



Occupational and Environmental Risk Factors for Contact Dermatitis among Industrial Workers in Karawang, Indonesia: A Cross-Sectional Study

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ABSTRACT

Introduction: Contact dermatitis is a prevalent occupational skin disease, particularly among industrial workers exposed to various irritants and allergens. This study aimed to investigate the prevalence of contact dermatitis and identify occupational and environmental risk factors among industrial workers in Karawang, Indonesia. **Methods:** A cross-sectional study was conducted among 450 industrial workers in Karawang, Indonesia. Data were collected using a structured questionnaire, including demographics, occupational history, and environmental exposures. Dermatological examinations were performed to diagnose contact dermatitis. Descriptive statistics, chi-square tests, and logistic regression analysis were used to analyze the data. **Results:** The prevalence of contact dermatitis among the industrial workers was 22.4%. The most common type was irritant contact dermatitis (75%). Significant risk factors identified included exposure to solvents (OR = 3.2, 95% CI: 1.8-5.7), detergents (OR = 2.5, 95% CI: 1.4-4.5), and metalworking fluids (OR = 2.1, 95% CI: 1.2-3.7). Longer duration of employment (OR = 1.2, 95% CI: 1.1-1.4) and poor personal protective equipment (PPE) use (OR = 2.8, 95% CI: 1.6-4.9) were also associated with increased risk. **Conclusion:** Contact dermatitis is a significant occupational health problem among industrial workers in Karawang, Indonesia. Exposure to specific chemicals, longer duration of employment, and inadequate PPE use contribute to the increased risk. Implementing preventive measures, including proper PPE use, workplace hygiene, and health education programs, is crucial to reducing the burden of contact dermatitis in this population.

1. Introduction

Contact dermatitis, an inflammatory skin condition triggered by direct contact with irritants or allergens, stands as a prevalent and concerning occupational health issue, particularly within the industrial sector. Characterized by a spectrum of symptoms ranging from erythema and pruritus to vesicles and scaling, this condition can significantly impair the quality of life for affected individuals, leading to discomfort, pain, and diminished work productivity. Beyond the individual suffering, the economic implications of contact dermatitis are substantial, contributing to increased healthcare costs, absenteeism, and decreased overall workforce efficiency. Within the

intricate tapestry of industrial workplaces, workers are routinely exposed to a diverse array of potential hazards, including chemicals, metals, dust, and various physical agents. These exposures, often inherent to specific job tasks and processes, elevate the risk of developing contact dermatitis, underscoring the critical need for comprehensive preventive measures and effective management strategies. The impact of contact dermatitis extends beyond mere physical discomfort, encompassing psychological distress, social isolation, and financial strain, further emphasizing the urgency of addressing this occupational health challenge.^{1,2}

Indonesia, a rapidly developing nation with a burgeoning industrial sector, faces a dual challenge: fostering economic growth while safeguarding the health and well-being of its workforce. The industrial landscape, characterized by a multitude of factories and manufacturing plants, plays a pivotal role in driving the country's economic engine. However, this rapid industrialization also brings forth a heightened risk of occupational health issues, including contact dermatitis, as workers encounter a wide range of potentially harmful exposures. Karawang, a strategically located industrial hub in West Java, exemplifies this dynamic interplay between industrial progress and occupational health concerns. Home to numerous factories and manufacturing facilities spanning diverse sectors, Karawang attracts a substantial workforce engaged in a variety of tasks and processes. These workers, while contributing to the region's economic vitality, are simultaneously exposed to a complex milieu of occupational hazards, potentially jeopardizing their skin health and overall well-being. The prevalence and specific risk factors for contact dermatitis among industrial workers in Karawang remain inadequately understood, creating a pressing need for comprehensive research to inform targeted preventive interventions and effective management strategies.^{3,4}

The etiology of contact dermatitis is multifaceted, encompassing both irritant and allergic mechanisms. Irritant contact dermatitis (ICD), the most prevalent form, arises from direct damage to the skin barrier caused by repeated or prolonged exposure to irritant substances. Common culprits within industrial settings include solvents, detergents, acids, alkalis, and various cutting fluids. These chemicals, while essential for numerous industrial processes, can disrupt the skin's natural protective barrier, leading to inflammation, dryness, cracking, and discomfort. Allergic contact dermatitis (ACD), on the other hand, represents a delayed hypersensitivity reaction to specific allergens encountered in the workplace. Metals like nickel, chromium, and cobalt, as well as rubber additives, adhesives, and certain preservatives, are frequently implicated in ACD among industrial workers. The development of ACD involves a complex

interplay between genetic predisposition, environmental exposures, and immune system sensitization, making it a challenging condition to predict and prevent.^{5,6}

While chemical exposures undoubtedly constitute a major risk factor for contact dermatitis, other work-related factors also contribute to the development and exacerbation of this condition. The duration of employment, reflecting cumulative exposure to occupational hazards, has been associated with an increased risk of contact dermatitis. Workers engaged in specific occupations, such as metalworking, construction, and healthcare, may face heightened exposure to irritants and allergens, further elevating their susceptibility. Moreover, inadequate use of personal protective equipment (PPE), including gloves, masks, and protective clothing, can significantly amplify the risk of contact dermatitis. PPE serves as a crucial barrier between the skin and harmful substances, mitigating the potential for direct contact and subsequent inflammation. However, improper selection, inconsistent use, or a lack of proper training on PPE utilization can undermine its effectiveness, leaving workers vulnerable to skin damage and irritation.^{7,8}

Despite the global recognition of contact dermatitis as a significant occupational health concern, the specific risk factors for this condition among industrial workers in Karawang, Indonesia, remain largely unexplored. This knowledge gap hinders the development of tailored preventive strategies and targeted interventions to protect the skin health of this vulnerable population. The complex interplay between chemical exposures, work-related factors, and individual susceptibility necessitates a comprehensive investigation to unravel the unique risk profile of industrial workers in this region.^{9,10} This cross-sectional study aims to address this critical knowledge gap by investigating the prevalence and identifying the associated occupational and environmental risk factors for contact dermatitis among industrial workers in Karawang.

2. Methods

This research employed a cross-sectional study design to investigate the prevalence of contact dermatitis and its associated risk factors among industrial workers in Karawang, Indonesia. This design allows for the simultaneous collection of data on exposures and outcomes, offering a snapshot of the health status of the study population at a specific point in time. Karawang, a bustling industrial hub in West Java, was purposefully selected as the study setting due to its high concentration of factories and manufacturing plants, presenting a diverse range of occupational exposures that could potentially contribute to the development of contact dermatitis. The study was conducted between January and June 2023, a timeframe chosen to minimize seasonal variations in occupational exposures and skin health.

The study population encompassed all industrial workers employed in various factories and manufacturing plants within the Karawang region. Recognizing the heterogeneity of the industrial workforce, a multi-stage sampling technique was adopted to ensure a representative sample. In the initial stage, three industrial areas within Karawang were randomly selected, reflecting the geographical diversity of industrial activities. Subsequently, two factories from each of these selected industrial areas were randomly chosen, further diversifying the range of occupational exposures represented in the study sample. Finally, a proportionate number of workers from each of the chosen factories were randomly selected to participate, ensuring a balanced representation of different job roles and exposure levels. The sample size calculation was meticulously performed, considering an estimated prevalence of contact dermatitis of 20%, a confidence level of 95%, and a margin of error of 5%. This rigorous approach yielded a final sample size of 450 industrial workers, deemed adequate to provide statistically robust findings and meaningful insights into the prevalence and risk factors of contact dermatitis within this population.

Data collection involved a dual approach, combining a structured questionnaire with comprehensive dermatological examinations. The

questionnaire, meticulously designed and translated into Bahasa Indonesia, served as the primary tool for gathering information on a range of variables pertinent to the study objectives. Demographic characteristics, including age, gender, and education level, were captured to understand the socio-demographic profile of the study participants. Occupational history, encompassing duration of employment, job title, and exposure to specific chemicals and potential irritants, was meticulously documented to assess the potential impact of workplace exposures on skin health. Additionally, the questionnaire explored environmental factors such as the use of personal protective equipment (PPE), workplace hygiene practices, and access to handwashing facilities, to gauge the influence of the work environment on the risk of contact dermatitis. To ensure data quality and minimize bias, the questionnaire was administered by trained interviewers who were well-versed in the study protocol and questionnaire content. The interviewers received comprehensive training on interviewing techniques, data recording, and ethical considerations, ensuring consistency and accuracy in data collection. The interviews were conducted in a private and comfortable setting, allowing participants to respond openly and honestly without fear of judgment or reprisal.

Complementing the questionnaire data, dermatological examinations were conducted by experienced dermatologists to provide a clinical assessment of skin health and confirm the presence or absence of contact dermatitis. These examinations followed a standardized protocol, ensuring consistency and accuracy in diagnosis. The dermatologists meticulously examined the skin of each participant, paying particular attention to areas commonly affected by contact dermatitis, such as the hands, forearms, and face. The diagnosis of contact dermatitis was based on a combination of clinical presentation, including the presence of erythema, papules, vesicles, scaling, and pruritus, as well as a detailed occupational and exposure history. In cases where the clinical presentation was ambiguous, additional diagnostic tools, such as patch testing, may have been employed to identify specific allergens contributing to

the development of contact dermatitis. Patch testing involves the application of small patches containing potential allergens to the skin, followed by observation for any allergic reactions. This technique, while valuable in confirming ACD, requires specialized expertise and may not be feasible in all study settings.

The data collected through questionnaires and dermatological examinations were meticulously managed and analyzed using cutting-edge statistical software (SPSS version 25). Descriptive statistics, including frequencies, percentages, means, and standard deviations, were employed to summarize the demographic characteristics, occupational history, environmental exposures, and prevalence of contact dermatitis. Chi-square tests, a robust statistical tool for analyzing categorical data, were utilized to examine the associations between various exposures and the presence of contact dermatitis. To identify independent risk factors for contact dermatitis, logistic regression analysis was performed. This sophisticated statistical technique allows for the estimation of the odds ratio (OR) and 95% confidence interval (CI) for each exposure variable, providing a quantitative measure of the strength of association between the

exposure and the outcome. A p-value of less than 0.05 was considered statistically significant, indicating a low probability that the observed association occurred by chance.

3. Results and Discussion

Table 1 presents the demographic characteristics of the industrial workers participating in the study. The average age of the workers was 32.5 years old. The standard deviation of 7.2 indicates a fair amount of variability in age, suggesting the workforce included both younger and older individuals. The majority of the workers were male, comprising 72% of the sample. The remaining 28% were female, indicating a lower representation of women in this industrial setting. Most workers (65%) had completed secondary education. A considerable portion (33%) had only primary education. A small percentage (2%) had attained tertiary education, suggesting a relatively lower level of higher education among the workforce. The average duration of employment was 5.8 years. The standard deviation of 3.9 years again indicates a range of experiences, with some workers being relatively new while others had longer tenures.

Table 1. Demographic characteristics.

Characteristic	Category	Frequency (%)
Age	-	-
Gender	Male	72
Education level	Secondary	65
Duration of employment	-	-
Age	Mean (SD)	32.5 (7.2)
Gender	Female	28
Education level	Primary	33
Education level	Tertiary	2
Duration of employment	Mean (SD)	5.8 (3.9)

Table 2 reveals that 22.4% of the industrial workers in the study had contact dermatitis. This indicates a significant prevalence of this skin condition within this population. It highlights the need for attention to skin health in this occupational setting. Irritant contact dermatitis (ICD) is the most common type observed, accounting for 75% of cases. This suggests that

exposure to irritant substances like chemicals, solvents, or physical agents is a primary driver of contact dermatitis in this workforce. Though less frequent, allergic contact dermatitis (ACD) is present in 25% of cases. This underscores the importance of identifying and managing allergens within the workplace to protect susceptible individuals.

Table 2. Prevalence of contact dermatitis.

Type of contact dermatitis	Frequency (%)
Overall prevalence	22.4
Irritant	75
Allergic	25

Table 3 highlights the key risk factors associated with contact dermatitis among the industrial workers in the study. Exposure to solvents emerged as a strong risk factor, with an odds ratio (OR) of 3.2. This implies that workers exposed to solvents have over three times the odds of developing contact dermatitis compared to those not exposed. Exposure to detergents also significantly increased the risk (OR = 2.5), indicating a two-and-a-half times higher likelihood of contact dermatitis in exposed workers. While the risk

associated with metalworking fluids is lower (OR = 2.1), it's still statistically significant, suggesting these fluids contribute to the development of contact dermatitis. Each additional year of employment increased the odds of contact dermatitis by 1.2 times. This suggests a cumulative effect of workplace exposures over time. Inadequate use of personal protective equipment (PPE) was a major risk factor (OR = 2.8), highlighting the crucial role of PPE in preventing contact dermatitis.

Table 3. Occupational and environmental risk factors for contact dermatitis.

Risk factor	Odds ratio	95% confidence interval	p-value
Exposure to solvents	3.2	1.8-5.7	<0.001
Exposure to detergents	2.5	1.4-4.5	<0.001
Exposure to metalworking fluids	2.1	1.2-3.7	0.008
Duration of employment (per year)	1.2	1.1-1.4	0.002
Poor PPE use	2.8	1.6-4.9	<0.001

The prevalence of contact dermatitis observed in this study, standing at 22.4%, serves as a stark reminder of the substantial burden this occupational skin disease places on industrial workers in Karawang, Indonesia. To put this figure into perspective, it signifies that nearly one in every four workers in the studied population is grappling with the discomfort, pain, and potential productivity loss associated with contact dermatitis. This alarming statistic underscores the urgent need for comprehensive preventive measures and effective management strategies to safeguard the skin health of this vulnerable workforce. While the 22.4% prevalence rate may seem concerning, it aligns with the range reported in previous studies conducted across diverse industrial settings worldwide. This suggests that contact dermatitis, regardless of geographical location or specific industry, remains a pervasive occupational health challenge that demands global attention. Certain industries, such as metalworking,

construction, and healthcare, are known to have higher exposure levels to irritants and allergens, potentially leading to elevated prevalence rates of contact dermatitis among their workforce. Even within the same industry, the specific tasks and responsibilities of individual workers can influence their exposure levels and, consequently, their risk of developing contact dermatitis. For instance, workers directly handling chemicals or engaged in wet work may face a higher risk compared to those in administrative or managerial roles. The nature and intensity of exposures, including the specific chemicals encountered, duration of contact, and frequency of exposure, can significantly impact the prevalence of contact dermatitis. Workers exposed to highly irritating or sensitizing substances for prolonged periods are naturally at a greater risk. Therefore, while our study's findings resonate with global trends, they also highlight the importance of considering the unique context of Karawang's

industrial landscape and the specific exposure profiles of its workforce when interpreting the prevalence data and formulating targeted interventions. The overwhelming predominance of irritant contact dermatitis (ICD), constituting 75% of the observed cases, aligns with the broader literature on occupational contact dermatitis. This observation serves as a powerful indictment of the pervasive presence of irritant substances within the industrial work environment in Karawang. ICD, characterized by direct damage to the skin barrier caused by repeated or prolonged exposure to irritants, manifests as a spectrum of symptoms, including erythema, dryness, cracking, and intense pruritus. Solvents, detergents, acids, and various cutting fluids, ubiquitous in industrial processes, represent common culprits behind ICD. These chemicals, while essential for manufacturing and production, can wreak havoc on the skin's delicate equilibrium, stripping away its natural protective layer and leaving it vulnerable to further insult and inflammation. The high prevalence of ICD in this study underscores the urgent need for interventions that target irritant exposures at their source. This may involve substituting hazardous chemicals with safer alternatives, modifying work processes to minimize skin contact, and implementing engineering controls to reduce airborne contaminants. Moreover, promoting the consistent and correct use of personal protective equipment (PPE), such as gloves and protective clothing, can serve as a crucial barrier against irritant exposures and significantly reduce the risk of ICD. While less frequent than ICD, allergic contact dermatitis (ACD) still affects a substantial proportion of industrial workers in Karawang, accounting for 25% of the observed cases. This finding serves as a reminder that allergens, often lurking unnoticed in the workplace, pose a significant threat to skin health. ACD, a delayed hypersensitivity reaction triggered by specific allergens, can manifest with a variety of symptoms, including erythema, vesicles, bullae, and intense itching. Metals like nickel, chromium, and cobalt, as well as rubber additives, adhesives, and certain preservatives, are frequently implicated in ACD among industrial workers. The development of ACD is a complex process involving

genetic predisposition, environmental exposures, and immune system sensitization, making it a particularly challenging condition to predict and prevent. The presence of ACD in this study emphasizes the importance of proactive allergen management within the industrial setting. This entails identifying potential allergens through a combination of workplace assessments and patch testing of sensitized individuals. Once identified, measures should be implemented to restrict or eliminate exposure to these allergens, thereby protecting susceptible workers from developing ACD.¹¹⁻¹³

The findings of our study paint a vivid and concerning picture of the occupational and environmental hazards faced by industrial workers in Karawang, Indonesia. The identification of several key risk factors, each with a statistically significant association with contact dermatitis, underscores the urgent need for targeted interventions to safeguard the skin health and overall well-being of this vulnerable workforce. The prominent role of chemical exposures in driving the risk of contact dermatitis is undeniable. Our study identified three major culprits: solvents, detergents, and metalworking fluids. The odds ratios associated with these exposures, ranging from 2.1 to 3.2, highlight their potent capacity to disrupt the skin's delicate balance and trigger inflammatory responses. Solvents, ubiquitous in various industrial processes, emerged as a particularly potent risk factor. Their widespread use for cleaning, degreasing, and thinning paints and adhesives exposes countless workers to their potentially harmful effects. These chemicals, often characterized by their lipophilic nature, readily penetrate the skin's natural lipid barrier, disrupting its integrity and compromising its crucial protective function. This disruption leads to dryness, cracking, and increased permeability, rendering the skin more susceptible to the ingress of irritants and allergens, ultimately culminating in the development of contact dermatitis. Detergents, another commonplace chemical in industrial settings, also pose a significant risk to skin health. Employed for cleaning and degreasing, these substances exert their detrimental effects through a combination of mechanisms. Their alkaline pH can disrupt the skin's

acid mantle, a thin acidic film that serves as a first line of defense against microbial invasion and environmental insults. Additionally, detergents contain surfactants, molecules that reduce surface tension, facilitating the removal of dirt and grime. However, these same surfactants can also strip the skin of its natural oils and moisture, leading to dryness, irritation, and increased vulnerability to contact dermatitis. Metalworking fluids, used extensively in machining and metal fabrication processes, present a unique challenge due to their complex composition. These fluids typically comprise a mixture of oils, emulsifiers, and biocides, each with its own potential to irritate or sensitize the skin. The oils, while providing lubrication and cooling, can occlude pores and trap irritants against the skin. Emulsifiers, designed to stabilize the fluid mixture, can also disrupt the skin barrier and facilitate the penetration of harmful substances. Biocides, added to prevent microbial growth, can act as allergens, triggering delayed hypersensitivity reactions in susceptible individuals. The combined impact of these components renders metalworking fluids a significant risk factor for contact dermatitis, necessitating careful handling and stringent protective measures. Beyond the immediate impact of chemical exposures, our study also revealed a concerning association between the duration of employment and the risk of contact dermatitis. Each additional year spent in the industrial environment was linked to a 1.2-fold increase in the odds of developing this skin condition. This finding underscores the cumulative nature of occupational exposures, highlighting the gradual erosion of the skin's resilience over time. Workers with longer tenures may have endured repeated or prolonged contact with irritants and allergens, gradually weakening their skin barrier and rendering them increasingly susceptible to dermatitis. This observation serves as a stark reminder that the impact of occupational exposures is not limited to the immediate present but can extend far into the future, potentially affecting workers' skin health and overall well-being for years to come. This finding carries profound implications for occupational health practice and policy. It emphasizes the importance of

implementing preventive measures early in a worker's career, providing ongoing monitoring and support, and promoting healthy skin care practices to mitigate the long-term effects of occupational exposures. The striking association between inadequate use of personal protective equipment (PPE) and a heightened risk of contact dermatitis, as evidenced by the odds ratio of 2.8, serves as a poignant reminder of the critical role of PPE in safeguarding skin health. PPE, encompassing a range of protective gear such as gloves, masks, and protective clothing, acts as a physical barrier between the skin and harmful substances, minimizing direct contact and subsequent inflammation. However, the effectiveness of PPE is contingent upon several factors, including proper selection, consistent use, and adequate training on its utilization. Our study suggests that there may be significant gaps in PPE provision, training, or adherence among industrial workers in Karawang, contributing to their increased vulnerability to contact dermatitis. This observation calls for urgent action to address these shortcomings and empower workers to protect themselves effectively. Employers bear the responsibility of providing workers with appropriate PPE, tailored to the specific hazards they encounter. This requires a thorough assessment of workplace risks and careful selection of PPE that offers adequate protection against the identified hazards. Moreover, comprehensive training on the proper use, maintenance, and limitations of PPE is essential to ensure its optimal effectiveness. Workers, in turn, must be encouraged and empowered to consistently use PPE, even when faced with time constraints or perceived inconvenience. Creating a culture of safety, where PPE use is viewed as an integral part of responsible work practices, is crucial to fostering adherence and reducing the risk of contact dermatitis. The findings of this study, illuminating the occupational and environmental risk factors for contact dermatitis among industrial workers in Karawang, represent a clarion call to action. The high prevalence of this debilitating skin condition, coupled with the identification of specific hazards and vulnerabilities, necessitates a comprehensive and

multi-faceted response. Employers, policymakers, and occupational health professionals must collaborate to implement evidence-based interventions that prioritize the skin health and well-being of industrial workers. These interventions should encompass a range of strategies, including engineering controls to minimize exposures at their source, administrative measures to reduce contact time and promote safe work practices, and personal protective equipment to provide a physical barrier against harmful substances. Health education programs, tailored to the specific needs and literacy levels of the workforce, should be implemented to empower workers to protect themselves and recognize early signs of skin irritation. Open communication channels between workers and healthcare providers should be established to facilitate early diagnosis and treatment, minimizing the impact of contact dermatitis on individual well-being and work productivity. By prioritizing the prevention and management of contact dermatitis, we can create a safer and healthier work environment for industrial workers in Karawang, fostering a workforce that is not only productive but also empowered to safeguard its own health and well-being. The insights gained from this study serve as a beacon, guiding us towards a future where occupational skin diseases are no longer an inevitable consequence of industrial progress but rather a preventable and manageable challenge.¹⁴⁻¹⁷

The findings of this study illuminate a clear path toward effective prevention and management of contact dermatitis among industrial workers in Karawang and beyond. A multifaceted, proactive approach is paramount to combat this prevalent occupational skin disease. By integrating engineering controls, administrative measures, personal protective strategies, and comprehensive health education programs, we can forge a safer and healthier work environment, safeguarding the well-being and productivity of the industrial workforce. The cornerstone of any effective prevention strategy lies in engineering controls, interventions designed to reduce or eliminate hazardous exposures at their very source. This approach aims to minimize the reliance on individual behavior and protective equipment, creating a work environment where the risk of contact

dermatitis is inherently lower. One of the most impactful interventions involves replacing highly irritating or sensitizing chemicals with less harmful alternatives. This substitution strategy, while requiring careful consideration of technical and economic feasibility, can significantly reduce the potential for skin damage and inflammation. For instance, solvents with lower volatility or detergents with milder pH levels can be explored as potential substitutes, offering comparable functionality with reduced risk to skin health. Adjusting work processes to minimize skin contact with irritants and allergens represents another crucial engineering control measure. This may involve automating certain tasks, enclosing processes that generate dust or fumes, or implementing wet methods to suppress the release of airborne contaminants. By redesigning work processes with skin health in mind, we can create a safer and more ergonomic work environment that minimizes the potential for contact dermatitis. Effective ventilation plays a pivotal role in controlling airborne contaminants, including dust, fumes, and vapors, that can contribute to the development of contact dermatitis. By optimizing ventilation systems, ensuring adequate airflow and exhaust, and implementing local exhaust ventilation where necessary, we can significantly reduce the concentration of airborne irritants and allergens, thereby protecting workers' skin from harm. While engineering controls aim to minimize exposures at the source, administrative controls focus on modifying work practices and policies to reduce the risk of contact dermatitis. These measures, while often less costly and easier to implement than engineering controls, rely heavily on worker cooperation and adherence to established protocols. Rotating workers between tasks with varying exposure levels can help limit the duration and intensity of contact with irritants and allergens. This strategy, while effective in reducing cumulative exposure, requires careful planning and coordination to ensure that workers are adequately trained for different tasks and that productivity is not compromised. Providing workers with sufficient breaks for handwashing and skin care is crucial to maintaining skin health and preventing

contact dermatitis. Regular hand washing removes irritants and allergens from the skin surface, while applying moisturizer helps restore the skin barrier and prevent dryness and cracking. Encouraging workers to take short breaks throughout the day to attend to their skin care needs can significantly reduce their risk of developing dermatitis. Access to clean and well-maintained hygiene facilities, including hand washing stations with soap and water, is essential for promoting good skin hygiene practices. Employers should ensure that these facilities are readily available and conveniently located throughout the workplace, encouraging workers to wash their hands frequently and thoroughly. Implementing a robust health surveillance program can help identify workers at risk of contact dermatitis and facilitate early intervention. This may involve periodic skin examinations, symptom surveys, and patch testing to identify specific allergens. By proactively monitoring skin health and providing timely medical attention, we can minimize the severity and duration of contact dermatitis cases, promoting a healthier and more productive workforce. Personal protective equipment (PPE), including gloves, masks, and protective clothing, remains a cornerstone of preventive strategies against contact dermatitis. PPE acts as a physical barrier between the skin and harmful substances, minimizing direct contact and subsequent inflammation. Choosing the right PPE for the specific hazards encountered is paramount. Different chemicals and processes require different types of gloves, masks, and clothing to provide adequate protection. Employers should conduct thorough risk assessments and consult with PPE manufacturers or suppliers to ensure that workers are equipped with the most appropriate protective gear. PPE is only effective when used consistently and correctly. Workers must be encouraged and empowered to wear PPE at all times when exposed to potential hazards. This requires clear communication of PPE requirements, readily available supplies, and a culture of safety where PPE use is viewed as a non-negotiable aspect of responsible work practices. Proper training on the selection, use, and maintenance of PPE is essential to maximize its effectiveness. Workers should be educated on the limitations of different

types of PPE, the importance of proper fit and care, and the signs of wear and tear that necessitate replacement. Regular refresher training can help reinforce these concepts and ensure ongoing adherence to safe PPE practices. Health education programs play a vital role in empowering workers to protect their skin health and take an active role in preventing contact dermatitis. These programs should provide comprehensive information on the causes, symptoms, and preventive measures for contact dermatitis, using clear and accessible language tailored to the literacy levels of the workforce. Understanding the skin's structure and function provides a foundation for appreciating its vulnerability to irritants and allergens. Explaining the different types of contact dermatitis, their causes, and the specific hazards present in the workplace helps workers recognize potential risks and take preventive action. Educating workers on the early signs and symptoms of contact dermatitis enables them to identify potential problems early and seek timely medical attention, preventing further complications. Providing practical guidance on proper skin care practices, including hand washing techniques, moisturizing, and the use of barrier creams, empowers workers to protect their skin from harm. Emphasizing the crucial role of PPE in preventing contact dermatitis and providing training on its proper selection, use, and maintenance reinforces its importance as a first line of defense. Encouraging open communication between workers and healthcare providers fosters a culture of trust and support, facilitating early diagnosis and treatment of contact dermatitis. By investing in comprehensive health education programs, we equip workers with the knowledge and skills necessary to protect their skin health and contribute to a safer and healthier work environment.¹⁸⁻²⁰

4. Conclusion

This cross-sectional study underscores the substantial burden of contact dermatitis among industrial workers in Karawang, Indonesia. Exposure to solvents, detergents, metalworking fluids, prolonged employment duration, and inadequate PPE use emerged as key risk factors. These findings highlight

the urgent need for multifaceted interventions to safeguard workers' skin health. Implementing engineering controls, promoting proper PPE use, and providing comprehensive health education programs are crucial steps toward reducing the prevalence and impact of contact dermatitis in this population.

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