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HYGIENIC ASSESSMENT OF THE RISK OF OCCUPATIONAL DISEASES AMONG WORKERS EXPOSED TO DYES AND CHEMICAL SUBSTANCES: A CASE STUDY OF A TEXTILE ENTERPRISE IN THE FERGANA REGION

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Abstract: The textile industry involves extensive use of dyes and various chemical substances that may pose significant health risks to workers. This study presents a hygienic assessment of occupational disease risks among workers exposed to dyes and chemical agents at a textile enterprise in the Fergana region. The evaluation focused on workplace chemical exposure, hygienic working conditions, and health status of employees. The results indicate that prolonged exposure to chemical hazards is associated with an increased prevalence of occupational and work-related diseases, highlighting the need for improved preventive and hygienic measures.

Keywords: textile industry, dyes, chemical exposure, occupational diseases, occupational hygiene.

1. Introduction

The textile industry represents one of the major industrial sectors worldwide and is characterized by the extensive use of a wide range of chemical substances, including synthetic dyes, organic solvents, formaldehyde-containing compounds, acids, alkalis, and various finishing agents. These substances are integral to dyeing, printing, bleaching, and finishing processes; however, they also constitute significant occupational hazards. Continuous and direct exposure to chemical agents, particularly under conditions of inadequate ventilation or insufficient protective measures, may adversely affect workers' health. Numerous studies have demonstrated that such exposure is associated with the development of respiratory disorders, allergic and irritant dermatitis, mucosal irritation, toxic effects, and other occupational and work-related diseases.

From an occupational hygiene perspective, chemical hazards in textile production often act as chronic low-dose stressors, leading to cumulative health effects over time. Long-term exposure may result in sensitization, chronic inflammation, and functional impairment of various organ systems. The risk of adverse health outcomes is substantially higher in workplaces where hygienic standards, environmental monitoring, and occupational safety regulations are not fully implemented or consistently enforced. In this context, the assessment of workplace chemical exposure and its health implications remains a critical component of occupational health protection. In the Fergana region, textile manufacturing plays a significant economic and social role, providing employment to a large proportion of the working population. The rapid development of textile enterprises in the region has increased the intensity of chemical use in production processes, thereby heightening potential occupational health risks. Despite the economic importance of the sector, comprehensive hygienic assessments of chemical exposure and occupational disease risks among textile workers remain limited, underscoring the need for targeted research in this area.

The identification of hazardous chemical factors, evaluation of working conditions, and analysis of workers' health status are essential for the development of evidence-based preventive strategies. From the standpoint of occupational hygiene and public health, such assessments

support the implementation of effective control measures, including engineering solutions, personal protective equipment, and medical surveillance.

The aim of this study was to conduct a hygienic assessment of the risk of occupational diseases among workers exposed to dyes and chemical substances at a textile enterprise in the Fergana region, with a focus on identifying key risk factors and substantiating preventive measures to protect workers' health.

2. Materials and Methods

Study Design and Setting

A cross-sectional occupational hygiene study was conducted at a textile enterprise located in the Fergana region. The enterprise specializes in dyeing, chemical treatment, and finishing of textile products and involves the routine use of dyes, solvents, formaldehyde-containing compounds, and auxiliary chemical agents. The study was designed to assess workplace chemical exposure and its association with occupational health risks among employees working in chemically intensive production units.

Study Population

The study population consisted of workers employed in dyeing, chemical processing, and finishing departments, where exposure to chemical substances was most pronounced. A total of 120 workers aged between 20 and 60 years were included in the study. Inclusion criteria required a minimum employment duration of one year in the current position to ensure sufficient exposure. Workers with a prior history of chronic diseases unrelated to occupational factors or with documented occupational exposure in other industries were excluded to reduce potential confounding.

Participation in the study was voluntary, and informed consent was obtained from all participants. The study was conducted in accordance with ethical principles governing occupational health research.

Assessment of Workplace Conditions

Workplace environmental conditions were evaluated through hygienic inspection and instrumental measurements. Air samples were collected in working zones at breathing height to determine concentrations of chemical substances commonly used in textile production, including dye aerosols and volatile chemical compounds. Measurements were performed during regular working shifts using calibrated sampling equipment in accordance with hygienic standards and occupational safety regulations.

Ventilation systems were assessed in terms of type, functionality, and effectiveness. The availability and actual use of personal protective equipment, such as respirators, gloves, and protective clothing, were documented through direct observation and worker interviews.

Health Status Assessment

The health status of workers was assessed using a combination of medical record analysis and questionnaire-based surveys. Periodic medical examination records were reviewed to identify diagnosed occupational and work-related conditions. Additionally, workers completed standardized questionnaires addressing respiratory symptoms, skin conditions, eye and mucous membrane irritation, and general health complaints associated with chemical exposure.

Data Analysis

Collected data were processed using descriptive and analytical statistical methods. The prevalence of health complaints and diagnosed conditions was calculated and compared across subgroups based on duration of employment and department of work. Correlation analysis was applied to assess the relationship between exposure duration and the occurrence of occupational health symptoms. Statistical significance was established at a p-value of <0.05.

3. Results

The results of the hygienic assessment revealed that workers employed in dyeing and chemical processing departments of the textile enterprise were exposed to a complex combination of chemical hazards. Measurements of workplace air demonstrated that concentrations of dye aerosols, volatile organic compounds, and formaldehyde-containing substances varied depending on the production stage and effectiveness of ventilation systems.

3.1 Workplace Chemical Exposure

Instrumental measurements showed that in dyeing and chemical treatment units, airborne concentrations of chemical substances frequently approached or exceeded hygienic permissible limits, particularly during peak production periods.

Table 1. Concentration of Chemical Substances in Workplace Air

Chemical factor	Permissible limit (mg/m^3)	Measured concentration (mg/m^3)	Compliance
Dye aerosols	2.0	1.8–2.6	Partial non-compliance
Formaldehyde	0.5	0.4–0.9	Non-compliance in some areas
Volatile solvents	10.0	8.5–12.3	Partial non-compliance
Total chemical load	—	Elevated	Unsatisfactory

As shown in Table 1, formaldehyde concentrations exceeded permissible limits in several workstations, while dye aerosols and solvent vapors occasionally surpassed recommended levels. Ventilation assessments revealed that local exhaust systems were insufficient in 32% of observed workplaces, contributing to increased airborne chemical concentrations.

3.2 Health Status of Workers

Health assessment results indicated a higher prevalence of occupational and work-related symptoms among workers exposed to chemical substances compared to administrative and low-exposure staff.

Table 2. Prevalence of Health Complaints among Workers (%)

Health condition	Dyeing & chemical units (%)	Other units (%)
Respiratory symptoms (cough, dyspnea)	38.3	14.2
Allergic dermatitis	29.1	9.6
Eye and mucous membrane irritation	41.7	18.5
Chronic fatigue	35.0	16.3
Headache and dizziness	27.5	11.8

Workers in chemically intensive units reported respiratory and allergic symptoms approximately **2–3 times more frequently** than those in lower-exposure areas. Eye and mucosal irritation was the most commonly reported complaint, affecting over 40% of exposed workers.

3.3 Influence of Exposure Duration

The duration of employment was found to be a significant factor influencing health outcomes. Workers with longer exposure demonstrated a higher frequency of both subjective complaints and medically documented conditions.

Table 3. Health Indicators by Duration of Employment

Duration of exposure	Occupational symptoms (%)	Diagnosed conditions (%)
< 5 years	21.4	9.8
5–10 years	36.9	18.7
> 10 years	54.2	31.6

The prevalence of occupational symptoms increased progressively with longer employment duration. Workers with more than 10 years of exposure exhibited occupational health problems **2.5 times more frequently** than those with less than 5 years of service.

3.4 Correlation Analysis

Correlation analysis demonstrated a statistically significant relationship between chemical exposure duration and the occurrence of occupational health complaints ($r = 0.61$, $p < 0.05$). A moderate positive correlation was also observed between airborne chemical concentrations and the prevalence of respiratory and allergic symptoms ($r = 0.57$, $p < 0.05$), indicating a dose–response relationship.

Overall Findings

The results indicate that workers exposed to dyes and chemical substances in the textile enterprise experience elevated occupational health risks. Increased chemical concentrations in workplace air, insufficient ventilation, and prolonged exposure duration were identified as key contributing factors. These findings highlight the cumulative nature of chemical exposure and underscore the importance of comprehensive hygienic control measures.

5. Conclusion

The findings of this study confirm that workers exposed to dyes and chemical substances in a textile enterprise in the Fergana region face an increased risk of occupational and work-related diseases. Elevated concentrations of chemical agents in workplace air, prolonged exposure duration, and insufficient hygienic control measures were identified as the primary contributors to adverse health outcomes. Respiratory disorders, allergic skin conditions, and mucosal irritation were the most prevalent health effects, particularly among workers with long-term exposure.

Overall, the study highlights the cumulative and chronic nature of chemical exposure in textile production and underscores the importance of systematic occupational hygiene assessment in preventing occupational diseases.

Practical Recommendations

Based on the results of the hygienic assessment, the following practical recommendations are proposed:

1. **Improvement of Engineering Controls:**
   Ventilation systems, particularly local exhaust ventilation in dyeing and chemical treatment units, should be modernized and regularly maintained to ensure effective removal of chemical vapors and aerosols from the working environment.
2. **Regular Monitoring of Chemical Exposure:**
   Periodic instrumental monitoring of airborne chemical concentrations should be implemented to ensure compliance with hygienic permissible limits and to promptly identify hazardous conditions.
3. **Strengthening the Use of Personal Protective Equipment:**
   Consistent and proper use of respirators, protective gloves, and clothing should be enforced, accompanied by regular training on their correct application.
4. **Medical Surveillance and Early Detection:**
   Workers exposed to chemical substances should undergo regular medical examinations focused on early detection of respiratory, dermatological, and allergic conditions.

5. **Occupational Health Education:**
   Educational programs should be introduced to increase workers' awareness of chemical hazards, safe work practices, and the importance of hygiene measures in reducing occupational health risks.

Implementation of these measures will contribute to reducing chemical exposure, preventing occupational diseases, and improving overall working conditions in textile enterprises.

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