

## Induction of sensitive skin and sensitive scalp by hair dyeing

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**Abstract:** Hair dyes are more and more used and the role of the exposure to these products in the development of skin reactions in the exposed region is suspected.

The aim of this study is to assess the effects of hair dyes on facial skin and scalp sensitivity by performing a Computer Assisted Web Interview on 1257 women older than 15 years old.

Differences were observed in the scores evaluating facial skin and scalp sensitivity according to different parameters. Women aged between 15 and 24 years old suffered more from skin and scalp sensitivity both for hair dye users and for non-users. The results obtained according to hair dye usage patterns indicated the highest sensitivity of the scalp and facial skin when the hair dyeing process was performed at home with professional products, or when the type of product used was bleach alone or bleach followed by another dyeing product.

The severity of facial skin and scalp sensitivity depends on different factors and seems to be potentially exacerbated by the hair dyeing process.

**Keywords:** Hair dye; Skin sensitivity; Scalp sensitivity; French women; Web survey; Dermatology; Sensitivity scores

## [16] Introduction:

Sensitive (or reactive/hyper-reactive) skin is defined as skin that exhibits erythema and/or subjective symptoms of irritation (stinging, tingling sensation, prickling, burning, pain...) [1–3] caused by various factors, which may be physical, chemical, psychological or hormonal. Sensitive skin symptoms occur over a wide range of intensities [4] and may be an adverse reaction occurring in response to topically applied agents such as cosmetics [5–7] with a usually rapid onset (within minutes) [7]. Most of the time, sensitive skin is located on the face but other localizations such as the scalp, hands, feet or neck are possible [2,8]. Thus, a sensitive scalp condition can exist even if the symptoms are different from those observed for facial skin sensitivity.

Only few of sensitive skin symptoms are objective clinical signs thereby giving to sensitive skin a subjective nature [9]. Thus, one of the best ways to study these symptoms is to conduct an epidemiological study [1], integrating questions about skin and scalp sensitivity symptoms and their intensity, the answers to which will be used to calculate the Sensitive Scalp Severity Score (3S score) [1] and the Sensitive Scale-10 (SS-10) for facial skin [8].

Some cosmetic product users may develop a burning, stinging or itching reaction after application of the product, without visible lesions [10,11]. Yet, in the case of a mild reaction, users will seldom seek medical care, resulting in an unreported reaction. It therefore remains difficult to assess the incidence of skin reactions due to the use of cosmetic products [10].

Hair dyes belong to the hair care branch of cosmetics. According to Draelos, approximately 70 % of women in developed countries use hair dye [12]. In France, the percentage of hair dye users in the general population of French women (15-70 years old) was assessed at 64 % [13]. Some adverse skin reactions are attributed to hair dyes, especially allergic contact dermatitis which may be severe and require a physician consultation. Mild skin reactions to hair dyes are usually identified by the users themselves due to the relative short timeframe between exposure and the development of skin reactions in the exposed region [14]. Corbett indicated that some colorants contained in hair dye give rise to skin problems including sensitization or irritation [15]. Hence, hair dye components such as ammonia or hydrogen peroxide are also liable to induce sensitization and irritation especially on users with a sensitive scalp [15]. Seo [16] indicated that more complaints are reported about side-effects of hair dyes on the scalp in relation to the increased use of hair dyes. In 2005, Søsted published the results of his study on contact dermatitis due to hair dye and determined, for the lifetime prevalence of skin symptoms, that 4.9 % of a sample of Danish adults who dyed their hair experienced redness, scaling and itching after the use of hair dye [17]. The results of Alghamdi's survey in 2012 indicated that 15.1% of the participants reported redness, 14.4% scaling, and 31.3% itchiness caused by the use of hair dyes. Among the participants who reported side effects, 85 % did not seek medical attention [18].

The purpose of this study was to analyse the effects of hair dyes on facial skin sensitivity and on scalp sensitivity by performing a survey on hair dye consumption among French women including an evaluation of the severity of skin sensitivity based on the Sensitive Scale-10 and of Sensitive Scalp Severity by the 3S score.

## [17] **Materials and Methods:**

### [18] Survey:

A web survey was carried out in April 2015 in collaboration with a private survey company: Consumer Science and Analytics (CSA). The questionnaire was designed by the authors and executed by the CSA. This survey was developed to provide information on French women's hair dye usage patterns and on the presence and intensity of dermatological symptoms on the scalp or face. To obtain a representative sample of the French female population, quotas were applied taking into account age, socio-professional category, geographical area and degree of urbanization. However, in order to obtain sufficient data to study the possible link between hair dye use and modification of sensitivity, a quota of 75 % of hair colouring users was required. Thereby, the study was conducted on 1257 women older than 15 years old (939 users and 318 non-users).

Only women were involved in this survey because a previous study indicated that the percentage of hair dye users among the French male population was only 6 % [19].

### [19] Ethical considerations:

This study was carried out in accordance with the principles outlined in the Declaration of Helsinki of 1973 as revised in 2000 [20] and in compliance with the "Protection of Human Subjects and Animals in Research" as described in the recommendations of the International Committee of Medical Journal Editor [21]. The questionnaire designed by the authors and used in this survey was totally anonymous, i.e. no identifying information were asked to the respondents. The execution of the survey was subcontracted to the CSA, a specialized company member of ESOMAR (European Society for Opinion and Marketing Research). The CSA performs its survey in the respect of the ICC/ESOMAR International Code on Market and Social Research [22].

### [20] Questionnaire:

The following questions about hair dye use were put to the interviewees:

- [1] Have you dyed your hair during the last 12 months?
- [2] Where did you have your hair dyed? At the hairdresser, at home using a professional product or at home using a supermarket product?
- [3] Which type of hair dye product did you use? Hair bleach alone, lightener, permanent dye, semi-permanent dye, temporary dye, vegetal dye or hair bleach plus another dye?

Dermatological evaluations were performed according to various parameters thanks to the 10-item Sensitive Scale named Sensitive Scale-10 (SS-10) for facial skin [8] and the 3S score (Sensitive Scalp Score) [1] for the scalp.

The following questions about sensitive scalp and sensitive skin severity were put to the participants:

Fig. 1. Which symptoms did you have on your scalp? Tightness, burning, prickling, itching and/or pain?

Fig. 2. Which grade would you give to each symptom?

Fig. 3. 0= absent

Fig. 4. 1= not troublesome

Fig. 5. 2= somewhat troublesome

Fig. 6. 3= very troublesome

Fig. 7. Which symptoms did you have on your facial skin? Irritability, Stinging, Burning, Heat sensation, Tautness, Itching, Pain, General discomfort, Flashes, Redness?

Fig. 8. What was the symptoms' intensity on a scale from 0 to 10?

Women were also asked to report the pre-existence of skin disease such as eczema, psoriasis, ringworm, folliculitis, seborrheic dermatitis, acne, urticaria; and if they performed a skin patch test prior to hair dyeing.

[21] Statistical analysis:

The global 3S score was calculated for each participant by adding together the grades of the 5 symptoms on the scalp (maximum possible score = 15) and the global SS-10 score by adding the intensity of the 10 symptoms on the skin (maximum possible score = 100). The global scores were then compared using the Kruskal-Wallis test and Dunn multiple pairwise comparisons. The statistical analyses were run with the XLSTAT 2015 software (Addinsoft). Groups that were not significantly different from each other are represented in the results' tables with the same letter (A, B, C, D or E) and contrariwise the groups represented by a given letter were statistically different from groups with other letters.

As there were more or less substantial differences between sample sizes in the groups compared, random resampling was performed to obtain groups of the same size before statistical analysis.

## [22] Results:

Mean and standard deviation values are presented in the various tables of results.

[23] Sensitive Scalp Score:

I. 3S score results by age group according to hair dye use:

The Sensitive Scalp Scores were calculated for hair dye users and non-users of each age group (Table 1). When considering the entire population, i.e. women older than 15 years old, there were no statistical differences between scores obtained for users and non-users. However, by looking at age sub-populations, statistical differences appeared between the scores of users and non-users for two age classes (15-24 and 50-64 years old). In these cases, the highest mean scores were found among hair dye users with values of 3.34 and

1.70 respectively for the 15-24 and 50-64 year-old users, while 3S score means of 2.31 and 1.62 were obtained respectively for 15-24 and 50-64 year-old non-users. No statistical difference was observed between users and non-users of the other age classes.

Table 1: Women 3S Score results according to age and hair dye use

| Age and hair dye use                                   | Minimal 3S Score | Maximal 3S Score | 3S Score mean | 3S Score SD | p-value |
|--|------------------|------------------|---------------|-------------|---------|
| Non users $\geq 15$ years old<br>(n=318) ( $n_R=939$ ) | 0.00             | 15.00            | 2.08          | 2.91        | 0.93    |
| Users $\geq 15$ years old<br>(n=939)                   | 0.00             | 15.00            | 2.02          | 2.77        |         |
| Non users 15-24 years old<br>(n=66) ( $n_R=107$ )      | 0.00             | 15.00            | 2.31          | 2.83        | 0.03    |
| Users 15-24 years old<br>(n=107)                       | 0.00             | 14.00            | 3.34          | 3.48        |         |
| Non users 25-34 years old<br>(n=64) ( $n_R=131$ )      | 0.00             | 8.00             | 1.84          | 2.06        | 0.40    |
| Users 25-34 years old<br>(n=131)                       | 0.00             | 15.00            | 2.33          | 2.93        |         |
| Non users 35-49 years old<br>(n=77) ( $n_R=242$ )      | 0.00             | 15.00            | 2.35          | 2.63        | 0.20    |
| Users 35-49 years old<br>(n=242)                       | 0.00             | 15.00            | 2.16          | 2.89        |         |
| Non users 50-64 years old<br>(n=46) ( $n_R=260$ )      | 0.00             | 15.00            | 1.62          | 3.57        | 0.00    |
| Users 50-64 years olds<br>(n=260)                      | 0.00             | 15.00            | 1.70          | 2.52        |         |
| Non users $\geq 65$ years old<br>(n=65) ( $n_R=199$ )  | 0.00             | 8.00             | 1.67          | 2.21        | 0.43    |
| Users $\geq 65$ years old<br>(n=199)                   | 0.00             | 14.00            | 1.38          | 2.05        |         |

( $n_R=000$ ) = Sample size after resampling

## II. 3S score results by age group among hair dye users:

Sensitive Scalp Scores were calculated for hair dye users at hairdressers (Table 2) and at home with supermarket products (Table 3) according to their age. The highest 3S score means of 3.15 (hairdresser) and 3.45 (supermarket products) were obtained for women aged between 15 and 24 years old with a marked statistical difference, i.e. p-value  $<0.0001$ , with the other age groups ( $\geq 25$  years old). The lowest 3S score means were obtained for women older than 65 years old with means of 1.24 (hairdresser) and 1.50 (supermarket products).

Table 2: Women hair dye users at the hairdresser 3S Score results according to their age

| Age                                      | Minimal 3S Score | Maximal 3S Score | 3S Score mean | 3S Score SD | p-value  | Statistical group |
|--|------------------|------------------|---------------|-------------|----------|-------------------|
| 15-24 years old<br>(n=53) ( $n_R=133$ )  | 0.00             | 14.00            | 3.15          | 3.37        | < 0.0001 | B                 |
| 25-34 years old<br>(n=66) ( $n_R=133$ )  | 0.00             | 10.00            | 1.44          | 1.91        |          | A                 |
| 35-49 years old<br>(n=112) ( $n_R=133$ ) | 0.00             | 11.00            | 1.58          | 2.39        |          | A                 |
| 50-64 years old<br>(n=123) ( $n_R=133$ ) | 0.00             | 14.00            | 1.60          | 2.45        |          | A                 |
| ≥ 65 years old<br>(n=133)                | 0.00             | 8.00             | 1.24          | 1.72        |          | A                 |

( $n_R=000$ ) = Sample size after resampling

Groups that were not significantly different from each other are represented with the same letter (A or B) and contrariwise were statistically different from groups with other letters.

Table 3: Women hair dye users, at home with supermarket products, 3S Score results according to their age

| Age                                      | Minimal 3S Score | Maximal 3S Score | 3S Score mean | 3S Score SD | p-value  | Statistical group |
|--|------------------|------------------|---------------|-------------|----------|-------------------|
| 15-24 years old<br>(n=32) ( $n_R=112$ )  | 0.00             | 11.00            | 3.45          | 3.05        | < 0.0001 | C                 |
| 25-34 years old<br>(n=52) ( $n_R=112$ )  | 0.00             | 15.00            | 2.85          | 3.30        |          | B                 |
| 35-49 years old<br>(n=112)               | 0.00             | 15.00            | 2.40          | 2.93        |          | B                 |
| 50-64 years old<br>(n=104) ( $n_R=112$ ) | 0.00             | 12.00            | 2.19          | 2.66        |          | B                 |
| ≥ 65 years old<br>(n=51) ( $n_R=112$ )   | 0.00             | 11.00            | 1.50          | 2.21        |          | A                 |

( $n_R=000$ ) = Sample size after resampling

Groups that were not significantly different from each other are represented with the same letter (A, B or C) and contrariwise were statistically different from groups with other letters.

### III. 3S score results for users according to the place of use:

The Sensitive Scalp Score was calculated for hair dye users by considering the place of use (Table 4). The lowest 3S score mean of 1.65 was obtained for women who had their hair dyed at the hairdresser with a clear statistical difference with mean scores obtained for women dyeing their hair at home with supermarket (2.20) or professional products (2.78).

Table 4: Women hair dye users 3S Score results according to the place of use

| Place of use   | Minimal 3S Score | Maximal 3S Score | 3S Score mean | 3S Score SD | p-value  | Statistical group |
|--|------------------|------------------|---------------|-------------|----------|-------------------|
| At the hairdresser<br>(n=487)                              | 0.00             | 14.00            | 1.65          | 2.37        | < 0.0001 | A                 |
| At home using<br>supermarket products<br>(n=351) (nr=487)  | 0.00             | 15.00            | 2.20          | 2.76        |          | B                 |
| At home using<br>professional products<br>(n=101) (nr=487) | 0.00             | 15.00            | 2.78          | 3.62        |          | B                 |

(nr=000) = Sample size after resampling

Groups that were not significantly different from each other are represented with the same letter (A or B) and contrariwise were statistically different from groups with other letters.

IV. 3S score results for users with differentiation according to the type of hair dye used:

The Sensitive Scalp Score was calculated for hair dye users depending on the type of product used (Table 5). The highest 3S score mean of 3.39 was obtained for women who applied bleach followed by another hair dye with no statistical difference with scores obtained for women who applied bleach alone. The lowest mean scores were found in the cases of use of semi-permanent (1.62) and temporary (1.62) hair dyes.

Table 5: Women hair dye users 3S Score results according to the type of hair dye used

| Type of hair dye                      | Minimal 3S Score | Maximal 3S Score | 3S Score mean | 3S Score SD | p-value  | Statistical group |
|---------------------------------------|------------------|------------------|---------------|-------------|----------|-------------------|
| Bleach + other dye<br>(n=28) (nr=503) | 0.00             | 14.00            | 3.39          | 3.93        | < 0.0001 | D                 |
| Bleach solely<br>(n=27) (nr=503)      | 0.00             | 11.00            | 2.88          | 3.32        |          | CD                |
| Lightener<br>(n=88) (nr=503)          | 0.00             | 15.00            | 2.40          | 2.99        |          | BC                |
| Permanent<br>(n=503)                  | 0.00             | 15.00            | 2.01          | 2.77        |          | A                 |
| Semi-permanent<br>(n=104) (nr=503)    | 0.00             | 14.00            | 1.62          | 2.21        |          | A                 |
| Temporary<br>(n=36) (nr=503)          | 0.00             | 7.00             | 1.62          | 1.70        |          | A                 |
| Vegetal<br>(n=37) (nr=503)            | 0.00             | 10.00            | 2.07          | 2.36        |          | B                 |

(nr=000) = Sample size after resampling

Groups that were not significantly different from each other are represented with the same letter (A, B, C or D) and contrariwise were statistically different from groups with other letters.

V. 3S score results for users according to their skin disease:

The Sensitive Scalp Score was calculated for hair dye users by taking into consideration their known skin disease (Table 6). The lowest 3S score mean of 1.48 was obtained for women with no skin disease with a marked statistical difference compared to scores obtained for women with skin disease, reaching a mean of 3.67 for users suffering from dermatitis.

Table 6: Women hair dye users 3S Score results according to their skin disease

| Skin diseases                 | Minimal 3S Score | Maximal 3S Score | 3S Score mean | 3S Score SD | p-value  | Statistical group |
|-------------------------------|------------------|------------------|---------------|-------------|----------|-------------------|
| None<br>(n=674)               | 0.00             | 15.00            | 1.48          | 2.31        | < 0.0001 | A                 |
| Eczema<br>(n=87) (nr=674)     | 0.00             | 14.00            | 3.39          | 3.36        |          | B                 |
| Psoriasis<br>(n=53) (nr=674)  | 0.00             | 15.00            | 3.42          | 3.45        |          | B                 |
| Dermatitis<br>(n=32) (nr=674) | 0.00             | 15.00            | 3.67          | 3.82        |          | BC                |
| Acne<br>(n=82) (nr=674)       | 0.00             | 15.00            | 3.61          | 3.21        |          | C                 |

(nr=000) = Sample size after resampling

Groups that were not significantly different from each other are represented with the same letter (A, B or C) and contrariwise were statistically different from groups with other letters.

[24] Facial skin Sensitive Scale-10 results:

VI. SS-10 score results by age group among hair dye users:

The Sensitive Scale-10 score was assessed by age classes among the women hair dye users (Table 7). There were no statistical differences between scores obtained for age groups from 25 to 64 years old. Women older than 65 years old presented the lowest mean score of 3.39 with clear statistical differences with the other groups. The highest scores were found for 15-24 year-olds, i.e. a mean of 18.93, with marked statistical differences with the scores of women older than 25 years old.

Table 7: Women hair dye users with SS-10 Score results according to their age

| Age                                 | Minimal SS-10 Score | Maximal SS-10 Score | SS-10 Score mean | SS-10 Score SD | p-value  | Statistical group |
|-------------------------------------|---------------------|---------------------|------------------|----------------|----------|-------------------|
| 15-24 years old<br>(n=107) (nr=260) | 0.00                | 82.00               | 18.93            | 24.85          | < 0.0001 | C                 |
| 25-34 years old<br>(n=131) (nr=260) | 0.00                | 88.00               | 11.33            | 19.13          |          | B                 |
| 35-49 years old<br>(n=242) (nr=260) | 0.00                | 93.00               | 10.04            | 16.73          |          | B                 |
| 50-64 years old<br>(n=260)          | 0.00                | 94.00               | 8.26             | 15.39          |          | B                 |
| ≥ 65 years old<br>(n=199) (nr=260)  | 0.00                | 51.00               | 3.39             | 6.48           |          | A                 |



(*nr=000*) = Sample size after resampling

Groups that were not significantly different from each other are represented with the same letter (A, B or C) and contrariwise were statistically different from groups with other letters.

VII. SS-10 score results for users according to the place of use:

Sensitive Scale-10 scores were assessed among the women hair dye users depending on the place they dyed their hair (Table 8).

Women dyeing their hair at the hairdresser obtained the lowest mean score (7.43) with statistical differences with groups of women who dyed their hair at home. The highest score was found for women using professional products at home, with a mean score of 12.96.

Table 8: Women hair dye users SS-10 Score results according to the place of use

| Place of use   | Minimal SS-10 Score | Maximal SS-10 Score | SS-10 Score mean | SS-10 Score SD | p-value     | Statistical group |
|--|---------------------|---------------------|------------------|----------------|-------------|-------------------|
| At the hairdresser<br>(n=487)  | 0.00                | 89.00               | 7.43             | 14.67          | <<br>0.0001 | A                 |
| At home using<br>supermarket<br>products<br>(n=351) ( <i>nr=487</i> )  | 0.00                | 77.00               | 9.14             | 15.92          |             | B                 |
| At home using<br>professional<br>products<br>(n=101) ( <i>nr=487</i> ) | 0.00                | 93.00               | 12.96            | 20.47          |             | C                 |

(*nr=000*) = Sample size after resampling

Groups that were not significantly different from each other are represented with the same letter (A, B or C) and contrariwise were statistically different from groups with other letters.

VIII. SS-10 score results for users according to the type of hair dye used:

Sensitive Scale-10 scores were assessed among the women hair dye users depending on the type of hair dye used (Table 9). Women applying bleach followed by another hair dye obtained the highest mean score value (24.34) with statistical differences with the other groups. The group of women with the lowest mean score, i.e. 7.75, is the group of permanent dye users.

Table 9: Women hair dye users SS-10 Score results according to the type of hair dye used

| Type of hair dye                               | Minimal SS-10 Score | Maximal SS-10 Score | SS-10 Score mean | SS-10 Score SD | p-value     | Statistical group |
|--|---------------------|---------------------|------------------|----------------|-------------|-------------------|
| Bleach + other dye<br>(n=28) ( <i>nr=503</i> ) | 0.00                | 79.00               | 24.34            | 28.79          | <<br>0.0001 | E                 |
| Bleach solely<br>(n=27) ( <i>nr=503</i> )      | 0.00                | 79.00               | 17.54            | 24.25          |             | D                 |
| Lightener<br>(n=88) ( <i>nr=503</i> )          | 0.00                | 94.00               | 14.75            | 23.33          |             | CD                |
| Permanent<br>(n=503)                           | 0.00                | 93.00               | 7.75             | 15.13          |             | A                 |
| Semi-permanent<br>(n=104) ( <i>nr=503</i> )    | 0.00                | 89.00               | 10.21            | 15.83          |             | BC                |

|                              |      |       |      |       |  |   |
|------------------------------|------|-------|------|-------|--|---|
| Temporary<br>(n=36) (nr=503) | 0.00 | 51.00 | 8.88 | 13.18 |  | B |
| Vegetal<br>(n=37) (nr=503)   | 0.00 | 43.00 | 7.85 | 12.23 |  | B |

(nr=000) = Sample size after resampling

Groups that were not significantly different from each other are represented with the same letter (A, B, C, D or E) and contrariwise were statistically different from groups with other letters.

IX. SS-10 score results for users according to their skin disease:

Sensitive Scale-10 scores were assessed among the women hair dye users according to whether or not they had a known skin disease (Table 10). Women with no skin disease obtained the lowest mean score of 6.66 with statistical differences with groups of women with a skin disease. Women suffering from eczema had the highest mean score (21.02) with statistical differences with all the other groups.

Table 10: Women hair dye users SS-10 Score results according to their skin disease

| Skin disease                  | Minimal SS-10 Score | Maximal SS-10 Score | SS-10 Score mean | SS-10 Score SD | p-value  | Statistical group |
|-------------------------------|---------------------|---------------------|------------------|----------------|----------|-------------------|
| None<br>(n=674)               | 0.00                | 77.00               | 6.66             | 13.13          | < 0.0001 | A                 |
| Eczema<br>(n=87) (nr=674)     | 0.00                | 94.00               | 21.02            | 25.59          |          | D                 |
| Psoriasis<br>(n=53) (nr=674)  | 0.00                | 79.00               | 15.62            | 22.31          |          | C                 |
| Dermatitis<br>(n=32) (nr=674) | 0.00                | 70.00               | 10.68            | 16.88          |          | B                 |
| Acne<br>(n=82) (nr=674)       | 0.00                | 93.00               | 16.83            | 24.69          |          | C                 |

(nr=000) = Sample size after resampling

Groups that were not significantly different from each other are represented with the same letter (A, B, C or D) and contrariwise were statistically different from groups with other letters.

**[25] Discussion:**

To our knowledge, this is the first study that assesses local side effects of hair dye use on facial skin and scalp sensitivity by an epidemiological approach using sensitivity scores. It allows us to highlight that some types of hair dye as well as the place of use influence sensitivity to a varying degree. Owing to the fact that reactions to hair dye are identified by the users due to their rapid onset [14], and that mainly of the symptoms are subjective, the implementation of an epidemiological study is appropriate to assess facial skin and scalp sensitivity [1]. Furthermore, this kind of study based on subjects' declarations by means of self-questionnaires on web is relevant because the subjects can easily identify sensitive skin symptoms and thus do not necessary require a dermatological consultation [23].

The scores obtained in the present study suggest that women between 15 and 24 years old are more likely than older women to exhibit skin and scalp sensitivity and appear to be more reactive to hair dyes as regards the differences in scores between users and non-users of this age class. This observation goes against previous results [1], which suggested that the prevalence of scalp sensitivity increases with the age. However, higher reactivity to hair dye obtained for 15-24 year-old is consistent with other studies stating that the skin of younger adults has been demonstrated to be more sensitive than the skin of elderly subjects [24] and that skin irritant reactivity declines with advanced age [3,25]. Women experiencing reactivity to hair dye in their youth, could stop the use of such products, thus leading to an older population of users composed predominantly of women non or less reactive to hair dyes but the frequencies of hair dye use found for the 15-24 year-old group were clearly lower than those found for women older than 65 years old, independently of the place or type of product used, in our hair dye consumption study [13]. The assumption of a possible link between the frequency of use and sensitivity scores was investigated but no link was highlighted between sensitivity changes and the frequency of use.

Some authors' conclusions emphasize that there could be a relationship between sensitive skin and other dermatological conditions [26]. Especially, skin reactivity could be exacerbated by eczema [2,3,27,28]. Fairly logically, the scores obtained for users with a dermatological disease were higher than the healthy users' scores both for scalp and facial skin sensitivity. Users exhibiting the highest sensitive scalp severity suffered from dermatitis or acne, and those with the highest facial skin sensitivity suffered from acne or eczema.

The place of hair dyeing and the type of product used seem to affect the results of sensitivity. Indeed, women who had their hair dyed at the hairdresser presented the lowest scalp and facial skin sensitivity, and the highest scores were obtained in the case of women dyeing their hair at home with professional products. This ascertainment is probably linked to the fact that women using professional products were found to be the most exposed to hair dye [13]. The scores assessed for women using professional products at home seem not to be related to excessive processing time because the vast majority reported that they respected the recommended time or decreased it. Rather, these scores could probably be explained by the complexity of the mixture preparation of professional products, and by the availability on the market of products with high concentrations of oxidants which may lead to improper use of professional products. Moreover, the results of facial skin and scalp sensitivity varied significantly depending on the type of hair dye used. The highest scores, both for scalp and facial skin, were obtained for women using bleach followed by another dye or bleach alone. A possible explanation is that bleach may be composed of hydrogen peroxide, ammonium persulfate and/or potassium persulfate. Persulfates are used in order to increase the action of bleaching agents and can cause irritant contact dermatitis as well as allergic contact dermatitis [11]. Brown reported on the fact that hydrogen peroxide can cause skin irritation, and ammonium and potassium persulfate have been found to cause a variety of reactions which vary in severity depending on the amount of these components in the

bleach [29]. For Fujita, hydrogen peroxide can cause sensory irritation on the skin surface, such as a stinging, prickling or burning sensation [30].

## **[26] Conclusion:**

In this study, the effects of hair dyes on facial skin sensitivity and on scalp sensitivity was analysed by performing a survey on hair dye consumption among French women and an evaluation of the severity of skin sensitivity based on the Sensitive Scale-10 and of Sensitive Scalp Severity by the 3S score. The severity of facial skin and scalp sensitivity depends on different factors such as age and dermatological disease. It also seems to be potentially exacerbated by the hair dyeing process, especially when women use professional hair dyeing products at home or when the type of product used is bleach, whether alone or followed by another dye.

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