

# Occupational contact dermatitis in hairdressers: an analysis of patch test data from the Danish Contact Dermatitis Group, 2002–2011

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## Summary

**Background.** Occupational contact dermatitis among hairdressers is frequent, owing to daily exposure to irritants and allergens.

**Objectives.** To identify sensitization to the most common allergens associated with the occupation of hairdressing.

**Methods.** Patch test results of 399 hairdressers and 1995 matched controls with contact dermatitis, registered by the Danish Contact Dermatitis Group between January 2002 and December 2011, were analysed. All patients were patch tested with the European baseline series, and hairdressers were additionally tested with the hairdressing series.

**Results.** Occupational contact dermatitis ( $p < 0.001$ ) and hand eczema ( $p < 0.001$ ) were observed significantly more often among hairdressers than among controls. Atopic dermatitis was less commonly observed among hairdressers (21.3%) than among controls (29.4%) ( $p < 0.01$ ). Allergens from the European baseline series with a statistically significant association with the occupation of hairdressing were *p*-phenylenediamine, thiuram mix, and benzocaine. Frequent sensitizers from the hairdressing series were ammonium persulfate, toluene-2,5-diamine, 3-aminophenol, and 4-aminophenol. Cysteamine hydrochloride and chloroacetamide emerged as new sensitizers.

**Conclusions.** These results indicate a healthy worker effect among hairdressers diagnosed with eczema. Ammonium persulfate and *p*-phenylenediamine remain frequent sensitizers in hairdressers with contact dermatitis. Cysteamine hydrochloride and chloroacetamide should be included in future surveillance studies.

**Key words:** allergic contact dermatitis; ammonium persulfate; atopic dermatitis; chloroacetamide; cysteamine hydrochloride; hairdressers; healthy worker effect; occupational contact dermatitis; *p*-phenylenediamine.

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Occupational contact dermatitis is the most commonly recognized occupational disease in Denmark (1). A recent article from Gentofte University Hospital found an incidence rate of 96.8 cases of occupational contact dermatitis per 10 000 workers per year among female hairdressers in the Capital Region of Denmark (2). This is in line with other European studies (3–5). Hairdressers are mainly affected at a relatively young age, at the beginning of their careers (3, 4, 6). The occupation of

hairdressing involves excessive exposure to wet work and skin contact with numerous allergens, but the use of protective gloves is inconsistent (7). Job loss and career changes owing to contact dermatitis are often observed among hairdressers (6). In Denmark, the average time spent in the profession of hairdressing is 8.4 years (6). The aim of this study was to identify the most common allergens associated with the occupation of hairdressing on the basis of patch test results for hairdressers registered by the Danish Contact Dermatitis Group in a 10-year period.

## Materials and methods

The study population comprised 399 consecutively registered cases of contact dermatitis among hairdressers, registered in the National Database for Contact Allergy by the Danish Contact Dermatitis Group between January 2002 and December 2011. The Danish Contact Dermatitis Group is a network consisting of nine dermatologists in private practice and three hospital dermatology departments in Denmark. All participants followed uniform guidelines (8).

The hairdressers were extracted from the database by means of occupational classification. Hairdressers are coded 51411 according to the Danish version of the International Classification of Occupation ('Disco'). The hairdressers were matched to a control group in a 1:5 case-control match. Each hairdresser was matched with 5 other patients with eczema, that is, controls, who were not registered as hairdressers in the database. Matching criteria were sex, age, and test year.

Information available from the database included MOAHLFA (Male, Occupational dermatitis, Atopic dermatitis, Hand eczema, Leg dermatitis, Face dermatitis, Age > 40 years) index, age, and patch test results. All hairdressers and controls included in this analysis were patch tested with the European baseline series. Allergens of potential relevance in relation to occupational exposures in hairdressers, that is, dyes, fragrances, and preservatives, were selected for comparison between hairdressers and controls. In addition, hairdressers were tested with the hairdressing series. Allergens in the hairdressing series varied among the centres, as did suppliers of test materials. Patch tests were applied to the upper back. The occlusion time was 48 hr, and readings were performed at least once on days 3 and 4 and often also on days 2 and 7, in accordance with the recommendations of the International Contact Dermatitis Research Group (9). Reactions of strength 1+, 2+ and 3+ were interpreted as positive responses. Irritant reactions, doubtful reactions and negative reactions were interpreted as negative responses.

In cases of re-testing, only patch test data obtained at the first visit were used in the analysis.

## Statistical Methods

All data analyses were performed with the statistical software spss™ version 19.0. The  $\chi^2$ -test was applied for the analyses of the MOAHLFA index. Associations between occupation and sensitization to allergens from the European baseline series were expressed as odds ratios (ORs) with 95% confidence intervals (CIs). Asymptomatic CIs for the patch test results of allergens selected from the hairdressing series were calculated according to standard theory. All *p*-values are two-sided, and 0.05 was chosen for statistical significance.

## Results

A total of 399 hairdressers (17 males and 382 females), patch tested between 2002 and 2011, were included in the analysis. In accordance with the 1:5 case-control matches, 1995 controls (85 males and 1910 females) were included.

At the time of patch testing, the youngest hairdresser was aged 16 years and the oldest was aged 79 years; the mean age was 30.8 years (95% CI 29.6–32.0).

The findings of the MOAHLFA index are shown in Table 1. Among hairdressers, contact dermatitis more often had occupational relevance ( $p < 0.001$ ), and included the hands ( $p < 0.001$ ). Hairdressers less often had dermatitis in the face ( $p < 0.001$ ) and on the legs ( $p < 0.02$ ). Atopic dermatitis was less commonly seen among hairdressers (21.3%) than among controls (29.4%) ( $p < 0.01$ ).

Positive patch test reactions in hairdressers and controls regarding the selected allergens in the European baseline series are shown in Table 2. Allergens in the European baseline series that are significantly associated with

**Table 1.** The distribution of the MOAHLFA index of total cases of contact dermatitis in hairdressers and controls

	Hairdressers (n = 399), % (n)	Controls (1995)	<i>p</i> -value*
Male	4.3 (17)	4.3 (85)	1.00
Occupation	56.9 (227)	12.5 (250)	<0.001
Atopic dermatitis	21.3 (85)	29.4 (586)	<0.01
Hand dermatitis	69.4 (277)	40.9 (815)	<0.001
Leg dermatitis	0.8 (3)	2.8 (55)	<0.02
Face dermatitis	11.5 (46)	19.5 (389)	<0.001
Age >40 years	21.3 (85)	21.2 (423)	1.00

\*Chi-square-sign-test.

**Table 2.** Positive patch test reactions in hairdressers and controls to allergens included in the European baseline series

	Positive test reactions		
	Hairdressers % (n/total tested)	Controls % (n/total tested)	Crude odds ratio (95% confidence interval)
Nickel sulfate	21.4 (85/398)	20.2 (400/1980)	1.073 (0.824–1.396)
<i>p</i> -Phenylenediamine	9.0 (36/399)	1.2 (24/1993)	9.855 (5.640–17.219)
Cobalt chloride	4.5 (18/399)	6.1 (121/1992)	0.731 (0.440–1.213)
Fragrance mix	4.5 (18/399)	6.4 (128/1991)	0.688 (0.415–1.140)
Thiuram mix	2.5 (10/399)	1.2 (24/1993)	2.109 (1.001–4.446)
Hydroxyisohexyl-3-cyclohexene carboxaldehyde	2.0 (8/398)	2.8 (56/1913)	0.701 (0.331–1.482)
Methylchloroisothiazolinone/methylisothiazolinone	1.8 (7/399)	1.2 (24/1993)	0.415 (0.054–3.199)
Methyldibromo glutaronitrile	1.5 (6/390)	1.8 (34/1858)	0.825 (0.344–1.979)
Formaldehyde	1.5 (6/399)	2.2 (44/1993)	0.676 (0.286–1.598)
Colophonium	1.5 (6/399)	3.1 (62/1992)	0.475 (0.204–1.106)
Benzocaine	1.3 (4/318)	0.2 (3/1526)	6.467 (1.440–29.038)
Lanolin alcohol	1.3 (5/399)	0.8 (16/1993)	1.568 (0.571–4.305)
Quaternium-15	1.0 (4/399)	0.9 (18/1993)	1.111 (0.374–3.301)
<i>Myroxylon pereirae</i>	0.8 (3/399)	3.0 (60/1993)	0.244 (0.076–0.782)
<i>N</i> -isopropyl- <i>N</i> -phenyl- <i>p</i> -phenylenediamine	0.6 (2/319)	0.3 (4/1581)	2.487 (0.454–13.683)
Mercapto mix	0.3 (1/399)	0.6 (12/1993)	0.415 (0.054–3.199)
Mercaptobenzothiazole	0.3 (1/399)	0.6 (12/1993)	0.415 (0.054–3.199)
Paraben mix	0.0 (0/399)	0.3 (6/1993)	–

the occupation of hairdressing were *p*-phenylenediamine (PPD) (OR 9.855; 95% CI 5.640–17.219), thiuram mix (OR 2.109; 95% CI 1.001–4.446), and benzocaine (OR 6.467; 95% CI 1.440–29.038). Sensitization to allergens included in the hairdressing series is shown in Table 3. The most frequently positive allergens of occupational relevance to hairdressing were ammonium persulfate (10.8%; 95% CI 7.8–13.9), cysteamine hydrochloride (8.3%; 95% CI 0.0–24.0), toluene-2,5-diamine sulfate (4.5%; 95% CI 2.1–7.0), chloroacetamide (1.7%; 95% CI 0.2–3.1), 3-aminophenol (1.7%; 95% CI 0.3–3.0), 4-aminophenol (1.4%; 95% CI 0.2–2.6), and glycerol monothioglycolate (1.0%; 95% CI 0.0–2.0).

Only 12 hairdressers were tested with cysteamine hydrochloride; 1 patient had a positive 1+ reaction to it. All patients were tested at the same major centre within three different time periods: January 2002 (1 patient), June 2002 (3 patients), and September 2011 to December 2011 (8 patients). The positive patch test result for cysteamine hydrochloride was found within the time period September 2011 to December 2011. No information is available on whether the testing was a result of targeting testing. No significant differences were found between hairdressers tested with cysteamine hydrochloride and those not tested with cysteamine hydrochloride concerning mean age or the MOAHLFA index findings.

Chloroacetamide was usually included in the hairdressing series, particularly in the major centres; a few small centres (dermatologists in private practice) did not patch test hairdressers with chloroacetamide.

**Table 3.** Patch test reactions with regard to allergens selected from the hairdressing series that the hairdressers were tested with

	Positive test reactions, % (n)	95% CI*
Ammonium persulfate	10.8 (43/397)	7.8–13.9
Cysteamine hydrochloride	8.3 (1/12)	0.0–24.0
Toluene-2,5-diamine	4.5 (13/287)	2.1–7.0
Chloroacetamide	1.7 (5/302)	0.2–3.1
3-Aminophenol	1.7 (6/362)	0.3–3.0
4-Aminophenol	1.4 (5/365)	0.2–2.6
Hydroquinone	1.4 (4/284)	0–2.8
2-Nitro-4-phenylenediamine	1.1 (3/281)	0–2.3
Glycerol monothioglycolate	1.0 (4/384)	0–2.0
4-Chloro-3,5-xyleneol	0.4 (1/283)	0–1.0
Resorcinol	0.4 (1/283)	0–1.0
Cocamidopropyl betaine	0.3 (1/287)	0.3–1.0
4-Chloro-3-cresol	0.3 (1/301)	0–1.0
Ammonium thioglycolate	0.3 (1/371)	0–0.8
2-Bromo-2-nitropropane-1,3-diol	0.3 (1/341)	0–0.9
Imidazolidinyl urea	0.3 (1/383)	0–0.8
Zinc pyrithione	0.0 (0/286)	–
Diazolidinyl urea	0.0 (0/383)	–

CI, confidence interval.

\*The negative lower confidence limit was set to 0.

## Discussion

The present analysis is based on data registered in the National Database for Contact Allergy by the Danish Contact Dermatitis Group over a 10-year period.

Hairdressing is a high-risk occupation for the development of hand eczema, owing to excessive skin exposure to allergens and irritants (2–4, 10). Hand

eczema affects female hairdressers at a relatively young age. In this analysis, the hairdressers were patch tested at a mean age of 30.8 years (95% CI 29.6–32.0), which is at a lower age than patients in other occupations. Our data correlate with previous findings (3, 4, 11, 12). Moreover, the hairdressers often develop hand eczema with occupational relevance as compared with the control group. Previous studies have reported high incidence rates for the development of occupational contact dermatitis among hairdressers as compared with other occupational groups in both Denmark and Germany (2, 3).

The hairdressers were diagnosed with atopic dermatitis (21.3%) significantly less often than the matched control group (29.4%). This finding is in accordance with a study that showed a healthy worker effect among Danish hairdressing apprentices (13). The hairdressing apprentices had atopic dermatitis less often than a matched control group, indicating that hairdressing apprentices were healthier than the controls with regard to skin diseases when entering the trade (13). To our knowledge, this is the first study demonstrating a healthy worker effect among educated hairdressers diagnosed with eczema. This new finding further substantiates the important debate concerning patients with atopic dermatitis and high-risk occupations such as hairdressing. Career guidance for individuals with atopic dermatitis, carried out by general practitioners, dermatologists and healthcare professionals in primary schools, should have a key role in preventing eczema in those employed in occupations with a high risk of developing eczema.

The hair dyes PPD, toluene-2,5-diamine, 3-aminophenol and 4-aminophenol emerged as important sensitizers. These allergens have previously been reported as sensitizers among hairdressers (10–12, 14). Our data show that 9.0% of hairdressers had contact allergy to PPD with a strong association with the occupation of hairdressing (OR 9.855; 95% CI 5.640–17.219). These findings clearly suggest that there is still a problem with sensitization to PPD. Previous studies have reported similar results (10–12, 14). Contact allergy to toluene-2,5-diamine was found in 4.5% (95% CI 2.1–7.0) of the hairdressers in this analysis, which is in line with other studies (10, 14).

Sensitization to benzocaine was found in 1.3% of the hairdressers as compared with 0.2% of controls. This is probably attributable to the known cross-reactivity between benzocaine and para-amino compounds such as PPD (15).

The rate of sensitization to bleach products was high for hairdressers. Sensitization to ammonium persulfate was found in 10.8% (95% CI 7.8–13.9) of the hairdressers,

and ammonium persulfate was among the most common sensitizers for hairdressers. In Europe and Australia, the prevalence of sensitization to ammonium persulfate has been reported to be between 8% and 21.7% (10, 14, 16, 17). Despite a focus on the rising trend of sensitization to ammonium persulfate, little is being done to prevent it.

Chloroacetamide, a preservative used in cosmetic products, is a known skin sensitizer for hairdressers (18, 19). Even though chloroacetamide has been found to cause allergic contact dermatitis among hairdressers (19), it is often neglected in epidemiological surveillance studies for allergic contact dermatitis and in studies based on clinical databases (12, 14, 20). This analysis found a sensitization prevalence of 1.7% (95% CI 0.2–3.1). Therefore, we recommend patch testing all hairdressers with eczema with chloroacetamide, as it is of importance to have national and international surveillance schemes concerning chloroacetamide.

In this analysis, glycerol monothioglycolate, which is used in permanent wave solutions, more often led to sensitization than ammonium monothioglycolate. This correlates with previous findings (10, 14, 16). In our analysis, the sensitization prevalence of glycerol monothioglycolate was 1.0% (95% CI 0–2.0), which is lower rate than found in other studies (10, 14). It is noteworthy that, in Denmark, no regional agreement or restriction of glycerol monothioglycolate by legislation exists. The low level of sensitization to glycerol monothioglycolate in Denmark may be a spin-off effect of the regional agreement restricting glycerol monothioglycolate in Germany (20, 21). Our data suggest that restricting the use of glycerol monothioglycolate is necessary at a European level.

Cysteamine hydrochloride is used as substitute for glycerol monothioglycolate. This analysis found a sensitization prevalence of 8.3% (95% CI 0–24.0). Even though only one positive 1+ patch test reaction to cysteamine hydrochloride was found among 12 hairdressers tested, we recommend further surveillance and patch testing with cysteamine hydrochloride of all hairdressers with eczema.

Thiuram mix is significantly associated with the occupation of hairdressing, as 2.5% of hairdressers had been sensitized to the allergen as compared with 1.2% of controls (OR 2.109; 95% CI 1.001–4.446). The extended use of protective gloves when hair is being washed, coloured, bleached and permed is considered to be the major cause of this contact allergy. Sensitization to thiuram mix among hairdressers is a known problem (10, 14). A solution to this problem could be the use of accelerator-free gloves.



The prevalence of sensitization to fragrances was relatively high among both hairdressers and controls, and no significant differences were found. The reason may be that a high degree of exposure to these substances is expected also outside the hairdressing trade, either through the personal use of cosmetics or in occupational settings, where preservatives are used extensively. It may also be that the strong sensitization potential of hair dyes overrides the effect of fragrances, for which longer exposure periods may be required for the development of sensitization. Once sensitized to hair dyes, hairdressers would often have to leave the trade, and those left in the profession may be less susceptible to sensitization or protect themselves better; that is, there may be a healthy worker effect.

In conclusion, the results of this analysis show an increased risk for hairdressers of developing occupation-

ally relevant hand eczema. This is, to our knowledge, the first study demonstrating a healthy worker effect among educated hairdressers diagnosed with eczema, and career guidance among individuals with atopic dermatitis have a high priority in the future.

As a new recommendation, we suggest that all hairdressers with eczema should be patch tested with cysteamine hydrochloride and chloroacetamide. Ammonium persulfate and PPD are still emerging as frequent sensitizers in hairdressers with contact dermatitis. Although a focus on occupational contact dermatitis among hairdressers in recent years has had high priority, it is still important to have surveillance schemes to follow the trends of sensitization and document the effects of intervention.

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