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Incidence and Associated Factors of Occupational Contact Dermatitis in Wood Furniture Finishing Workers

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ABSTRACT

Background: Occupational contact dermatitis (OCD) is a prevalent skin disease caused by workplace exposure to exogenous agents. Wood furniture finishing workers are at high risk due to significant contact with allergens and irritants, yet specific research on this group remains limited.
Objective: To determine the incidence rate of OCD and analyze its associated factors among wood furniture finishing workers.
Methods: : An observational analytical study with a cross-sectional design was conducted involving 36 wood furniture finishing workers. Data on potential risk factors were collected using a modified Nordic Occupational Skin Questionnaire (NOSQ)-2002. The diagnosis of OCD was established using the Mathias criteria. A patch test was performed with four common industrial allergens (Formaldehyde 1%, Isothiazolinone 0.2%, Cobalt Chloride 1%, and Colophony 20%) to identify specific sensitisations. Data were analyzed using Mann-Whitney, Fisher's exact, and logistic regression tests.
Results: The incidence rate of OCD was 58.3% (21 of 36 subjects). Positive patch test results were found in 20 subjects (55.5%), with Cobalt Chloride 1% being the most frequent sensitizer (44.4%), followed by Colophony 20% (30.5%), Formaldehyde 1% (19.4%), and Isothiazolinone 0.2% (13.8%). Univariate analysis identified younger age (p=0.012), shorter length of work (p=0.001), and a history of atopic dermatitis (p<0.001) as significant risk factors. Multivariate logistic regression analysis confirmed that younger age was the strongest predictor for OCD (OR 1.086; 95% CI 1.018–1.158; p=0.012).
Conclusion: Wood furniture finishing workers exhibit a high incidence of OCD. Younger age, shorter work duration, and a history of atopic dermatitis are significant associated factors. These findings highlight the need for targeted preventive strategies, including worker education and improved safety measures in the furniture finishing industry.

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1. Introduction

Occupational skin disease is a pathological condition of the skin and mucous membranes caused by exposure to agents within the work environment.[1] Globally, occupational skin diseases account for 30-45% of all work-related illnesses.[2] Occupational contact dermatitis (OCD) is the most common, representing 90-95% of these cases.[3] OCD is an inflammatory skin reaction resulting from direct contact with specific exogenous agents in the workplace.[4] It is broadly classified into allergic contact dermatitis (ACD) and irritant contact dermatitis (ICD). ACD is a type IV delayed-hypersensitivity reaction requiring prior sensitization,[5] while ICD is a non-immunological reaction caused by the cytotoxic effects of an irritant.[6]

The construction industry reports high rates of occupational illness, and within this sector, furniture workers have a high prevalence of occupational skin diseases.[7] The wood finishing stage is particularly hazardous, exposing workers to potent sensitizers and irritants like formaldehyde, isothiazolinones, colophony, and cobalt chloride, which are present in glues, paints, and varnishes.[8,9]

Despite the high-risk nature of this occupation, OCD among wood furniture finishing workers is often underdiagnosed due to the difficulty in establishing a causal link between dermatitis and the work environment.[10] While some studies have focused on broader categories of woodworkers or those exposed to specific raw materials, research specifically analyzing the incidence and associated factors of OCD in the finishing sub-sector is lacking.[11-12] This knowledge gap hinders the development of effective prevention and management strategies.

This study aimed to determine the incidence rate of OCD among wood furniture finishing workers and to analyze the factors associated with its occurrence. Furthermore, the study sought to identify common sensitizing allergens in this population through patch testing.

2. Methods

Study Design and Participants

This observational analytical study employed a cross-sectional design. The study was conducted in February 2025 among wood furniture finishing workers at PT. PIKA Imbon in Semarang, Indonesia. The target population included all workers involved in the furniture finishing process. The sample size was calculated using the Slovin formula with a 17% margin of error, resulting in a target of 30 participants. A total of 36 workers who met the inclusion criteria and provided informed consent were enrolled via purposive sampling. Inclusion criteria were: (1) employed as a wood furniture finishing worker for at least 30 days, and (2) willingness to participate and undergo a patch test. Exclusion criteria were: (1) severe active skin lesions on the test area (back), (2) pregnancy or lactation, (3) use of systemic or topical corticosteroids, antihistamines, or immunomodulators within one week of the study, and (4) sunburn or phototherapy on the test area within four weeks of the study.

Data Collection

Data were collected through researcher-administered questionnaires and clinical examinations. A modified version of the Nordic Occupational Skin Questionnaire (NOSQ)-2002 was used to gather information on demographics, work history, history of atopic dermatitis (defined by a personal history of asthma, allergic rhinitis, or atopic dermatitis), skin symptoms, and exacerbating factors. The diagnosis of OCD was established using the seven-point Mathias criteria. A subject was diagnosed with OCD if they met four or more of the criteria.

Patch Testing

All 36 participants underwent patch testing to identify potential sensitizing allergens. The selection of allergens was based on their high prevalence in furniture finishing materials (paints, varnishes, glues) as identified in previous occupational health studies.8,9 The panel included Formaldehyde 1% aq., Isothiazolinone 0.2% aq., Cobalt Chloride 1% pet., and Colophony 20% pet. These allergens were selected to target specific occupational exposures from urea-formaldehyde resins, water-based paint preservatives, metal cutting tools, and varnishes identified at the study site. These specific agents were selected to capture the most likely occupational sensitizers while maintaining feasibility within the clinical setting. The allergens were applied to the upper back using Finn Chambers® on Scanpor® tape and left in place for 48 hours.

Readings were performed at 48, 72, and 96 hours after application, according to the International Contact Dermatitis Research Group (ICDRG) guidelines. Results were graded as negative (-), doubtful (?+), weak positive (+), strong positive (++), or extreme positive (+++). A reaction was classified as allergic if it showed a crescendo pattern (increasing intensity over subsequent readings). A decrescendo pattern (decreasing intensity) was considered an irritant reaction.

Data Analysis

Data were analyzed using SPSS software. Descriptive statistics were used to summarize participant characteristics. The incidence of OCD was calculated as the proportion of subjects with a Mathias score of ≥ 4. The relationship between categorical variables (gender, history of atopic dermatitis) and OCD was analyzed using Fisher's exact test. The Mann-Whitney U test was used to compare differences in numerical variables (age, work duration) between the OCD and non-OCD groups after the Shapiro-Wilk test indicated a non-normal distribution. A multivariate logistic regression analysis (backward conditional method) was performed to identify the strongest predictors of OCD. Variables with a p-value <0.25 in the univariate analysis were included in the multivariate model. A p-value of <0.05 was considered statistically significant.

Ethical Considerations

Ethical clearance was obtained from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Diponegoro with the registration number 027/EC/KEPK/FK-UNDIP/II/2025. All participants provided written informed consent before enrollment.

3. Result

Participant Characteristics and OCD Incidence

A total of 36 wood finishing workers participated in the study. The majority were male (58.3%). The mean age was 31.39±14.92 years (range: 18–58), and the mean duration of employment was 7.21 ± 8.26 years (range: 0.58–32). The average daily working duration was 6.39 ± 1.66 hours (range: 3–9 hours). A significant portion of the participants (69.4%) reported a personal history of atopic dermatitis (Table 1).

Based on the Mathias criteria, 21 of the 36 participants (58.3%) were diagnosed with OCD, establishing an incidence rate of 58.3% (95% CI: 42.2%–74.4%). Regarding anatomical distribution, the dermatitis was predominantly located on the hands and fingers (85.7%), followed by the forearms (14.3%). Clinically, the severity was mostly mild to moderate, with subjects reporting symptoms of erythema, scaling, and fissures consistent with the NOSQ-2002 symptom profile.

Table 1. Characteristics of Study Participants

Characteristic	Category	n (%)
Gender	Male	21 (58.3)
	Female	15 (41.7)
Age (years)	Mean ± SD	31.39 ± 14.92
	Median (Range)	22.5 (18–58)
Work Duration (years)	Mean ± SD	7.21 ± 8.26
	Median (Range)	3.0 (0.58–32)
Daily Working Hours	Mean ± SD	6.39 ± 1.66
	Range	3.0 – 9.0
History of Atopic Dermatitis	Yes	25 (69.4)
	No	11 (30.6)
OCD Diagnosis (Mathias ≥4)	Yes	21 (58.3)
	No	15 (41.7)

Patch Test Results

Positive patch test results (crescendo reaction) to one or more allergens were observed in 20 participants (55.5%). No irritant (decrescendo) reactions were recorded. Among the 21 subjects diagnosed with OCD, 19 (90.5%) had at least one positive patch test result. Conversely, among the 15 subjects without OCD, only 1 (6.7%) had a positive result.

The most frequent sensitizer was Cobalt Chloride 1%, with a positive reaction in 16 subjects (44.4%). This was followed by Colophony 20% (30.5%), Formaldehyde 1% (19.4%), and Isothiazolinone 0.2% (13.8%). Polysensitization was common, with 11 subjects reacting to two or more allergens (Table 2).

Table 2. Distribution of Positive Patch Test Results

Allergen	n (%) Positive
Cobalt Chloride 1%	16 (44.4)
Colophony 20%	11 (30.5)
Formaldehyde 1%	7 (19.4)
Isothiazolinone 0.2%	5 (13.8)
Number of Positive Reactions	
Any positive reaction	20 (55.5)
1 allergen	9 (25.0)
2 allergens	6 (16.6)
3 allergens	2 (5.5)
4 allergens	3 (8.3)

Risk Factor Analysis

The univariate analysis revealed significant differences between the OCD and non-OCD groups for age, work duration, and history of atopic dermatitis (Table 3). The median age of the OCD group (19 years) was significantly lower than that of the non-OCD group (48 years) ($p=0.012$). Similarly, the median work duration was significantly shorter in the OCD group (2 years) compared to the non-OCD group (9 years) ($p=0.001$). A history of atopic dermatitis was strongly associated with OCD; 84% of subjects with atopic dermatitis were diagnosed with OCD, whereas none of the subjects without atopic dermatitis had OCD ($p<0.001$). Gender was not significantly associated with OCD ($p=0.490$).

In the multivariate logistic regression analysis, after adjusting for work duration, younger age remained the only significant independent predictor of OCD (OR 1.086; 95% CI 1.018–1.158; $p=0.012$).

Table 3. Analysis of Factors Associated with OCD

Factor	OCD (n=21)	No OCD (n=15)	p-value	OR (95% CI)
Gender, n (%)			0.490*	
Male	15 (71.4)	6 (40.0)		
Female	6 (28.6)	9 (60.0)		
Age (years), median (range)	19 (18–55)	48 (18–58)	0.012†	
Work Duration (years), median (range)	2 (0.58–22)	9 (2–32)	0.001†	
History of Atopic Dermatitis, n (%)			<0.001*	
Yes	21 (100)	4 (26.7)		
No	0 (0)	11 (73.3)		
Multivariate Analysis				1.086 (1.018–1.158)
Age (per year increase)			0.012	

* Fisher's exact test; † Mann-Whitney U test.

4. Discussion

This study revealed a high incidence of occupational contact dermatitis (58.3%) among wood furniture finishing workers, underscoring the significant dermatological risks associated with this profession. This rate is considerably higher than the 4.62% prevalence previously reported among general furniture workers in Indonesia and the 35% prevalence among plywood industry workers, suggesting the finishing process carries a particularly high burden of disease.[13] The intensive exposure to chemicals unique to the finishing stage likely contributes to this elevated risk.

The patch test results identified Cobalt Chloride (44.4%) as the most frequent sensitizer. This finding is consistent with occupational exposures in furniture making, where cobalt is present in the "hard metal" of cutting and carving tools and can also be found in wood fillers and paint driers.[14] The second most common allergen, Colophony (30.5%), is a well-known sensitizer derived from pine resin and is a component of varnishes, adhesives, and wood dust.[15] The identification of Formaldehyde and Isothiazolinone as sensitizers further aligns with their roles as preservatives and biocides in water-based paints, glues, and wood coatings.[16,17]

A key finding of this study was the strong association between OCD and younger age and shorter work duration, which contradicts the common assumption that risk increases with cumulative exposure. The median age for the OCD group was 19 years, compared to 48 years for the non-OCD group. This may be explained by immunological tolerance or anergy, where long-term, chronic exposure to an antigen can lead to a state of immune non-responsiveness in older, more experienced workers.[18] Furthermore, older individuals experience immunosenescence, a decline in immune efficiency which can impair the capacity of dendritic cells and T-cells to mount a response.[19]

Regarding exposure dynamics, our study found that younger age and shorter work duration were stronger predictors of OCD than cumulative exposure. While cumulative exposure to irritants typically increases the risk of dermatitis, our findings suggest that mechanisms of immunological anergy or "hardening" may be dominant in this population. Chronic, low-dose exposure to allergens over many years can lead to a state of Low Zone Tolerance, where T-cells become non-responsive (anergic) or T-regulatory cells suppress the inflammatory response.[19] Consequently, the visible burden of disease is paradoxically higher in the newer, younger workforce who have not yet developed this tolerance, while older workers with high cumulative exposure show fewer symptoms. This "healthy worker effect" implies that those who develop severe sensitization early likely leave the profession, leaving behind a cohort of tolerant survivors.

The link between a history of atopic dermatitis (AD) and OCD was exceptionally strong in our univariate analysis ($p<0.001$). Individuals with AD have a constitutionally impaired skin barrier function, often due to mutations in proteins like filaggrin, which facilitates the penetration of irritants and allergens.[20,21] The underlying Th2-dominant inflammatory environment in AD is also thought to lower the threshold for contact sensitization, making these workers highly susceptible to developing OCD in a high-exposure environment.[22]

The study has several limitations. First, it was a single-center study, which may limit the generalizability of the findings. Second, the panel of allergens tested was limited to four substances and did not include testing with the workers' own materials, which may have missed other relevant workplace sensitizers. Third, the cross-sectional design identifies associations but cannot establish causality.

5. Conclusion

The incidence of occupational contact dermatitis among wood furniture finishing workers is alarmingly high. Younger age, a shorter duration of employment, and a personal history of atopic dermatitis are significant factors associated with the condition. Cobalt chloride, colophony, formaldehyde, and isothiazolinone are key sensitizing agents in this occupational setting. These findings emphasize the urgent need for targeted interventions, including comprehensive worker education on chemical hazards, promotion of appropriate personal protective equipment, and early screening programs, particularly for new and atopic employees, to mitigate the burden of OCD in the furniture finishing industry.

Ethical Approval

This study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Health Research Ethics Committee of the Faculty of Medicine, Diponegoro University (Ethical Clearance Number: 027/EC/KEPK/FK-UNDIP/II/2025).

Conflicts of Interest

The authors declare no conflict of interest.

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Author Contributions

Conceptualization, B.F.; methodology, B.F.; investigation, B.F.; data curation, B.F.; formal analysis, B.F.; writing original draft preparation, B.F.; writing review and editing, D.A.M. and L.A.; supervision, D.A.M. and L.A.; project administration, B.F. All authors have read and agreed to the published version of the manuscript.

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