Differences between hairdressers and consumers in skin exposure to hair cosmetic products: A review

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Abstract

Hairdressers are at high risk of developing occupational hand eczema. Opinions on the health and safety concerns of nonfood consumer products, such as cosmetics and their ingredients, consider the exposure of a “common consumer,” which may not account for occupational exposure of hairdressers. As a result, there is a parlous scenario in which serious safety concerns about occupational exposures are present. The purpose of this review is to compare the frequency of exposure to various types of hair cosmetic products among hairdressers and consumers. Database searches for this review yielded a total of 229 articles; 7 publications were ultimately included. The analysis showed that—dependent on the task—hairdressers were exposed 4 to 78 times more than consumers to a wide spectrum of hair cosmetic products used in their daily working life, ranging from shampoos, conditioners, oxidative and non-oxidative hair colors, to bleaching agents. The highest frequency was found for coloring hair with oxidative hair color. Consumer use frequency does not appear to be appropriate for representing hairdresser exposure. The current standards do not effectively address the occupational risks associated with hairdressers’ use of cosmetics. The findings of this study should cause current risk-assessment procedures to be reconsidered.

KEYWORDS

contact dermatitis, exposure, hairdressers, occupational, occupational diseases, skin diseases
1 | INTRODUCTION

Hairdressers are subjected to a high degree of occupational skin strain within their professional surroundings, mainly arising from frequent wet work and skin contact to detergents and hairdressing chemicals.1-3 This occupational skin exposure may lead to adverse skin reactions of an irritant and/or allergic nature. Thus, prevalence of occupational dermatoses, mostly hand eczema, is very high in hairdressers, causing personal suffering due to illness as well as high financial burden due to health expenditures for society.4,5

In the European Union (EU), utilization of carcinogenic, mutagenic, or substances toxic for reproduction (CMR) in cosmetic products is restricted by the so-called Cosmetics Regulation, which, however, allows exceptions to this basic principle, making it possible to use such substances in cosmetic products after adequate safety assessment and appropriate risk management (mostly, maximum permissible concentrations).6 The Scientific Committee on Consumer Safety (SCCS) elaborates opinions on health and safety risks of nonfood consumer products, including cosmetic products and their ingredients, whereby the exposure to such products by a “common consumer” is taken into account. Such typical exposure is outlined in the SCCS “Notes of Guidance” (NoG),7 which, in turn, are based on empirical data on product use in consumers.8,9 The exposure of hairdressers—who are in contact with such substances throughout their daily working life—is, however, not considered in the process of the evaluation of the SCCS, leading to opinions that may not adequately address occupational exposure of hairdressers. This leads to the precarious situation that grave safety concerns with regard to occupational exposures remain.

Against this background, the objective of the present article is to examine the frequency of exposure—as reported in literature—to important types of hair cosmetic products as well as of wet work in hairdressers compared to non-hairdressers, termed “consumers” (representing “clients”) or “self-users.”

2 | METHODS

2.1 | Hairdressers’ exposure

Literature searches were performed in February 2021. The time period from 1990 to 2020 was taken as the eligible publication period. We systematically searched for (Hairdressers* OR Hairdressing apprentice*) AND (skin) AND (exposure*) in PubMed/Medline and Web of Science–Core Collection (WoS). Only English-language search terms were used. Search results were exported from Medline and WoS in a suitable format and imported into Zotero libraries, documenting the number of references contributed by each export/import set. In the Zotero library, bibliographical duplicates were identified and the entry including less information (e.g., no abstract) was discarded. The remaining unified library was exported in Research Information System Format (RIS) and imported into a new Rayyan (Rayyan QCRI) project by a reviewer for eligibility based on title, keywords, and abstract. The final set of references eligible for full-text screening was exported from Rayyan in Bibtex format for import into the Zotero cloud-based reference database, after the initial set of references was archived.

2.2 | Consumers’ exposure

Typical use frequencies of hair cosmetics by consumers (when normally applied by professionals in a hairdressing salon) and self-users (when applying hair cosmetics at home) have been considered together. Some products are usually applied only in a hair salon (e.g., waving agents or hair relaxers), others frequently at home (e.g., shampoos and oxidative or nonoxidative hair colors). Data on consumers’ exposure was obtained primarily from the NoG, as far as available, which refers back to Hall et al. (2007) as well as Hall et al. (2011),5,9 who suggest a framework for conducting population exposure assessments regarding European consumer exposure to cosmetic products.

2.3 | Data extraction

In a first step, we extracted data on hairdressers’ exposure including the frequency of procedures using corresponding products, mean duration of procedures, the share of hairdressers who usually conduct the respective procedure, and the share of hairdressers who usually wear gloves during the respective procedure. Regarding consumers’ exposure, the frequency of procedures using the corresponding products, mean duration of procedures, and the share of people who usually conduct the respective procedure were extracted. Study characteristics (type of investigation, country, study design/method, study population, age range, and sex of the study population) of the included studies were recorded using a publication record form (PRF).

For hairdressers, data on exposure were extracted from the respective studies. Data on mean duration of procedures, data on the share of hairdressers who usually conduct the respective procedure, and data on the share of hairdressers usually wearing gloves while conducting the respective procedure was taken from Uter et al. (1998),10 who assessed risk factors for hand dermatitis in a cohort of hairdressing apprentices.

In a second step, the aforementioned data were condensed and have undergone further refinement. For displaying the frequency of procedures using certain products we decided to use median values for data obtained in hairdressers. To provide greater clarity, we extracted the mean duration of procedures for hairdressers and consumers as well as the share of hairdressers and consumers who usually conduct the respective procedure. All procedures usually only performed by hairdressers were discarded, since these cannot be compared to consumers regarding exposure. The following procedures were removed from further consideration: cutting wet hair (without previous coloring), cutting wet hair (after coloring), highlighting the hair (mostly using bleach with 6% to 9% hydrogen peroxide), and lowlighting (mostly using oxidative hair color with 6% hydrogen peroxide) the hair using foil, highlighting the hair (mostly using bleach...
with 6% to 9% hydrogen peroxide) and lowlighting (mostly using oxidative hair color with 6% hydrogen peroxide) the hair using a cap, perming the hair using waving/perming lotions (acid, alkaline, and exothermic perms), and coloring eyelashes and/or eyebrows with oxidative hair color (using mostly 3% hydrogen peroxide).

2.4 Daily exposure doses per area

From the included studies, data on frequency of use were available. However, the most relevant dose-metric for risk assessment concerning skin sensitization is the dose per area. Hence, information about daily exposure doses per skin area were calculated with the following calculation formula:

\[
\frac{\text{amount}}{\text{skin surface area} \times \text{daily exposure frequency}}
\]

Data on the amount is taken from the SCCS or NoG for the testing of cosmetic ingredients and their safety, 11th revision, which refer back to Hall et al. (2007), Hall et al. (2011), Colipa 16.01.97 BB-97/007, and the Scientific Committee on Cosmetic products and Non-Food Products intended for consumers (SCCNFP) SCCNFP/0321/00. Dose per area for hairdressers was calculated with the skin surface area (SSA) for hands (860 cm²); dose per area for consumers (clients in a hairdressing salon) was calculated with the SSA for ½ head (580 cm²). The aforementioned SSAs for application were indicated according to the NoG, which refer back to Bremmer et al. (2006) and Bremmer et al. (2006). Data on daily exposure frequency were calculated from the respective information given in Table 2.

2.5 Exposure factor

The factor by which hairdressers are higher exposed as consumers was calculated using the following formula:

\[
\frac{\text{frequency of exposure for hairdressers} + \text{frequency of exposure for consumers}}{\text{frequency of exposure for consumers}}
\]

In the designed formula it was laid down that hairdressers additionally are subjected to an exposure as consumers themselves. Consumer exposure is considered as reference exposure in this calculation. Data on exposure frequency regarding hairdressers were taken from the respective information given in Table 2. Frequency of exposure regarding consumers was taken from the NoG, which refer back to Hall et al. (2007) as well as Hall et al. (2011).

**FIGURE 1** Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) 2020 flow diagram of literature search according to Page et al. (2021)
3 | RESULTS

3.1 | Study selection

A flow diagram of the study selection concerning hairdressers’ exposure is presented in Figure 1. Initial searches generated 229 individual study records. After elimination of bibliographic duplicates, 170 references remained and were screened. Manual searching of references retrieved another two references. After elimination of publications that were irrelevant because they did not give details on the frequency of use of product categories, we arrived at a final number of seven publications considered for this review.

3.2 | Characteristics of included studies concerning hairdressers’ exposure

3.2.1 | Study types

The included studies covered a prospective population-based cohort study including a questionnaire survey combined with clinical examinations (n = 1), an observational study (n = 1), an observational study combined with a questionnaire survey (n = 1), questionnaire surveys (n = 2), and questionnaire surveys combined with clinical examinations (n = 2). The study characteristics are summarized in a PRF and can be found in the Appendix (Table S1).

3.2.2 | Population studied

All studies reported either on the exposure of hairdressers (n = 5) or hairdressing apprentices (n = 2). Of the two studies reporting on hairdressing apprentices, one study included only the final year hairdressing apprentices, who have an almost equal exposure in comparison to hairdressers who have finished training, and one study included hairdressing apprentices from all three apprenticeship years (according to the German dual-training system) so that it can be assumed that the exposure of the apprentices may be comparable to the exposure of trained hairdressers. Thus hairdressing apprentices are counted as hairdressers in the present review.

The included studies were all conducted within the EU, namely in Finland (n = 1), Sweden (n = 1), Denmark (n = 1), France (n = 1), Croatia (n = 1), and Germany (n = 2). In five studies reporting on gender, the proportion of women in the study population was 89.0% (n = 1), 95.7% (n = 1), and 100% (n = 3). Within three studies giving detailed information about the age of the participants, the ages ranged from 15 to 54 years (n = 1), 19 to 50 years (n = 1), and 22 to 65 years (n = 1).

3.2.3 | Exposure studied

All of the seven included studies provided details on the frequency of use of/quantification of exposures to hair cosmetic products in hairdressers.

3.3 | Synthesis of results

3.3.1 | Exposure to hair cosmetic products in hairdressers compared to consumers

Within the seven reviewed studies, data on the 12 procedures along-side with concomitantly used product types were available. Most of the identified tasks are performed exclusively by hairdressers (Table 1). Data on hairdressers’ exposure including frequency of procedures using corresponding products, mean duration of procedures, the share of hairdressers who usually conduct the respective

| Procedure with products types | Likely performed by consumers? a |
|------------------------------|---------------------------------|
| 1. Shampooing/washing hair using shampoo | Yes, possibly daily |
| 2. (deep) Conditioning hair using hair conditioner | Yes, possibly daily |
| 3. Cutting wet hair (i) without previously conducted coloring service and (ii) after previously conducted coloring service | (i) no, (ii) no |
| 4. Coloring hair (i) with permanent/oxidative hair color using 6-12% hydrogen peroxide on the full head, (ii) with semi-permanent oxidative hair color using 2-3% hydrogen peroxide or nonoxidative hair color on the full head, (iii) on the root/regrowth only with oxidative/nonoxidative hair colors according to previous treatment | (i) Yes, possibly monthly, (ii) yes, possibly monthly, (iii) yes, possibly monthly |
| 5. Highlighting the hair (mostly using bleach with 6-9% hydrogen peroxide) and lowlighting the hair (mostly using oxidative hair color with 6% hydrogen peroxide) using (aluminum) foil | No |
| 6. Highlighting the hair (mostly using bleach with 6-9% hydrogen peroxide) and lowlighting (mostly using oxidative hair color with 6% hydrogen peroxide) the hair using a cap | No |
| 7. Bleaching the hair with bleach using mostly 6-9% hydrogen peroxide on the full head | Rarely |
| 8. Perming the hair using waving/perming lotions (acid, alkaline, and exothermic perms) | No |
| 9. Coloring eyelashes and/or eyebrows with oxidative hair color using mostly 3% hydrogen peroxide | Highly unlikely |

aCategories: yes, possibly daily; yes, possibly monthly; rarely; highly unlikely; no.
procedure, and the share of hairdressers usually wearing gloves while conducting the respective procedure, as well as consumers’ exposure including frequency of procedures using corresponding products, mean duration of procedures, and the share of people who usually conduct the respective procedure were extracted as summarized in Table S2.

While shampooing/washing the hair, consumers and/or self-users are exposed to shampoo one time per day, whereas hairdressers are exposed to shampoo up to 12 times per day, with a mean duration of 7.5 minutes for each washing procedure. The study by Uter et al. has shown that this task is done by 99.8% of hairdressers, and that gloves—which should be used carrying out the task—are worn.

### Table 2

**Characteristics of exposures of the hands (“H”) and scalp (“S”) in hairdressers and consumers**

| Exposure | Hairdressers | Consumers | Exposure factor<sup>a</sup> |
|----------|--------------|-----------|-----------------------------|
|          | frequency of procedures using corresponding products (median) | Regular glove wearing (%)<sup>b</sup> | Dose per area (mg/cm²/day)<sup>b</sup> | Frequency of procedures using corresponding products (median)<sup>c</sup> | Dose per area (mg/cm²/day)<sup>b</sup> |
| Shampooing/washing the hair with shampoo (H and S) | 5-12 times/day<sup>10,17</sup> | 23.9 | 60.8-145 | 1 time/day | 18.0 | 6-13 |
| Deep conditioning the hair with hair conditioner (H and S) | 1-5 times/day<sup>10,17</sup> | 11.5 | 4.56-22.8 | 0.28/day | 1.89 | 5-19 |
| Coloring hair with permanent/oxidative hair color using 6-12% hydrogen peroxide (full head) (H and S) | 30.6-76.6 times/month<sup>10,17,21</sup> | 95.2 | 0.247-1.55 | 1 time/month | 0.00039 | 32.78 |
| Coloring hair with semi-permanent oxidative hair color using 2-3% hydrogen peroxide or nonoxidative hair color (full head) (H and S) | 3 times/week<sup>17</sup> | 95.2<sup>c</sup> | 0.0147 | 1 time/week<sup>c</sup> | 0.00241 | 4 |
| Coloring hair (root/regrowth only) using oxidative/nonoxidative hair colors according to previous treatment (H and S) | 11.5 times/month<sup>17</sup> | 95.2<sup>c</sup> | 0.0122 | 1 time/month<sup>d</sup> | 0.00014 | 13 |
| Bleaching the hair with bleach using mostly 6-9% hydrogen peroxide (full head) (H) | 7.6-47.9 times/month<sup>10,17,21</sup> | 77.9 | 0.0152-0.0960 | -- | -- | 9.49<sup>e</sup> |
| Bleaching the hair with bleach using mostly 6-9% hydrogen peroxide (full head) (S) | 1 time/month<sup>d</sup> | -- | 0.00039 | 1 time/month<sup>d</sup> | 0.00039 |

**Note:** Procedures included used products alongside the dose per area and the exposure factor by which hairdressers are more exposed as consumers.

<sup>a</sup>Data taken from Uter et al. (1998)<sup>10</sup>
<sup>b</sup>Calculation formula: (amount/skin surface area) x daily exposure frequency; the amount is taken from the SCCS Notes of Guidance (NoG) for the testing of cosmetic ingredients and their safety, 11th revision, which refers back to Hall et al. (2007), Hall et al. (2011), Colipa 16.01.97 BB-97/007,11 and the Scientific Committee on Cosmetic products and Non-Food Products intended for consumers (SCCNFP) SCCNFP/0321/0012; data on the skin surface area (SSA) is taken from the NoG, which refer back to Bremmer et al. (2006)<sup>13</sup> and Bremmer et al. (2006),<sup>14</sup> for hairdressers the SSA of the hands (860 cm²) and for consumers the SSA of ½ head (580 cm²) was considered.
<sup>c</sup>Data taken from the NoG.<sup>7</sup>
<sup>d</sup>Factor by which hairdressers are more exposed as consumers, calculation formula: (frequency of exposure for hairdressers + frequency of exposure for consumers)/frequency of exposure for consumers; day, 8 working hours; month, 21 working days; week, 5 working days.
<sup>e</sup>Relating to both lines for bleaching the hair.
regularly by only 23.9% of the hairdressers.\textsuperscript{10} During deep conditioning the hair with hair conditioner, consumers and/or self-users are exposed to hair-conditioning products 0.28 times per day,\textsuperscript{20} in contrast to hairdressers who are exposed to hair conditioners up to 5 times per day, with a mean duration of 10 minutes plus possibly additional 12.5 minutes each due to potentially following use of conditioning products with head massage.\textsuperscript{10,17} Deep conditioning is done by 90.5% of hairdressers, and 11.5% of hairdressers reported wearing gloves while doing this task; head massages are conducted by 91.7% of hairdressers and 8.4% of hairdressers wear gloves massaging the head.\textsuperscript{10} Cutting wet hair is done either without previous coloring or previous coloring. The former strategy avoids exposure of hairdressers to residual dye monomers, as it is known that colored hair exposes hairdressers to substances released from the hair color. Consumers as well as self-users are not exposed to wet hair during the cutting of hair. Hairdresser are exposed to wet, uncolored hair for up to 9.9 times per day and to colored hair for \textasciitilde 2 times per day, with a mean duration of a haircut being 25.0 minutes each.\textsuperscript{10,15,17-19,21} This task is conducted by 93.5% of the hairdressers, and 1.3% of them use gloves for it.\textsuperscript{10}

Regarding coloring of the full head of hair with permanent/oxidative hair color using 6% to 12% hydrogen peroxide, consumers and/or self-users are exposed one time per month in contrast to hairdressers who are exposed to permanent/oxidative hair color for up to four times per day.\textsuperscript{10,15-19,21} In terms of coloring a full head of hair with semi-permanent oxidative hair color using 2% to 3% hydrogen peroxide or nonoxidative hair color, consumers or self-users are exposed one time per week regarding semi-permanent, nonoxidative hair color and one time per month regarding semi-permanent oxidative hair color, whereas hairdressers are exposed to such coloring agents about three times per week.\textsuperscript{16,17} While coloring roots/regrowth only using oxidative/nonoxidative hair colors according to previous treatment, consumers and/or self-users are exposed a maximum of one time per week regarding semi-permanent, nonoxidative hair color and one time per month regarding semi-permanent oxidative hair color, in contrast to hairdressers who are exposed to the agents approximately three times per week.\textsuperscript{17} The mean duration of each of the coloring services mentioned is 15.0 minutes, and the services are conducted by 99.3% of the hairdressers, of whom 95.2% wear gloves during this task.\textsuperscript{10}

There is no scientific data on consumers’ exposure in highlighting the hair (mostly using bleach with 6% to 9% hydrogen peroxide) and lowlighting (mostly using oxidative hair color with 6% hydrogen peroxide) the hair using (aluminum) foil and using a cap. Presumably, self-users do usually not conduct the aforementioned procedures. Hairdressers, however, are reportedly exposed to bleach or oxidative hair color while using foils for bleaching/coloring 1.2 times per week and while using a cap for bleaching/coloring 0.84 times per day.\textsuperscript{17,18} In addition, scientific data on mean durations as well as the share of hairdressers conducting these tasks and wearing gloves while doing so are not available. For using bleach—mostly with 6% to 9% hydrogen peroxide—for bleaching hair on the full head, data for consumers and/or self-users are not available. It nevertheless needs to be considered that for consumers/self-users the label full head only applies for first-time bleaching; after that full head refers to root/regrowth only, since already bleached hair cannot be bleached as often as desired in contrast to coloring the hair with oxidative or nonoxidative hair colors.

In contrast, hairdressers are exposed to bleach—mostly using 6% to 9% hydrogen peroxide—while bleaching the hair of the full head or also the root/regrowth 2.5 times per day, with a mean duration of 15 minutes for each procedure, which is done by 96.9% of hairdressers, of which 77.9% wear gloves.\textsuperscript{10,16,21}

For perming the hair, data for consumers’ exposure is lacking and self-use is highly unlikely. Hairdressers, in contrast to consumers, are exposed to different types of perming lotions (acid, alkaline, and exothermic perms) and apply perming solutions two (acid perm) to three (alkaline perm) times a day with a mean duration of 5 minutes per procedure (acid and alkaline perm) conducted by 44.3% (alkaline perm) and 97.5% (acid perm) of hairdressers, whereas 29.2% (alkaline perm) and 34.7% (acid perm) wear gloves in each perm solution application process.\textsuperscript{10,15,17}

Exposure data on coloring eyelashes and/or eyebrows has been laid out in only one study, revealing that hairdressers are exposed to oxidative hair color using mostly 3% hydrogen peroxide, conducting this task 0.8 times per day with no further specification on mean duration, share of hairdressers conducting this task, and share of hairdressers wearing gloves while carrying out the task.\textsuperscript{17} For consumers, there are no data available for this exposure; self-use, however, is very rare.

Table 2 summarizes data on the daily dose per area and the exposure factor by which hairdressers have higher exposure to hair cosmetic products than consumers do. For washing the hair with shampoo, the dose per area is 60.81395 to 145.95349 mg/cm²/day for hairdressers and 18.03448 mg/cm²/day for consumers. The exposure of hairdressers regarding shampoo is 6 to 13 times higher compared to consumers. Deep conditioning the hair with hair conditioner provides a dose per area from 4.55814 to 22.79070 mg/cm²/day for hairdressers and 1.89241 mg/cm²/day for consumers. Exposure for hair conditioner is 5 to 19 times higher in hairdressers than in consumers. While coloring hair with permanent/oxidative hair color using 6% to 12% hydrogen peroxide (full head), a dose per area from 0.24689 to 1.54711 mg/cm²/day is given in hairdressers and of 0.00039 mg/cm²/day in consumers. Hairdressers are 32 to 78 times more exposed to permanent/oxidative hair color using 6% to 12% hydrogen peroxide than consumers are. For coloring hair with semi-permanent oxidative hair color using 2% to 3% hydrogen peroxide or nonoxidative hair color (full head), the dose per area is 0.01465 mg/cm²/day for hairdressers and 0.00241 mg/cm²/day for consumers. The exposure of hairdressers is four times higher compared to consumers for semi-permanent oxidative hair color using 2% to 3% hydrogen peroxide or nonoxidative hair color (full head). With respect to coloring hair (root/regrowth only) using oxidative/nonoxidative hair colors according to previous treatment, the dose per area amounts to 0.01220 mg/cm²/day for hairdressers and 0.00014 mg/cm²/day for consumers. Exposure is 13 times higher in hairdressers than in consumers for oxidative/nonoxidative hair colors according to previous treatment (root/regrowth only). In terms of bleaching the hair with bleach mostly using 6% to 9% hydrogen
Exposure to wet work according to epidemiological studies involving hairdressers

| Wet work (h/day)               | Hairdressers’ exposure according to the respective study (mean values) | Consumers’ exposure according to the respective study (mean values) |
|-------------------------------|------------------------------------------------------------------------|-------------------------------------------------------------------|
| Kralj et al. (2011)\(^{15a}\), n = 106 | 8234 ± 3826 s (for 8 h shifts) | –                                                                 |
| Lysdal et al. (2012)\(^{17a}\), n = 2896 | Never: 0.1% <½ h/day: 2.2% ½ h to 1 h/day: 4.1 1 to < 2 h/day: 7.0% 2-3 h/day: 16.8% >3 to < 4 h/day: 15.8% ≥4 h/day: 54.0% | –                                                                 |
| Lund et al. (2019)\(^{22a}\), n = 74 | 4.75 ± 2.63 | –                                                                 |
| Meding et al. (2017)\(^{21b}\), n = 5091 | 0-10 times/day: 71.4% >10 times/day: 28.7% >20 times/day: 3.1% | –                                                                 |

Glove wearing (h/day)

| Lysdal et al. (2012)\(^{17a}\), n = 2887 | <½ h/day: 5.8% ½ h/day: 19.6% >1 to < 2 h/day: 33.7% 2-3 h/day: 31.7% >3 to < 4 h/day: 6.8% ≥4 h/day: 2.4% | – |

Hand washing (times/day)

| Lysdal et al. (2012)\(^{17a}\), n = 2911 | 0-5 times/day: 22.0% 6-10 times/day: 41.1% 11-20 times/day: 29.9% >20 times/day: 7.0% | – |

**Abbreviations:** h, hour; s, seconds.
- **The studied cohort consists of hairdressers.**
- **The study cohort consists of adolescents.**
- **Water exposure is studied rather than wet work.**

3.3.2 | Exposure to wet work in hairdressers compared to consumers

In addition, information about wet work exposure in hairdressers was extracted (Table 3). These data support the known fact that hairdressers are exposed to a considerable amount of wet work within their daily working life, which can add up to even more than 4 hours per working day for a considerable amount of hairdressers, whereas wet work is likely less performed by the “common consumer.”

### TABLE 3 Exposure to wet work according to epidemiological studies involving hairdressers

Hairdressers’ exposure according to the respective study (mean values)

- Hairdressers’ exposure according to the respective study (mean values)
- Consumers’ exposure according to the respective study (mean values)

Wet work (h/day)

| Study on | Hairdressers’ exposure according to the respective study (mean values) | Consumers’ exposure according to the respective study (mean values) |
|----------|------------------------------------------------------------------------|-------------------------------------------------------------------|
| Kralj et al. (2011)\(^{15a}\), n = 106 | 8234 ± 3826 s (for 8 h shifts) | –                                                                 |
| Lysdal et al. (2012)\(^{17a}\), n = 2896 | Never: 0.1% <½ h/day: 2.2% ½ h to 1 h/day: 4.1 1 to < 2 h/day: 7.0% 2-3 h/day: 16.8% >3 to < 4 h/day: 15.8% ≥4 h/day: 54.0% | –                                                                 |
| Lund et al. (2019)\(^{22a}\), n = 74 | 4.75 ± 2.63 | –                                                                 |
| Meding et al. (2017)\(^{21b}\), n = 5091 | 0-10 times/day: 71.4% >10 times/day: 28.7% >20 times/day: 3.1% | –                                                                 |

Glove wearing (h/day)

| Lysdal et al. (2012)\(^{17a}\), n = 2887 | <½ h/day: 5.8% ½ h/day: 19.6% >1 to < 2 h/day: 33.7% 2-3 h/day: 31.7% >3 to < 4 h/day: 6.8% ≥4 h/day: 2.4% | – |

Hand washing (times/day)

| Lysdal et al. (2012)\(^{17a}\), n = 2911 | 0-5 times/day: 22.0% 6-10 times/day: 41.1% 11-20 times/day: 29.9% >20 times/day: 7.0% | – |

**Abbreviations:** h, hour; s, seconds.
- **The studied cohort consists of hairdressers.**
- **The study cohort consists of adolescents.**
- **Water exposure is studied rather than wet work.**

4 | DISCUSSION

In this review we have shown that hairdressers are exposed up to 78 times more than ordinary consumers to customary hair cosmetic products. This applies for a wide spectrum of products ranging from shampoo, conditioner, oxidative and nonoxidative hair colours, to bleaching agents. Assuming comparable product composition, the daily dose per area of single-product ingredients can be compared (hairdressers vs consumers).

To the best of our knowledge, this is the first review to compare occupational exposure in hairdressers with exposure in consumers regarding relevant potentially skin-harming products. In order to assess typical use frequencies of hair cosmetics by consumers, data from the SCCS NoG for the testing of cosmetic ingredients and their safety, 11th revision, were taken into account, to the extent available. For assessing hairdressers’ exposure, a structured literature search was conducted, leading to the inclusion of seven studies in the present review. All included study types can be regarded as adequate, although it should be mentioned that that questionnaire surveys possibly suffer from a certain bias due to the subjective nature of the answers. The study populations cover a wide age structure so that the age of the included hairdressers may reflect the overall age structure in the hairdressing trade. Because the largest proportion of workers in the hairdressing sector of the EU is female, the present high female share among hairdressers was to be expected and does not thus constitute a potential bias.

All of the included studies (n = 7) provided details on the frequency of use of/quantification of exposures to hair cosmetic products in professional hairdressers. Because the period from 1990 to 2020 was taken as an eligible publication period, it should be mentioned that the frequency of exposure to important types of addressed cosmetics might have undergone a change over the last years depending on current trends and changing preferences. In the future, the current frequency of exposure to important types of hair cosmetic products in hairdressers may be assessed via observational studies and in consumers via questionnaire surveys. The latter should also differentiate between consumers (subjected to exposure mainly on the scalp and only partly on the hands) and professional hairdressers (exposed mainly on the hands in the occupational setting). Obviously, as consumers themselves, some hairdressers might also be more exposed to hair cosmetic products within their private surroundings, this being a not quantifiable add-on exposure to the occupational exposure. As a default, the same exposure pattern as laid down in the NoG was used for the self-use share of exposure in hairdressers. It was not only substantiated that hairdressers are exposed to products at a much higher rate than the ordinary consumer while conducting
| Product                                      | Potentially harmful substances (extract) | Exposure route       | Are gloves usually worn? | Comment                                                                                                                                 |
|---------------------------------------------|-----------------------------------------|----------------------|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Eyelash glue                                | Acrylates                               | Dermal, Respiratory  | No                       | Eyelash extensions are used for some make-up services. The eyelash glue is placed on the back of the hand and the eyelash extension is dipped into the glue. The remaining eyelash glue (dried residue) may only be removed at the end of the working day. Dermal and respiratory effects of eyelash glues have already been reported. |
| Nail glue                                   | Acrylates                               | Dermal, Respiratory  | No                       | Press-on-nails or nail art decorations (e.g., rhinestones) are applied with nail glue within the course of conducting manicures. The nail glue may get on the fingers of the hairdresser and only be removed at the end of the working day. Dermal and respiratory effects of nail glues have already been reported. |
| Hair extension glue                         | Acrylates, latex                         | Dermal, Respiratory  | No                       | A variation of hair extension glues is used to install hair extensions. Allergic reactions against hair extension glues have already been reported. The mentioned glues range from liquid delivery forms to adhesive strips (so-called tapes). While installing hair extensions, gloves are regularly not worn, thereby exposing the hairdressers to the glues for a considerable amount of time while providing the service to the client. Glue residue might remain on the hands until they are thoroughly cleaned off at the end of the working day. |
| Hot wax, sugaring paste                     | Colophony, Cera alba, fragrances         | Dermal               | No                       | Depilation of undesired body hair (e.g., facial hair in women) may be removed by hairdressers using hot wax or sugaring paste. While depilating the hair, the hot wax/sugaring paste can get on the hands of the hairdresser and needs to dry before it can be removed. Dermal effects of hot wax/sugaring paste have already been reported. |
| Hair styling and setting products (e.g., hairspray) | Aerosols, resins, fragrances             | Dermal, respiratory | No                       | Styling products (e.g., hair gels) are applied by the hairdresser without gloves, and the hands are usually not washed until the service is finished. In order not to get setting products (e.g., hairspray) into the customers’ face, the hairdresser protects it using their own hand while spraying with the other, getting the hairspray on the protecting hand. Dermal and respiratory effects of hairsprays have already been reported. |
| Metal tools/objects (e.g., tweezers, crochet hooks) | Nickel and/or cobalt                     | Dermal               | No                       | Tweezers are used to pluck eyebrows and to remove undesired facial hair. A nickel and cobalt release (and also a co-release of both) from tweezers has already been reported. Crochet hooks are used for highlighting/lowlighting the hair using a cap. A nickel release from tweezers in the hairdressing trade has already been reported. |
many working tasks, but also that a considerable amount of identified procedures are usually performed only by hairdressers, such as perming the hair using diverse types of perming solutions (Table 1). These procedures provide a set of hairdressing-exclusive services on their own and provide an extra exposure for hairdressers that consumers presumably do not have.

Because data on 12 procedures alongside with concomitantly used product types were available, many of the most relevant procedures exposing hairdressers to hair cosmetic products are covered in this review. However, there are other additional tasks conducted within the hairdressing trade that expose workers to additional cosmetic products for which no data are yet available. Additional sources of exposure to potentially harmful substances are listed in Table 4, among them cosmetic glues for applying eyelashes, nails, and hair extensions, hot wax and sugaring paste for hair removal, hair styling and setting products, as well as metallic work tools. Occupational exposure may be fluctuating due to changing product formulations. Regarding acrylates, two current investigations focus on the increasing use of (meth)acrylates in gel nail polish—such as daylight curing “hybrid” gel nail polish—and their role as sensitizers. With regard to the common contact allergens nickel and cobalt, two recent studies found release of these metal allergens in allergologically relevant amounts from a broad spectrum of tools that are used on a daily basis in hairdressing. The frequency of use of the products listed in Table 4 could be evaluated in forthcoming studies. As permanent remodeling of the hair structure—that is, curling or straightening—with various new methods (i.e., so-called Brazilian blow-outs or keratin treatments for smoothing the hair structure) has gained more popularity over the last years, the utilized chemicals prospectively need particular attention regarding dermal and/or respiratory effects in hairdressers.

It was also shown that concerning all procedures that should only be conducted wearing adequate protective gloves, the share of hairdressers actually wearing gloves is disenchanted. Especially against the background of hairdressers reusing already worn gloves, contamination due to wrong use or while taking off the gloves, break-through times of gloves, and the fact that some substances used in hairdressing products (e.g. p-phenylenediamine [PPD] used in hair color) penetrate glove material, glove use is not as effective as envisaged. Correct utilization of suitable gloves according to the type of conducted tasks should always be promoted. This is especially relevant for hairdressers with a high exposure in their working life, but also should not be neglected in consumers using hairdressing chemicals at home. Regarding the second group, data are lacking and could be gathered in future studies. Concerning glove use while shampooing, such protection can probably be deemed exceptional in consumers.

Data on wet work has again supported the known fact that this exposure is likely present in considerable extent in hairdressers, whereas this is not the case for the “common consumer.” Wet work leads to an impairment of the epidermal barrier function concomitant with the genesis of a proinflammatory milieu. Thus, penetration of skin with hazardous substances, such as allergens, is facilitated and the risk of the development of allergic contact dermatitis—especially of the hands—is promoted. Recently it was shown that PPD itself, a common ingredient in hair dyes, can turn down the function of tight junctions and stratum corneum proteins, even when there are no clinical symptoms present. These effects on the skin and combined exposures to irritants and allergens lead to a higher susceptibility and risk of skin sensitization, which need to be taken into account in future risk assessment, for example, by applying extra safety factors. First attempts of quantitative risk assessment have indeed indicated that for PPD and toluene-2,5-diamine (PTD) contact that sensitization may occur when skin protection is not applied adequately. Moreover, aggregated exposure—that is, exposure to the same ingredient via different products—can be expected concerning auxiliary ingredients such as preservatives, fragrances, or emulsifiers. This will further increase cumulative exposure to such substances, both in consumers, and, even more so, in hairdressers. It should additionally be specified that the exposure of hairdressers should always be evaluated with the starting level being on the level of a consumer, as it was shown that hairdressers tend to apply many hairdressing procedures to themselves.

5 CONCLUSION

The results of the present review imply that an assumed frequency of use for consumers is not suitable for representing exposure—and with it, morbidity risk—of hairdressers. Higher exposure leads to a greater risk of skin irritation and sensitization, which consequently also has ramifications regarding systemic exposure via skin. The regulations in force do not adequately address the occupational dangers linked with the use of cosmetic products in hairdressers. A rethinking of present risk assessment practices should be prompted.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

Carasymanzik: Conceptualization (equal); data curation (lead); formal analysis (lead); methodology (equal); project administration (supporting); visualization (lead); writing – original draft (lead); writing – review and editing (equal). Jeanne D. Johansen: Conceptualization (lead); data curation (lead); formal analysis (equal);
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DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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