



Research Article

CLINICO-EPIDEMIOLOGICAL STUDY OF METAL SENSITIZATION IN ALL THE CLINICALLY SUSPECTED CASES OF ALLERGIC CONTACT DERMATITIS

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ABSTRACT

Background: Allergic contact dermatitis (ACD) is an inflammatory skin condition triggered by contact with allergens, with metals being a significant contributing factor. Identifying specific allergens and understanding demographic trends are essential for managing ACD effectively. **Objective:** This study aimed to analyze the clinico-epidemiological patterns of metal sensitization in clinically suspected ACD cases, focusing on common contactants and demographic variables. **Methods:** This observational, cross-sectional study was conducted at SMS Medical College and attached groups of Hospitals, Jaipur. It involved 90 patients clinically diagnosed with ACD. Patch testing was performed to identify specific allergens, particularly metals, and data were collected on demographic characteristics, occupational exposure, and symptoms. Statistical analyses, including Chi-square tests, were used to compare patch test outcomes across various subgroups. **Results:** Among 90 patients, 67.78% had positive patch test reactions, with significant sensitization to metals like potassium dichromate (27.78%) and nickel sulphate (21.11%). Sensitization was notably higher among construction workers and individuals frequently exposed to metal-containing products. Results showed significant associations between metal exposure and ACD symptoms ($p < 0.05$), with hands being the most affected site ($p = 0.001$). **Conclusion:** Metal sensitization remains a primary cause of ACD, underscoring the importance of preventive measures in high-risk occupations. Patch testing is invaluable for diagnosing and managing ACD, particularly in patients with chronic or recurrent symptoms.

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INTRODUCTION

Allergic contact dermatitis (ACD) is a prevalent inflammatory skin condition that typically represents a delayed hypersensitivity reaction to external substances, leading to symptoms like itching, redness, and vesiculation. ACD is a type of exogenous eczema. The term "eczema" originates from the Greek word *ekzein*, meaning "to boil" or "effervesce," accurately describing the inflamed and sometimes oozing nature of this condition. This condition manifests when a sensitized individual's skin comes in contact with a chemical or antigen, activating specific T-lymphocytes.^{1,2}

Contact dermatitis contributes to 4%-7% of all dermatological consultations.³ Exposure to the allergen may be occupational or in the form of substances to which a person is exposed in day-to-day life. More than 3,700 allergens have been identified as triggers for ACD in people.⁴ Among the diverse allergens

responsible for ACD, metals such as nickel, chromium and cobalt have been identified as major triggers, causing a hypersensitivity reaction in sensitized individuals.⁵

Nickel, a common allergen, is widely used in daily items such as costume jewelry (earrings, necklaces, bracelets), accessories (watches, belt buckles), kitchen utensils, cutlery, hardware, sporting equipment, electrical devices, cosmetic tools (eyelash curlers), and hand tools (wrenches), often triggering sensitivity in susceptible individuals. In recent years, increasing cases of allergic contact dermatitis (ACD) caused by exposure to nickel in mobile phones have been documented, highlighting its presence in modern technology.⁶ Chronic exposure to chromium, particularly hexavalent chromium in cement, is a major cause of occupational ACD among construction and industrial workers. Artists using pigments and tanners handling leather goods are also at risk. Cobalt is used in alloys, its exposure is prevalent in occupations involving grinding, cutting, or handling metal objects, as well as in manufacturing pigments for ceramics and glass. Sensitization to cobalt often occurs concurrently with nickel due to their coexistence in

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products.

ACD significantly impacts patients' quality of life, often resulting in chronic symptoms and recurrent flare-ups upon re-exposure to allergens. Managing ACD requires careful identification of specific allergens through diagnostic methods like patch testing, which remains the gold standard for ACD diagnosis. Patch testing helps identify causative agents and guides effective management strategies. Patch testing serves as both a screening and provocation test specifically for the skin which is the target organ. This entails testing the relevant allergens in their proper vehicle and concentration.⁷

ACD affects individuals across different demographics, with occupational exposure being a crucial risk factor. Occupations involving frequent contact with metal-based products, such as construction work, are at a higher risk for ACD. According to studies, up to 90% of occupational skin diseases are forms of contact dermatitis, highlighting the public health importance of accurate diagnosis and targeted prevention strategies.^{8,9}

This study aims to perform a clinico-epidemiological analysis of metal sensitization in ACD, focusing on the role of metal allergens and demographic factors influencing ACD prevalence. By clarifying the patterns of sensitization, this research intends to aid in the early identification and prevention of ACD in high-risk populations, ultimately improving patient outcomes and reducing the economic burden of this condition on healthcare systems

MATERIALS AND METHODS

Study Design

This study was designed as an observational, cross-sectional study, conducted in the Department of Dermatology, Venereology, and Leprosy at SMS Medical College, Jaipur. Ethical clearance was obtained from the institutional review board, and all participants provided informed consent prior to inclusion.

Study Population—included 90 patients clinically diagnosed with allergic contact dermatitis (ACD), selected based on specific inclusion and exclusion criteria.

Patients clinically suspected of ACD, aged above 18 years, who agreed to participate and were able to attend follow-up sessions, were included in the study.

Exclusion criteria included individuals with active skin diseases on the back, compromised immune status due to medical conditions or medications, and those treated for contact dermatitis within the past one month.

Study Procedure

Following consent, each participant's demographic information, medical history, occupational exposure, and dermatological findings were documented in a pre-designed proforma. The clinical examination focused on identifying ACD patterns, probable allergens, and associated risk factors like exposure to metals through occupational or personal practices. Patch tests were performed using the standard allergens panel, including metals like nickel sulphate, potassium dichromate, and cobalt chloride. The tests were administered on each participant's back and monitored over 48 hours. Reactions were scored according to the

International Contact Dermatitis Research Group (ICDRG) criteria. Positive reactions were recorded and analyzed. Statistical analyses were conducted using Chi-square tests for categorical data and Student's t-test for continuous data, comparing results across age, gender, occupational exposure, and patch test outcomes. Statistical significance was set at a p-value < 0.05.

RESULTS

The study included 90 patients with clinically suspected ACD, comprising 56.67% males and 43.33% females. The mean age was 41.08 ± 3.05 years, with the majority of cases (28.89%) falling within the 41-50 age group. Occupational exposure analysis indicated that housewives (30%) and construction workers (24.44%) represented the largest groups affected by ACD, reflecting high-risk exposures, particularly to metal allergens.

The hands were the most commonly affected site, involved in 31.11% of cases, followed by combined hand and foot involvement in 10%. Other notable sites included the ear (10%), neck (7.78%) and feet (7.78%). These findings emphasize the importance of direct contact with allergens, particularly on exposed or frequently used body parts such as the hands. This highlights the need for preventive measures like gloves or protective equipment in high-risk individuals.

Out of 90 patients, 61 (67.78%) showed positive patch test results, with 42 cases (46.67%) sensitive to metal allergens. The high proportion of positive patch test results demonstrates the reliability of patch testing in identifying ACD triggers. The significant metal sensitization rate underscores the prominence of metals as common allergens in this population.

The most common allergen was potassium dichromate (27.78%), followed by nickel sulphate (21.11%). Among the 42 metal-positive cases, 28 were males and 16 were females. Potassium dichromate was significantly more prevalent in males (23.33%) than females (4.44%, $p=0.006$), while nickel sulphate sensitivity was higher in females (13.33%) compared to males (7.78%). The gender-specific distribution of metal allergens reflects occupational exposures, with potassium dichromate being linked to industries like construction, more male-dominated, and nickel sulphate to jewelry or cosmetic use, more associated with females.

Double metal allergen positivity (e.g., potassium dichromate and nickel sulphate) was observed in 2 patients, while one male patient had triple allergen positivity. The highest prevalence of metal sensitization was in the age group 31–40 years (15.57%), followed by 19–30 years (12.22%). This age-related trend suggests that younger adults are at higher risk of developing ACD, potentially due to greater occupational or lifestyle-related exposure during their active years

Urban residents (26.67%) had slightly higher metal sensitivity than rural residents (22.22%), though this was not statistically significant. While not statistically significant, the urban-rural difference may hint at environmental or occupational variations in allergen exposure. Further studies with larger sample sizes could provide deeper insights.

DISCUSSION

This study provides an in-depth clinico-epidemiological

analysis of metal sensitization in allergic contact dermatitis (ACD), highlighting key allergens and identifying demographic and occupational factors associated with heightened ACD risk. Our findings underscore the significant role of metals, specifically potassium dichromate and nickel sulphate, as major allergens, which aligns with previous studies identifying these metals as frequent ACD triggers. The high rate of sensitization to metals (46.67%) is consistent with findings in occupational dermatology, where metals like potassium dichromate are often implicated, especially among construction workers and others in metal-related industries. This study's results show that construction workers exhibited a significantly higher rate of sensitization, notably to potassium dichromate ($p < 0.001$). Previous research has similarly shown that individuals working with cement and construction materials are prone to metal-induced ACD, often due to the presence of hexavalent chromium in these materials, reinforcing the occupational health significance of metal allergens. While male patients represented a larger proportion of sensitized individuals, the gender distribution was not statistically significant ($p = 0.39$), suggesting that both genders are equally susceptible to metal allergens in the presence of sufficient exposure. The age distribution data revealed that the 31–40 age group exhibited the highest prevalence of positive patch test results for metals. However, no significant age-related differences were observed in sensitization patterns across other age groups ($p = 0.9$). These findings suggest that susceptibility to metal allergens may not be age-dependent but is more closely tied to exposure patterns and occupational factors.

The sensitization rates observed in this study align with findings from similar studies in India and globally. The distribution of allergens in this study revealed that Potassium Dichromate (27.78%) and Nickel Sulphate (21.11%) were the most common allergens, these findings align with previous studies, such as **Sahu S et al.**¹⁰, which also identified Potassium Dichromate (30.43%) as the most prevalent allergen, while **Khatami et al.**¹¹ observed Nickel Sulphate (20%) as the leading allergen in their study.

The gender-specific prevalence of allergens was significant, with Nickel Sulphate being more common in females (13.33%) and Potassium Dichromate more common in males (23.33%), which is consistent with the findings of **Khatami et al.**¹¹ (18% females and 30% males). This disparity is likely due to different exposure routes: Nickel Sulphate is more common in females due to contact with jewelry and cosmetics, while Potassium Dichromate is primarily encountered in male-dominated industries like construction and metalworking. This highlights the importance of considering gender-based occupational exposures when managing ACD.

The study's findings on the high prevalence of metal allergens—Potassium Dichromate and Nickel Sulphate—underscore the significant role of metals in ACD. These metals are frequently encountered in industrial settings, with Potassium Dichromate's high sensitization potential further amplified by its environmental stability and cross-reactivity with other chromium compounds.

Clinical and Public Health Recommendations

The results of this study underscore the need for preventive interventions in high-risk occupational groups. Strategies may

include stricter regulations on metal content in construction materials, mandatory use of personal protective equipment (PPE), and regular screening for ACD symptoms in at-risk workers. For clinicians, patch testing remains a critical diagnostic tool, allowing for early identification of metal sensitization and the implementation of avoidance strategies to mitigate ACD progression. Educating patients about potential sources of metal allergens, including everyday items such as jewelry and personal care products and to occupational products is essential in managing and preventing ACD flare-ups.

Limitations and Future Directions

This study was conducted in a single hospital setting, which may limit the generalizability of findings to broader populations. Future studies involving multicenter, larger cohorts would provide a more comprehensive view of ACD sensitization patterns. Additionally, incorporating histopathological or immunological analyses could offer deeper insights into the mechanisms underlying metal sensitization, further refining diagnostic and therapeutic approaches in ACD management.

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Declarations

- **Conflicts of Interest:** The authors declare no conflicts of interest.
- **Funding:** This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.
- **Ethical Approval:** Ethical approval was obtained from the Institutional Review Board of SMS Medical College and attached groups of Hospitals. All procedures followed were in accordance with institutional and national ethical standards.
- **Consent to Participate:** Informed consent was obtained from all individual participants included in the study.

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