

Deodorants are the leading cause of allergic contact dermatitis to fragrance ingredients*

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Summary

Background. Fragrances frequently cause contact allergy, and cosmetic products are the main causes of fragrance contact allergy. As the various products have distinctive forms of application and composition of ingredients, some product groups are potentially more likely to play a part in allergic reactions than others.

Aim. To determine which cosmetic product groups cause fragrance allergy among Danish eczema patients.

Method. This was a retrospective study based on data collected by members of the Danish Contact Dermatitis Group. Participants ($N = 17\,716$) were consecutively patch tested with fragrance markers from the European baseline series (2005–2009).

Results. Of the participants, 10.1% had fragrance allergy, of which 42.1% was caused by a cosmetic product: deodorants accounted for 25%, and scented lotions 24.4%. A sex difference was apparent, as deodorants were significantly more likely to be listed as the cause of fragrance allergy in men (odds ratio 2.2) than in women. Correlation was observed between deodorants listed as the cause of allergy and allergy detected with fragrance mix II (FM II) and hydroxyisohexyl 3-cyclohexene carboxaldehyde.

Conclusion. Deodorants were the leading causes of fragrance allergy, especially among men. Seemingly, deodorants have an 'unhealthy' composition of the fragrance chemicals present in FM II.

Key words: allergic contact dermatitis; clinically relevant patch tests; cosmetics; deodorants; fragrance.

Cosmetic products cover wide range of different consumer products, and almost everyone has daily contact with a

cosmetic product. The EU Directive gives the following definition: 'A cosmetic product is any substance or preparation intended to be placed in contact with the various external parts of the human body or with the teeth and the mucous membranes of the oral cavity, with a view exclusively or mainly to cleaning them, perfuming them, changing their appearance, and/or correcting body odours, and/or protecting them or keeping them in good condition' (1).

Several aspects contribute to a cosmetic product's ability to cause fragrance allergy (2). Foremost, a product must contain sensitizing fragrance ingredients.

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Sensitization can occur after a single significant exposure or after multiple exposures (2, 3), and once sensitization has occurred, a lower dose can cause an elicitation response (4). In our study, we use the term fragrance allergy synonymously with allergic contact dermatitis.

A wide range of fragrance ingredients exists, approximately 2500 different substances (5); many are known to be sensitizers in humans and are used in cosmetic products (6–8).

The individual fragrance ingredients are used in various combinations, and some cosmetic products contain hundreds of individual fragrance ingredients (9). Other principal factors contributing to a product's ability to cause allergy are related to its composition and intended use conditions. For example, the following may all play a role in a cosmetic product's ability to elicit fragrance allergic contact dermatitis: the nature of fragrance ingredients, as some may have synergistic effects (10); the concentration and potency of the allergenic fragrance ingredients; the application site; the frequency of application; the duration of exposure; and the user's skin barrier function (2, 11–13).

The purpose of this study was to determine the distribution of cosmetic product groups listed as the cause of fragrance allergic contact dermatitis among Danish eczema patients. Furthermore, our aim was to investigate sex differences and to evaluate whether there was an association between the cosmetic product listed as having caused a fragrance allergy and the different fragrance markers detecting an allergy.

Materials

Data were retrieved from a clinical database containing patch test results, patient characteristics, and exposure sources. All patients were examined by members of the Danish Contact Dermatitis Group (DCDG). During the study period (January 2005 to June 2009) the DCDG comprised three dermatology departments (university hospitals in Gentofte, Odense, and Århus) and seven dermatology clinics (Rødovre, Aalborg, Herning, Vejle, Bagsværd, Hørsholm, and Kalundborg). All patients had been patch tested with fragrance markers included in the baseline series: fragrance mix I (FM I), fragrance mix II (FM II), hydroxyisohexyl 3-cyclohexene carboxaldehyde (HICC) 5%, and *Myroxylon pereirae*/balsam of Peru 25% in petrolatum. FM I contains eight individual fragrance compounds: 1% cinnamal, 1% cinnamyl alcohol, 1% geraniol, 1% isoeugenol, 1% eugenol, 1% hydroxycitronellal, 1% *Evernia prunastri* (oak moss absolute), 1% α -amyl cinnamal and an emulsifier 5% sorbitan sesquioleate. FM II is composed of six different

fragrances: 2.5% HICC, 1% citral, 2.5% farnesol, 2.5% coumarin, 0.5% citronellol and 5% α -hexyl cinnamal in pet.

A total of 17 716 subjects were consecutively patch tested: 11 610 women and 6106 men. The mean age was 44 years (standard deviation 18.3). Table 1 shows the study participants' demographic characteristics.

Relevant exposure sources causing a positive patch test reaction are registered in the database. The exposure sources are categorized as either 'leave-on' or 'rinse-off' products (Table 2) and further into specific cosmetic product groups (Table 3). If a cosmetic product could not be specified because it was unknown or did not fit any of the predetermined categories, it was registered as 'unspecified leave-on' or 'unspecified rinse-off'. Patients could have more than one specific cosmetic product recorded.

Methods

The patients included had been patch tested with at least one of the fragrance markers from the European baseline series (FM I, FM II, *M. pereirae* and HICC). The

Table 1. MOAHLFA index of consecutively patch tested eczema patients and patients with a fragrance allergy caused by a cosmetic product

Index	Tested subjects		Cosmetic fragrance allergy	
	No.	%	No.	%
M	6106	34.5	190*	25.2
O	2067	11.7	97	12.9
A	3115	17.6	137	18.2
H	6625	37.4	272	36.1
L	815	4.6	23*	3.1
F	3370	19.0	248*	32.9
AA	10465	59.1	488*	64.8
Total	17716	100	753	100

MOAHLFA index: M, male; O, occupational cause of dermatitis; A, atopy; H, hand dermatitis; L, leg dermatitis; F, facial dermatitis; and AA $\geq$ 40 years.

* χ^2 -test, $p < 0.05$.

Table 2. Leave-on or rinse-off cosmetic products listed as the exposure causing fragrance allergy

	Leave-on		Rinse-off		All No.
	No.	%	No.	%	
Women	556	75.9	176	24.1	732
Men	162	69.2	72	30.8	234
Total	718	74.3	248	25.7	966

Table 3. The cosmetic product groups listed as having caused fragrance allergic contact dermatitis

Cosmetic product categories	Men and women	Women		Men	
	n	n	%	n	%
Unspecified stay-on products	286	224	29.8	62	26.1
Deodorant	146	91	12.4	55	23.5
Scented lotion	142	123	16.8	19	8.1
Unspecified rinse-off products	104	77	10.5	27	11.5
Fine fragrances	93	85	11.6	8	3.4
Shampoo	76	57	7.8	19	8.1
Liquid soap	63	41	5.6	22	9.4
Aftershave	16	2	0.3	14	6.0
Lipstick	11	9	1.2	2	0.9
Sun lotion	6	5	0.7	1	0.4
Hairstyling product	6	5	0.7	1	0.4
Shaving foam	5	1	0.1	4	1.7
Mascara	4	4	0.5	0	0.0
Hair dye	4	4	0.5	0	0.0
Eyeshadow	2	2	0.3	0	0.0
Makeup cream	2	2	0.3	0	0.0
Sum of cosmetic product within each category listed as the cause of fragrance allergic contact dermatitis	966	732		234	

patch tests were performed according to international guidelines (14) with Finn Chambers® (8 mm; Epitest Ltd Oy, Tuusula, Finland) applied on the back with Scanpor tape® (Norgesplaster A/S, Alfarma, As, Norway) and kept in place for 2 days. Readings were performed on day 2, 3 or 4, and on day 7, according to the recommendations of the International Contact Dermatitis Research Group (15).

Data administration and statistical analysis were performed using SPSS version 15 and OPENEpi (www.openepi.com). Percentages of the cosmetic product groups listed as causing a positive patch test reaction to a fragrance marker were calculated. χ^2 -tests for characteristic differences were performed, and $p < 0.05$ was considered to be significant.

Results

Fragrance contact allergy to one or more of the fragrance markers was found in 1790 (10.1%) of the participants. Cosmetic products were the cause of fragrance allergic contact dermatitis in 753, comprising 42.1% of those with fragrance allergy, or 4.3% of the subjects consecutively examined for contact allergy. Some patients had more than one cosmetic product listed as causing their allergy; 966 product groups were listed. The majority of cosmetic products listed were 'leave-on' products (74.3%) rather than 'rinse-off' products (25.7%).

In general, many different cosmetic product categories were listed as causing fragrance allergic contact dermatitis (Table 3); 576 products had been listed as belonging to specific product categories. The commonest sources of allergic contact dermatitis were deodorants (25.3%), scented lotions (24.4%), fine fragrances (16.0%), shampoos (13.0%), liquid soaps (10.8%), aftershaves (2.7%), lipsticks (1.9%) and the remaining categories had frequencies of 1% or less (Fig. 1).

A sex difference was apparent in the distribution of cosmetic products listed as causing fragrance allergic contact dermatitis (Fig. 2). Deodorants, in particular, played a large role in men, accounting for 37.9% of the 145 products listed as causing fragrance allergic contact dermatitis among men, which was highly significant ($p < 0.001$). Scented lotions and fine fragrances played the largest role in women, accounting for 28.5% and 19.7%, respectively, of the products listed ($n = 436$) and the sex difference was highly significant ($p < 0.001$). No sex difference was observed in the reporting of shampoo as the cause of fragrance allergic contact dermatitis.

Figure 3 shows the role of the four most common products listed as having caused a positive patch test reaction to the different screening markers of the baseline series. There was a significant correlation between products listed as having caused allergy and the different markers (χ^2 -test, $p < 0.001$). FM II and HICC were overrepresented in deodorants. Scented lotion

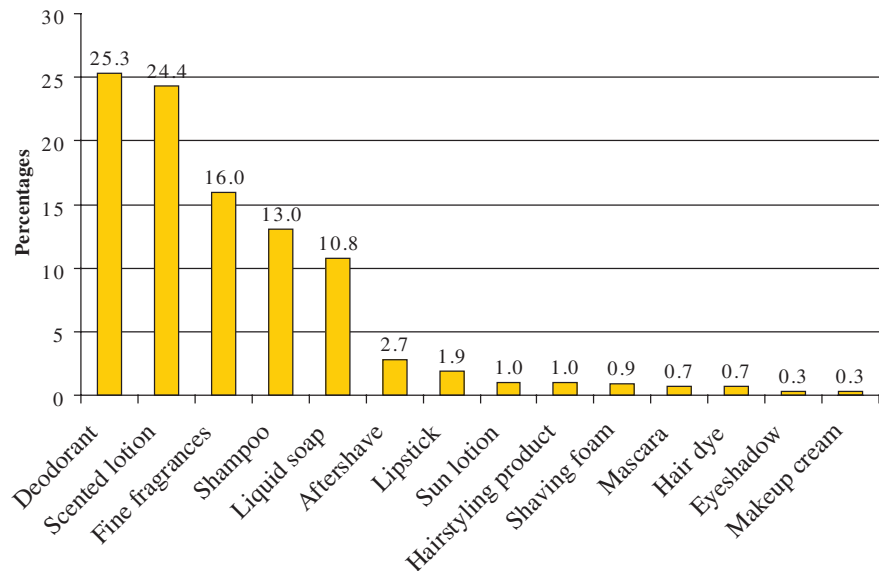


Fig. 1. Prevalence of specific cosmetic product groups listed as having caused fragrance allergy. The total number of specific products listed was 576.

and shampoo were more likely to be associated with fragrance allergic contact dermatitis detected by FM I and *M. pereirae*.

Among all the deodorants listed ($n = 213$) as having caused fragrance allergic contact dermatitis, an FM II allergy (34.3%) was more likely than an FM I (28.2%), HICC (24.9%) or *M. pereirae* (12.7%) allergy (Table 4).

Discussion

Adverse skin reactions caused by cosmetics are an increasing problem in the population of Denmark (16). The most frequent causes of cosmetic allergy have been shown to be fragrances (7, 11, 17, 18). Many different cosmetic product groups can cause allergic contact dermatitis; according to our study, it appears

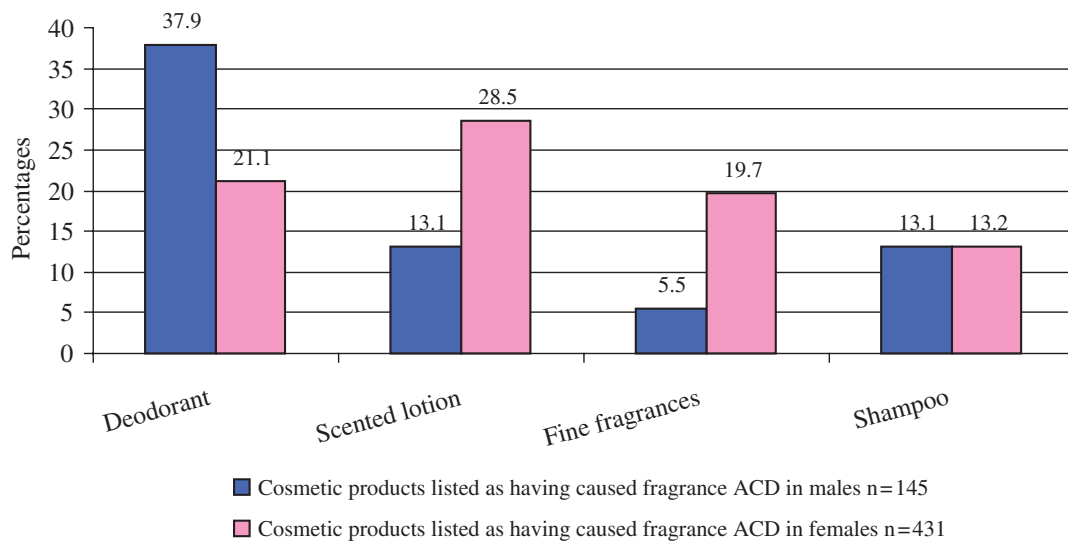


Fig. 2. Sex distribution of the four most frequent cosmetic products listed as having caused fragrance allergic contact dermatitis (ACD). A statistical sex difference in deodorants listed as the cause of fragrance allergy was observed ($p < 0.001$). The odds ratio for a deodorant listed as the cause of fragrance allergy in men versus women was 2.3 [confidence interval (CI) 1.5–3.5]. Likewise, a statistical sex difference was seen for scented lotion and fine fragrances as the cause of fragrance allergic contact dermatitis ($p < 0.001$). They were more frequent among women: the odds ratio for a cream with a scent was 2.6 (CI 1.6–4.5), and the odds ratio for a fine fragrance was 4.2 (CI 2.0–9.4). No sex difference was observed for shampoo listed as the cause of fragrance allergic contact dermatitis.

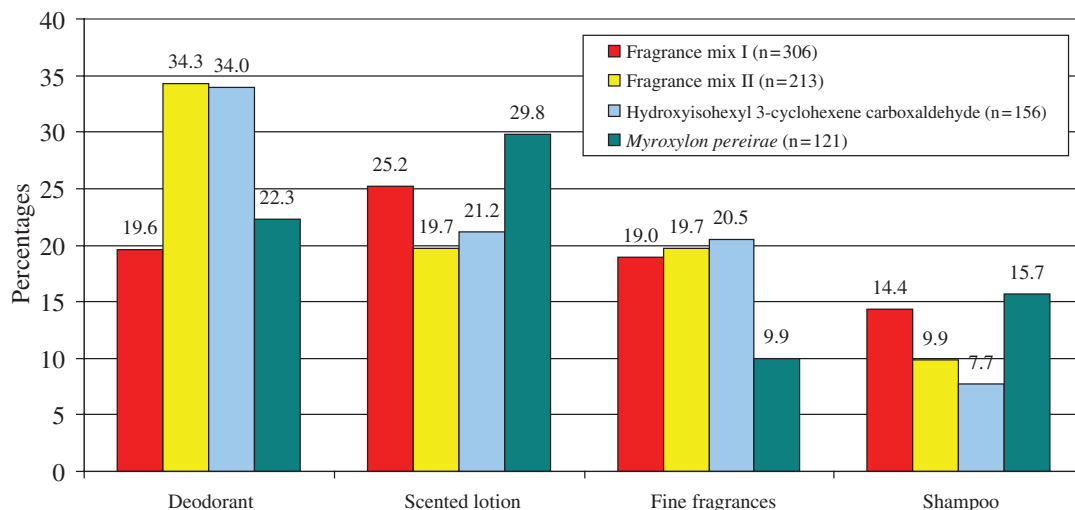


Fig. 3. The prevalence of each of the four most frequent cosmetic products responsible for fragrance allergy detected by different fragrance markers of the baseline series.

that the use of deodorants is especially associated with an increased risk of fragrance allergic contact dermatitis. We found deodorants listed as the leading causes of fragrance allergic contact dermatitis among eczema patients. Likewise, a study of the general population in Denmark reported deodorants as the leading causes of allergic and irritant contact dermatitis (16).

Deodorants are also related to first-time symptoms of fragrance allergy. A study of 925 eczema patients and a control group of 806 persons, randomly selected

from the population, reported a statistically significant correlation between development of a rash resulting from a scented deodorant as a first-time symptom (odds ratio: 2.3–2.9) and a later diagnosis of fragrance allergy (19). In a German study (20), eczema patients were patch tested with their own deodorants; 501 deodorants were tested, and 6.2% caused allergic reactions.

The sex difference in the use of cosmetic products is obvious, and a difference was expected with regard to

Table 4. The distribution of cosmetic product groups according to the fragrance screening markers that had a positive and clinically relevant patch test reaction (positive +, ++, +++)

Product	n	Fragrance screening markers of the baseline series							
		Fragrance mix I		Fragrance mix II		Hydroxyisohexyl 3-cyclohexene carboxaldehyde		Myroxylon pereirae	
		n	%	n	%	n	%	n	%
Deodorant	213	60	28.2	73	34.3	53	24.9	27	12.7
Scented lotion	188	77	41.0	42	22.3	33	17.6	36	19.1
Fine fragrances	144	58	40.3	42	29.2	32	22.2	12	8.3
Shampoo	96	44	45.8	21	21.9	12	12.5	19	19.8
Liquid soap	84	37	44.0	17	20.2	16	19.0	14	16.7
Aftershave	23	9	39.1	6	26.1	3	13.0	5	21.7
Lipstick	12	4	33.3	5	41.7	0	0.0	3	25.0
Sun lotion	10	4	40.0	2	20.0	3	30.0	1	10.0
Hairstyling product	6	3	50.0	2	33.3	1	16.7	0	0.0
Shaving foam	6	4	66.7	1	16.7	0	0.0	1	16.7
Mascara	4	2	50.0	0	0.0	1	25.0	1	25.0
Hair dye	4	3	75.0	0	0.0	0	0.0	1	25.0
Eyeshadow	5	2	40.0	1	20.0	1	20.0	1	20.0
Makeup cream	3	1	33.3	1	33.3	1	33.3	0	0.0

A cosmetic product could be listed as the cause of allergic contact dermatitis resulting from more than one fragrance marker.

which products were reported as having caused fragrance allergic contact dermatitis. Deodorants were significantly more likely to be listed as the cause of fragrance allergic contact dermatitis in men than in women (odds ratio 2.3), whereas women were significantly more likely to report a scented lotion or a fine fragrance as the cause of fragrance allergic contact dermatitis.

Many factors may explain why deodorants in particular are associated with a high risk of developing a fragrance allergic contact dermatitis. The environment in the axillae is moist and occluded, and this, in combination with the presence of hair follicles, can increase the penetration of certain allergens (21, 22). Shaving also increases penetration, and thus the risk of contact allergy (23). In a case study, 14 fragrance-allergic patients were asked to use one of their own deodorants in both the axillae and on the upper arm for 1 week. Twenty deodorants were tested; 12 of these (60%) caused eczema in the axillae, whereas only four (20%) caused eczema on the upper arm. The deodorants that caused eczema contained 1.3–8.6-fold higher concentrations of allergenic fragrance substances than those products that did not cause eczema (24). To provoke an allergic reaction, a lower concentration of a fragrance allergen is needed in the axillae than in other parts of the body. This could be explained by less fragrance evaporating than on non-occluded sites and the concentration of the fragrance substance remaining high for a longer time (25). As a lower concentration threshold is needed in the axillae to provoke an elicitation response to an allergen (22), it could be argued that a lower concentration of allergen can cause sensitization when administered in the axillae; the study on first-time symptoms previously mentioned could be an indication of this (19). Another reason why deodorants are responsible for allergic contact dermatitis caused by fragrances is that they may contain irritants that help to deliver a stronger danger signal (26), facilitating the sensitization response (27) to an allergen and the elicitation response (28, 29).

The differences in formulation of deodorants (aerosol sprays, roll-ons, and sticks) also seem to play a role in the

bioavailability of allergenic fragrance substances. One small study investigated a deodorant spray and a deostick with the same concentrations of allergenic fragrance substances tested in the antecubital of 7 fragrance allergic patients. Five of these subjects reacted to the deodorant spray, whereas only 1 reacted to the deostick (30). The effects of using different deodorant formulations have not yet been systematically investigated.

In our study, we identified a correlation between a deodorant being listed as the cause of allergy and a relevant, positive patch test reaction to HICC or FM II. This could be explained by frequent exposure to the single-compound fragrances of FM II used in deodorants (19, 31). A UK study on the labelling of cosmetic and household products revealed that deodorants had a mean of 7.8 (3–13) different fragrance ingredients in each deodorant, and almost 30% of all products investigated ($n = 300$) contained HICC (32). Likewise, a study from Denmark reported that 50% of deodorants on the market contained HICC (31). It will be interesting to see whether HICC allergy will decrease after the recent reduction in the maximal concentration recommended by the International Fragrance Association (33).

This study confirms that deodorants play a major role in allergic contact dermatitis caused by fragrances. Deodorants seem to have an unfortunate composition of FM II fragrance ingredients, leading to allergic contact dermatitis. As deodorants are used in sensitive areas of the body, it could be argued that these sensitizing fragrance ingredients should either be avoided or used in lower concentrations in deodorants than in other types of product.

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