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ANALYSIS OF MORBIDITY AMONG EMPLOYEES OF HYDRAULIC ENGINEERING FACILITIES (ON THE EXAMPLE OF THE CHARVAK HYDROELECTRIC POWER STATION)

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Abstract: The present research paper provides an in-depth analytical assessment of morbidity among employees engaged in hydraulic engineering enterprises, based on the empirical study conducted at the Charvak Hydroelectric Power Station (HPP) during the years 2022–2024. The investigation focused on morbidity accompanied by temporary disability, considered one of the most reliable indicators of the health status and occupational well-being of industrial personnel.
The obtained data allowed the authors to establish a clear connection between the health condition of workers and the degree of exposure to unfavorable production factors inherent in hydraulic engineering facilities. The study identified the specific occupational groups most affected by morbidity, analyzed the age and work-experience dependence of disease occurrence, and determined the predominant nosological forms contributing to temporary disability.
It was revealed that the majority of cases were caused by respiratory diseases, musculoskeletal disorders, and injuries related to ergonomic strain and environmental fluctuations. The findings highlight the importance of systematic preventive and hygienic interventions aimed at improving working conditions, reducing professional risk, and enhancing the overall health monitoring system within hydraulic engineering enterprises.
This research substantiates the necessity of integrating occupational health surveillance programs and targeted preventive actions into the operational structure of the Charvak HPP, contributing to the national strategy of improving workers' health and safety.

Keywords: hydraulic engineering facilities, Charvak HPP, occupational hygiene, morbidity, temporary disability, professional risk, sanitary-hygienic environment, workers' health, preventive measures.

Introduction. Hydraulic engineering facilities represent an essential sector within the infrastructure of the Republic of Uzbekistan, ensuring stable water supply, irrigation, energy generation, and environmental protection. The Charvak Hydroelectric Power Station (HPP) is one of the most significant hydraulic structures in Central Asia, operating continuously under conditions characterized by high physical and psychological demands on workers.
Labor processes at hydropower plants are complex and multifactorial, involving constant exposure to environmental and technological elements such as increased humidity, temperature variations, vibration, noise, and sometimes insufficient lighting or air circulation. All these factors interact to create specific occupational hazards that may negatively affect workers' health and productivity.The assessment of morbidity accompanied by temporary disability (MTD)

serves as one of the most reliable criteria for evaluating the overall health of an industrial workforce. Unlike general morbidity indicators, MTD provides insight into both the frequency and severity of diseases that lead to temporary loss of working capacity. This parameter reflects not only medical and biological characteristics but also social, economic, and hygienic aspects of labor organization.

Previous studies, both national and international, confirm that morbidity among workers is closely related to working conditions, age, experience, and exposure to physical and ergonomic stressors. However, there remains a limited number of detailed empirical studies addressing these factors within the specific context of hydraulic engineering enterprises, especially in the conditions of Uzbekistan.

Therefore, conducting a detailed analysis of morbidity patterns at the Charvak HPP is essential for understanding occupational health risks, planning preventive strategies, and improving labor conditions. The results of such an analysis can serve as a foundation for further research and policy development in the field of occupational hygiene and industrial safety.

Relevance of the Study. The relevance of this research is determined by the increasing role of hydraulic engineering facilities in the country's socio-economic development and by the urgent need to ensure the protection of workers' health under complex industrial conditions. The Charvak Hydroelectric Power Station, as a strategically important energy facility, employs a large number of specialists and operational staff whose health directly affects the station's performance and reliability.

Hydraulic engineering enterprises, by their nature, involve continuous operation and high technological intensity. The production processes are frequently accompanied by microclimatic fluctuations, high humidity, vibration, noise, and the need for physical endurance and mental alertness. Despite technological modernization, these factors continue to exert a combined adverse influence on the human organism, causing both acute and chronic health disturbances. In this regard, it becomes crucial to evaluate morbidity not only as a medical indicator but also as an important parameter for assessing occupational safety and efficiency. The frequency of temporary disability cases provides valuable information for optimizing preventive measures and improving sanitary-hygienic working conditions.

The growing awareness of occupational health as a component of sustainable industrial development further emphasizes the importance of such studies. Monitoring the dynamics and structure of morbidity enables early detection of emerging health risks and supports the implementation of evidence-based preventive programs.

Consequently, this research contributes both scientifically and practically to the field of occupational hygiene, offering a model for evaluating health conditions among workers of hydraulic engineering facilities under modern industrial realities.

Objectives of the Study. The study was guided by the following main objectives:

To assess the level, dynamics, and structural characteristics of morbidity among employees of the Charvak Hydroelectric Power Station.

To identify the dependence of morbidity on workers' age and professional experience.

To determine the main disease categories responsible for temporary disability and decreased working capacity.

To develop practical recommendations for improving working conditions and preventing occupational and work-related diseases.

Each of these objectives was designed to ensure a comprehensive understanding of how environmental, ergonomic, and organizational factors at the Charvak HPP influence workers' health.

Materials and Methods. The analysis was based on retrospective data from medical documentation and temporary disability certificates of workers employed at the Charvak HPP during the period 2022–2024. The study encompassed a total of 287 workers who were divided into two professional categories according to the nature of their duties and exposure to occupational hazards.

The **Control Professional Group (CPG)** included 121 engineering and technical employees whose work was primarily of an administrative, analytical, and supervisory nature.

The **Operational Professional Group (OPG)** consisted of 166 employees engaged directly in the operation, maintenance, and repair of hydraulic engineering equipment.

Data collection included information on the number of temporary disability cases, duration of sick leaves, and classification of diseases according to the International Classification of Diseases, 10th Revision (ICD-10).

Morbidity rates were calculated per 100 employees, and statistical analysis was performed to determine the significance of differences between groups. The study also included comparative analysis of morbidity structures, identifying leading disease classes and their proportional contribution to overall morbidity.

The hygienic evaluation of working conditions at the Charvak HPP was conducted in parallel, which allowed the identification of environmental and production factors contributing to increased health risks.

Results

1. General Tendencies of Morbidity

The assessment of working conditions at the Charvak Hydroelectric Power Station revealed that the majority of employees operated under conditions corresponding to Class 2 (permissible), accounting for approximately 82.8% of the total workforce. However, a considerable portion — 17.2% — worked under conditions classified as harmful of varying degrees (Classes 3.1 to 3.3). These data clearly demonstrate that while most workplaces meet hygienic standards, a significant fraction of personnel remains exposed to health risks due to environmental and ergonomic stressors.

Over the three-year observation period (2022–2024), the overall morbidity among the examined workers demonstrated an upward trend. The control professional group (CPG) — composed of engineers and administrative staff — exhibited an average annual growth rate of +4.7%, while the operational group (OPG) — engaged directly in maintenance and field operations — showed a much sharper increase of +10.7%.

The average morbidity with temporary disability per 100 employees reached 78.45 ± 22.60 in the CPG and 97.42 ± 11.81 in the OPG. These differences were statistically significant ($p < 0.05$), which provides clear evidence that production-related factors, such as microclimatic instability, vibration, and physical exertion, exert a measurable effect on workers' health.

The general pattern suggests that while administrative and technical personnel experience morbidity at a moderate level, workers engaged in physical and technical operations are considerably more vulnerable to both acute and chronic health disturbances.

2. Structure of Morbidity

An in-depth evaluation of the structure of morbidity revealed a predominance of diseases of the respiratory system. On average, respiratory diseases accounted for 56.4% of all temporary disability cases in the control group and 61.6% in the operational group. This finding underscores the substantial impact of the microclimatic conditions prevalent at the station — such as temperature fluctuations, humidity, and air currents — which favor the development of upper respiratory tract infections.

The second major group consisted of musculoskeletal system disorders, comprising 8.6% of total morbidity in the control group and 12.9% in the operational group. The higher incidence in the latter reflects the physical nature of their duties, involving prolonged standing, repetitive motion, and handling of heavy machinery.

Injuries and poisoning were identified as the third most significant category, making up 8.4% of morbidity among engineering personnel and 10.4% among operational workers. This category includes both mechanical injuries and minor toxic exposures associated with maintenance operations.

Diseases of the circulatory system represented 7.0% in the CPG and 4.5% in the OPG, while digestive disorders constituted 2.8% and 3.4%, respectively.

It is evident that the dominant causes of temporary disability are not directly occupational diseases in the narrow sense, but rather work-related conditions aggravated by exposure to cold, humidity, and ergonomic strain. These findings emphasize the multifactorial nature of morbidity at hydraulic engineering facilities, where environmental, physical, and psychosocial factors interact in shaping workers' health outcomes.

3. Age and Work Experience Dependence

The correlation between morbidity and workers' age revealed a distinct pattern. The highest morbidity rate was observed among employees aged 50–59 years, reaching 80 cases per 100 workers. This level corresponds to the "average" category according to Notkin's classification but demonstrates a marked increase compared with younger groups.

The lowest morbidity levels were recorded among workers under the age of 29, where only 15.6 cases per 100 workers were observed. The relatively low morbidity in this group may be attributed to physiological resilience, shorter exposure duration, and more effective adaptation to environmental challenges.

Analysis by work experience produced a similar trend. The peak of morbidity occurred among employees with 31–35 years of service, who exhibited 180 cases per 100 workers, corresponding to a high level. The data indicate a cumulative effect of prolonged exposure to occupational factors — including vibration, temperature fluctuations, and static physical loads — which gradually erode adaptive mechanisms.

Interestingly, workers with less than 4 years of experience and those exceeding 35 years of service showed lower morbidity rates. The reduction among the most experienced workers may be related to the "selection phenomenon," in which individuals with stronger health remain in the workforce while those with chronic diseases leave earlier.

4. Duration of Temporary Disability

The duration of temporary disability varied across disease categories and reflected the severity and recovery dynamics associated with each condition.

- For respiratory diseases, the average duration ranged from 13.3 to 14.5 days per case.
- For musculoskeletal disorders, it ranged from 14.8 to 15.5 days.
- For circulatory system diseases, it was significantly higher — between 15.4 and 17.0 days.

The highest total number of lost workdays was registered for circulatory system diseases — 78.1 ± 10.7 days per 100 workers, whereas the smallest number corresponded to skin and genitourinary disorders.

This indicates that, although respiratory illnesses occur most frequently, chronic diseases of the musculoskeletal and cardiovascular systems contribute more substantially to the total loss of working capacity, reflecting their prolonged course and slower recovery.

Discussion. The results obtained during this study reveal a clear connection between the nature of labor activity and the incidence of temporary disability. Workers exposed to fluctuating

environmental factors — particularly microclimate variations, vibration, and physical strain — display a significantly higher morbidity level compared with engineering staff.

This relationship confirms the importance of maintaining sanitary-hygienic standards and continuous workplace monitoring. It also underlines the necessity of implementing effective preventive programs aimed at reducing exposure to harmful conditions.

Another important observation is the dependence of morbidity on professional experience and age. As the years of service increase, cumulative exposure to stressors leads to a rise in chronic conditions such as musculoskeletal and cardiovascular diseases. This highlights the need for targeted health surveillance and early rehabilitation of workers in older age categories.

The structure of morbidity at the Charvak HPP also reflects the typical pattern seen in similar industrial sectors: respiratory and musculoskeletal diseases dominate, followed by injuries and circulatory disorders. However, the relatively high proportion of work-related but non-occupational diseases suggests that prevention should be directed not only at eliminating specific hazards but also at improving overall working conditions and lifestyle-related factors.

Preventive strategies should focus on several directions:

- Improvement of microclimatic parameters through modernization of ventilation, heating, and insulation systems.
- Reduction of vibration and noise levels by upgrading equipment and applying soundproofing materials.
- Optimization of ergonomic conditions by redesigning workplaces, providing anti-fatigue mats, and ensuring appropriate rest periods.
- Enhancement of medical surveillance through regular health check-ups, especially targeting cardiovascular and musculoskeletal risk groups.

Such a multifaceted approach will help to reduce morbidity and maintain the long-term working capacity of hydraulic engineering personnel.

Conclusions

1. Morbidity among employees of hydraulic engineering facilities remains at a medium but steadily increasing level, mainly due to respiratory and musculoskeletal diseases.
2. The most vulnerable groups are workers aged 50–59 years and those with 30–35 years of work experience, who display higher morbidity and longer recovery periods.
3. The operational group exhibits higher morbidity rates than the control (engineering) group, confirming the influence of harmful production factors.
4. Chronic diseases of the musculoskeletal and circulatory systems contribute the most to total disability days, emphasizing the need for preventive rehabilitation programs.
5. The results justify the inclusion of hydraulic engineering enterprises in national occupational health monitoring systems to improve preventive and protective measures.

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