The Association Between Occupational Contact Dermatitis and Atopic Dermatitis

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Abstract

This study investigates the prevalence and association between atopic dermatitis (AD) and occupational contact dermatitis (OCD), aiming to explore their connection and identify common allergens affecting individuals with both conditions. Understanding this relationship is crucial for improving workplace dermatological health and allergen avoidance strategies. A retrospective review was conducted on patients diagnosed with OCD between 2012 and 2021. The subjects were divided into two groups: those with and without AD. Patch tests, skin prick tests, and specific IgE tests were analyzed to identify relevant allergens, and statistical analysis was performed to assess prevalence and associations. Among 555 subjects, AD was found in 54 subjects, which accounted for the prevalence of 9.7% (95% CI: 7.5%-12.5%), significantly higher than in the general population ($p < 0.001$). The most common allergens included nickel (29%), methylchloroisothiazolinone /methylisothiazolinone (20%), and methylisothiazolinone (15%). Occupationally linked allergens were nickel (28%) and thiuram mix (16%). Cobalt chloride was significantly more prevalent among AD patients (20.4%, $p = 0.004$), whereas thiuram mix was more common in non-AD patients (14.4%, $p = 0.028$). These findings suggest that AD increases susceptibility to occupational skin issues, particularly from allergens like nickel and cobalt chloride. The results highlight the importance of implementing preventive measures for workers with AD.

Keywords: *atopic dermatitis, occupational contact dermatitis, patch tests*

1. Introduction

Occupational contact dermatitis (OCD) is the most common occupational skin disease (OSD) (DeKoven et al., 2022). OCD is an inflammatory skin disease caused by exposure to various substances in the workplace. These substances may include allergens, irritants, or proteins. Exposure can occur through direct contact, airborne transmission, or indirect contact when unwashed hands transfer materials to other parts of the body. OCD is a disease that has a public health effect and directly affects patients' quality of life. Because OCD is a chronic disease and often has a poor prognosis, more than 50% of patients had to take time off work (Holness, 2019).

The two primary forms of OCD are allergic contact dermatitis (ACD) and irritant contact dermatitis (ICD). ACD, caused by type IV hypersensitivity, is typically diagnosed through patch testing, while ICD results from the direct cytotoxic effects of chemical or physical agents on the skin. Factors such as occlusion, wetness, and mechanical stress contribute to ICD development (Milam et al., 2020; Schubert et al., 2020). Less common forms of OCD include contact urticaria (CU) and protein contact dermatitis (PCD), with rarer variants like photo contact dermatitis and systemic contact dermatitis also reported. Atopic dermatitis (AD) is a chronic inflammatory skin disorder influenced by genetic factors, such as filaggrin (FLG) gene mutations, Th2 cytokine dysregulation, and various environmental triggers. AD patients are at an increased risk of developing ICD due to an impaired skin barrier, though the relationship between AD and ACD is less clear. AD may not necessarily increase the risk of ACD but can result in more severe disease presentations (Houle et al., 2021; Schubert et al., 2020). Currently, the relationship between AD and occupational ACD remains inconclusive, with previous studies offering conflicting evidence. This research aims to clarify whether AD patients are more susceptible to developing OCD.

2. Objectives

1) To study the prevalence of atopic dermatitis in patients diagnosed with occupational contact dermatitis.

2) To study and compare the allergens found in the group of occupational contact dermatitis patients with atopic dermatitis.

3. Materials and Methods

3.1 Population and Samples

Subjects are patients diagnosed with occupational contact dermatitis, with confirmation by patch test, skin prick test, or specific IgE test treated at the Occupational and Contact Dermatitis Clinic, Institute of Dermatology, over the past ten years (2012–2021) and who met the following inclusion criteria:

1) Male and female patients.

2) All participants underwent patch testing.

3) Diagnosis was based on specific ICD-10 codes from the clinic's database, including L23 (allergic contact dermatitis), L24 (irritant contact dermatitis), L25 (unspecified contact dermatitis), and L50.6 (contact urticaria), along with a history indicating that the disease was work-related. The diagnosis was further confirmed using the Mathias criteria, requiring at least 4 out of 7 criteria.

4) A history of atopic dermatitis (AD), as documented in medical records.

3.2 Research Instruments

Medical records of patients diagnosed with occupational contact dermatitis at the Institute of Dermatology from 2012 to 2021.

3.3 Data Collection

This retrospective study analyzed data from 555 subjects diagnosed with occupational contact dermatitis (OCD) at the Institute of Dermatology, Thailand, over a decade (2012 to 2021). Patients were categorized into two groups based on their medical histories: those with a previous diagnosis or association with atopic dermatitis (AD) and those without. The diagnosis of OCD was confirmed using the Mathias criteria.

Data were collected through a standardized case record form, including demographic information (age, sex, history of atopy, family history of atopy, occupation, and duration of employment). The history of patch tests, skin prick tests, or specific IgE tests was reviewed to identify relevant allergens.

3.4 Data Analysis

Statistical analyses included descriptive statistics for general data, with continuous quantitative data reported as means and standard deviation and discrete data as percentages. The prevalence of AD in OCD patients was determined as the primary outcome. Chi-square or Fisher's exact tests were used to compare allergen distribution between the AD and non-AD groups. Binary logistic regression analysis was conducted to adjust for confounding variables, including gender, age, occupation, and history of atopy.

All statistical analyses were performed using IBM SPSS software (version 23).

4. Results and Discussion

4.1 Results

The demographic characteristics of 555 subjects were listed in Table 1. The mean age of the participants was 39.5 ± 11.39 years. Females were more prevalent than males, constituting 75.5% and 24.5%, respectively. In our study, all 555 subjects underwent patch testing, with 431 (77.6%) yielding positive results. Allergic contact dermatitis (ACD) was the most common diagnosis, accounting for 57.5% of cases, followed by irritant contact dermatitis (ICD) at 21.8%. However, some diagnoses overlapped, and detailed results are provided in Table 1. Atopic dermatitis (AD) was identified in 54 patients, representing 9.7%, which revealed a statistically significant correlation with OCD in our study (P-value < 0.001). Among the 177 patients with

a history of atopy, the most common conditions were allergic rhinitis (23.6%), atopic dermatitis (9.2%), asthma (4.1%), and allergic conjunctivitis (0.5%). Additionally, 20.9% of patients had a family history of atopy. The most frequent sites of lesions were the hands, palms, and fingers, which were affected in 78.6% of cases.

Table 1 Demographic and clinical data of OCD patients in this research

Characters	**N**	**%**
Age (years), mean ± SD	39.55 ± 11.39	
Sex		
female	419	75.5
male	136	24.5
Personal history of atopy		
None	378	68.1
Atopic dermatitis (AD)	51	9.2
Asthma	23	4.1
Allergic rhinitis (AR)	131	23.6
Allergic conjunctivitis	3	0.5
Diagnosis		
Allergic contact dermatitis (ACD)	319	57.5
Irritant contact dermatitis (ICD)	121	21.8
Protein contact dermatitis (PCD)	2	0.4
Contact urticaria (CU)	4	0.7
ACD with ICD	73	13.2
ACD with PCD	13	2.3
ACD with CU	16	2.9
ICD with PCD	2	0.4
ACD with ICD with PCD	1	0.2
ACD with ICD with CU	3	0.5
ACD with PCD with CU	1	0.2
Final Diagnosis of AD with OCD	54	9.7
Family history of atopy		
yes	116	20.9
no	439	79.1
Location		
hands, palms, fingers	436	78.6
arm	123	22.2
feet, toes, soles	83	15

The most common occupation among our subjects was food handlers or cooks, comprising 21.3% of the study population, followed by factory workers (16.4%), healthcare workers (9.19%), cleaners (7.93%), beauticians (6.49%), and spa workers (6.31%). Other occupations included office workers, mechanics, construction workers, farmers, gardeners, fishermen, and florists. Additionally, a smaller number of participants worked in various other professions, such as scientists, jewelry makers, seamstresses, drivers, painters, sellers, chemists, geologists, models, musicians, drugstore workers, salespersons, cruise ship workers, flight attendants, hotel staff, and clothing sellers.

The most common allergens found in this research were shown in Figure 1. Nickel emerged as the predominant allergen, exhibiting a prevalence rate of 0.29. This was followed by Methylchloroisothiazolinone /Methylisothiazolinone (MCI/MI) at 0.20 and Methylisothiazolinone (MI) at 0.16. Additionally, other identified allergens include Fragrance Mix I at 0.14 and Thiuram Mix at 0.13. Furthermore, the study noted the presence of other allergens such as Colophony, Cobalt chloride, Fragrance Mix II, Potassium Dichromate,

and Balsam of Peru or Myroxylon Pereirae. Table 2 illustrates the most prevalent allergens related to occupations identified in this study, with nickel remaining the most common allergen, found in 28% of cases, followed by Thiuram Mix at 16% and MCI/MI at 12%.

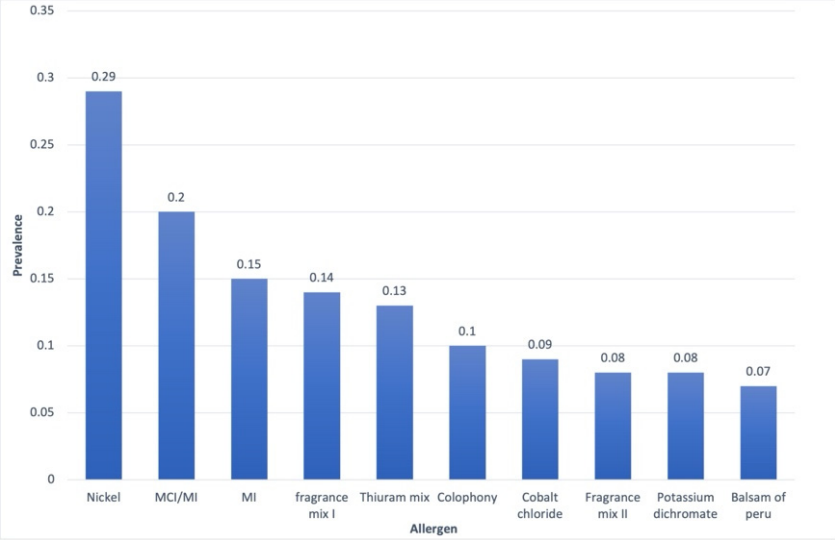

Figure 1 Most prevalent allergens found in this study

Table 2 Most prevalent allergens related to occupations found in this study

Allergen related to occupations	n	%
Nickel(II)sulfate hexahydrate	118	27.5
Thiuram mix	70	16.3
Methylchloroisothiazolinone/Methylisothiazolinone	51	11.9
Methylisothiazolinone	41	9.6
Fragrance mix I	40	9.3
Potassium dichromate	37	8.6
Cobalt(II)chloride hexahydrate	29	6.8
Colophonium	28	6.5
2-Mercaptobenzothiazole	28	6.5
Tetraethylthiuram disulfide (TETD)	25	5.8

The study observed intriguing disparities the most prevalent allergens between sexes. Nickel remained the foremost prevalent allergen among females, accounting for 32.20% of cases. Conversely, potassium dichromate emerged as the most prevalent allergen among males, with a prevalence rate of 19.10%. Notably, Nickel persisted as the second most prevalent allergen among males, recorded at 16.20%.

The prevalence of allergens among patient groups with and without atopic dermatitis did not exhibit significant differences. Nickel consistently remained the most prevalent allergen, followed by MCI/MI in both groups. Nonetheless, discernible distinctions between the two groups are portrayed in Figure 2.

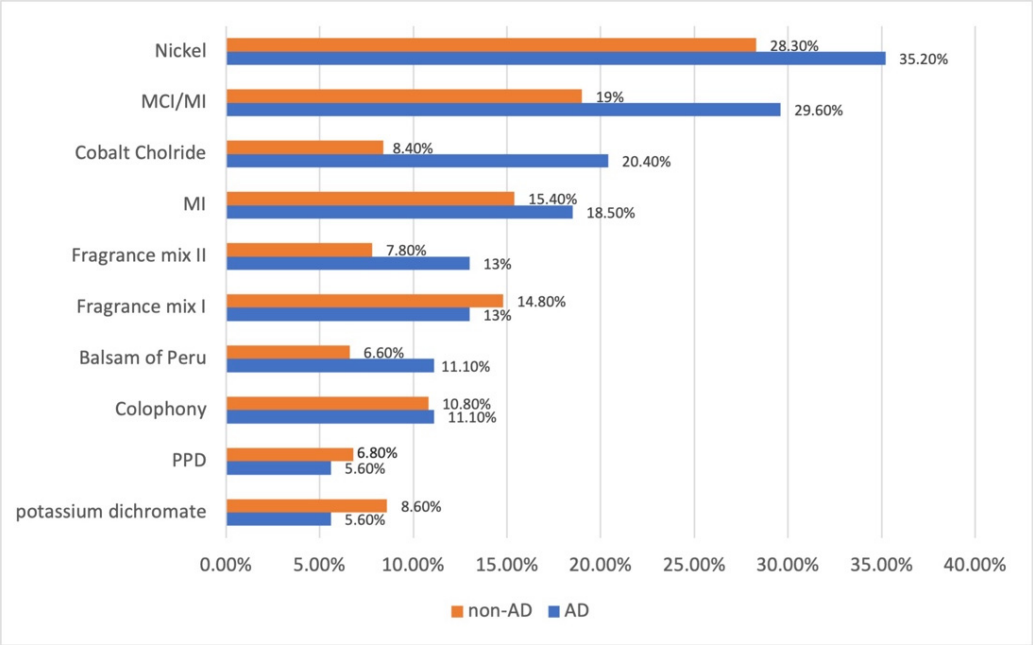

Figure 2 Most prevalent allergens in AD compared with non-AD

Among the 67 patients who underwent a skin prick test, only 32 showed positive results. Shrimp (10.4%), carrot (4.5%), and latex (4.5%) emerged as the most common allergens in this test. Additionally, IgE tests were conducted on 11 patients, with only 3 showing positive results, all of which were positive for latex IgE.

Our study found that Nickel was the most prevalent allergen across all occupational groups. In food handlers and cooks, Nickel was the most prevalent allergen at 26.05%, while thiuram mix allergy was observed in 21.01% Among factory workers in our study, the most prevalent allergens were Nickel (35.16%), MCI/MI (24.18%), and Cobalt chloride (17.58%). Healthcare workers showed a notable prevalence of thiuram mix allergy, affecting 17.65% of this group; the other prevalence is MCI/MI at 19.61%, Nickel at 17.65%. In the cleaner group, the most common allergens identified were Nickel (29.55%), MI (20.45%), fragrance mix I (20.45%), MCI/MI (18.18%), and fragrance mix II (15.91%). In the hairdresser group, PPD was identified as a significant allergen, affecting 36.11% of workers. Among spa workers, Fragrance Mix I was particularly prevalent, affecting 62.86% of individuals. This allergen was also linked to Balsam of Peru, found in 42.86% of spa workers.

The final diagnosis confirmed OCD in 54 patients with atopic dermatitis (AD) out of a total of 555 OCD patients, resulting in an AD prevalence of 9.7% in this study. (95% CI: 7.5%-12.5%). The comparison of responses to patch test allergens according to the OCD group was shown in Table 3. It was found that the thiuram mix exhibited a statistically significant prevalence among OCD patients without Atopic Dermatitis (AD). Conversely, cobalt was statistically significantly more prevalent among OCD patients diagnosed with AD.

Table 3 Comparison of the patch test allergens according to OCD group

Patch Test Allergens	OCD with AD		OCD without AD		P-value
	n	%	n	%	
Nickel(II)sulfate hexahydrate (2.5% pet)	19	35.20%	142	28.30%	0.293
Methylchloroisothiazolinone/Methylisothiazolinone	16	29.60%	95	19.00%	0.063
Methylisothiazolinone	10	18.50%	77	15.40%	0.545
Fragrance mix I (8.0% pet)	7	13.00%	74	14.80%	0.721
Thiuram mix (1.0% pet)	2	3.70%	72	14.40%	0.028*
Colophonium (20.0% pet)	6	11.10%	54	10.80%	0.94
Cobalt(II)chloride hexahydrate (1.0% pet)	11	20.40%	42	8.40%	0.004*
Fragrance mix II (14.0% pet)	7	13.00%	39	7.80%	0.19
Potassium dichromate (0.5% pet)	3	5.60%	43	8.60%	0.443
Peru balsam (25.0% pet)	6	11.10%	33	6.60%	0.217
p-p-Phenylenediamine (PPD) (1.0% pet)	3	5.60%	34	6.80%	0.73

4.2 Discussion

Our study analyzed 555 patients diagnosed with Occupational Contact Dermatitis (OCD) between 2012 and 2021, revealing key demographic trends, diagnostic overlaps, and occupational risk factors. The mean age was 39.55 ± 11.39 years, with a female predominance of 75.5%, aligning closely with previous findings from Thailand (Boonchai et al., 2014). The higher prevalence of OCD among women may be attributed to their increased exposure to irritants and a higher likelihood of seeking medical attention for dermatological conditions. However, studies from North America (DeKoven et al., 2022) report a male predominance, suggesting geographic and occupational variations.

Among the study population, Allergic Contact Dermatitis (ACD) was the most common diagnosis (76.8%), followed by Irritant Contact Dermatitis (ICD) (36%), Protein Contact Dermatitis (PCD) (4.3%), and Contact Urticaria (CU) (3.4%). Notably, 13.2% of patients had overlapping ACD and ICD diagnoses, likely due to workplace exposures that involve both irritants and allergens.

The overlap between ACD and PCD (2.3%) was most frequently observed in food handlers, suggesting that protein allergens can trigger both irritant and allergic reactions. Similarly, ACD and CU co-occurred in 2.9% of cases, particularly among individuals who regularly wear latex gloves, such as nurses and cooks, emphasizing occupational risk factors.

The predominance of ACD over ICD contrasts with earlier studies that reported ICD as the most common diagnosis. This discrepancy could stem from referral biases, as our study was conducted in a specialized patch testing clinic that primarily assessed allergic responses.

The most affected anatomical site was the hands (78.6%), followed by the arms and feet, reaffirming that occupational exposure predominantly involves direct contact. Food handlers and cooks represented the largest occupational group affected (21.3%), with significant associations with CU and PCD, likely due to frequent contact with food allergens and latex gloves. Factory workers (16.4%), healthcare workers (9.19%), and cleaners (7.39%) were also at high risk, with ICD being particularly prevalent among healthcare workers and farmers. Cleaners exhibited nearly equal rates of ACD (59.1%) and ICD (56.8%), likely due to repeated exposure to water and chemical cleaning agents.

Nickel is emerging as the most common sensitizer, affecting 29% of patients. Other prevalent allergens include methylchloroisothiazolinone/methylisothiazolinone (MCI/MI) (20%), fragrance mix I (14.6%), thiuram mix (13.3%), colophony (10.8%), cobalt chloride (9.5%), and potassium dichromate (8.3%). Occupational exposure influenced sensitization patterns significantly. Factory workers exhibit high sensitization rates to nickel (35.16%) and MCI/MI (24.18%), likely due to contact with industrial materials. Cleaners are most frequently sensitized to nickel (29.55%) and MI (20.45%), reflecting their exposure to preservatives and cleaning equipment. In contrast, spa workers showed high sensitivity to fragrance mix I (62.86%) and Balsam of Peru (42.86%), aligning with their frequent use of essential oils and scented products.

Healthcare workers and food handlers exhibited heightened thiuram mix sensitization due to their routine use of rubber gloves.

A family history of atopy was observed in 20.9% of cases. Notably, ACD showed a significant association with familial atopy ($p = 0.047$), supporting previous findings that genetic predisposition may influence susceptibility to allergic contact dermatitis. (Kirchhof, & de Gannes, 2018) However, other diagnoses did not show statistically significant familial associations.

The prevalence of AD among OCD patients was 9.7% (95% CI: 7.5%-12.5%), significantly higher than the general adult population (2.1%-4.9%, $p < 0.001$) (Barbarot et al., 2018). Among allergen responses, thiuram mix sensitization was significantly lower in patients with AD (3.7% vs. 14.4%, $p = 0.028$), whereas cobalt chloride sensitization was significantly higher (20.4% vs. 8.4%, $p = 0.004$). This aligns with theories suggesting that metal allergens like cobalt and nickel may directly activate Toll-like receptor 4 (TLR-4), contributing to increased contact sensitization in AD patients. (Roach et al., 2024)

Conversely, rubber allergens exhibit a Th-2 bias, given that acute AD is characterized by Th-2 and Th-22 polarization ; this may explain the higher prevalence of rubber sensitization in AD patients. (Leonard, & Guttman-Yassky, 2019) This contrasts with our findings and the hypothesis that a Th-2 cytokine bias in AD could reduce the risk of contact sensitization (CS), which is primarily Th-1-driven, thus influencing the relationship between AD and CS.

While some prior studies suggest AD increases the risk of nickel and fragrance sensitization, others report a reduced risk due to Th-2 polarization. (Silverberg et al., 2021; Tagka et al., 2020) Our study found no significant difference in nickel sensitization between AD (35.2%) and non-AD patients (28.3%) ($p = 0.293$), but a trend toward increased nickel, fragrance, and Balsam of Peru sensitization in AD patients was noted. These findings emphasize the complex interplay between AD and contact sensitization.

Our study has several limitations, including its retrospective design, which may introduce potential data gaps. Additionally, selection bias may be present due to the nature of referrals for patch testing. To address these limitations, future research should focus on broader studies with larger and more diverse datasets to enhance generalizability.

5. Conclusion

In conclusion, patients with AD demonstrated a tendency toward contact sensitization to cobalt chloride. Although not statistically significant, there was also a trend suggesting that patients with AD may be more prone to sensitization from nickel, fragrance mix, and Balsam of Peru. Conversely, thiuram mix sensitization was less common in patients with AD, despite previous studies reporting a higher prevalence of thiuram mix in this group. These findings suggest that the factors influencing contact sensitization in patients with AD are likely multifactorial. Thus, preventive measures should be tailored to different occupational groups, with particular attention to high-risk allergens, to improve workplace safety and reduce the burden of occupational contact dermatitis.

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