

ORIGINAL ARTICLE

Nickel release from metal tools in the German hairdressing trade—A current analysis

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Background: Nickel is one of the most common contact allergens. Despite EU regulations concerning the maximum permissible release of nickel from metal objects, nickel release at inappropriately high levels from metal objects has been detected in various studies.

Objectives: To screen current nickel release from metal tools in the German hairdressing trade.

Methods: Two hundred and twenty-nine metal tools from the German hairdressing trade were tested with the dimethylglyoxime (DMG) test for nickel release. Additionally, an employee survey was conducted to collect data about the metal tools.

Results: The DMG test showed that 21 of 229 metal tools (9.2%) released nickel. Nickel release was detected in 8 of 45 hair clips (17.8%), 2 of 27 tail combs (7.4%), and 11 of 17 tweezers (64.7%).

Conclusion: It must be assumed that hairdressers in Germany have prolonged skin contact with nickel-releasing metal tools. This should prompt further testing for nickel release from metal tools, and the development of regulations to eliminate nickel-releasing metal tools in the (German) hairdressing trade.

KEYWORDS

dimethylglyoxime test, Germany, hairdresser, metal tools, nickel

1 | INTRODUCTION

Hairdressers have one of the highest risks of developing occupational dermatoses.¹ The intense occupational exposure in terms of a combination of frequent wet work and skin contact with detergents and chemicals may lead to barrier impairment, and thus—among other factors, for example, a proinflammatory milieu—to a higher risk of developing allergic contact dermatitis.^{2,3} Nickel is, according to the German Contact Dermatitis Group and the Information Network of Departments of Dermatology, among the most frequent contact allergens, with a sensitization prevalence of 15.3%.⁴ The risk of developing occupational allergic contact dermatitis in the hairdressing trade is 10.58%.⁵ Currently, the REACH Regulation (Entry 27 of Annex XVII to REACH) regulates the allowed maximum quantity of nickel released from metal objects in the EU.⁶ According to the REACH Regulation, nickel release from products with direct and prolonged skin contact must not be $>0.5 \mu\text{g}/\text{cm}^2/\text{week}$.⁶ The European Chemicals Agency (ECHA) defines prolonged skin contact as contact with the skin with

“nickel of potentially more than 10 minutes on three or more occasions within two weeks, or 30 minutes on one or more occasions within two weeks”.⁷ As the REACH Regulation is general, occupational exposure to nickel-containing metal objects is included in it. Moreover, the occupational use of tools in the hairdressing trade can be regarded as prolonged skin contact according to the definition of the ECHA.

Although the prevalence of nickel allergy decreased between 1994 and 2012, nickel allergy is still an established health problem in the EU.^{8–11} In addition to individual consequences, occupational nickel contact allergy may pose an economic problem, as it may lead to a change of occupation, precarious work, or unemployment.¹²

The nickel release from metal objects in the EU has been examined in various screening studies over the years (Table 1). In Table 1, screening studies—which assessed nickel release from either occupationally used metal tools or metal objects used for styling hair (eg, hair clasps and accessories)—are summarized. In these studies, a nickel

TABLE 1 Summary of dimethylglyoxime (DMG) test results in studies detecting nickel release from metal objects in the EU

Study	Tested objects	n (total)	% DMG test-positive
Thyssen et al 2009 ¹³	Hairdressing scissors and crochet hooks	207	3.7
Thyssen et al 2009 ¹⁴	Jewellery and hair clasps	354	22.0
Thyssen et al 2010 ¹⁵	Various metallic items	151	43.7
Thyssen et al 2011 ¹⁶	Hand-held work tools	200	5.0
Kickinger-Lörsch et al 2015 ¹⁷	Hand-held work tools	600	32.5
Ringborg et al 2016 ¹⁸	Accessories, utensils, and electronic devices	141	44.0
Present study	Hairdresser tools	229	9.2

release from metal objects was detected with a dimethylglyoxime (DMG) test.^{13–18} Despite the current regulations regarding the utilization and the allowed maximum release quantity of nickel, nickel release from various metal objects (eg, tools and cell phones) in the EU above legally required threshold levels was repeatedly shown by these studies.

The aim of the present study was to assess whether metal tools in the German hairdressing trade release nickel. Various metal tools were tested for nickel release with the DMG test, and an employee survey was conducted in order to collect data about the age, price and manufacturers of the tested metal tools.

2 | MATERIALS AND METHODS

A DMG test (Chemo Nickel Test; Chemotechnique Diagnostics, Vellinge, Sweden) and ordinary white cotton swabs from pure cotton wool of the brand ebelin (dm-drogerie markt, Karlsruhe, Germany) were used for DMG testing. The Chemo Nickel Test is a solution and contains the following ingredients: water, ethanol, ammonium hydroxide, and DMG (CAS no. 95-45-4).

Various metal tools ($n = 229$) in the hairdressing trade were examined with the DMG test. These included scissors ($n = 62$), hair clips ($n = 45$), hair rollers ($n = 45$), tail combs ($n = 27$), whisks ($n = 20$), tweezers ($n = 17$), and hand showers ($n = 13$) (Table 2). The testing was conducted in randomly chosen hair salons ($n = 12$) of the low-range ($n = 4$), mid-range ($n = 4$) and high-range ($n = 4$) price segments located within 100 km of Osnabrück in Lower Saxony, Germany and North Rhine-Westphalia, Germany. According to the ECHA definition, areas of the metal objects with direct and prolonged skin contact were selected beforehand as sites for the DMG spot tests.⁷

Scissors were tested at the upper scissor shank, hair clips were tested at the lower grasp area, hair rollers were tested at the edge area, tail combs were tested at the upper tail area, whisks were tested at the intermediate grasp area, tweezers were tested at the upper exterior surface, and hand showers were tested at the upper grasp

TABLE 2 Dimethylglyoxime (DMG) test results of the metal tools tested for nickel release in the presented study

Metal tool	No. tested	No. DMG test-positive	% DMG test-positive
Scissors	62	0	0
Hair clips	45	8	17.8
Hair rollers	45	0	0
Tail combs	27	2	7.4
Whisks	20	0	0
Tweezers	17	11	64.7
Hand showers	13	0	0
All	229	21	9.2

area (Figure 1). The test spots averaged 0.5 cm², depending on the tested metal tool (Figure 1).

The DMG testing was conducted as follows. For every test spot, two drops (<50 µL) of the DMG test solution were placed on a new cotton swab, and the cotton swab was rubbed intensively against the test spot for up to 60 seconds. If a colour change to reddish-pink occurred before the 60 seconds had elapsed, the testing was stopped at that time. The testing was performed on the used metal tools as found, that is, without any prior cleaning or preparation. At the beginning of each study day, a positive control in terms of a nickel-containing €1 coin was used to ensure the usability of the test solution. A colour change to reddish-pink of the test solution (Chemo Nickel Test) on the cotton swab marked a positive test reaction. The test result was negative if there was no colour change on the cotton swab. For optimal reliability, the cotton swab was placed in front of a white surface for assessment. In order to validate the reproducibility, 23 of the previously tested metal tools were randomly chosen and retested with a time lag of 2 weeks. The results were 100% reproducible.

An employee survey was conducted to collect data about the metal tools. Thereby, the age, price and manufacturer of the tested scissors were recorded. It was decided to collect only the aforementioned data regarding scissors, owing to the observation that the requested information regarding the other tools could not be reliably given.

3 | RESULTS

The DMG test showed that 21 of 229 metal tools (9.2%) released nickel (Table 2). Nickel release was detected in 8 of 45 hair clips (17.8%), 2 of 27 tail combs (7.4%), and 11 of 17 tweezers (64.7%). In every hair salon—regardless of the price segment or location—nickel-releasing metal tools were found. The tested scissors ($n = 62$), hair rollers ($n = 45$), whisks ($n = 20$) and hand showers ($n = 13$) showed no positive DMG test results. No doubtful test results were observed. Sixty-two scissors from 21 different manufacturers were tested. The price of the tested scissors ranged from €10.00 to €700.00, the average price being €210.00. The age of the scissors ranged from 1 to 15 years, with an average of 6 years.



FIGURE 1 Metal tools with test spots in which the dimethylglyoxime test was conducted, marked with red circles. The areas of the metal tools with expected direct and prolonged skin contact according to the European Chemicals Agency definition were selected

4 | DISCUSSION

In this study, nickel release was detected in 9.2% of the tested metal tools in the German hairdressing trade. Owing to comparable DMG test results of studies conducted in the EU—namely Denmark, Germany, and Sweden—it was to be expected that nickel release from metal tools in the German hairdressing trade would also be detected.^{13–18} As shown in Table 1, the proportion of nickel release in the German hairdressing trade is low as compared with the results of these previous studies.

Nevertheless, nickel release from metal tools in the hairdressing trade is still a health risk in terms of the development of allergic contact dermatitis. Positive DMG test results show nickel release of $<0.5 \mu\text{g nickel}/\text{cm}^2/\text{week}$, which is generally considered to be the detection limit of the DMG test.^{19,20} This level is considered to be sufficient to induce nickel allergies and also to elicit nickel contact dermatitis.^{20,21} In the hairdressing trade, in which the skin is often damaged, this is highly relevant. The detected nickel release from hair clips, tweezers and tail combs is problematic, because—according to the ECHA definition—direct and prolonged skin contact with these metal tools is evident in hairdressing.⁷ Although such contact may also be regarded as a hazard for consumers, hairdressers are exposed to a serious health risk by direct and prolonged skin contact with nickel. The repetitive irritant exposure in the hairdressing trade resulting from the high amount of wet work and contact with detergents may harm skin barrier homeostasis and consequently increase the risk of sensitization to contact allergens such as nickel.^{2,3} Direct and prolonged contact with hair clips, tweezers and tail combs is observed during the following work tasks: Hair clips are used very frequently and repeatedly to section off strands of hair during cutting, colouring, and styling, which is why direct and prolonged skin contact with this

metal tool occurs. Tweezers are used to pluck eyebrows, which is a highly demanded service in the hairdressing trade. Owing to the duration of such eyebrow correction, skin contact with this metal tool is prolonged. The same applies for tail combs, which are used primarily for creating hairstyles.

Because of the direct and prolonged skin contact with these metal tools, their nickel release is a relevant health hazard in the German hairdressing trade. This leads to the conclusion that compliance with the REACH Regulation (Entry 27 of Annex XVII to REACH) has hitherto not been sufficiently ensured. Compliance with the REACH Regulation should be strictly monitored in this respect.

In this study, nickel release was assessed by means of the DMG test, which is a semiquantitative testing method. The accuracy of the DMG screening test has been examined in a previous study, in which the sensitivity of the DMG test was described as modest, and the specificity was described as high.¹⁹ It was concluded that the DMG test can be regarded as being useful for screening purposes.¹⁹ The threshold value (limit of detection) of the DMG test is $0.5 \mu\text{g nickel}/\text{cm}^2/\text{week}$.¹⁹ This level can be regarded as relevant, and the method used can be regarded as being sufficient for the purpose of the study. However, further studies might use quantitative testing methods, for example, atomic emission spectrometry, to exactly analyse the released amount. Moreover, the skin of hairdressers, which has direct and prolonged skin contact with nickel-releasing metal tools, can be examined in further studies. For this purpose, a semiquantitative method to determine nickel on the skin in terms of the DMG test can be used, and quantitative detection of nickel on the skin can be achieved with acid wipe sampling or acid sampling by swab with collateral inductively coupled plasma mass spectrometry. These methods have already been used to quantify nickel ions on the skin in several studies.^{22–26} In addition, the release of other metal allergens from metal tools in the hairdressing trade can be examined in further studies. In comparable studies, metal tools were tested for nickel release and also for cobalt release.^{16,17} Beyond hairdressing, on the basis of the observation of 11 of 17 tested tweezers (64.7%) releasing nickel, it can be assumed that tweezers used by cosmeticians also release nickel.

In conclusion, 9.2% of the tested metal tools in our random sample from the German hairdressing trade released nickel, and tweezers and hair clips were found to be most problematic. As the DMG testing in this study was conducted in randomly chosen hair salons of the low-range, mid-range and high-range price segments in two German states, and the tested metal tools are sold all over Germany, the results of this study are probably relevant for the German hairdressing trade in general. It must thus be assumed that a considerable proportion of hairdressers in Germany have direct and prolonged skin contact with nickel-releasing metal tools. Within the framework of the primary prevention of occupational dermatoses in the German hairdressing trade, the results of this study lead to the following requirements: further qualitative and quantitative testing for nickel release from metal tools—especially tweezers and hair clips—in the hairdressing trade together with the development of regulations to eliminate nickel-releasing metal tools in the (German) hairdressing trade. As an immediate recommendation, the general preventive advice to wear gloves in the hairdressing trade should be followed, as this would also reduce hairdressers' exposure to nickel-releasing tools.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to report.

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