Prevalence of Contact Allergy to *p*-Phenylenediamine in the European General Population

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Population-based studies on contact allergy to *p*-phenylenediamine (PPD) are scarce. A cross-sectional study was performed to assess the prevalence of contact allergy to PPD and its risk factors in the general population of 5 European countries. A total of 10,425 subjects were interviewed, and a random sample (n = 2,739) was patch tested to PPD. Overall, 5,286 individuals (50.9%) reported having used hair colorants at least once in their lifetime (78% female, 20% male), and 35% had used hair colorants during the last 12 months. Hair colorant avoidance because of any skin problem during the lifetime was reported by 6%. Black henna tattoos had been used by 5.5% during their lifetime. The prevalence of PPD contact allergy was 0.8% (95% confidence interval 0.6–1.0%), with no statistically significant association with gender or hair dye use. The prevalence of PPD in black henna tattoo users was 3.2% versus 0.6% in nonusers ($P < 0.001$). A clinically relevant positive patch test reaction to PPD related to hair coloring products was found in 0.1% (95% confidence interval 0.0–0.2%). A significant association with PPD contact allergy was observed for subjects who had black henna tattoos in their lifetime, with an age- and gender-adjusted odds ratio of 9.33 (95% confidence interval 3.45–25.26, $P < 0.001$). Black henna tattoos are an important risk factor for PPD contact allergy.

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INTRODUCTION

The diagnosis of contact allergy is based on patch testing. However, a positive patch test reaction only indicates that an individual is sensitized and is not necessarily an indicator of allergic contact dermatitis. Allergic contact dermatitis occurs when exposure to an allergen exceeds the individual's threshold for elicitation.

Most studies on contact allergy are based on patch testing of consecutive eczema patients. *p*-Phenylenediamine (PPD), used as an indicator of allergy to hair coloring products, has been present in the baseline series for many years. Data on PPD allergy in this highly selected population have been extensively published (Krasteva et al., 2009; Thyssen and White, 2008; Thyssen et al., 2009), and the weighted prevalence average was found to be 4% in Europe (Thyssen and White, 2008).

Data on the prevalence of contact allergy to PPD in the general population are scarce. The data are generally derived from small studies conducted in a single country. The rates reported in those studies vary from 0% to 1.5% in Europe (Dotterud and Smith-Sivertsen, 2007; Mortz et al., 2001; Nielsen and Menné, 1992; Nielsen et al., 2001; Schäfer et al., 2001; Seidenari et al., 1990; Thyssen et al., 2009). The clinical relevance of PPD allergy to hair coloring products or black henna tattoos was not investigated in any of those studies. The objectives of this study were to obtain descriptive indicators in the European general population of the prevalence of contact allergy to PPD in users and nonusers of hair coloring products and to define the risk factors for PPD contact allergy.

RESULTS

Sociodemographic characteristics of hair colorant ever-users and nonusers

Overall 5,282 individuals (50.9%) reported that they had used hair coloring products (18.5% male, 81.4% female) at least once in their lifetime. The demographic characteristics of hair coloring products ever-users and nonusers are presented in Table 1. Other than gender distribution, the other demographic characteristics did not differ substantially between ever-users and nonusers. Similar distributions of smoking habits and body mass index were observed overall and in all countries. With regard to smoking habits and body mass index categories in strata of gender, data of hair dye users in the European Dermato-Epidemiology Network (EDEN) Study were comparable with those of the general

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Abbreviations: CI, confidence interval; EDEN, European Dermato-Epidemiology Network; IVDK, Information Network of Departments of Dermatology; OR, odds ratio; PPD, p-phenylenediamine

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Table 1. Sociodemographic characteristics of ever-users and nonusers of hair coloring products

	Total (N = 10,388)[1]			
	Not users (N = 5,100)		*Hair dye users (N = 5,282)*	
	N	%	N	%
Gender				
Men	3,887	76.2	980	18.5
Women	1,213	23.8	4,302	81.4
Age, y				
18–30	1,394	27.3	1,609	30.4
31–45	1,355	26.6	1,500	28.4
46–60	1,222	24.0	1,412	26.7
61–74	1,128	22.1	760	14.4
Marital status				
Married	3,041	59.6	2,591	49.0
Divorced/widowed	347	6.8	648	12.3
Single	1,678	32.9	2,021	38.2
Occupational status				
Working	2,935	57.5	3,029	57.3
Student	742	14.5	843	15.9
Unemployed/searching a job	190	3.7	252	4.8
Retired	909	17.8	604	11.4
Homemaker, male or female	170	3.3	307	5.8
Other	147	2.9	239	4.5
Smoking habits				
Nonsmoker	2,953	57.9	2,895	54.8
Ex-smoker	1,023	20.1	1,120	21.2
Smoker	1,116	21.9	1,264	23.9
Body mass index, kg/m^2				
<20	3,87	7.6	606	11.5
20–<25	2,275	44.6	2,746	51.9
25–30	1,838	36.0	1,360	25.7
>30	570	11.2	546	10.3

[1]Six missing answers for lifetime use of hair coloring products. Numbers in each category may not add up to the total because of missing values.

European population. There were no substantial differences with regard to the sociodemographic characteristics of all the subjects interviewed and those who were randomly selected for patch testing (data not shown).

The percentage of ever-users were higher in Germany (62.9%), The Netherlands (56.6%), and Sweden (55.4%) than in Italy (35.5%) and Portugal (38.4%). The prevalence of ever-use of hair dyes was much higher in women than in men in all countries.

Age distribution showed some variations among different geographic areas, particularly in Sweden, where the proportion of ever hair dye users was higher in the oldest age group (29% vs. 20% in the age group <30 years) and in southern Europe, where the higher proportion of ever hair dye users was observed in those between 31 and 60 years old. Overall, 34.6% of the subjects interviewed (N = 3,583) had used hair coloring products during the last 12 months (190 male [4%], 3,392 female [62%]).

Subjects who had used hair coloring products during the last 12 months were asked to determine the type of product. Altogether. 2,313 of 3,583 individuals (65%) had used oxidation hair coloring products alone or in combination with other techniques, 1,103 individuals (30%) had used exclusively one technique other than oxidation hair coloring products, and 130 (3.6%) individuals had used a combination of techniques other than oxidation hair coloring products.

Overall, 1,503 users (28.4%) of hair coloring products (n = 5,286) had used these products for more than 10 years, 1,080 (20.4%) for 6–10 years, 1,281 (24.2%) for 1–5 years, and 1,290 (24.4%) for <1 year. Among the 2,313 users of oxidation hair coloring products (oxidation only plus oxidation and other techniques), the rate of long-term use was even greater, with 40.8% using the products for more than 10 years, 27.9% for 6–10 years, 23.5% for 1–5 years, and 5.9% for <1 year. The mean duration of use for individuals who colored their hair 10 years or more is 21 years.

Localized itchy skin rash lasting more than 3 days on the scalp and face/ears, during the last month, last year, and lifetime

Ever-hair dye users reported an itchy skin rash on the scalp and/or face/ears more often than nonusers (Table 2). Itchy skin rash on face/ears only was reported by 4.3% of hair dye users and by 2.7% of non-users during the last month; by 6.3% and 3.8%, respectively, during the last year (excluding the last month); and by 10.3% and 5.4%, respectively, during their lifetime (excluding the last year). Inclusion of the site "face/ears" in the absence of scalp involvement in the decision tree contributes to making the attribution of clinical relevance more conservative because the face in particular is the site of contact allergic reactions to many cosmetic and noncosmetic products and of other skin diseases. The lifetime prevalence of itchy skin rash lasting more than 3 days on areas including the scalp was 19.4% in hair dye users versus 9.3% in nonusers ($P < 0.001$).

Confirmed diagnosis of contact dermatitis during the last month, last year, and lifetime

Confirmed contact dermatitis was reported by 0.2% of hair dye users and by 0.1% of nonusers during the last month ($P = 0.388$); by 0.2% in both groups during the last year (excluding the last month) ($P = 0.832$); and by 9.5% and 4.1%, respectively, during their lifetime (excluding the last year) ($P < 0.001$). The characteristics of contact dermatitis (allergic, irritant) are not specified and its site is not related specifically to areas exposed to hair coloring products in consumers.

Lifetime avoidance of hair coloring products because of any skin reaction

Of the total of 10,425 subjects, 624 (6%) reported avoiding hair dyes because of any skin problem during their lifetime. Considering all 5,286 hair dye users, the proportion of subjects with a history of avoidance was 11.7%. Most of them (60%) declared noticing the skin problem while the hair colorant was on the head (before rinsing), 11.4% within 1 hour after rinsing, and 6% within 6 hours. Eighty-three subjects (13.3% of ever-users who reported a skin problem) indicated that the problem began between 6 hours and 3 days after rinsing.

Among the 1,151 exclusive oxidation hair dye users, 114 (9.9%) reported a history of avoidance. Most of these users (61.9%) declared noticing the skin problem while the