

**ICEST 2022****III International Conference on Economic and Social Trends for Sustainability of Modern Society****SOCIO-HYGIENIC DETERMINANTS OF HEALTH OF  
WORKERS IN THE PRODUCTION OF POLYACRYLONITRILE  
FIBERS**

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**Abstract**

The aim of the work was to evaluate the most significant social and hygienic factors in the formation of the health of workers involved in the production of synthetic polyacrylonitrile fiber based on the results of complex sociological, hygienic and epidemiological studies. Research and hygienic assessment of the working environment and the labor process, a sociological survey and an assessment of social, domestic and behavioral factors, a study of the health status of workers according to data obtained in the process of conducting a mandatory periodic medical examination, self-assessment of their own health and the relationship of its violations with factors of working conditions and lifestyle. It has been established that the population-significant hygienic factors that threaten the health of workers in the production of polyacrylonitrile fiber are harmful working conditions, with the impact of which 22.2% of respondents associated the deterioration in health. Employees indicated as the main harmful factors of the working environment noise, dust, drafts, unfavorable microclimate, vibration, insufficient illumination, severity and labor intensity. The most important social and behavioral factors that determine the health status of the surveyed workers include smoking, drinking alcohol, unhealthy diet, and insufficient physical activity. Prevention of the negative impact of risk factors on the health of workers is possible through the implementation of state and corporate policies aimed at ensuring safe working conditions, improving the quality and standard of living, promoting a healthy lifestyle and health-saving behavior.

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## 1. Introduction

Ensuring decent living conditions, reducing premature mortality from non-communicable diseases through prevention is a necessary condition for preserving and strengthening human resources in the implementation of the goals for sustainable development adopted on September 25, 2015 by the Resolution of the United Nations (UN) General Assembly (Resolution adopted by the General Assembly on 25 September 2015, 2015). The concept of sustainable development acts as the main direction in the 21st century, and the goals set during its adoption as the priorities of the state policy of all UN member countries. In the Russian Federation, the goals of sustainable development are implemented in the Concept of the modern demographic policy of Russia, aimed at maintaining the health of the population, strengthening it and increasing active life expectancy, reducing mortality and stabilizing the demographic situation as a whole (The concept of the demographic policy of the Russian Federation for the period up to 2025, 2007).

The state of human health is due to the synergism of a number of determinants that determine the causes of his disorder, affecting the genesis, manifestations and consequences of his disorders, the possibility of preserving and strengthening. The main factors influencing the state of health of an individual can be conditionally divided into internal uncontrollable or weakly controllable (genetic, biological) and exogenous controllable factors, which, in turn, are divided into personal and behavioral risks, socio-economic conditions and standard of living, environmental characteristics, as well as the working environment, the availability and quality of medical services. When developing and planning measures to preserve the health of the population, controllable factors that together form individual and public health are of paramount interest (Aslanov, 2011; Shapovalova, 2020).

Labor activity plays a key role in shaping the health of the working population, providing economic resources and well-being, life opportunities for the implementation of the social needs of workers and their families. However, in some cases, especially in case of non-observance of hygienic standards of the labor process, factors of the production environment can lead to the development of functional disorders of the body, cause or contribute to the development of occupational and work-related diseases, increase the risk of progression of chronic non-communicable diseases and mental disorders (Doré & Caron, 2017; Izmerov, 2011; Soren et al., 2021). According to the European Observatory on Public Health Systems and Policies, occupational and work-related diseases are among the top ten risk factors that determine the overall burden of disease (Rechel & McKee, 2018).

Socio-economic and behavioral factors - low income, lifestyle, eating disorders, lack of physical activity, bad habits, exposure to tobacco smoke and alcohol abuse, chronic stress, professional burnout are the causes of the development of chronic non-communicable diseases, which include diseases of the circulatory system and respiratory diseases, diabetes mellitus II, a number of malignant neoplasms, dorsalgia (Kobyakova et al., 2019). In the light of the foregoing, studies on the manageable determinants of the health of the population employed in various types of economic activity are currently becoming particularly relevant in order to determine relevant measures to prevent health disorders, prolong professional longevity, and preserve labor resources.

## **2. Problem Statement**

When studying factors influencing public health, sources of information can be both objective data (results of studies of conditions, lifestyle, the state of the environment, including the working environment, medical documentation, official statistics), on individual health - subjective self-assessments of the subjects, giving the opportunity to identify patterns of health formation at the individual level (Hanmer, 2021; Shapovalova, 2020).

Currently certain foreign and domestic experience has been accumulated in assessing the factors that determine individual and public health, developing and implementing programs to preserve and improve the health of the working-age population employed in the production of various types of economic activity, indicating their economic and medical and preventive effectiveness (Drapkina & Salagaya, 2021; Popovich et al., 2020).

A promising industry in the modern world industry in the current millennium has become the production of artificial fibers, which are widely used by the population and in various industries as raw materials (Klepikov & Kukushkin, 2017). The data available in the scientific literature indicate that the working conditions in the production of synthetic polyacrylonitrile fiber are characterized by air pollution of the working area with a multicomponent set of harmful substances (raw materials, solvents, synthesis by-products), increased noise levels, physical overload and emotional stress (Kochetova et al., 2018; Varov et al., 2007). However, the factors of formation of health disorders of workers employed in this production have not been studied enough, which makes it difficult to develop sound programs for individual and group prevention of risks to their health, determining the relevance of these studies.

## **3. Research Questions**

Research questions include the following:

- i. Research and hygienic assessment of the leading factors of the working environment and the labor process in the production of polyacrylonitrile fiber.
- ii. Sociological survey and assessment of socio-economic and behavioral factors in the formation of workers' health.
- iii. Investigation of the health status of workers in the main professions involved in the production of polyacrylonitrile fiber based on periodic medical examinations.
- iv. Employees' self-assessment of their own health and the relationship of its violations with factors of working conditions and lifestyle.
- v. Determination of priority controlled social and hygienic factors that determine the health of workers, and ways to prevent their negative impact

## **4. Purpose of the Study**

The purpose of the study is the evaluation of the most significant social and hygienic factors in the formation of the health of workers involved in the production of synthetic polyacrylonitrile fiber based on the results of complex sociological, hygienic and epidemiological studies.

## 5. Research Methods

The hygienic assessment of the leading factors of the working environment and the labor process was performed based on the results of field sanitary and hygienic studies in accordance with the sanitary and epidemiological rules and norms in force in the Russian Federation (SanPiN 1.2.3685-21, 2021), hygienic criteria and the classification of working conditions (Guidelines for the hygienic assessment of factors of the working environment and the labor process, 2006). To assess the occupational health risk, criteria generally accepted in Russian occupational medicine were used (Guidelines for assessing the occupational risk to the health of workers. Organizational and methodological foundations, principles and evaluation criteria, 2004).

The study of the health status of 139 workers (average age  $49.3 \pm 10.1$  years, average professional work experience  $20.8 \pm 11.1$  years) was carried out at the enterprise for the production of polyacrylonitrile fiber based on the results of a medical examination conducted on the basis of the regional Center for Occupational Pathology of the Saratov MRC of Hygiene in 2021 in accordance with the approved Procedure (Order of the Ministry of Health of Russia, 2021). The first detected morbidity was studied according to the methodology generally accepted in health care (Medic & Tokmachev, 2006). The selection criterion for the study was belonging to the main professions involved in the production process of obtaining polyacrylonitrile fiber.

Sociological research was carried out by the method of distributing a sociological survey. It studied socio-economic characteristics of respondents (gender, age, marital status, education, income, living conditions); behavioral factors and lifestyle (physical activity, alcohol use, smoking); social status (satisfaction with medical care); assessment of working conditions factors; self-assessment of health and its disorders in connection with professional activity (Basic principles and methods of ergonomic assessment of workplaces for performing work while sitting and standing).

In accordance with ethical principles, with the participation of a person, informed and voluntary consent of the examined was obtained for scientific medical research.

When processing the data and analyzing the results of the research the Microsoft Excel 2007 and Statistika 10 applications were used.

## 6. Findings

As a result of studies of the working environment and the labor process it was found that workers in the course of their work are exposed to a complex of harmful production factors, including chemicals of 1-4 hazard classes, industrial noise, physical and neuro-emotional stress. Harmful chemicals that can have a negative impact on the body of workers were represented by starting substances (acrylonitrile and methyl acrylate), their degradation products (hydrocyanide, ammonia), solvents and reagents (sodium thiocyanate, sulfuric acid, methanol, isopropyl alcohol, ethylene glycol).

The content of all the above harmful substances in the breathing zone of workers during the normal conduct of the technological process was within the permissible limits. However, sporadically (in 2% of samples) in case of violations of the tightness of equipment and communications, peak increases in the content of these toxicants were recorded in excess of the maximum permissible concentrations

(MAC). The maximum excess of the MPC of acrylonitrile increased by 1.9 times, and of methyl acrylate - by 1.4 times, with sequential exposure, their concentrations corresponded to harmful working conditions of the 1st degree (class 3.1), with the cumulative - to harmful 2nd degree (class 3.2). The methanol content exceeded the MPC by 1.5 times (class 3.1). The concentrations of other harmful substances did not exceed the MPC (class 2).

The constant presence of a complex of harmful chemicals in the air of the working area was combined with the impact of industrial noise, insufficient lighting, physical and emotional stress. The sources of noise were the operation of equipment and ventilation systems. In terms of time characteristics, the noise is constant, in terms of the nature of the spectrum it is broadband with maximum sound levels of 82-91 dBA. The excess of equivalent sound levels, taking into account the exposure time per shift, was 1-6 dBA, which corresponded to harmful working conditions of 1-2 degrees (classes 3.1-3.2).

The parameters of illumination of the working surface from artificial lighting in the service areas of the equipment and on the panels of instrumentation corresponded to the normative ones (75 lux and 200 lux, respectively). At the same time, individual workplaces (operators of the remote control panel, apparatchiks) were located in rooms with no natural light.

The severity of the labor process of workers was characterized by a long stay (60-80% or more of the shift time) in a standing position and long horizontal and vertical transitions when servicing equipment located on different floors.

Due to the high chemical hazard of production and the likelihood of emergency and emergency situations, psycho-emotional stress was formed due to increased responsibility for the result of personal activity, a high risk to life and the safety of others. The auditory load was typical as a result of the production need for the perception of speech and sound signals against the background of noise interference. The intensity of work of workers was also associated with work in night shifts according to the schedule.

According to the results of the hygienic assessment of working conditions, the occupational health risk of workers in the production of synthetic polyacrylonitrile fiber is categorized from low to high (Table 1).

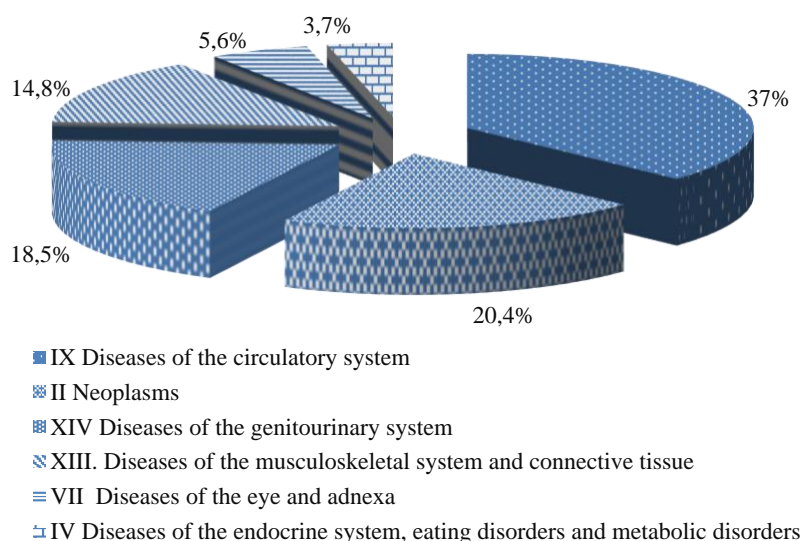
**Table 1.** Evaluation of the occupational health risk for workers in the production of polyacrylonitrile fiber under the influence of harmful factors of working conditions

Production units	Class (subclass) working conditions		Category of professional risk to health
	Name of the harmful factor	General assessment	
Department of receiving methylacrylate, a section of cleaning of kinds	The severity of labor (3.1)	3.1	Small (moderate) risk
	Labor tension (3.1)		
Polymerization departments; regeneration, walking, A site of chemical solutions	Chemical factor (3.1)	3.2	Average (essential) risk
	Production noise (3.1)		
	The severity of labor (3.1-3.2)		
Filtering and deaeration department	Labor tension (3.1)	3.3	High (intolerable) risk
	Chemical factor (3.1)		
	Lighting (3.2)		

	Production noise (3.1)		
	The severity of labor (3.3)		
	Labor tension (3.1)		
	Lighting (3.2)		
Workshop for manufacturing Filter	Production noise (3.1)	3.2	Average (essential) risk
	The severity of labor (3.1)		
	Labor tension (2)		
	Lighting (3.2)		
Spinning and dry decoration department, packaging department	Production noise (3.2)	3.3	High (intolerable) risk
	The severity of labor (3.2)		
	Labor tension (3.1)		

According to the results of PMO 44 employees were diagnosed with 54 chronic non-communicable diseases for the first time, seven of which had comorbidities. The prevalence of primary morbidity among the examined persons was 388.4‰.

Most often, workers in the production of polyacrylonitrile fiber were diagnosed with diseases of the circulatory system, including arterial hypertension (essential); the second ranking place was occupied by benign neoplasms of the cervix, the third - diseases of the genitourinary system (glandular hyperplasia of the endometrium, endometriosis, unspecified ovarian cysts). The fourth place was occupied by diseases of the musculoskeletal system and connective tissue, mainly dorsalgia of the lumbar level. Diseases of the eye and adnexa (presbyopia and astigmatism) were in fifth place. The last ranking place was occupied by diseases of the endocrine system, eating disorders and metabolic disorders, mainly obesity of various degrees (Figure 1).



**Figure 1.** The structure of the primary morbidity of workers in the production of polyacrylonitrile fibers

Diseases of the circulatory system are socially significant diseases, being the most common diseases and the leading cause of death in the adult population, both throughout the world and in the

Russian Federation (Balanova et al., 2019). In relation to workers in the production of polyacrylonitrile fibers, their development may be associated with the negative impact of production factors, among which are functional overstrain from physical overload, psycho-emotional stress, industrial noise. Emotional stress in production is due to the potential threat of emergency situations, chronic intense emotional stress associated with a risk to life and a high responsibility for the safety of others, as well as an irrational work and rest regimen, night shift work. According to the scientific literature, psychogenic factors may play a leading role in the development of chronic occupational stress, associated diseases of the circulatory system, and fatal cardiovascular events (Babanov & Baraeva, 2015; Mesa-Vieira et al., 2021). In addition, chronic exposure to elevated sound levels (more than 80 dBA) at high frequencies can lead to an increase in blood pressure and the development of hypertensive reactions with a slow progression of arterial hypertension (Bolm-Audorff et al., 2020; Strizhakov et al., 2018), increasing the risk of cardiovascular and cerebrovascular diseases (Yadav et al., 2021).

The development of disorders in the circulatory system in the examined contingent of workers can also be associated with exposure to harmful chemicals present in the air of the working area. There is evidence in the scientific literature that prolonged inhalation of acrylonitrile vapors at concentrations significantly below the MPC leads to a decrease in blood pressure and muffled heart sounds (Kutsenko, 2004). In workers who have worked in the production of Nitron fiber for more than 1.5 years, an instrumental and clinical examination revealed a decrease in the electrical activity of the myocardium, a slight decrease in the content of hemoglobin, erythrocytes and reticulocytes in violation of the maturation of normoblasts in the bone marrow (Babanov et al., 1959). The general toxic effect of cyanides and nitriles, acrylates, methanol can lead to chronic occupational intoxications involving various organs and systems of the body (hemato-, hepatobiliary, nervous, bronchopulmonary, cardiovascular, endocrine). However, their diagnosis requires in-depth medical examinations, identification of preclinical stages of diseases due to the nonspecific picture of chronic poisoning (Varov et al., 2007).

The greatest danger to the health of workers is cyanides, the toxicity of which is due to the ability of entering the body to form compounds with heavy metal ions that block the enzymes necessary for cellular respiration, especially cytochrome oxidase, which leads to a loss of the ability of tissues to absorb oxygen, causing tissue hypoxia. The consequences of tissue hypoxia can be atherosclerosis, hypercholesterolemia, diabetes mellitus (Lazarev & Levina, 1979). When examining the health status of workers, it was found that 33.3% of the surveyed workers were diagnosed with obesity, 60% had an increased level of glucose in the venous blood on an empty stomach ( $> 7.0$  mmol/l), and 66.7% had hyperlipidemia.

A risk factor for the development of diseases of the musculoskeletal system and connective tissue in workers in the production of polyacrylonitrile fiber can be physical overload when performing work in a standing position, with lifting and moving loads manually, contributing to the development of pathologies of the spine and joints (Shaikhislamova et al., 2018).

Working in an uncomfortable working position with forced tilts of the body, moving loads manually contributes to circulatory disorders in the pelvic organs, inflammatory processes of the internal genital organs, and violation of the female reproductive sphere (Fesenko et al., 2017).

Social and behavioral factors are also involved in determining the health status of the examined workers. The results of sociological surveys showed that 58% of workers in the main production were women. The majority of employees (78.1%) had a secondary education, of which 82.6% had specialized secondary education, and the remaining 8.3% had incomplete secondary education. 13.6% of the surveyed workers had higher education. Almost all employees (99%) lived in the city in comfortable apartments with central (89.1%) and gas (10.9%) heating. According to marital status, 58.2% of respondents were married, 83.6% had children.

Almost a third (33.3%) of the respondents described their own health as "satisfactory", the rest as "excellent" (10.4%), "very good" (8.15%) and "good" (48.15%). When comparing the assessments of their own health depending on the gender of the respondents, it was revealed that men more often than women believed that their health was "excellent", "very good" and "good" (respectively, 16.4; 16.4; 54, 1% versus 5.4; 1.35; 43.2%). However, women surveyed were more likely than men to have chronic diseases. The revealed gender differences are consistent with the results of sociological studies of domestic and foreign authors, which show that men are less attentive to their health, they have to work harder to support their families, they more often manifest destructive behavior aimed at their physical condition (Korolenko, 2018; Williams et al., 2021). The most positive ("excellent" and "very good") self-health was assessed by respondents with higher education and unmarried persons. There is evidence in the scientific literature that more educated people tend to take better care of themselves and have fewer bad habits. There is also evidence that unmarried men, and among women, widows were more likely to have complaints of poor health (Vangorodskaya, 2018).

At the same time the self-assessment of the health of the surveyed workers did not correspond to the objective results of medical examinations, according to which 84.3% of the surveyed were diagnosed with chronic pathological conditions, among them 75% of the workers had two, and 38.6% of the persons had three chronic non-communicable diseases. At the same time, only 6.3% of employees were registered with the dispensary. Despite the state of their health, only 16.4% of respondents were convinced of the need for annual mandatory periodic medical examinations, and 74.5% were ready to undergo it on a voluntary basis. The data obtained may indicate a low motivation for health care of the respondents and the manifestation of dissimulation of diseases, probably due to their obstacles to further professional activity, regulated by admission to work for health reasons.

In the group of behavioral factors that have a negative impact on health, self-preserving behavior plays a primary role (Shapovalova, 2020). The results of the survey made it possible to determine the prevalence among the respondents of bad habits, irrational nutrition, and insufficient physical activity. Of the surveyed workers, only 32.7% adhered to a balanced diet. Maintaining an active lifestyle (going in for sports, visiting the pool, walking in the fresh air) was conducted only by 25.4% of the respondents. At the same time, it was found that among respondents with an active lifestyle, 39.3% had body mass index (BMI) values corresponding to normal, 32.1% were overweight, and 25.0% were obese of varying degrees. Among workers who do not adhere to an active lifestyle, 18.3% had normal body weight, the rest of the workers were overweight (40.2%) and obese (34.1%). Thus, among workers leading an active lifestyle, there were 1.3 times less obese people, and 2.0 times more people with normal body weight than in the opposite group.



Tobacco smoking and alcohol consumption are important risk factors for health problems. Among the surveyed workers, 46% smoked, the average number of cigarettes smoked was  $4.4 \pm 0.6$  cigarettes per day, and the average smoking experience was  $8.8 \pm 1.1$  years. Of the respondents who smoke, 27.3% planned to quit smoking in the future. 8.6% of workers were exposed to tobacco smoke in everyday life, 1.4% used electronic cigarettes.

Alcohol was consumed by 83.7% of the surveyed men and 72% of women. The frequency of drinking alcoholic beverages was 1 time per month in 22.5% of men and 14% of women. The rest drank alcohol only on holidays. Most of the surveyed men (53.7%) preferred drinks with a strength of 40% or more, 82.5% of women preferred drinks with a strength of 5-20%. Respondents have information about the dangers of alcohol consumption, that it causes the development of diseases of the circulatory system, liver, causes the development of depression and alcoholic psychosis (Korolenko, 2018; Vangorodskaya, 2018).

When studying the influence of working conditions on self-assessment of the state of health, it was revealed that 22.2% of respondents associated the deterioration of their health with the impact of adverse production factors. However, 56.3% believed that working conditions do not affect their health, 20% found it difficult to answer. As the main factors harmful to health, employees indicated noise (65.2%), dust (17.8%), drafts (17.8%), unfavorable microclimate (29.6%), vibration (19.2%), low illumination (13.3%), severity (15.6%) and labor intensity (16.3%). According to the respondents, the severity of their work was due to long work in the "standing" position without interruption for more than 60% of the shift time (29.6%), lifting and moving the load manually (19.5%). Workers associated intense work with concentrated observation (48.9%), concentration of attention (47.4%), eye strain (25.2%), strain on the hearing aid (19.3%) and high personal responsibility (46.7%). 38.3% of respondents pointed to increased emotional stress caused by the possibility of accidents and emergency situations, and 23.7% of respondents indicated a large amount of work.

Unsatisfactory working conditions, according to workers, were the main reason for poor health in the process of work. During the working day, 83.0% of respondents were moderately tired, while 25.2% indicated a feeling of fatigue and pain in the legs, 24.4% in the lumbar region, 14.8% in the arms in the neck and shoulders, 2.2% of workers had headaches. The occurrence of fatigue and pain was associated by 23.7% of respondents with prolonged work on their feet, 14.1% by lifting and carrying heavy objects by hand, and 11.8% by an uncomfortable working posture.

## **7. Conclusion**

Thus, the results of complex sociological, hygienic and epidemiological studies made it possible to determine the priority social and hygienic factors that determine the health status of workers in the production of polyacrylonitrile fiber. Almost all of the identified factors are manageable, reducing their negative impact on the health of workers is possible through the implementation of state and corporate policies aimed at ensuring safe working conditions, improving the quality of life and physical activity, realizing individual opportunities, promoting a healthy lifestyle and health-saving behavior.

So, we can do the following conclusions:

- Population-significant hygienic factors that threaten the health of workers in the production of polyacrylonitrile fiber are unfavorable working conditions - air pollution of the working area with harmful chemicals, industrial noise, physical overload and psycho-emotional stress associated with the harmfulness and danger of production.
- Among the behavioral factors that determine the state of health of the surveyed, the leading role belongs to destructive behavior - smoking, drinking alcohol, irrational nutrition, reduced physical activity after hours, inactive lifestyle.
- The development and implementation of preventive measures to improve social and living conditions, promote a healthy lifestyle, give up bad habits, and improve working conditions at workplaces will help preserve the health of workers and extend their professional longevity.

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