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ORIGINAL ARTICLE

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Bleaching powders, bleaching creams and other hair lightening preparations as sources for (airborne) allergic contact dermatitis and other health effects in hairdressers: Results of an empirical study

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Abstract

Background: Various products are available for lightening hair. There are no data on which applications are actually used in hairdressing, impeding proper estimation of actual exposure and necessary preventive measures.

Objectives: To assess information about availability, usage and formulation of lightening preparations in the German hairdressing trade.

Methods: A market survey was conducted and hairdressers were surveyed by online questionnaires.

Results: Of 783 hairdressers clicking the link, 565 hairdressers (91.2% female, mean age of 40.2 ± 11.7 years) from all German states responded (response rate: 72.2%). The questionnaire survey has shown that available hair-lightening preparations in the German hairdressing trade are (multiple selection possible): dust-free (88.5%) and non-dust-free bleaching powders (22.1%), bleaching creams (41.9%), high-lifting hair colour creams (88.8%) and normal hair colour creams (58.4%). Five hundred eighteen (91.7%) hairdressers favour lightening hair with powder. The market survey revealed that bleaching powders and creams contain potassium persulfate, ammonium persulfate and sodium persulfate or combinations of these persulfate salts.

Conclusions: Hairdressers are exposed to various hair-lightening applications containing different chemicals. Preventive measures need to address adverse skin and respiratory effects. Implementation of targeted health education already in early career stages (i.e., apprenticeship) seems advisable and can be maintained by refresher trainings.

KEYWORDS

bleach, contact dermatitis, eczema, German, hair colour, hair dye, hairdresser, hairdressing, persulfate, respiratory toxicity

1 | INTRODUCTION

In the hairdressing sector, various products are available for lightening the hair, comprising dust-free and non-dust-free bleaching powders, bleaching creams and other hair lightening preparations, such as so-called high-lifting hair colour creams or usual hair colour creams mixed with higher concentrations of oxidant. Different bleaching preparations, namely dust-free and non-dust-free bleaching powders, demonstrably differ in their characteristics (e.g., particle size, granulation, microencapsulation or being oil-mixed) and thus present different risk profiles.[1] It, however, remains unclear which of the above-mentioned preparations are actually used in daily practice, impeding proper estimation of exposure-associated risks and necessary preventive measures. In a recent review, it was shown that lightening the hair is a frequent service in hairdressing salons,[2] exposing hairdressers to bleach 7.6–47.9 times/month[3–5] with only 77.9% of the hairdressers wearing gloves regularly whilst conducting this task.[5]

Due to work-related skin damage, hairdressers are at significant risk of developing occupational skin disorders (OSD), with hand dermatitis (hand eczema, HE) being the most common OSD.[6] A current systematic review and meta-analysis by Havmose et al. found a pooled lifetime prevalence of 38.2% (95% confidence interval [CI]: 32.6%–43.8%), a pooled 1-year prevalence of 20.3% (95% CI: 18.0%–22.6%) and a pooled point prevalence of 7.7% (95% CI: 5.8%–9.6%) of HE in hairdressers.[7] The course of HE is often chronic and entails personal suffering alongside socio-economic consequences,[8,9] including high illness-related costs and in the worst case a premature termination of career.[10,11]

In terms of adverse effects of bleaching agents, particularly persulfate salts, besides occupational allergic contact dermatitis on the directly exposed hands or lower arms, airborne allergic contact dermatitis may develop, for example, in the face and neck or other exposed regions. Moreover, adverse respiratory effects have been reported in hairdressers in earlier studies.[12–14] Persulfate salts can target the skin, the respiratory route or even have systemic effects; the underlying mechanisms can be *immediate* or *delayed* hypersensitivity or combinations thereof, with the former being diagnosed by open and prick testing, and the latter with patch testing. In a recent systematic review, Macan et al. identified bleaching products as the most hazardous hair cosmetic product regarding respiratory adverse effects in hairdressing.[15] Persulfate salts contained in bleaches are known to cause immediate reactions like rhinitis, asthma, contact urticaria and anaphylaxis.[12,16,17] Against this background, this empirical study aimed at assessing information about current availability, usage and formulation of contemporary lightening preparations in the German hairdressing trade.

2 | METHODS/MATERIALS

First, an orientating market survey was conducted regarding bleaching preparations currently available on the German market. To this end, information was randomly retrieved from publicly available online hairdressing shops. Products were included in a descending order according to their listing in the search on the respective online hairdressing shops website. It was chosen only to include products intended primarily for professional use but available online with the ingredients disclosed, which in terms of salon use comprised the most widely used products in Germany. Drugstore products with intended home use were not included as those are likely not used by hairdressers in the salon.

Second, hairdressers in the German hairdressing trade were surveyed using a fully standardized online questionnaire only including single choice questions (Table S1) with respect to the availability and usage of different lightening preparations in their daily working life. To reach many hairdressers from all over Germany, the link to the questionnaire was distributed to selected District Craft Trades Associations of the hairdressing trade which are personally known to the authors, namely Cloppenburg and Osnabrück, Germany, with the request to forward it to the member hairdressing salons. The questionnaire link was further spread via relevant hairdressing groups on social media platforms (WhatsApp, Facebook and specific hairdressing forums). Informed consent was obtained from all participants. In terms of statistical analysis, the association between exhaust air system use and use of powdery bleach products was assessed with Chi^2 tests or, if expected cell frequencies fell below 5, Fisher's exact test.

3 | RESULTS

3.1 | Market survey on hair lightening preparations

Ten of the 17 randomly selected bleaching powders were labelled as dust-free. Of the 7 bleaching powders not labelled as dust-free, one was labelled as low-dusting (Table S2). In addition to information about the aforementioned bleaching powders, information about 6 randomly bleaching creams available on the German market was retrieved (Table S3), showing that bleaching creams are less commonly available than bleaching powders. In dust-free and non-dust-free bleaching powders as well as in bleaching creams, different persulfates were present, namely potassium, ammonium and sodium persulfate. Among the 17 bleaching powders, the following combinations of persulfates were observed: potassium plus ammonium persulfate in 13 powders, potassium plus sodium persulfate in 1 powder, sodium plus ammonium persulfate in 1 powder, only potassium persulfate in 1 powder and no persulfate at all in 1 powder. In 2 of the 6 bleaching creams, the combination of potassium, sodium and ammonium persulfate was present, whereas the other 4 creams did not contain persulfates. Bleaching powders and creams without persulfates—which are used in these agents to increase the oxidation process and expand the reaction time of the bleaching preparation—might instead be mixed with higher concentrated hydrogen peroxide; in some cases, different galenics of hydrogen peroxide might also be used (i.e., creamy formulations instead of liquid formulations) to compensate for the missing effect of persulfates.

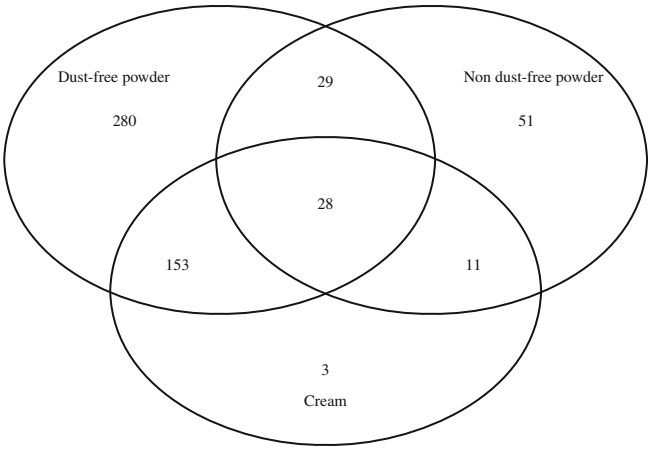

FIGURE 1 Venn diagram showing the number of hairdressers using dust-free bleaching powder, non-dust-free bleaching powder and bleaching cream (created with the R package "VennDiagram" v. 1.7.1).

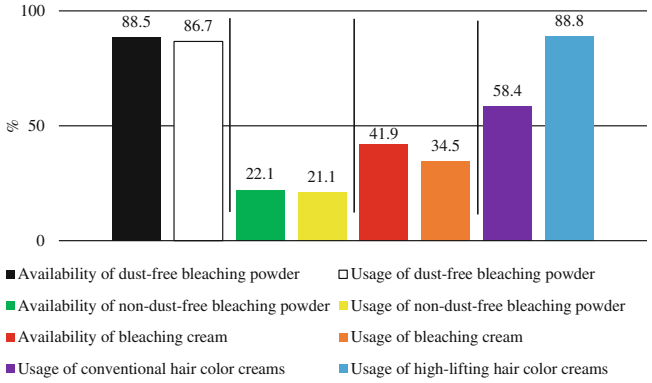

FIGURE 2 Percentage of hairdressers (n = 565) confirming availability and/or usage in the salon of dust-free bleaching powder, non-dust-free bleaching powder, bleaching cream, conventional hair colour creams with a higher concentration of hydrogen peroxide to lighten hair by 1 to 2 shades and high-lifting hair colour creams with a higher concentration of hydrogen peroxide to lighten hair by 2 to 4 shades.

3.2 | Availability and usage of hair lightening preparations in the salons

Of 783 hairdresser who clicked on the link, 565 hairdressers (91.2% female, mean age of 40.2 ± 11.7 years) answered the questionnaire (response rate: 72.2%). The sample includes 31 (5.5%) hairdressing apprentices, 153 (27.1%) journeymen hairdressers and 381 (67.4%) master hairdressers. On average (SD), the profession had already been performed for 21.5 ± 12.3 years. Twenty-four (4.3%) salons belong to the low-price segment, 446 (78.9%) salons to the medium-price segment and 95 (16.8%) salons to the high-price segment. All 16 German federal states were represented with the most participants coming from Lower Saxony (25.8%), North Rhine-Westphalia (24.3%) and Bavaria (13.6%).

Five hundred (88.5%) of the 565 hairdressers stated that dust-free bleaching powder was available in their salon and 490 (98.0%) of these 500 hairdressers stated that they use these products. Regarding non-dust-free bleaching powder, 125 (22.1%) of the 565 hairdressers mentioned these to be stocked by the salon of which 119 (95.2%) reported to use it. Bleaching cream was available for 237 (41.9%) of the 565 hairdressers and 195 (82.3%) of these 237 hairdressers used such a product (Figure 1). Three hundred thirty (58.4%) and 502 (88.8%) of the 565 hairdressers stated to use conventional hair colour creams with a higher concentration of hydrogen peroxide to lighten hair by 1 to 2 shades and high-lifting hair colour creams with a higher concentration of hydrogen peroxide to lighten hair by 2–4 shades, respectively (Figure 2). Five hundred eighteen (91.7%) of 565 hairdressers stated that their favourite preparation to lighten hair was bleaching powder and 47 (8.3%) of 565 hairdressers stated that their favourite preparation to lighten hair was bleaching cream.

Five hundred twenty-nine (93.6%) of 565 hairdressers declared that in the salon where they work, a separate area for mixing bleaching and hair colouring preparations (e.g., "mix corner," "colour bar") existed. One hundred five (19.8%) of these 529 hairdressers confirmed that in the salon where they work, an exhaust air system (e.g., exhaust system, extractor hood) in the separate area for mixing bleaching and hair colouring preparations was installed. There was no significant association between use of an exhaust air system and usage of powdered preparations (both dust-free and non-dust-free); $P > 0.3$.

4 | DISCUSSION

With the present study, we were able to show that dust-free and non-dust-free bleaching powders, bleaching creams and other hair lightening preparations, such as common hair colour creams or so-called high-lifting hair colour creams, which usually require higher concentrations of hydrogen peroxide to lighten hair, are currently on the market and used by hairdressers to a varying extent. To the best of our knowledge, this is the first study looking at actual availability, usage and formulation of different hair lightening applications in the hairdressing trade. As all 16 German federal states were included in this study, it may be assumed that the results are characteristic for the whole German hairdressing trade.

The market survey revealed that available bleaching powders and creams contain different persulfate salts, namely potassium persulfate, sodium persulfate and ammonium persulfate and different combinations thereof. The Cosmetic Ingredient Review Expert Panel has conducted a safety assessment of these persulfate salts and concluded that adverse skin and respiratory effects are known; the use of these persulfate salts, however, is classified as safe when used as oxidizing agents in hair colourants and lighteners designed for brief intermittent use completed by complete rinsing from hair and skin.[18] As safety assessment of hair cosmetic ingredients does not account for the exposure of a professional user handling the product frequently in daily working life, but rather the client or consumer,[2,19] it must be

assumed that the skin contact of hairdressers might exceed the above-described contact with persulfate salts contained in bleaching agents. This is corroborated by data from the German Information Network of Departments of Dermatology (IVDK), showing that allergic contact dermatitis caused by ammonium persulfate is a health problem, especially in hairdressers, compared with clients or self-users.[20–22] Accordingly, a current study from the United States concluded that clinicians should be aware of hair colouring products being one of the primary categories of consumer products that contain persulfate salts.[23]

The market survey showed that most of the bleaching powders available on the German market are dust-free, which might lead to the idea that industry seems to have in part understood the problematic of bleach dusts in hairdressing. Also, the survey showed that the majority of hairdressers actually uses dust-free bleaching powders. This is reassuring, as a series of tests by the Institute for Occupational Safety and Health of the German Social Accident Insurance (IFA) has shown that when using bleaching powders in the form of granules, microencapsulated or oil-mixed powders (dust-free bleaching powders), the release of dust from bleaching powders with the active ingredient ammonium persulfate is reduced.[1] However, non-dust-free bleaching powders are still available on the market and also used in salons. It should be mentioned that despite dust-free formulations are considered less hazardous than non-dust-free bleaching powders, both formulations may trigger bronchial asthma.[24]

According to the hierarchical STOP principle in prevention (substitution, technical measures, organizational measures, personal protective measures), it seems to be the easiest way to substitute non-dust-free bleaching powder by dust-free bleaching powder or bleaching cream. As can be seen in Figure 1, a considerable share of hairdressers does not only strictly use bleaching powders or creams. It can be assumed that the preparation (i.e., powder or cream) is also chosen according to the needed mixture considered necessary to achieve the shade the customer requests. For so-called freehand techniques, such as painted highlights, the hairdresser will probably use a cream application and for bleaching the whole hair (e.g., to achieve an overall platinum blonde colour), the hairdresser might rather use a powder application. The broad spectrum of hairdressing services and concomitant customer requests leads one to expect that both application types will still be used in the future. Our results clearly show that hairdressers prefer bleaching powder over bleaching cream, which might be attributed to (i) habit or (ii) differing galenics of these applications which could be favoured over the other. As only less than half of the surveyed hairdressers have access to bleaching cream in their salon, availability might play a role as well, which could be solved very quickly by the employers. To facilitate an understanding of bleaching creams being a feasible alternative to bleaching powders, hairdressers' education needs to be expanded in terms of teaching correct concentration of hydrogen peroxide in combination with choosing an adequate reaction time for the application when using bleaching creams so that the desired colour result can also be reached with a less hazardous preparation.

Interestingly, a very high share of nearly 90% of the hairdressers uses high-lifting hair colour creams and more than half of the hairdressers use usual hair colour creams to lighten hair just a few tones. This application also seems to be a reasonable alternative for substituting bleaching powders, at least in these special cases. It must yet be assumed that these choices are made with the colour result for the client in mind rather than considering health protection. Moreover, the colour creams may contain contact allergens as well,[25] so that adequate skin protection by wearing gloves is always a necessity. This is not only of relevance for working with oxidative hair dyes, as addressed in this article, but also for non-oxidative hair dye products, which have been addressed in a recent survey.[26]

The results discussed above demonstrate the need for preventive measures regarding adverse skin and respiratory effects of hair-lightening procedures, in which potentially hazardous substances are used. To sufficiently protect the skin, personal protective measures, that is, gloves, should generally be worn by hairdressers whilst lightening the hair of clients, regardless of the used preparation. It seems crucial to emphasize how important it is for hairdressers to wear gloves, as prior research has revealed that the percentage of hairdressers who do so is remarkably low. Even if using gloves, hairdressers frequently reuse disposable gloves,[27] and contamination oftentimes happens as a result of incorrect handling or when gloves are taken off.[28] Due to the breakthrough time of the gloves used among hairdressers,[29] and since some of the ingredients in hairdressing chemicals swiftly pass through the glove material,[30] their use does not always have the intended effect.

For preventing adverse respiratory effects as well as airborne contact allergen exposure, the technical preventive measure of adequate ventilation of the salon is of utmost importance to reduce inhalation, for example, by exhaust fans, natural cross-ventilation or a ventilation and air conditioning system. In Germany, the Technical Regulations for Hazardous Substances (TRGS) 530 directs hairdressers to set up specially designated workplaces for mixing and decanting work,[31] which is fortunately ensured for most of the surveyed hairdressers in this study. Separate exhaust air systems (e.g., exhaust system, extractor hood) in these areas, however, remain an exception. Thus, the importance of general ventilation of the salon becomes evident. The results of the present work have shown that there seems to be no awareness regarding the need of using exhaust air systems when preparing powdered bleaching applications. As skin contact and inhalation of chemicals results in absorption into the organism and possible risk of acute and chronic systemic health effects, prevention of these exposures reduces the risk of not only local but also potential systemic toxic effects.

As a limitation of this study, it should be mentioned that the answers, which were generated via online questionnaires, are not verifiable. As the questions were not about personal information, such as individual health problems and the questionnaire was framed as a status check regarding the use of hair-lightening applications, it is plausible to assume that social desirability of the answers—which is a known source of bias in questionnaire studies—did not play a crucial role. In the future, an observational study in the hairdressing trade to objectively assess further parameters seems warranted, such as for

which specific hair-lightening application gloves are worn, whether gloves are worn adequately and how long gloves are worn conducting these procedures. This might also be interesting for other hairdressing tasks, such as colouring the hair with permanent hair dye or perming the hair, involving other hairdressing chemicals.

In conclusion, hairdressers are exposed to various hair-lightening applications with different substances potentially entailing adverse skin, respiratory or systemic effects. The consistent use of preventive measures—particularly in terms of primary prevention—is already necessary in early career stages,[32] in which the specific learning contents can be incorporated into the regular training within vocational schools. Preventive educational programs for hairdressers were proven to be effective in past studies.[33,34] A regular update of knowledge in terms of a refresher training should be facilitated by the employer, as educational effects might diminish over time.[35] Within continuing education (e.g., as in Germany in the setting of a hairdressing master course), implementation of these measures should be stressed again, especially because master hairdressers then often become employers themselves and can then function as multipliers with regard to knowledge transfer.

AUTHOR CONTRIBUTIONS

Cara Symanzik: Conceptualization; data curation; formal analysis; investigation; methodology; project administration; supervision; visualization; writing – original draft. **Kirsten Koopmann:** Data curation; formal analysis; investigation. **Christoph Skudlik:** Resources; supervision. **Swen M. John:** Conceptualization; resources; supervision. **Wolfgang Uter:** Formal analysis; conceptualization; software; visualization.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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REFERENCES

1. Berges M, Kleine H. Ermittlung der exposition gegenüber gefahrstoffen in der luft an friseurarbeitsplätzen. *Gefahrst Reinhalt Luft*. 2002;62(10):405-409.
2. Symanzik C, Johansen JD, Weinert P, et al. Differences between hairdressers and consumers in skin exposure to hair cosmetic products: a review. *Contact Dermatitis*. 2022;86(5):333-343.
3. Leino T, Tammilehto L, Hytönen M, Sala E, Paakkulainen H, Kanerva L. Occupational skin and respiratory diseases among hairdressers. *Scand J Work Environ Health*. 1998;24(5):398-406.
4. Lysdal SH, Johansen JD, Flyvholm MA, Søsted H. A quantification of occupational skin exposures and the use of protective gloves among hairdressers in Denmark. *Contact Dermatitis*. 2012;66(6):323-334.
5. Uter W, Pfahlberg A, Gefeller O, Schwanitz HJ. Risk factors for hand dermatitis in hairdressing apprentices. *Derm Beruf Umwelt*. 1998;46(4):151-158.
6. Jamil W, Svensson Å, Josefson A, Lindberg M, Von Kobyletzki L. Incidence rate of hand eczema in different occupations: a systematic review and meta-analysis. *Acta Derm Venereol*. 2022;102:adv00681.
7. Havmose MS, Kezic S, Uter W, et al. Prevalence and incidence of hand eczema in hairdressers-a systematic review and meta-analysis of the published literature from 2000-2021. *Contact Dermatitis*. 2022;86(4):254-265.
8. Havmose M, Thyssen JP, Zachariae C, Johansen JD. Long-term follow-up of hand eczema in hairdressers: a prospective cohort study of Danish hairdressers graduating from 1985 to 2007. *J Eur Acad Dermatol Venereol*. 2022;36(2):263-270.
9. Meding B, Swanbeck G. Consequences of having hand eczema. *Contact Dermatitis*. 1990;23(1):6-14.
10. Havmose M, Thyssen JP, Zachariae C, Uter W, Johansen JD. Occupational hand eczema reduces career length in hairdressers: a prospective cohort study of Danish hairdressers graduating from 1985 to 2007. *Occup Environ Med*. 2022;79:649-655.
11. Lysdal SH, Søsted H, Andersen KE, Johansen JD. Hand eczema in hairdressers: a Danish register-based study of the prevalence of hand eczema and its career consequences. *Contact Dermatitis*. 2011;65(3):151-158.
12. Hougaard MG, Menné T, Søsted H. Occupational eczema and asthma in a hairdresser caused by hair-bleaching products. *Dermatitis*. 2012;23(6):284-287.
13. Hagemeyer O, Marek E, van Kampen V, et al. Specific inhalation challenge in persulfate asthma. *Adv Exp Med Biol*. 2015;861:85-91.
14. Nemer M, Sikkeland LI, Kasem M, et al. Airway inflammation and ammonia exposure among female Palestinian hairdressers: a cross-sectional study. *Occup Environ Med*. 2015;72(6):428-434.
15. Macan J, Babić Ž, Hallmann S, et al. Respiratory toxicity of persulphate salts and their adverse effects on airways in hairdressers: a systematic review. *Int Arch Occup Environ Health*. 2022;95(8):1679-1702. doi:10.1007/s00420-022-01852-w
16. Kezic S, Nunez R, Babić Ž, et al. Occupational exposure of hairdressers to airborne hazardous chemicals: a scoping review. *Int J Environ Res Public Health*. 2022;19(7):4176.
17. Hoekstra M, van der Heide S, Coenraads PJ, Schuttelaar MLA. Anaphylaxis and severe systemic reactions caused by skin contact with persulfates in hair-bleaching products. *Contact Dermatitis*. 2012;66(6):317-322.
18. Pang S, Fiume MZ. Final report on the safety assessment of ammonium, potassium, and sodium persulfate. *Int J Toxicol*. 2001;20(Suppl 3):7-21.
19. Symanzik C, Weinert P, Babić Ž, et al. Skin toxicity of selected hair cosmetic ingredients: a review focusing on hairdressers. *Int J Environ Res Public Health*. 2022;19(13):7588.
20. Uter W, Gefeller O, John SM, Schnuch A, Geier J. Contact allergy to ingredients of hair cosmetics - a comparison of female hairdressers and clients based on IVDK 2007-2012 data. *Contact Dermatitis*. 2014;71(1):13-20.
21. Uter W, Lessmann H, Geier J, Schnuch A. Contact allergy to hairdressing allergens in female hairdressers and clients: current data from the IVDK, 2003–2006. *J Dtsch Dermatol Ges*. 2007;5(11):993-1001.
22. Uter W, Lessmann H, Geier J, Schnuch A. Contact allergy to ingredients of hair cosmetics in female hairdressers and clients: an 8-year analysis of IVDK* data. *Contact Dermatitis*. 2003;49(5):236-240.
23. Dean OR, Somers KE. Persulfate-containing consumer products in the US market. *Contact Dermatitis*. 2022;86(4):295-299.

24. Nielsen J, Nilsson P, Dahlman-Höglund A, et al. Dust-free bleaching powder may not prevent symptoms in hairdressers with bleaching-associated rhinitis. *J Occup Health*. 2016;58(5):470-476.
25. He L, Michailidou F, Gahlon HL, Zeng W. Hair dye ingredients and potential health risks from exposure to hair dyeing. *Chem Res Toxicol*. 2022;35(6):901-915.
26. Hedberg YS, Uter W, Banerjee P, et al. Non-oxidative hair dye products on the European market: what do they contain? *Contact Dermatitis*. 2018;79(5):281-287.
27. Geens T, Aerts E, Borguet M, Haufroid V, Godderis L. Exposure of hairdressers to aromatic diamines: an interventional study confirming the protective effect of adequate glove use. *Occup Environ Med*. 2016;73(4):221-228.
28. Oreskov KW, Søsted H, Johansen JD. Glove use among hairdressers: difficulties in the correct use of gloves among hairdressers and the effect of education. *Contact Dermatitis*. 2015;72(6):362-366.
29. Lind M-L, Johnsson S, Lidén C, Meding B, Boman A. The influence of hydrogen peroxide on the permeability of protective gloves to resorcinol in hairdressing. *Contact Dermatitis*. 2015;72(1):33-39.
30. Antelmi A, Young E, Svedman C, et al. Are gloves sufficiently protective when hairdressers are exposed to permanent hair dyes? An in vivo study. *Contact Dermatitis*. 2015;72(4):229-236.
31. Committee for Hazardous Substances of the German Federal Agency for Industrial Health and Safety. Technical Rules on Hazardous Substances (TRGS) 530 for the Hairdressing Trade. Accessed February 8, 2022. https://www.bgw-online.de/resource/blob/20628/5f65bd1bb394e88d7ba969b57d2d26e5/trgs530-gefahrstoffe-friseurhandwerk-data.pdf.
32. Samardžić T, Varnai VM, Bakotić M, et al. Skin health and safety at work in Croatian hairdressing apprentices. *Contact Dermatitis*. 2016;75(1):25-31.
33. Bregnhøj A, Menné T, Johansen JD, Søsted H. Prevention of hand eczema among Danish hairdressing apprentices: an intervention study. *Occup Environ Med*. 2012;69(5):310-316.
34. Wulfhorst B, Bock M, Gediga G, Skudlik C, Allmers H, John SM. Sustainability of an interdisciplinary secondary prevention program for hairdressers. *Int Arch Occup Environ Health*. 2010;83(2):165-171.
35. Steengaard SS, Bregnhøj A, Johansen JD. Hand eczema among hairdressing apprentices in Denmark following a nationwide prospective intervention programme: 6-year follow-up. *Contact Dermatitis*. 2016;75(1):32-40.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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