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Social and hygienic monitoring of labor conditions at industrial enterprises

The article describes the method of socio-hygienic monitoring of working conditions. A comprehensive assessment of the psycho-physiological state of the working enterprises in the conditions of real production activities was completed. To carry out preventive measures at industrial enterprises, the criteria for identifying groups of «risk» and predicting the loss of efficiency are calculated. This methodical approach allows us to assess and predict the health status depending on age, experience, profession, personal characteristics, as well as to assess the level of adverse effects of factors of the working environment on the body. The proposed method can be used in preventive medical examinations and prenosological diagnosis. According to the results of the research, methodological recommendations were developed, which were introduced in the production and in studying process of medical educational institutions.

Keywords: production factors, working conditions, morbidity, temporary disability, environmental impact assessment, correlation, regulatory intensive indicators, risk criteria, forecasting, mathematical model.

Introduction

Despite the fact that the production factors of industrial enterprises (microclimate, noise, vibration, dust, etc.) have a complex effect, the effects of their mutual summation or potentiation are still not well understood. The issues related to the study of the nature and intensity of the impact of individual production factors and their combinations against the background of neuro-emotional tension of the body are also poorly covered in the literature. The lack of such information makes it difficult to develop scientifically based recommendations for forecasting and reducing the intensity of adverse factors of the working environment, which confirms the novelty of the topic of this study [1].

The proposed methodological approach to the socio-hygienic monitoring of working conditions allows one to calculate the level of functional stress of the body of workers depending on working conditions, profession, age and work experience.

Criteria have been worked out to carry out preventive measures at industrial enterprises with the aim of identifying groups of «risk» and predicting the loss of working capacity in the context of actual production activities. This methodical approach allows us to assess and predict the functional stress of workers depending on age, length of service, profession, personal characteristics, as well as an assessment of the level of adverse influence of factors of the production environment on the body.

The proposed method can be used in conducting preventive medical examinations and prenosological diagnostics.

According to the results of research, methodological recommendations have been developed, which were introduced in production and included during lectures of medical educational institutions.

Assessment of the impact of production factors on the health and performance of workers of metallurgical enterprises

The identification of those factors of the working environment that create psycho-emotional stress of a person and the development of criteria for assessing and predicting the nervous-emotional stress of the body of workers is an urgent task of occupational health [2].

Labor activity of workers of metallurgical enterprises is characterized by a whole complex of harmful production factors, the most significant of which are: heating microclimate, noise, dust, chemical factors, increased nervous and emotional stress, requiring constant attention, speed and accuracy of reactions, heavy load of sensory systems. That undoubtedly affects the functional state of the body of workers and cases of morbidity with temporary disability (MTD).

So, in accordance with the N.V. Dogle's scale of incidence, which contains seven indicator assessments, the level of indicators of the STE at metallurgical enterprises refers to «very high» and «high».

Factor analysis of dispersion showed that the studied indicators reflecting the state of health deteriorated with an increase not only in age, but also in professional experience. Thus, in 30-year-old workers, compensatory links consistently linked almost all the functional characteristics under study, and the correlation coefficient between them exceeded 0.6, which indicated a significant voltage in the system. These phenomena are also characteristic of workers with work experience of up to 5 years, regardless of age, indicating a low body adaptation to working conditions.

In the group of 30–39-year-old workers, based on the principle of the systemic organization of physiological processes, optimization of physiological cost and adaptability was observed, indicating adaptation to working conditions, which is formed within 10–14 years of work experience.

The observed decrease in the regulation of body functions in 40–49 year old workers with 15–19 year experience on the background of actualization and labialization of the cardiovascular system (CS), neuromuscular activity (NA), the Central nervous system (CNS), as well as the increase of the physiological state index (PhSI) and the work ability index (WAI) indicates a decrease in the adaptive potential of individual functions, leading to the need for the formation of a certain set of elements of so-called limiting links, a clear correlation of which allowed to ensure the stability of the whole system at the stage of adaptive realignment of functions to achieve the proper functional level.

The achievement of the peak of cumulation of all the above phenomena in 50-year-olds and older workers who have worked 20–25 years, is characterized by the development of states of poor adaptation, which is manifested by various diseases and, first, the circulatory system, which further forces workers being a «critical contingent» to leave the professional cohort voluntarily or involuntarily due to disability.

Thus, the age-seniority categories of the surveyed workers completely repeat a set of compensatory connections formed at the age of 30, 30–39, 40–49 and 50 and more years that allowed to assume existence of the uniform regulatory mechanism which provides steady functioning of an organism as biological system at the reached functional level. At the same time, the low level and premature decrease in efficiency, depletion of functional reserves of adaptation of the organism to the effects of a complex of harmful factors of the working environment significantly reduce the professional suitability of workers in the «man — production factors — health» system.

The analysis of the dynamics of the MTD indicators by occupational groups showed that the main professions of workers engaged directly in the production process and in contact with the whole complex of production factors and, as a result, receiving a full «load» on the body have the highest values.

It should be noted that the workers of auxiliary professions do not fully experience the full range of harmful factors, since their work is to carry out repair work when the equipment either does not work or does not function in full. Engineering and technical workers also have low rates because they don't always, in accordance with official duties, face harmful factors of production.

In the structure of morbidity in all workshops leading place is occupied by respiratory diseases (acute respiratory diseases (ARD), second place is held by indicators of diseases of the musculoskeletal system, third place — injuries, fourth place — diseases of the digestive system and cardio-vascular system.

Respiratory system diseases holds first place among men and women in all workshops, second place, again in all workshops without exception — diseases of the musculoskeletal system, third place — men's injuries and women's digestive diseases. In fourth place: diseases of the cardiovascular system of both men and women, digestive diseases. To assess the impact on the morbidity of the complex of production factors, a correlation analysis of Spearman ranks was carried out. So the result of the calculation obtained values of the correlation coefficient in the interval from 0 to 1 (-1), which in accordance with Dogle N.'s method is consistent with the presence of a direct (inverse) relationship in which an increase in one trait leads to an increase (decrease) in other characteristic [3].

As it is known, the degree of correlation is measured by the binding force, which can be «high», «medium» and «low» depending on the value of the correlation coefficient. According to the data obtained, the strength of the relationship, for example, between the «age» factor, «experience», «occupational group» and «sick individuals» is «strong», whereas with «cases of morbidity» the strength of the relationship is «average» (Table 1).

Thus, the analysis of the level of health of workers of the metallurgical enterprise showed that harmful factors of the working environment negatively affect the health of workers, which is reflected in the high values of morbidity with temporary disability, both in cases and on days of disability. At the same time, their values, in accordance with the classification, correspond to the «high level». In addition, this is confirmed by the percentage of sick people, which also corresponds to the «high level».

To assess the impact of a set of production factors on morbidity, it is usually necessary to further establish the nature and extent of the relationship between the factors. And as is known, changing the value of one indicator leads to a change in the value of another. Therefore, the correlation analysis method is used to solve this problem.

Table 1

Calculated correlation coefficients for workshops

Factor indicators	Workshop 1			Workshop 2			Workshop 3		
	Sick individuals	Cases	Days	Sick individuals	Cases	Days	Sick individuals	Cases	Days
Age	–0,80	–0,60	–0,60	–0,80	–0,20	–0,80	0,20	0,40	0,20
Experience	–0,80	–0,50	–0,80	–0,80	–0,70	–1,00	0,20	0,40	0,20
Prof. Group	–0,80	–0,50	–1,00	–0,40	–0,50	–0,80	0,80	1,00	0,20

Note. 0.80 — the value of the correlation coefficient is valid ($p < 0.05$).

One of the leading moments in the practice of hygienic, physiological, and pathophysiological studies is the problem of identifying the relationship between the factors, the search for methodological ways to obtain results that allow us to judge one factor of them by changes in other factors. In this regard, the method of correlation analysis plays a primary role, allowing to answer the question — «are the different separately measurable features or traits of the body dependent on each other or independent, whether it is possible to draw a conclusion about the properties of any other feature based on the properties of any single feature» [3].

At the final stage of this study, to build a mathematical model of the prognosis of the morbidity level, it would be necessary to establish quantitative relationships between the hygienic parameters of the factors of the working environment and the morbidity level, however, the level of morbidity is influenced not only by working conditions, work experience, having quantitative values, but also by such difficult factors as social and living conditions, level of education, marital status, etc., the impact of which is difficult to calculate, since there are no quantitative criteria. In different situations, the degree of their influence is not the same, and their changes in dynamics are random. All this makes it difficult to quantify the relationship between the production factors of the environment and the level of morbidity.

In this regard, N.V. Dogle and A.Y. Yurkevich proposed to use the method of Regulatory intensive indicators of the incidence (RII) for cases where the use of the method of correlation and regression analysis is impossible, or it is extremely inefficient (due to the obtained approximate quantitative values) and developed the following formula to assess the impact of a set of factors of the working environment and social factors on the level of health or the calculation of the risk of disability [3]:

$$\text{Risk} = R\text{IIage} \times K1 + R\text{IIexperience} \times K2 + R\text{IIprof} \times K3 + R\text{IIsex} \times K4, \quad (1)$$

where *R*IIage, *R*IIexperience, *R*IIprof, *R*IIsex — regulatory intensive indicators of the incidence by age, experience, professional group and sex; *K*1, *K*2, *K*3, *K*4 — weight coefficients.

To assess the risk, it is necessary first of all to have an idea of the range of possible fluctuations in risk indicators for persons working in this workshop. By summing the product of the weighted coefficients on the RII (Table 2) having the lowest values for each of the factors, we obtain the minimum risk of disability R_{min}, if we sum up the maximum values of each of the factors, we obtain the maximum risk of disability $R_{max.}$

Table 2

Calculations of the NIP for a comprehensive assessment of the probability of the risk of disability in workshop 1

Age, years	Cases of morbidity with temporary disability	Regulatory intensive indicators (*R*II)	Experience, years	Cases of morbidity with temporary disability	Regulatory intensive indicators (*R*II)	Profession	Cases of morbidity with temporary disability	Regulatory intensive indicators (*R*II)	Sex	Cases of morbidity with temporary disability	Regulatory intensive indicators (*R*II)
Up to 30	164,7	1,024	<5	158,3	0,984	Main	174	1,082	Male	158,9	0,988
30–39	182,8	1,137	5–10	178,2	1,108	Repair	154,4	0,960	Female	170	1,057
40–49	145,5	0,905	11–15	190,1	1,182	Engineering staff	83,3	0,518			
> 50	131,9	0,820	16–20	103,6	0,644	Auxiliary	105	0,653			
Cases on the workshop = 160,8			>20	127,2	0,791						
Weight *K* coefficients	*K*1=Max/min			*K*2=Max/min			*K*3=Max/min		*K*4=Max/min		
	1,39			1,83			2,09		1,07		

The difference between these risks ($R_{max} - R_{min}$) will represent the entire range of fluctuations within which all the values of the integrated risk assessment for people working in this workshop are located. Taking into account the range of fluctuations in complex estimates, as well as their nature, it is possible to distribute all working in the workshop to the following groups: *with a favorable prognosis, attention group and a group with an unfavorable risk of losing performance* (*adverse prognosis).*

Using formula (1), we will calculate the minimum and maximum risks of disability for employees of workshops 1, 2, 3 (Tables 3–5), using standardized intensive and factor indicators (age, experience, profession, sex).

Risk min = 0,820·1,39 + 0,644·1,83 + 0,518·2,09 + 0,988·1,07 = **4,46 Favorable prognosis**;

Risk max = 1,137·1,39 + 1,182·1,83 + 1,082·2,09 + 1,057·1,07 = **7,14 Adverse prognosis**.

Table 3

Range of fluctuations of the risk of disability in the shop 1

Risk group in workshop 1	Risk range
Favorable prognosis	4,464–5,06
Attention group	5,06–5,73
Adverse prognosis	5,74–7,14

We will calculate the risk of loss of efficiency on the example of shop 1 indicators, using the developed quantitative criteria of the mathematical model of risk prediction:

Risk (shop 1) = 1,398 × Age + 1,83 × Experience + 2,09 × Prof.group + 1,07 × Sex.

1. A., age 29, 4 year experience, job title — fueler, sex — female:

Risk (shop 1) = 1,39 × 1,024 + 1,83 × 0,984 + 2,09 × 1,082 + 1,07 × 1,131 = **6,62**.

Conclusion: L.M. As-va belongs to the group with **Adverse prognosis**.

2. M., age 45, 12 year experience, job title — the mechanic-repairman, sex — male:

Risk (shop 1) = 1,397 × 0,905 + 1,83 × 1,182 + 2,09 × 0,96 + 1,07 × 0,988 = **6,69**.

Conclusion: H.A. Mos-v belongs to the group with **Adverse prognosis**.

3. S., age 52, 25 year experience, job title — main line supervisor, sex — male:

Risk (shop 1) = 1,397 × 0,820 + 1,83 × 0,791 + 2,09 × 0,518 + 1,07 × 0,988 = **4,73**.

Conclusion: A.I. Sha-n refers to the group with a **Favorable prognosis**.

Table 4

Range of fluctuations of the risk of disability in shop 2

Risk group in workshop 2	Risk range
Favorable prognosis	1,55–1,93
Attention group	1,93–2,30
Adverse prognosis	2,30–3,06

Table 5

Range of fluctuations of the risk of disability in shop 3

Risk group in workshop 3	Risk range
Favorable prognosis	1,09–1,31
Attention group	1,31–1,52
Adverse prognosis	1,52–1,94

The obtained equations and quantitative criteria of the risk of disability allow the simplification of the procedure of the complex integrated assessment and risk prediction, as well as they allow to indirectly assess the degree of adverse effects of harmful factors of production and labor process for the development and implementation of a set of preventive measures.

This methodical approach allows us to assess and predict the health status depending on age, experience, profession, personal characteristics, as well as to assess the level of adverse effects of factors of the working environment on the body. The proposed method can be used in preventive medical examinations and prenosological diagnosis.

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Ж.Т. Алпысбаева

Өнеркәсіп кәсіпорындарының еңбек жағдайларын әлеуметтік және гигиеналық тұрғыдан бақылау

Мақалада еңбек жағдайларына әлеуметтік-гигиеналық мониторинг жүргізу әдісі сипатталған. Нақты өндірістік қызмет жағдайында кәсіби жұмысшылардың жай-күйіне толық психофизиологиялық бағалау жүргізілді. Өнеркәсіптік кәсіпорындарда алдын ала іс-шараларын жүргізу үшін «тәуекел» топтарын анықтау және жұмысқа қабілеттіліктің жоғалуын болжау өлшемдері есептелген. Мұндай әдістемелік тәсіл жасына, еңбек өтіліне, мамандығына, жеке сипаттамаларына байланысты денсаулық жағдайын бағалау мен болжауды, сондай-ақ өндірістік орта факторларының ағзаға жағымсыз әсер ету деңгейін бағалауды беруге мүмкіндік береді. Ұсынылған әдіс алдын ала медициналық тексеру мен донозологиялық диагностика жүргізуде қолданылуы мүмкін. Зерттеу нәтижелері бойынша әдістемелік ұсынымдар әзірленді, олар өндірісте енгізілді және медициналық білім беру мекемелерінің лекциялары курсына енгізілді.

Кілт сөздер: өндірістік факторлар, еңбек жағдайлары, ауру, уақытша еңбекке жарамсыздық, қоршаған ортаның әсерін бағалау, корреляция, реттеудің қарқынды көрсеткіштері, тәуекел критерийлері, болжау, математикалық модель.

Ж.Т. Алпысбаева

Социально-гигиенический мониторинг условий труда на промышленных предприятиях

В статье описан метод проведения социально-гигиенического мониторинга условий труда. Проведена комплексная оценка психофизиологического состояния рабочих предприятий в условиях реальной производственной деятельности. Для проведения профилактических мероприятий на промышленных предприятиях рассчитаны критерии выявления групп «риска» и прогнозирования утраты работоспособности. Такой методический подход позволяет дать оценку и прогноз состояния здоровья в зависимости от возраста, стажа, профессии, личностных характеристик, а также оценку уровня неблагоприятного влияния факторов производственной среды на организм. Предложенный метод может быть использован в проведении профилактических медосмотров и донозологической диагностики. По результатам исследований разработаны методические рекомендации, которые были внедрены на производстве и включены в курс лекций медицинских образовательных учреждений.

Ключевые слова: производственные факторы, условия труда, уровень заболеваемости, временная нетрудоспособность, оценка влияния среды, корреляция, нормативные интенсивные показатели, критерии риска, прогнозирование, математическая модель.

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