuals) were men aged 20 to 60 years old, with work experience ranging from 3 to over 10 years. The 433 workers from the main group were categorized into professional subgroups: tunnelers (46.5%), loading machine operators (4.4%), loading and haulage machine operators (8.1%), blasters (14.3%), fixers (9.7%), drilling rig operators (8.1%), and underground miners (8.3%).

Their health indicators were compared against those of the control group, comprising 80 office workers (15.6%) - administrators, accountants, secretaries, managers, legal advisers, HR personnel, and others. All participants had been exposed to silica-containing dust, noise, and vibration, with varying degrees of labor intensity, for periods spanning 3 to 10+ years. Their cardiovascular health was assessed via consultations with specialized physicians, along with clinical-biochemical and instrumental investigations.

Medical examination uncovered interstitial fibrotic alterations in the lungs in 15.9% of the workers (based on chest radiographs), chronic bronchitis in 35.4%, bilateral sensorineural hearing impairment in 10.3%, dermatological conditions in 5.6%, angiodystonic syndrome in 2.1%, lumbar osteochondrosis and herniated discs in 14.8%, anemia in 13.3%, and post-traumatic encephalopathy in 3.4% of the workforce. Cardiovascular pathology was identified in 15.1% of all examinees.

Specifically, hypertension was diagnosed in 9.6% of the examinees, while ischemic heart disease affected 5.5% (Table 1).

Evaluation of the cardiovascular system in both the main and control groups revealed a series of functional shifts across various bodily systems, accompanied by an unfavorable evolution of key indicators as the workers' professional tenure advanced. Within the cohort possessing 5-10 or more years of experience, this metric was notably 2.5 times higher among the examined workers relative to the control group, underscoring the accumulative effect of prolonged occupational exposure. Moreover, the incidence of individuals afflicted with vegeto-vascular dystonia - a condition characterized by autonomic nervous system imbalance - was alarmingly 7.2 times greater. This disparity highlights the profound impact of prolonged exposure to occupational stressors on the cardiovascular and neurological systems.

Furthermore, cardiovascular pathologies were discernibly more prevalent among specific occupational groups, being twice as frequent among tunnelers, rammer operators, fasteners, and drilling rig operators. These findings suggest that the nature of work in these roles, which typically entails sustained physical exertion, exposure to extreme environmental conditions, and repetitive movements, plays a pivotal role in aggravating cardiovascular health risks. Such observations emphasize the urgent need for targeted interventions and preventive measures tailored to these high-risk occupational categories to mitigate the long-term detrimental effects on workers' cardiovascular wellbeing.

Table 1.

Disease Rates Among Surveyed Workers in Main Underground Mine Site Occupations

№	Diagnosis	Number of workers (n=433)	%
1.	Pathology of the cardiovascular system	65	15,1
2.	Chronic bronchitis	153	35,4
3.	Bilateral sensorineural hearing loss	45	10,3
4.	Skin diseases	24	5,6
5.	Angiodystonic syndrome	9	2,1
6.	Lumbar osteochondrosis and disc herniation	64	14,8
7.	Anaemia	58	13,3
8.	Post-traumatic encephalopathy	15	3,4

Among the 433 workers who underwent examination, 153 (35.4%) exhibited cardiovascular pathology, specifically hypertension and ischemic heart disease.

These workers reported recurring symptoms such as headaches, dizziness, elevated blood pressure, irritability, rapid heartbeat, insomnia, chest pains, excessive sweating, and numbness in the limbs.

Upon analyzing blood pressure parameters, a tendency towards hypertension was noted among workers with 10 or more years of experience. Individuals working directly at underground sites, exposed to chemical and physical factors, as well as intense labor conditions, were grouped according to their length of service. It was discovered that workers with up to 5 years and 5-9 years of experience maintained normal blood pressure levels. However, in those with 10 or more years of experience, blood pressure rose to 130-132.8±0.76 mm Hg (observed in 243 workers). Pulse rates also increased with longer job tenures, though this rise was less pronounced compared to the maximum systolic blood pressure readings (Table 2).

Table 2.

Cardiovascular System Indicators of Underground Mine Workers Considering Work Experience (M±m)

Parameters Control		**Parameters Control**	**Main group**			P_{2-3}	P_{2-4}	P_{2-5}
			Up to 5 (n-36)	**5-9 (n-153)**	**10 or more (n-243)**			
1		2	3	4	5	6	7	8
Arterial blood pressure, mm Hg.	max	117,7±0,96	120,1±1,42	125,2±0,99	132,8±0,76		0,001	0,001
	min	75±0,88	77,1±1,25	79,7±0,63	83,7±0,44	0,001		0,001
Pulse rate, beats per minute		72,3±0,43	75,9±0,72	76,8±0,49	79,2±0,40	0,001	0,001	0,001
Pulse pressure, mm Hg.		42,7±0,44	43,1±0,72	45,5±0,51	49,1±0,48		0,001	0,001
Heart beat volume, ml		52,5±0,99	57,1±1,17	55,1±0,54	50,6±0,43	0,01	0,05	
Minute blood volume, ml		3779,5±64,1	4321,6±77,1	4213,4±39,7	3985,9±30,9	0,001	0,001	0,01
Average dynamic pressure, mm. Hg.		89,2±0,88	91,4±1,30	94,8±0,73	100,1±0,52		0,001	0,001

An evaluation of the cardiovascular system in both the main and control groups revealed multiple functional changes across different physiological systems, alongside an unfavorable progression of key indicators as the miners' professional experience increased. These changes included variations in heart rate, blood pressure regulation, and the efficiency of oxygen transport throughout the circulatory system. Furthermore, prolonged exposure to harsh working conditions,

characterized by physical exertion, environmental hazards, and psychological stressors, appeared to exacerbate these negative trends. As a result, workers with extended tenure exhibited a higher incidence of cardiovascular pathologies, highlighting the cumulative impact of occupational factors on long-term health outcomes.

Thus, arterial hypertension was identified in 9.6% of the examined workers. Notably, no cases of hypertension were recorded among miners and surface workers with up to 5 years of professional experience, nor in the 5-9 year experience group. The findings from the workers' examinations align with the outcomes derived from the analysis of periodic medical check-ups, indicating that the prevalence of individuals diagnosed with hypertension among the examined group of miners is twice as high as among workers in the control group. Additionally, the frequency of individuals experiencing vegetovascular dystonia is eight times higher.

Numerous risk factors contribute significantly to the development of cardiovascular pathology among workers. Prominent among these are prolonged exposure to industrial noise, which can lead to heightened stress levels and subsequent cardiovascular strain. Additionally, the characteristics of the work schedule, often involving long hours and irregular shifts, disrupt circadian rhythms and exacerbate fatigue, thereby increasing the likelihood of cardiovascular issues. The arduous nature of the labor process, marked by sustained physical exertion, places additional demands on the cardiovascular system. Handling heavy loads imposes substantial strain on the musculoskeletal system and can indirectly affect cardiovascular health by increasing blood pressure and heart rate. Assuming forced body positions for extended periods can impede proper circulation and contribute to the formation of varicose veins and other vascular problems. Finally, repetitive bending motions, common in many manual labor roles, can induce chronic muscle fatigue and inflammation, potentially compromising cardiovascular function over time. Collectively, these factors create a multifaceted and challenging environment that elevates the risk of cardiovascular pathology among workers.

To analyze the functioning of the cardiovascular system, we conducted electrocardiograms on the examined workers. At rest, in workers over 40 years of age, 25.6% showed a leftward shift in the cardiac axis with a tendency toward decreased heart rate; 10.4% had a heart rate between 45 and 55 beats per minute, and 15.1% had a rate between 56 and 66 beats per minute. The ECG changes primarily involved diminished amplitude of the P and T waves and slight irregularities in the QRS complex. Reduced and inverted T-waves were observed in 18.9% of the workers. Conduction disturbances were found in 13.5% of the

examined: widening of the P wave, incomplete atrioventricular block of the first degree in 2.5% of workers, and irregularities and nodules on the P and T waves in 1.3% of workers.

The observed electrocardiographic changes signify subtle impairments in the heart's rhythm and automaticity, indicative of underlying disruptions in the electrical conduction system. Additionally, these changes point to widespread degenerative alterations in the myocardium, suggesting a diffuse dystrophic process affecting the muscular tissue of the heart. In approximately 6% of the workers evaluated, the early signs of coronary insufficiency were evident, hinting at compromised blood flow to the heart muscle, which could progress to more severe forms of coronary artery disease if left unaddressed. These findings collectively highlight the gradual deterioration of cardiovascular health due to prolonged exposure to occupational stressors, necessitating proactive intervention and ongoing monitoring to mitigate further damage.

Conclusion. Individuals exposed to silica-containing dust, noise, and vibration displayed distinct patterns in their arterial pressure based on their work experience. Those with up to 5 years and 5-9 years of experience generally maintained maximum and minimum arterial pressures within the normal range, similar to the control group. However, a significant deviation emerged among workers with more than 10 years of experience. This finding implies that workers with extensive work histories demonstrate amplified vascular sensitivity to physical stressors like lifting and moving heavy objects, in contrast to those with fewer years on the job. Additionally, advancing age likely contributes to this heightened susceptibility.

Throughout the various workplaces analyzed, the most critical risk factors for the development of cardiovascular pathologies were consistently linked to the intensity and strain of the labor process, classified as hazard classes 3.4 to 4.0, and the presence of industrial noise, designated as hazard class 3.2. These environmental and occupational factors cumulatively impose considerable strain on the cardiovascular system, underscoring the need for enhanced safety protocols and regular health monitoring for workers in these settings.

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