



Health Risk Analysis of Chemical Exposure in Occupational Environments

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Abstract

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Exposure to chemicals in the workplace is one of the primary factors contributing to workers' health risks, particularly in industrial sectors that involve intensive use of chemicals. This study aims to analyze health risks resulting from chemical exposure by comprehensively considering hazard levels, exposure levels, and risk factors. The method used was a literature review, examining various relevant scientific publications from the past five years. The results of the study indicate that chemical exposure occurs via inhalation and dermal routes, both of which have the potential to cause health impacts such as respiratory disorders, skin irritation, and other occupational diseases. The level of risk is influenced by the characteristics of the chemical, the frequency and duration of exposure, and workplace conditions. The health risk assessment approach allows for the identification of risk levels, which can then serve as a basis for determining control strategies. Effective risk control involves a combination of technical and administrative approaches, as well as the use of personal protective equipment. Therefore, comprehensive risk management efforts are necessary to create a safe and healthy work environment.

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1. Introduction

The food and light chemical manufacturing industry is a sector that continues to grow as consumer demand for processed products with consistent taste and aroma quality increases. In its production process, the industry utilizes various chemicals, both natural and synthetic, to improve product characteristics. Although such ingredients are generally safe to consume within certain limits, their use on an industrial scale can pose potential hazards to workers who are directly exposed during the production process (CDC, 2017).

Exposure to chemicals in the work environment has long been a concern in the field of occupational health and safety, particularly related to risks to the respiratory system and skin. Inhalation exposure can cause acute and chronic respiratory distress, while dermal exposure has the potential to cause irritation, sensitization, and systemic toxic effects (Lamplugh et al., 2019). Other studies have also shown that exposure to volatile organic compounds (VOCs) in industrial environments can increase the risk of workers' health problems, especially if exposure occurs in high duration and frequency (El-Harbawi et al., 2020).

A number of previous studies have examined the impact of chemical exposure on the health of workers in various industrial sectors. Akpinar-Elci et al. (2017) found that workers who were exposed to chemicals in the production process showed a high prevalence of respiratory symptoms such as coughing and shortness of breath. Similar findings were also reported by De Matteis et al. (2019), who stated that exposure to chemicals in the workplace contributes significantly to an increased risk of work-related lung disease. In addition, research by Borghi et al. (2020)

emphasizes the importance of systematic exposure assessments to identify health risks that may arise in workers.

In the context of risk assessment, the Chemical Health Risk Assessment (CHRA) approach has been widely used to evaluate the level of hazard, exposure, and risk faced by workers. This approach allows the identification of factors that contribute to the level of risk, such as the nature of the chemical, the duration of exposure, and the frequency of contact (DOSH, 2018). Using this method, potential risks can be classified making it easier to determine the right control strategy.

Although various studies have been conducted, there are still limitations in studies that integrate comprehensive inhalation and dermal exposure analyses in a single risk assessment framework. Most studies tend to focus on just one exposure pathway, so they don't provide a comprehensive picture of workers' health risks. In addition, variations in the characteristics of chemicals and production processes in various industries mean that the results of previous research cannot always be directly generalized (Baloch et al., 2021).

Based on this, a more comprehensive study is needed to analyze the health risks due to chemical exposure by considering the various exposure pathways and factors that affect them. Therefore, this study aims to analyze the health risks of workers due to exposure to chemicals by systematically examining the level of danger, exposure level, and risk level. The results of this study are expected to contribute to the development of more effective risk control strategies to improve occupational safety and health in the industrial environment.

2. Literature Review

2.1. Exposure to Chemicals in the Work Environment

Exposure to chemicals in the work environment is one of the main factors contributing to workers' health risks, especially in the manufacturing and processing industry sectors. This exposure can occur through various pathways, such as inhalation, dermal contact, or ingestive, with the level of risk affected by the nature of the chemical as well as the working environment. Chemical compounds such as volatile organic compounds (VOCs) are known to be easily evaporated and inhaled by workers, thereby increasing the potential for health problems, especially in the respiratory system (Lamplugh et al., 2019).

In addition, long-term exposure to chemicals can also lead to more serious chronic effects, such as work-related lung disease and other organ function disorders. De Matteis et al. (2019) stated that workers exposed to industrial chemicals have a higher risk of respiratory disorders than the general population. This shows the importance of controlling exposure in the work environment to minimize long-term health impacts.

Other studies also highlight that exposure intensity is strongly influenced by the frequency and duration of work factors, as well as the characteristics of the production process. Therefore, a comprehensive understanding of the sources and mechanisms of exposure is an important basis for efforts to control workers' health risks (Borghi et al., 2020).

2.2. Health Risk Assessment

Health risk assessment is a systematic approach used to identify, analyze, and evaluate the potential hazards that workers face due to exposure to chemicals. One of the commonly used methods is Chemical Health Risk Assessment (CHRA), which integrates hazard analysis, exposure level, and risk level to determine control priorities (DOSH, 2018).

In practice, risk assessment involves several key parameters, such as the toxic nature of the chemical, the frequency and duration of exposure, and the amount of materials used in the production process. El-Harbawi et al. (2020) emphasized that the combination of the level of hazard and the level of exposure is a key factor in determining the magnitude of the health risks that may occur to workers. This approach allows for the grouping of risks into specific categories, such as low, medium, or high.

In addition, the implementation of proper risk assessments can help in designing effective control strategies, both through technical, administrative, and personal protective equipment approaches. Baloch et al. (2021) stated that a comprehensive risk evaluation is essential to create a safe work environment and reduce the potential for occupational diseases.

3. Methods

This study uses a qualitative approach with a library research method to comprehensively examine health risks due to exposure to chemicals in the work environment. Literature studies were chosen because they allow researchers to

collect, analyze, and synthesize a variety of relevant scientific sources in order to gain an in-depth understanding of the topic being studied. The data used in this study are secondary data from scientific journals, research reports, international standards, and official documents related to occupational health and safety, especially those that discuss chemical exposure and health risk assessment.

The data collection process is carried out by searching various literature sources through academic databases such as Google Scholar using relevant keywords, including “chemical exposure”, “occupational health”, “health risk assessment”, and “industrial safety”. The inclusion criteria in the selection of literature include publications published in the last five years, have relevance to the research topic, and come from credible sources such as indexed journals and official institutions. Literature that does not meet these criteria is not included in the analysis to maintain the validity and reliability of the data.

After the data collection process, the literature selection and classification stage was carried out based on the suitability of the theme and the focus of the research. The selected literature was then analyzed descriptively by identifying the main concepts, research findings, and methodological approaches used in each study. The analysis is carried out by comparing various research results to find patterns, similarities, and differences that can provide a comprehensive picture of the health risks due to exposure to chemicals.

Furthermore, the data that has been analyzed is synthesized to build a conceptual framework that supports the research objectives. This synthesis process involves integrating various information related to chemical hazards, exposure

pathways, and risk assessment methods used in previous research. The results of the synthesis are then used as a basis for compiling a discussion about the level of health risk and the factors that affect it.

Using the literature study method, this study is expected to be able to provide a comprehensive picture of health risks due to chemical exposure and provide a scientific basis for the development of risk control strategies in the work environment. This approach also allows researchers to identify gaps in research that still exist as well as provide recommendations for future research.

4. Results and Discussion

The results of the literature review show that exposure to chemicals in the work environment is a significant risk factor for workers' health, especially in industries that involve production processes with the use of large amounts of chemicals. This exposure can occur through a variety of pathways, with inhalation and dermal contact being the most common primary pathways. Based on the analysis of various studies, the level of risk posed depends largely on the characteristics of the chemical, the frequency of exposure, and the duration of contact experienced by the worker (El-Harbawi et al., 2020).

Exposure through inhalation generally occurs due to the presence of volatile compounds that are easily vaporized into the air and inhaled by workers during the production process. Compounds such as volatile organic compounds (VOCs) are known to have a significant impact on the respiratory system, especially if exposed for a long period of time. Lamplugh et al. (2019) explained that exposure to VOCs

can cause impaired lung function, respiratory irritation, and increased risk of chronic diseases. In addition, research by Borghi et al. (2020) emphasized that the concentration of chemicals in the air as well as the ventilation of the work environment are important factors that affect the level of inhalation exposure.

On the other hand, exposure through the dermal pathway also shows an equally important contribution to the health risks of workers. Direct contact between the skin and chemicals can cause irritation, allergic reactions, and damage to skin tissues, depending on the toxic nature of the material. Some chemicals are corrosive and can cause serious skin damage even in a relatively short exposure time. This shows that protection of workers' skin is an important aspect of risk control efforts (Baloch et al., 2021).

Furthermore, the results of the study show that the combination of inhalation and dermal exposure can increase the overall risk level. In many cases, workers are not only exposed through one pathway, but through several pathways simultaneously. This reinforces the importance of a comprehensive risk assessment approach to identify all potential hazards in the work environment (DOSH, 2018).

Health risk assessments conducted through the Chemical Health Risk Assessment (CHRA) approach have proven to be effective in identifying and classifying risk levels based on hazard levels and exposures. This approach allows researchers and practitioners to determine control priorities based on the level of risk generated. El-Harbawi et al. (2020) stated that this method provides a systematic picture of the relationship between chemical exposure and the health impacts it causes.

In addition, the frequency and duration of exposure factors also play an important role in determining the level of risk. Continuous exposure with a long duration tends to increase the likelihood of health problems, both in the short and long term. De Matteis et al. (2019) showed that workers with chronic exposure to chemicals had a higher risk of lung disease compared to workers who were exposed for a short period of time.

The results of the analysis also showed that the conditions of the work environment, such as ventilation systems and the use of personal protective equipment (PPE), greatly affected the level of exposure received by workers. Inadequate ventilation can lead to the accumulation of chemicals in the air, increasing the risk of inhalation. Meanwhile, the use of non-compliant or suboptimal PPE can reduce the effectiveness of protection against chemical exposure (NIOSH, 2018).

In the context of risk control, the control hierarchy approach is the most effective strategy to reduce exposure to chemicals in the work environment. This approach includes elimination, substitution, technical control, administrative control, and the use of personal protective equipment. The implementation of technical controls such as the installation of local ventilation systems has been proven to significantly reduce the concentration of chemicals in the air (ACGIH, 2018).

In addition, administrative controls such as worker training and working time management also play an important role in reducing exposure risks. Workers who have a good knowledge of the dangers of chemicals tend to be better able to protect

themselves from harmful exposures. This is in line with the findings of Borghi et al. (2020) who stated that education and training are important factors in improving occupational safety.

Other research also suggests that variations in the types of chemicals used in the production process can affect the level of risk workers face. Each chemical has different characteristics, so it requires a different control approach. Lamplugh et al. (2019) emphasize that the identification of chemical properties is an important first step in the risk assessment process.

In addition to technical factors, the management aspect also has an important role in risk control. A good occupational safety and health management system can help in identifying potential hazards as well as ensuring that control measures have been implemented effectively. Baloch et al. (2021) state that organizations that have a good K3 management system tend to have lower rates of accidents and occupational diseases.

Based on the overall results, the results of this study show that exposure to chemicals in the work environment is a complex problem and requires a comprehensive approach in its handling. The combination of various factors, such as chemical characteristics, working environmental conditions, as well as worker behavior, determines the level of risk faced. Therefore, risk control efforts must be carried out comprehensively by involving various aspects, ranging from technical to managerial.

5. Conclusion

Based on the results of the study conducted, it can be concluded that chemical exposure in the workplace is a significant risk factor for workers' health, particularly in industries that involve intensive use of chemicals. The primary routes of exposure identified are inhalation and dermal contact, both of which have the potential to cause health effects in both the short and long term. The level of risk faced by workers is greatly influenced by the characteristics of the chemicals, the frequency and duration of exposure, as well as workplace conditions.

A systematic approach to health risk assessment has proven effective in providing a comprehensive overview of potential hazards. By integrating hazard and exposure factors, risks can be classified, thereby facilitating the prioritization of control measures. Furthermore, the study findings indicate that effective risk control requires a combination of various strategies, including technical and administrative approaches, as well as the use of personal protective equipment. The management of chemical exposure risks must be conducted comprehensively and sustainably, involving multiple stakeholders. These efforts are crucial for creating a safe work environment and minimizing the potential for future work-related illnesses.

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