

Original Research Article

INCIDENCE AND PATTERN OF DERMATITIS IN PEOPLE USING HAIR DYE": A STUDY FROM TERTIARY CARE CENTRE

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ABSTRACT

Background: Hair dye use has increased considerably worldwide, with para-phenylenediamine (PPD) being the most common cause of hair dye-induced allergic contact dermatitis. This study evaluated the incidence, clinical patterns, and patch test profile of dermatitis among hair dye users.

Materials and Methods: This prospective, observational, descriptive, single-center study was conducted in the Department of Dermatology, Venereology and Leprosy, Maharishi Markandeshwar Medical College and Hospital, Solan, from April 2024 to December 2025. A total of 71 adult hair dye users were enrolled. Sociodemographic details, hair dye usage patterns, clinical features, lesion morphology, and patch test findings using the Indian Standard Patch Test Series were recorded and analyzed descriptively.

Results: The mean age of participants was 44.0 ± 12.1 years, and 60.6% were males. Dermatitis was present in 83.1% of participants, with localized scalp dermatitis (42.3%) being the most common presentation. Pruritus was the predominant symptom (60.6%), and acute lesions were the most frequent lesion type (29.6%). Patch test positivity was observed in 52.1% of patients, with PPD identified as the most common allergen (38.8% positivity at 72 hours).

Conclusion: Hair dye-associated dermatitis predominantly affects middle-aged adults and is strongly associated with PPD sensitization. Early diagnosis, patch testing, and patient education regarding safe hair dye practices are essential for preventing recurrent dermatitis and reducing disease burden.

Keywords: Hair dye, Allergic contact dermatitis, Para-phenylenediamine, Patch test, Contact allergy, Dermatitis.

INTRODUCTION

Hair coloring has become one of the most commonly practiced cosmetic procedures worldwide for concealing grey hair and enhancing appearance. Increasing availability of over-the-counter products and professional salon services has led to widespread use among both men and women across all age groups, thereby increasing the incidence of adverse cutaneous reactions associated with hair dye application.^[1] The hair shaft consists of three layers—the cuticle, cortex, and medulla.

Hair dyes are classified into temporary, semi-permanent, and permanent (oxidative) dyes based on their mechanism of action and durability. Permanent hair dyes penetrate the cortex and produce long-lasting color through oxidative chemical reactions involving dye precursors and hydrogen peroxide.^[2] These formulations contain several chemical ingredients, among which para-phenylenediamine (PPD) is the most important allergen responsible for hair dye-induced allergic contact dermatitis (ACD).^[3] PPD is an aromatic amine widely used in more than 70% of permanent hair dyes because of its low molecular weight, excellent hair penetration,

strong protein-binding capacity, and oxidative stability. However, these same properties make it a potent sensitizer capable of inducing type IV hypersensitivity reactions. PPD also exhibits cross-reactivity with para-aminobenzoic acid (PABA), para-aminosalicylic acid, sulphonamides, ester-type local anesthetics, thiazides, and azo dyes, increasing the risk of allergic reactions in susceptible individuals.^[4,5] The prevalence of PPD sensitization varies geographically, with patch-test positivity reported to be 4.4% in Asia, 4.1% in Europe, 6.0% in North America, and as high as 11.5% in India.^[6,7] Clinically, hair dye dermatitis ranges from localized eczema involving the scalp, face, ears, neck, and hands to severe manifestations such as airborne contact dermatitis, periorbital edema, photo-distributed dermatitis, generalized eczema, contact urticaria, angioedema, bronchospasm, and rarely systemic complications including renal involvement.^[8,9] Hair dye use has increased substantially over recent decades, accompanied by a growing burden of adverse reactions. An Indian study reported that 42% of hair dye users experienced adverse effects, with a mean age of first use of 27 years.^[10] Similarly, a Danish population-based study found that 75% of women and 18% of men had used hair dyes, while 5.3% reported adverse reactions despite stringent cosmetic regulations.^[11] Nevertheless, awareness regarding the potential adverse effects of hair dyes and PPD sensitization remains inadequate among consumers, often resulting in delayed diagnosis and repeated exposure.^[12-14] Hairdressers and salon professionals constitute a high-risk occupational group because of repeated exposure to hair dye chemicals.^[15] Occupational contact dermatitis is common among hairdressers, with PPD sensitization rates ranging from approximately 19% to 21% in different countries, while nearly half of hairdressers have been reported to suffer from occupational allergic or irritant contact dermatitis.^[16,17] These findings emphasize the need for greater awareness, preventive measures, and safe hair dye practices among both consumers and professionals. Considering the increasing use of hair dyes and the limited regional data from Himachal Pradesh, the present study was designed to evaluate the incidence and clinical pattern of dermatitis among hair dye users.

MATERIALS AND METHODS

This prospective, observational, descriptive, single-center, hospital-based study was conducted in the Department of Dermatology, Venereology and Leprosy (DVL), Maharishi Markandeshwar Medical College and Hospital, Kumarhatti, Solan, from April 2024 to December 2025. The study included 71 consecutive adult patients (>18 years) with a history of hair dye use who attended the Dermatology outpatient department and provided written informed consent to participate.

Inclusion Criteria

- Adults aged >18 years using hair dye.
- Patients willing to provide written informed consent.

Exclusion Criteria

- Patients with known allergy to para-phenylenediamine (PPD) or allergens exhibiting cross-reactivity with PPD.
- Pregnant or lactating women.
- Patients unwilling to participate in the study.

Sample Size Calculation

Sample size was calculated using the formula:

$$n = \frac{Z^2 P(1 - P)}{d^2}$$

Where:

Z = Z statistic for 95% confidence

P = expected prevalence

d = precision

As per Handa et al., the incidence of allergic contact dermatitis to hair dye was 4.7%. Taking an average prevalence of 4.75%, a confidence level of 95%, and precision of 5%, the final calculated sample size was 71.

Data Collection: Data were collected using a predesigned structured case record form. Sociodemographic information including age, gender, religion, place of residence, and socioeconomic status was recorded. Socioeconomic status was assessed using the Modified Kuppaswamy Scale (2022).

A detailed history regarding hair dye use was obtained, including duration and frequency of application, quantity of dye used, type of hair dye, occupational exposure, previous adverse reactions, and symptoms experienced following hair dye application.

Clinical Assessment: All participants underwent a comprehensive dermatological examination. The clinical pattern and distribution of dermatitis were documented, including localized scalp dermatitis, facial and neck dermatitis, periorbital dermatitis, eyelid dermatitis, hand and foot dermatitis, airborne contact dermatitis, generalized dermatitis, disseminated dermatitis, discoid dermatitis, erythema multiforme-like lesions, and other clinical presentations. Morphological characteristics of skin lesions, including papules, macules, plaques, urticarial lesions, crusting, oozing, fissuring, lichenification, pigmentary changes, angioedema, and depigmented or hypopigmented lesions, were also recorded.

Patch Testing: Patch testing was performed using Finn Chambers with the Indian Standard Patch Test Series containing para-phenylenediamine (PPD) 1% in petrolatum, as recommended by the Contact Dermatitis and Occupational Dermatoses Forum of India. Patches were applied to the upper back under occlusion, and readings were recorded at 48 and 72 hours. Patch test reactions were interpreted according to the International Contact Dermatitis Research

Group (ICDRG) criteria and graded as doubtful ($\pm$), weak positive (+), strong positive (++), very strong positive (+++), or negative (-). Only reactions persisting at the Day-3 reading were considered positive.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 25.0. Continuous variables were expressed as mean $\pm$ standard deviation (SD) and median with interquartile range (IQR), whereas categorical variables were presented as frequencies and percentages. As the primary objective of the study was to describe the incidence and clinical pattern of dermatitis among hair dye users, descriptive statistical analysis was performed.

Ethical Considerations: The study protocol was approved by the Institutional Ethics Committee before commencement of the study. Written informed consent was obtained from all participants prior to enrollment, and confidentiality of participant information was maintained throughout the study.

RESULTS

A total of 71 adult hair dye users who fulfilled the inclusion criteria were enrolled in the present study. The sociodemographic characteristics of the study population are presented in [Table 1]. The mean age of the participants was 44.0 ± 12.1 years, while the median age was 45 years (IQR: 36–53 years). The majority of the participants belonged to the 41–50 years age group (31.0%; $n=22$), followed by the 31–40 years age group (22.5%; $n=16$). Participants aged 51–60 years accounted for 21.1% ($n=15$), whereas those aged ≤ 30 years and >60 years each constituted 12.7% ($n=9$) of the study population [Table 1 and Figure 1]. As shown in [Table 1], males predominated in the study population, comprising 60.6% ($n=43$) of the participants, while females constituted 39.4% ($n=28$). Regarding religious distribution, the majority of participants were Hindus (59.2%; $n=42$), followed by Muslims (15.5%; $n=11$), Sikhs (14.1%; $n=10$), and Christians (11.3%; $n=8$). Based on place of residence, 54.9% ($n=39$) of participants resided in urban areas, whereas 45.1% ($n=32$) belonged to rural areas. Occupationally, housewives represented the largest group (42.3%; $n=30$), followed by office-goers (29.6%; $n=21$), shopkeepers (12.7%; $n=9$), defence personnel (8.5%; $n=6$), and students (7.0%; $n=5$). According to the Modified Kuppaswamy socioeconomic classification, the largest proportion of participants belonged to the lower middle class (31.0%; $n=22$), followed by the upper middle class (25.4%; $n=18$), upper lower class (22.5%; $n=16$), upper class (11.3%; $n=8$), and lower class (9.9%; $n=7$) [Table 1]. The hair dye usage characteristics and clinical profile of the participants are summarized in [Table 2]. The majority of participants had been using hair dye for 1 month to 1 year (59.2%; $n=42$), while 23.9% ($n=17$) had been

using hair dye for 1–3 years. Hair dye use for less than one month was reported by 15.5% ($n=11$) participants, whereas only one participant (1.4%) had been using hair dye for more than 3 years [Table 2]. With respect to the frequency of hair dye application, the most common practice was application once every month (22.5%; $n=16$), followed by weekly application (18.3%; $n=13$) and once every two weeks (16.9%; $n=12$). Hair dye application once every two months was reported by 15.5% ($n=11$) participants, while 14.1% ($n=10$) used hair dye once every three weeks and 12.7% ($n=9$) applied it once every three months [Table 2].

Regarding the quantity of hair dye used per application, 20 ml was the most frequently used amount, reported by 25.4% ($n=18$) of participants. This was followed by 25 ml (21.1%; $n=15$), 15 ml (19.7%; $n=14$), while 10 ml and 30 ml were each used by 16.9% ($n=12$) of participants [Table 2]. Clinical reactions following hair dye application are also shown in [Table 2]. The majority of participants experienced some form of adverse reaction after hair dye use. Pruritus or itching was the most frequently reported symptom, affecting 60.6% ($n=43$) of participants. Another 22.5% ($n=16$) reported raised lesions, pain, or skin darkening following hair dye application. Only 16.9% ($n=12$) participants reported no adverse reaction after using hair dye [Table 2]. The clinical pattern of dermatitis observed among affected participants is presented in Table 2. Localized scalp dermatitis involving the scalp and scalp margins was the commonest clinical presentation, accounting for 42.3% ($n=30$) of cases. Facial and neck involvement was observed in 19.7% ($n=14$) participants, while the airborne contact dermatitis (ABCD) pattern was seen in 11.3% ($n=8$). Other clinical manifestations included hands and feet involvement (8.5%; $n=6$), miscellaneous patterns (8.5%; $n=6$), isolated hand dermatitis (5.6%; $n=4$), and eyelid dermatitis (4.2%; $n=3$) [Table 2]. The type of skin lesions observed among study participants is also summarized in Table 2. Acute dermatitis represented the most common lesion type and was observed in 29.6% ($n=21$) participants. Chronic lesions accounted for 28.2% ($n=20$), while subacute lesions were present in 25.4% ($n=18$) participants. No clinically evident skin lesion was observed in 16.9% ($n=12$) participants [Table 2 and Figure 2]. The morphological characteristics of skin lesions are detailed in [Table 3]. Hyperpigmented or scaly plaques with or without erythema constituted the most common morphological pattern, accounting for 15.5% ($n=11$) of participants. The second most common morphology was multiple skin-coloured papules with or without erythema (12.7%; $n=9$), followed by hyperpigmented macules (8.5%; $n=6$). Other observed lesion morphologies included hyperpigmented papules (7.0%; $n=5$), urticarial plaques (7.0%; $n=5$), crusted erosions with oozing or fissuring (7.0%; $n=5$), and hyperpigmented patches (7.0%; $n=5$). Less frequent lesions included

depigmented macules or papules (5.6%; n=4), hypopigmented patches (4.2%; n=3), seborrheic melanosis (2.8%; n=2), angioedema (2.8%; n=2), and lichenified plaques (2.8%; n=2). No skin lesions were observed in 16.9% (n=12) participants [Table 3 and Figure 3]. Patch test findings are presented in Table 3. A positive patch test reaction was observed in 37 participants (52.1%), whereas 30 participants (42.3%) demonstrated negative patch test results. Patch test readings could not be obtained in 4 participants (5.6%). Among the allergens tested, para-phenylenediamine (PPD) showed the highest positivity, with 38.8% (n=26) demonstrating a positive reaction at 72 hours. Other commonly

identified allergens included Parthenium (10.4%; n=7), Neomycin sulfate (7.5%; n=5), Nickel sulfate (6.0%; n=4), and Fragrance mix (6.0%; n=4). No positive reaction was observed with Vaseline [Table 3]. The overall incidence of dermatitis among hair dye users is shown in Table 3. Out of the 71 participants enrolled in the study, 59 participants (83.1%) had clinically evident hair dye-associated dermatitis, whereas 12 participants (16.9%) did not demonstrate any clinical evidence of dermatitis. These findings indicate that the majority of individuals using hair dye in the present study developed clinically significant dermatitis following exposure to hair dye products [Table 3].

Table 1: Sociodemographic Characteristics of the Study Population (n = 71)

Variable	Category	Number (n)	Percentage (%)
Age Group (years)	≤30	9	12.7
	31–40	16	22.5
	41–50	22	31.0
	51–60	15	21.1
	>60	9	12.7
Mean age	44.0 ± 12.1 years		
Median age (IQR)	45 years (36–53)		
Gender	Male	43	60.6
	Female	28	39.4
Religion	Hindu	42	59.2
	Muslim	11	15.5
	Sikh	10	14.1
	Christian	8	11.3
Residence	Urban	39	54.9
	Rural	32	45.1
Occupation	Housewives	30	42.3
	Office goers	21	29.6
	Shopkeepers	9	12.7
	Defence personnel	6	8.5
	Students	5	7.0
Socioeconomic Status (Modified Kuppuswamy Scale)	Upper (I)	8	11.3
	Upper Middle (II)	18	25.4
	Lower Middle (III)	22	31.0
	Upper Lower (IV)	16	22.5
	Lower (V)	7	9.9

Table 2: Hair Dye Usage Characteristics and Clinical Profile of Participants (n = 71)

Variable	Category	Number (n)	Percentage (%)
Duration of Hair Dye Use	<1 month	11	15.5
	1 month–1 year	42	59.2
	1–3 years	17	23.9
	>3 years	1	1.4
Frequency of Hair Dye Use	Weekly	13	18.3
	Once in 2 weeks	12	16.9
	Once in 3 weeks	10	14.1
	Once a month	16	22.5
	Once in 2 months	11	15.5
	Once in 3 months	9	12.7
Quantity Used per Application	10 ml	12	16.9
	15 ml	14	19.7
	20 ml	18	25.4
	25 ml	15	21.1
	30 ml	12	16.9
Reaction After Hair Dye Use	No reaction	12	16.9
	Itching/Pruritus	43	60.6
	Raised lesions/Pain/Darkening	16	22.5
Clinical Pattern of Dermatitis	Localized scalp dermatitis	30	42.3
	Face & neck involvement	14	19.7
	ABCD pattern	8	11.3
	Hands & feet involvement	6	8.5
	Hand dermatitis	4	5.6
	Eyelid dermatitis	3	4.2

	Miscellaneous	6	8.5
Type of Skin Lesion	Acute	21	29.6
	Subacute	18	25.4
	Chronic	20	28.2
	No lesion	12	16.9

Table 3: Morphological Characteristics, Patch Test Results, and Incidence of Dermatitis (n = 71)

Variable	Category	Number (n)	Percentage (%)
Morphology of Skin Lesions	No skin lesions	12	16.9
	Hyperpigmented/scaly plaques ± erythema	11	15.5
	Multiple skin-coloured papules ± erythema	9	12.7
	Hyperpigmented macules	6	8.5
	Hyperpigmented papules	5	7.0
	Urticarial plaques	5	7.0
	Crusted erosions/oozing/fissuring	5	7.0
	Hyperpigmented patches	5	7.0
	Depigmented macules/papules	4	5.6
	Hypopigmented patches	3	4.2
	Seborrheic melanosis	2	2.8
	Angioedema	2	2.8
	Lichenified plaques	2	2.8
Patch Test Result	Positive	37	52.1
	Negative	30	42.3
	Reading not taken	4	5.6
Most Common Allergens (72-hour positivity)	Para-phenylenediamine (PPD)	26	38.8
	Parthenium	7	10.4
	Neomycin sulfate	5	7.5
	Nickel sulfate	4	6.0
	Fragrance mix	4	6.0
	Dermatitis present	59	83.1
Overall Incidence of Dermatitis	No dermatitis	12	16.9

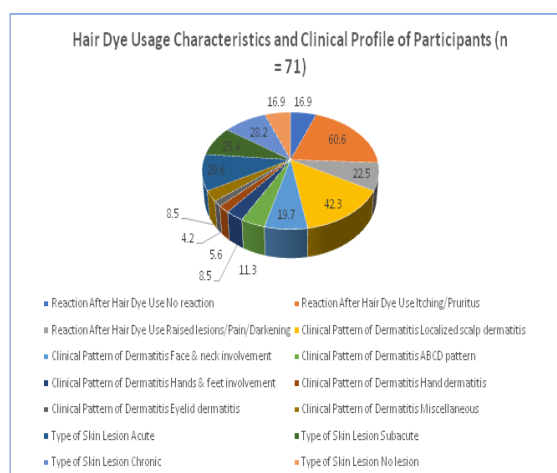
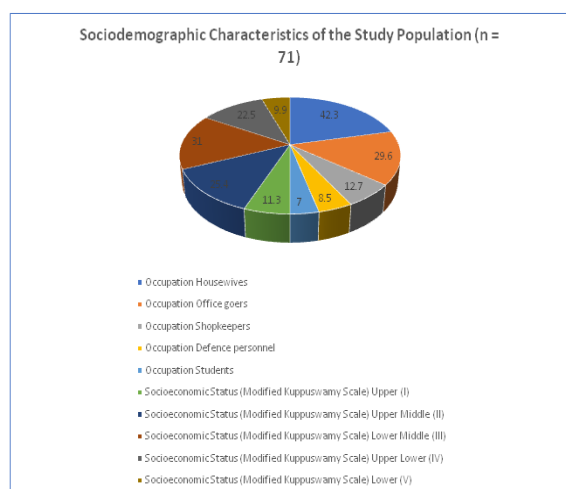
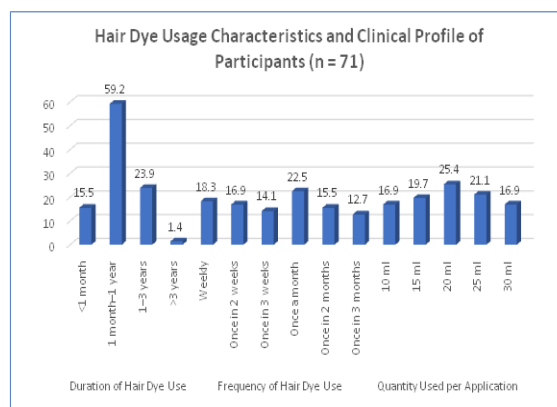
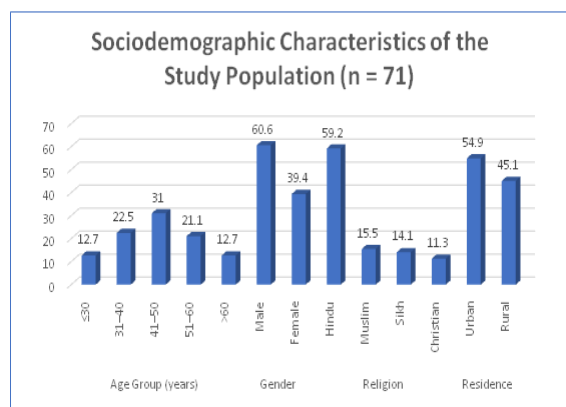


Figure 1: Sociodemographic Characteristics of the Study Population (n = 71)

Figure 2: Hair Dye Usage Characteristics and Clinical Profile of Participants (n = 71)

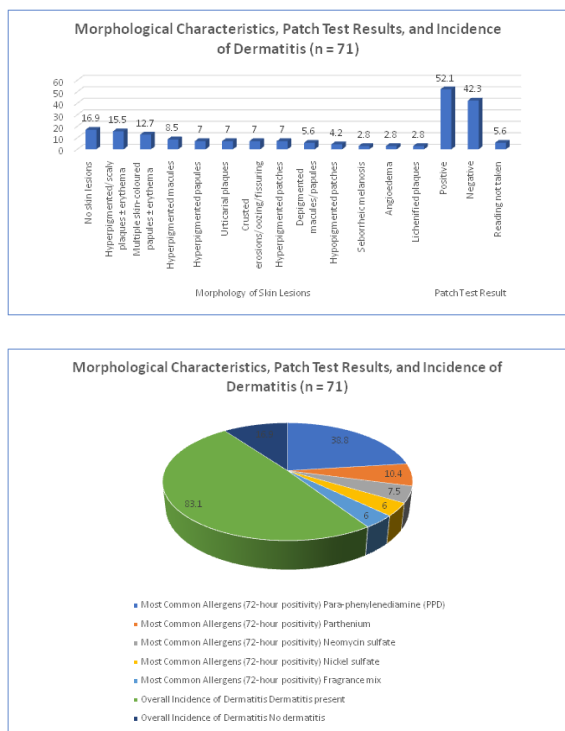


Figure 3: Morphological Characteristics, Patch Test Results, and Incidence of Dermatitis (n = 71)

DISCUSSION

The present prospective, observational study evaluated the incidence and clinical pattern of dermatitis among hair dye users attending a tertiary care dermatology center in Himachal Pradesh. Hair dye-associated dermatitis is an increasingly recognized dermatological problem due to the widespread use of permanent hair dyes containing para-phenylenediamine (PPD), one of the most potent contact sensitizers. The study assessed the demographic profile, hair dye usage characteristics, clinical manifestations, and patch test positivity among affected individuals.

In the present study, hair dye dermatitis predominantly affected middle-aged adults, with the highest proportion of patients belonging to the 41–50 years age group (31.0%), followed by the 31–40 years group (22.5%). The mean age was 44.0 ± 12.1 years. Similar findings were reported by Handa et al,^[18] who observed that patients with hair dye dermatitis had a mean age in the mid-forties in both study periods (1999–2000 and 2009–2010), indicating that middle age remains the most vulnerable period for PPD sensitization. Gupta et al.^[7] also reported that 71% of patients with suspected hair dye dermatitis were older than 40 years. Likewise, Han et al.^[19] found that patch test-confirmed hair dye allergy was more common in individuals older than 50 years. The predominance of middle-aged adults in the present study probably reflects cumulative exposure to hair dye chemicals over several years. A male predominance was observed in the present study, with males accounting for 60.6% of participants. In contrast,

Gupta et al,^[7] reported that although more males initially presented with suspected hair dye dermatitis, females constituted the majority of PPD-positive cases. Søstet et al,^[11] in a Danish population-based study involving 4,000 adults, found that 74.9% of women and only 18.4% of men had used hair dyes, suggesting greater cosmetic exposure among females. The male predominance observed in our study may therefore reflect regional grooming practices and the increasing use of hair dyes among men for premature greying. Most participants had been using hair dye for one month to one year (59.2%), while nearly one-fourth reported use for one to three years. Monthly application was the most common frequency of use (22.5%), and 20 ml was the most frequently used quantity per application (25.4%). Han et al,^[19] demonstrated a significant positive correlation between both the duration and frequency of hair dye exposure and the extent of dermatitis ($p < 0.001$), indicating that repeated exposure increases the risk of sensitization. Handa et al,^[18] also reported increasing PPD sensitization over time with continued use of hair dyes. These findings support the role of repeated exposure in the development of allergic contact dermatitis. The majority of participants belonged to urban areas (54.9%) and the lower middle socioeconomic class (31.0%). Similar observations have been reported by Gupta et al,^[7] where most patients were from urban backgrounds, reflecting greater accessibility and use of cosmetic products. Søstet et al,^[11] also demonstrated widespread hair dye use in developed urban populations. However, the substantial proportion of rural patients in the present study suggests that cosmetic hair dye use has become increasingly common irrespective of residence. Housewives constituted the largest occupational group (42.3%), followed by office-goers (29.6%), indicating that domestic cosmetic use rather than occupational exposure accounted for most cases. In contrast, Hassan et al,^[20] studied 100 hairdressers and beauticians and reported dermatoses in 54% of workers, with hand eczema being the commonest manifestation and PPD identified as the principal allergen. Similarly, Uter et al,^[21] reported that hairdressers have a 5.4-fold higher risk of developing PPD allergy than the general population. These findings suggest that while occupational exposure carries a higher individual risk, cosmetic exposure among the general population contributes substantially to the overall burden of disease. Localized contact dermatitis involving the scalp and scalp margins was the commonest clinical presentation (42.3%), followed by facial and neck involvement (19.7%). Gupta et al,^[7] similarly reported scalp involvement in 90.7% and facial or neck dermatitis in 42.6% of PPD-positive patients. Han et al,^[19] also found that the face and scalp were the most frequently affected sites and that disease extent increased with repeated exposure. These findings are expected because these anatomical sites

come into direct contact with hair dye during application. Pruritus was the most common symptom following hair dye use, occurring in 60.6% of participants, while acute, chronic, and subacute lesions were observed in 29.6%, 28.2%, and 25.4% of participants, respectively. Gupta et al,^[7] and Han et al,^[19] likewise reported pruritus and eczematous dermatitis as the predominant clinical manifestations. The high proportion of symptomatic patients in the present study reflects the hospital-based nature of the study population. The morphology of skin lesions was highly variable, with hyperpigmented or scaly plaques (15.5%) being the most frequent presentation, followed by skin-coloured papules and hyperpigmented macules. Kim et al in a multicenter study of 1,033 patients with pigmented contact dermatitis, demonstrated that hair dye use significantly increased the risk of pigmentary dermatitis (adjusted OR 2.74), while henna use further increased the risk (adjusted OR 7.02). Bishnoi et al,^[22] also highlighted pigmentary changes as an important manifestation of chronic hair dye allergy, particularly in Asian populations. The spectrum of lesions observed in our study is therefore consistent with previous reports describing both inflammatory and pigmentary presentations of hair dye dermatitis.

Patch testing showed positive reactions in 52.1% of participants. PPD was the most common allergen, with positivity increasing from 32.8% at 48 hours to 38.8% at 72 hours, emphasizing the importance of delayed readings in detecting type IV hypersensitivity reactions. Similar findings were reported by Handa et al,^[18] who observed a progressive increase in PPD sensitization over a decade, and Gupta et al,^[7] who reported positive PPD patch tests in 67.5% of patients. Han et al,^[19] also confirmed PPD as the predominant allergen in patients with hair dye contact allergy. Besides PPD, Parthenium, Neomycin sulfate, Nickel sulfate, and Fragrance mix were commonly identified allergens in our study, suggesting frequent co-sensitization. Alajaji et al,^[23] similarly reported PPD, fragrances, persulfates, and ammonium thioglycolate as the principal allergens associated with hair dye exposure, while Tsimpidakis et al,^[24] emphasized the importance of cross-reactivity among aromatic amines in sensitized individuals. Overall, dermatitis was present in 83.1% of hair dye users in the present study, indicating a substantial burden of hair dye-associated skin disease among patients attending dermatology services. Hassan et al,^[20] reported that more than half of occupationally exposed hairdressers developed at least one skin disorder, whereas Søstet et al,^[11] found allergic skin reactions in only 5.3% of hair dye users in the general population. The considerably higher incidence observed in our study is expected because participants were recruited from a dermatology clinic with suspected hair dye-related dermatitis. The findings of the present study confirm that hair dye dermatitis is predominantly associated with

repeated exposure to PPD-containing permanent hair dyes. Early recognition of symptoms, appropriate patch testing, identification of causative allergens, and patient education regarding safer alternatives remain essential for preventing recurrent disease and minimizing long-term morbidity associated with hair dye use.

CONCLUSION

Hair dye-associated dermatitis was frequently observed among adult hair dye users, particularly in middle-aged individuals with repeated exposure. Localized scalp dermatitis and pruritus were the most common clinical manifestations, and para-phenylenediamine (PPD) emerged as the predominant allergen on patch testing. Early recognition, appropriate patch testing, and patient education regarding safe hair dye practices are essential for preventing recurrent dermatitis and reducing disease burden.

Limitations of the Study: This was a single-center, hospital-based study with a relatively small sample size. The observational design did not permit assessment of long-term outcomes or causal relationships. Patch testing was limited to the Indian Standard Series and may not have identified all hair dye allergens. Additionally, hair dye usage history was based on patient recall, introducing the possibility of recall bias.

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