

Water exposure – challenging differences between occupations

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doi:10.1111/cod.12479

Summary

Background. Few studies have compared water exposure between different occupations in the general population.

Objectives. To investigate and compare the extent of occupational water exposure, with a focus on service, healthcare and production occupations previously classified as involving a high risk for hand eczema.

Methods. In two public health surveys (2006 and 2010), a validated question regarding occupational water exposure was answered by 18 342 and 15 736 gainfully employed individuals, respectively.

Results. Exposure for ≥ 0.5 hr/day was reported by 17.5% and 16.3% ($p=0.020$) for the respective years, and exposure for > 2 hrs/day by 7.8% and 7.7% ($p=0.73$). Exposure in women was almost twice as high as in men for both years ($p \leq 0.001$) and exposure levels ($p < 0.001$). Exposure for > 2 hrs/day was more common in high-risk occupations in service and healthcare than in non-high-risk occupations [prevalence proportion ratios of 16.7 (95%CI: 14.0–20.0) and 8.3 (95%CI: 6.9–9.9), respectively]. Exposure was highest in service occupations, where 44.6% reported exposure for > 2 hrs/day in 2010, and kitchen work, cleaning and hairdressing dominated. In healthcare, the corresponding figure was 22.0%.

Conclusions. Challenging differences in water exposure between occupational groups were found, and extensive water exposure was reported in a number of occupations previously classified as involving a high risk for hand eczema.

Key words: general population; hand eczema; high-risk occupations; prevalence proportion ratios; wet work.

Wet work is common in some occupations, particularly within the service, healthcare and production sectors. In these sectors, selected occupations have previously been categorized as involving a high risk for hand eczema

(1). Quantitative data on the extent of wet work can be achieved through self-reports (2–10), direct observations (11–15), or instrumental measurements (16, 17). However, information on the amount of occupational water exposure in the general population is scanty, as is knowledge of possible changes over time (4, 5, 9, 18).

The wider concept of 'wet work' is often used, and includes, beyond exposure to water, also exposure to soaps and detergents. It has been shown that prolonged water exposure may induce skin irritation (19–21). Wet work is considered to be of importance for hand eczema (22–24) which is the most common occupational skin disease (25).

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Conflicts of interest: The authors declare no conflicts of interest.
Funding sources: Grants from Hudfonden.

Accepted for publication 9 September 2015

In Sweden, there is a long tradition of epidemiological surveillance, and our research group has previously studied occupational and non-occupational skin exposure to water in the general population (4, 5, 9).

The aim of the present study was to investigate and compare the extent of occupational skin exposure to water, with a focus on service, healthcare and production occupations classified as involving a high risk for hand eczema. The study is based on data from two public health surveys performed in the general population of Stockholm.

Subjects and Methods

Study population

Public health survey 2006. Questionnaires were sent to 57 009 randomly selected individuals aged 18–84 years in the general population of Stockholm County. Answers were obtained from 34 707 persons (61%). For the present study, individuals aged 18–64 years were selected, on condition that they were gainfully employed and had given an answer to a question on daily occupational skin water exposure of the hands. In total, 18 342 individuals were included in the analyses: 8704 men and 9638 women. Of those gainfully employed, 84.5% reported working full time (> 35 hrs/week; women, 77.9%; men, 91.7%).

Public health survey 2010. Questionnaires were sent to 56 037 randomly selected individuals aged ≥ 18 years in the general population of Stockholm County. Answers were obtained from 30 767 individuals (55%). For the present study, individuals aged 18–64 years were selected, on condition that they were gainfully employed and had given an answer to a question on daily occupational skin water exposure of the hands. In total, 15 736 individuals were included in the analyses: 7124 men and 8612 women. Of those gainfully employed, 82.9% reported working full time (> 35 hrs/week; women, 76.7%, men, 90.3%).

In both surveys, stratified random samples were used, and in each of these different weights were created: the design weight and the non-response weight. More details about the procedure for generating stratified random samples in the surveys, and clarification of how the weights were created, are shown in Appendix S1.

Questionnaires

Questionnaires and instruction letters were sent to all individuals in the samples. In cases of non-response, up

to three reminders were sent. The questionnaires used in the surveys comprised ~90 questions regarding physical and mental health, social relationships, economic status, work, and occupation. A previously validated question on water exposure at work was included: 'Are your hands exposed to water at work?' (13, 14). There were five response alternatives (not at all, < 0.5, ≥ 0.5 –2, > 2–5 and ≥ 5 hrs/day).

Selected occupations in the service, healthcare and production sectors were categorized as involving a high risk for hand eczema, on the basis of a previous classification (1) (Table S1; Appendix S1). Self-reported water exposure in the high-risk occupations was analysed. In the analyses, all other occupations constituted the group of non-high-risk occupations.

Data analysis and statistics

SUDAAN (Survey Data Analysis) version 11 was used to calculate prevalence proportion ratios (PPRs) on the basis of data from stratified samples. This software is specialized for analysing data collected through survey sampling (26). Details on how weights and statements were incorporated in the LOGLINK procedure in SUDAAN are shown in Appendix S1.

The response alternatives for the question of occupational water exposure were dichotomized in two different ways, i.e. ≥ 0.5 and > 2 hrs/day. All analyses were based on both of the dichotomized variables, and were performed for men and women together, and for each sex separately.

Descriptive data on self-reported occupational water exposure in 2006 and 2010 among the gainfully employed population aged 18–64 years, in relation to age and sex, are shown as percentages in Table 1. The proportions of water exposure in relation to high-risk occupations in the sectors service, healthcare and production, and in non-high-risk occupations, are shown in Table 2.

In all analyses conducted to test possible differences in water exposure, PPRs were used. This was performed with a generalized linear model with a logarithmic link function and a binomial distribution function. Non-high-risk occupations served as the reference.

Analyses were performed to investigate possible differences in water exposure within each of the four occupational groups, comparing the surveys conducted in 2006 and 2010. We were also interested in exploring possible differences between sexes in each survey, for each of the four occupational groups. The distributions of prevalence of exposure in age groups between sexes in the 2006 and 2010 surveys were tested by including an interaction term, whereby age group was multiplied by sex.

Table 1. Self-reported daily occupational skin exposure to water, in relation to sex and age, among the gainfully employed population aged 18–64 years. Results from the Stockholm County Council Public Health Surveys in 2006 and 2010

Age (years)	2006			2010		
	Total (n = 18 342) %	Women (n = 9638) %	Men (n = 8704) %	Total (n = 15 736) %	Women (n = 8612) %	Men (n = 7124) %
Water exposure for ≥ 0.5 hr						
18–29	22.7	28.2	16.8	18.2	24.4	12.2
30–39	14.9	18.5	11.8	14.6	19.1	10.4
40–49	17.3	22.2	13.1	16.6	20.5	12.9
50–59	18.3	24.3	12.6	16.8	23.3	10.4
60–64	14.3	19.3	10.1	17.1	23.0	11.8
Total	17.5	22.4	12.9	16.3	21.4	11.4
Water exposure for > 2 hrs						
18–29	11.2	13.7	8.5	8.4	11.5	5.4
30–39	6.8	9.2	4.7	7.3	9.3	5.4
40–49	7.9	10.6	5.5	7.9	9.4	6.5
50–59	7.6	9.9	5.5	7.5	9.7	5.4
60–64	4.8	7.2	2.8	7.6	10.0	5.4
Total	7.8	10.4	5.5	7.7	9.8	5.7

Table 2. Self-reported daily occupational skin exposure to water in service, healthcare and production occupations previously classified as involving a high risk for hand eczema (1) and in non-high-risk occupations

	2006 n	2010 n	Water exposure for ≥ 0.5 hr		Water exposure for > 2 hrs	
			2006 %	2010 %	2006 %	2010 %
Service ^a						
Total	948	775	64.3	67.8	40.2	44.6
Women	582	499	68.9**	67.4	46.2**	44.8
Men	366	276	58.5	68.5 ¹	32.9	44.4 ¹
Healthcare ^a						
Total	2063	1809	55.4	52.7	23.3	22.0
Women	1766	1569	60.0***	56.8***	26.2***	23.7*
Men	297	240	35.2	34.0	10.5	14.5
Production ^a						
Total	1076	844	32.7	26.1 ¹	11.3	10.7
Women	100	74	37.2	28.9	11.4	12.7
Men	976	770	32.3	25.9 ¹	11.3	10.6
Non-high-risk occupations ^b						
Total	14 255	12 308	7.5	6.5 ²	3.0	2.7
Women	7190	6470	8.9***	8.1***	3.3	3.0
Men	7065	5838	6.4	5.2 ¹	2.8	2.3

^aOccupations defined as involving a high risk for hand eczema in a previous classification (1) (Table S1; Appendix S1).

^bAll occupations not categorized as involving a high risk for hand eczema.

Comparison between the sexes: *** $p < 0.001$; ** $p < 0.01$; * $p \leq 0.05$.

Comparison between years 2006 and 2010: ² $p < 0.01$; ¹ $p < 0.05$.

The probability of being exposed to water for > 2 hrs/day was assessed for each group of high-risk occupations as compared with the group of non-high-risk occupation within the 2010 survey (Table 3).

The occupations with the largest proportions reporting water exposure for > 2 hrs/day are shown in Fig. 1. Furthermore, a comparison of water exposure in those occupations in 2006 and 2010 was performed. An

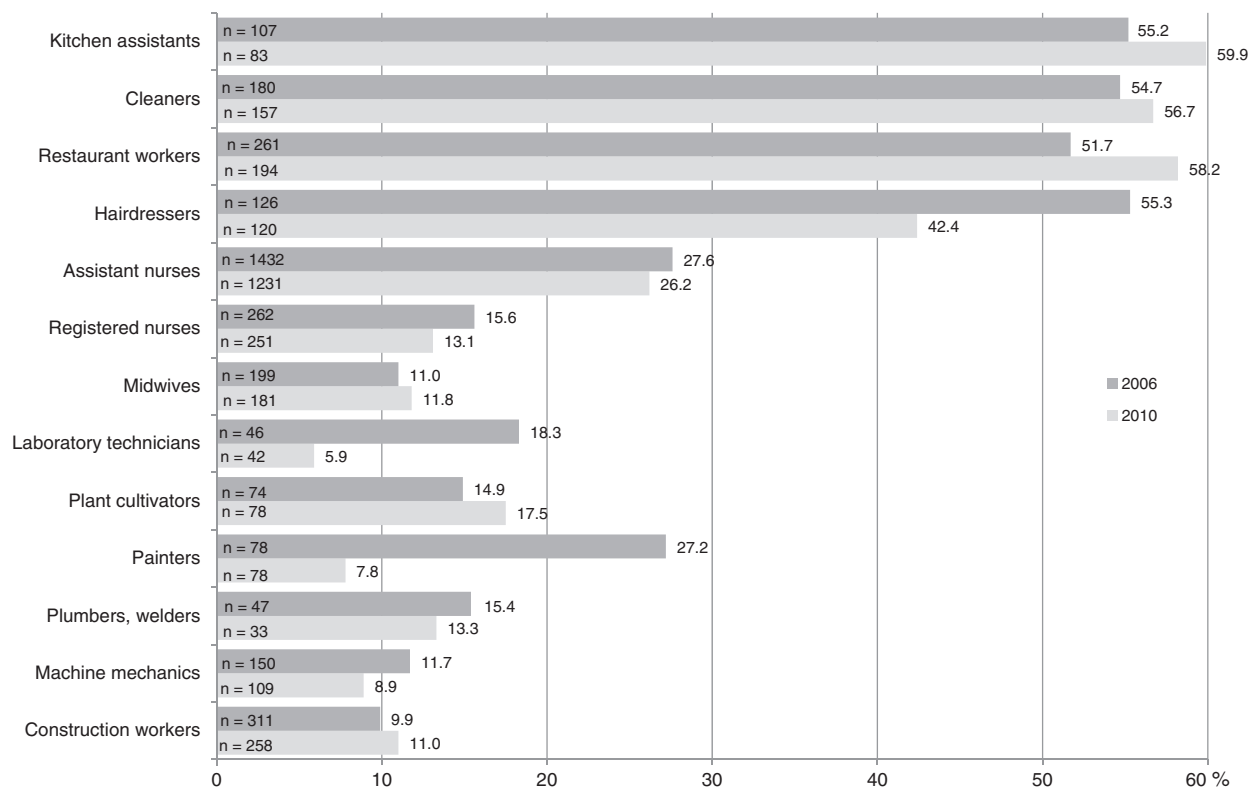
inclusion condition of at least 30 individuals within each occupation was applied.

Ethical approval

The study was approved by the Regional Ethical Review Board in Stockholm, Sweden (2007/323-31, 2013/140-32, and 2013/1344-32).

Table 3. Prevalence proportion ratios (PPRs) and 95% CIs for reported occupational skin exposure to water for > 2 hr/day in 2010 in service^a, healthcare^a and production^a occupations previously classified as involving a high risk for hand eczema (1) in relation to non-high-risk occupations^b

	Total PPR (95% CI)	Women PPR (95% CI)	Men PPR (95% CI)
Service ^a	16.7 (14.0–20.0)	14.7 (11.6–18.6)	19.0 (14.4–25.0)
Healthcare ^a	8.3 (6.9–9.9)	7.8 (6.2–9.8)	6.2 (4.0–9.5)
Production ^a	4.0 (3.0–5.4)	4.2 (1.9–9.1)	4.5 (3.2–6.4)
Non-high-risk occupations ^b	1	1	1

^aOccupations defined as involving a high risk for hand eczema in a previous classification (1) (Table S1; Appendix S1).^bAll occupations not categorized as involving a high risk for hand eczema.**Fig. 1.** Occupations with the largest proportions (%) of individuals reporting water exposure for > 2 hr/day for the years 2006 and 2010 (dark grey, 2006 data; light grey, 2010 data).

Results

Self-reported occupational skin exposure to water in the gainfully employed general population in 2006 and 2010 is presented in Table 1. Exposure for ≥ 0.5 hr/day was reported by, in total, 17.5% and 16.3% ($p = 0.020$) for the respective years. A higher level of exposure, > 2 hrs/day, was reported by 7.8% and 7.7% ($p = 0.73$), respectively. Exposure in women was almost twice as high as in men for the 2 years ($p < 0.001$) and also for the two exposure levels ($p < 0.001$). In 2006, the reported exposure was largest in the youngest age group,

18–29 years, for both exposure levels ($p < 0.001$), when the youngest age group was compared with any of the other age groups. In 2010, the p -values for the lower level were in the range of 0.004–0.4610; for the higher level, no statistically significant differences were found. The age distributions of exposure between men and women were similar regardless of how the variable of exposure was dichotomized or when the survey was conducted; that is, the interaction terms age group multiplied by sex were not statistically significant ($p \geq 0.20$).

In 2006, 22.6% of the participants were classified as having an occupation at high-risk for hand eczema and in 2010, 22.4% were classified as having an occupation at high-risk for hand eczema ($p=0.74$). Reported occupational water exposures in service, healthcare and production occupations are shown in Table 2. The reported exposure in the group of non-high-risk occupations is also shown. Exposure was highest in the service occupations: 44.6% reported water exposure for > 2 hrs/day in 2010. In healthcare, the corresponding figure was 22.0%. In the service sector, women were significantly more exposed to water than men in 2006, but this difference did not remain in 2010. For men in service occupations, increased exposure at both exposure levels was found in 2010. In healthcare, women were more exposed than men in both years.

The occupations with largest proportions of individuals reporting water exposure for > 2 hrs/day are shown in Fig. 1. The results for men and women together are shown for the 2 years. Kitchen assistants, cleaners, restaurant workers and hairdressers are at the top of the list, followed by some occupations in healthcare and construction work. The differences in exposure between 2006 and 2010 are not statistically significant, except for female kitchen assistants: 54.4% in 2006 versus 71.3% in 2010 ($p < 0.05$) (data not shown in Fig. 1).

Table 3 shows PPRs reflecting the differences in 2010 between each sector of high-risk occupations and non-high-risk occupations as regards water exposure for > 2 hrs/day. In service the PPR was 16.7 (95%CI: 14.0–20.0), and in healthcare the PPR was 8.3 (95%CI: 6.9–9.9).

Discussion

Occupational exposure to water in the general population of Stockholm, Sweden was examined through self-reports in two public health surveys, enabling comparison of exposure between different occupations. The results clearly show large differences in water exposure between occupations and also between the sexes.

The highest water exposure was reported in occupations previously classified as involving a high risk for hand eczema (1). The differences in water exposure between occupations are of considerable magnitude (Table 2). In 2010, the probability of being exposed to water for > 2 hrs/day in service and healthcare was many times greater than the probability in non-high-risk occupations (PPR of 16.7 in service, and PPR of 8.3 in healthcare; Table 3).

Previous studies have presented water exposure in different occupations (5, 13, 18, 22, 27). In our study, a

number of occupations had reports of high water exposure, and at the top of the list were jobs in service and healthcare (Fig. 1). The majority have previously been classified as high-risk occupations for hand eczema, based mainly on clinical experience (1) (Table S1; Appendix S1). The high water exposure reported in these occupations strongly indicates a relationship between water exposure and hand eczema. Data on hand eczema were not available in this study, and a causal relationship cannot, in any case, be proven by studies with a cross-sectional design.

In the present study, the highest water exposure was found for kitchen work, restaurant work, cleaning, and hairdressing, where $> 50\%$ reported exposure for > 2 hrs/day (Fig. 1). This is in agreement with previous findings in a number of studies, in particular regarding hairdressers (6, 15, 22), cleaners (2, 12), and healthcare workers (7, 8, 11, 14). In a Danish questionnaire study, 86.6% of hairdressers reported having wet hands for ≥ 2 hrs/day (6), and in German observational studies a duration of wet work of ≥ 2 hrs/day was recorded in 63% of hairdressers (15), and wet work made up 50% of working time in the cleaning industry (12). According to Jungbauer et al (11), wet work in healthcare is characterized by frequency of wet exposure rather than duration, and also varies with the type of ward. In a number of publications, water exposure in kitchen work is mentioned, but remarkably few studies have placed the main focus on the wet exposure in these occupations (3–5, 10, 13, 18, 25, 27).

The reported occupational water exposure in the general population was found to be almost twice as high in women as in men for the two exposure levels and for the 2 years studied (Table 1). Women were significantly more exposed to water in service and healthcare in 2006 (Table 2). In 2010, the difference remained for healthcare but not for service, indicating increased wet work in men in the included service occupations (Table 2). The difference in water exposure between the sexes is striking. It is also well established that the occurrence of hand eczema is higher in women than in men (1, 28). In 2006, higher water exposure was reported in the youngest age group, 18–29 years, than in the older age groups (Table 1). A tendency for young people to start their careers in low-skilled occupations in service and healthcare where water exposure is high is well known. Interestingly, the pattern was somewhat different in 2010, with increased exposure in the oldest age group, 60–64 years, in particular in men ($p=0.035$). The reported water exposure in the total working population was rather similar for the 2 years, but a small but statistically significant decrease ($p=0.020$) for the lower level was found

(Table 1). For healthcare, no difference between the years was found, but for service the exposure in men was increased. In production and non-high-risk occupations, a reduction in water exposure was noted for the lower level (Table 2). This reduction may be attributable to fewer manual work tasks and, possibly, more glove use in some jobs.

A correlation between occupational and non-occupational wet exposure has previously been observed (4), and the importance of considering non-occupational exposure has been pointed out (3, 4, 7–9, 29). In a previous health survey in Sweden, it was found that 30% of women and 12% of men reported skin exposure to water > 20 times during an entire day, indicating that a significant proportion of water exposure seems to occur outside work (9).

One strength of the present study is the large sample size, enabling analyses of subgroups, for example occupational and age groups. The response rates in the two surveys were 61% and 55%, respectively, which is considered to be acceptable in this type of survey in the general population. No analyses of non-responders to the question on water exposure were performed. Younger individuals were overrepresented among non-responders, which may have led to an underestimation of water exposure, as younger individuals were more exposed. An advantage is the possibility of generalizing our results from data based on the public health questionnaires to the population in the Stockholm County, thanks to the design and non-response weights, but the results may not be generalizable to other populations. The same previously validated question on water exposure was used in the two surveys, which warrants comparison of the results (13, 14). The fairly stable results in the two surveys indicate high reliability. It is probably not realistic to expect large differences over a 4-year time period, but it might be possible to visualize trends. The previous validation of the question regarding water exposure showed a strong correlation between self-reports and observation, although a tendency to overestimate exposure time was noted (13, 14), as has also been shown in another study (11). In our study, data on the frequency of water exposure were, unfortunately, not available. The comparison of exposure

time between different occupational groups, reflected by PPRs, would probably be influenced to only a limited degree by an overestimation of exposure, although the total exposure time may be overestimated.

The high water exposure reported in a limited number of occupations brings the subject of prevention to the fore. Achieving reductions in wet exposure is a keystone in the prevention of hand eczema. In Germany, there are regulations defining wet work as having wet hands for > 2 hrs/day, the use of protective gloves for > 2 hrs/day, or frequent daily hand washing (30). A number of promising intervention projects have been presented (31, 32). In Europe, a network of experts (EPOS) has been created, with the objective of providing scientific guidance (33). StanDerm is another European project from 2013, with the objective of developing standards on prevention of occupational skin diseases (34).

In conclusion, extensive water exposure was reported in a number of occupations previously classified as involving a high risk for hand eczema. More than 40% of individuals in high-risk service and 20% of individuals in high-risk healthcare occupations reported > 2 hrs of water exposure/day. Challenging differences in water exposure between occupational groups were found. Women reported more exposure than men, and younger people reported more exposure than older people. Surveillance of occupational water exposure gives knowledge that is applicable to preventive interventions.

Acknowledgements

This study was supported by grants from Hudfonden.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Additional information regarding the method used for selection of stratified random samples and explanation of the design weight and the non-response weight. Table S1. Occupations classified as having high risk of hand eczema.

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Table S1: Summary results of additional series tested and prick testing results

Series	Frequency used, n (%)	Number of positive cases identified (NB: One case may have >1 allergen)	Allergens Identified: Number of cases,
Medicament	214 (43%)	9 (4%)	Thiomersal 0.1% pet. 7, Triclosan 2% pet. 2, Phenylmercuric acetate 0.01% aq. 1
Facial	202 (40%)	8 (4%)	Abitol 10% pet 3, Ditertiary butyl hydroquinone 1% pet. 1, Sorbic acid 2% pet. 1, Dimethylaminopropylamine 1% pet. 1, Triethanolamine 2% pet. 1, Propylene glycol 20% aq. 1, Lauryl glucoside 3% pet. 1, Decylglucoside 10% aq. 1, Caprylyl/caprylglucoside 10% aq. 1, Cocoglucoside 10% aq. 1, Shellac 20% EtOH 1
Fragrance	125 (25%)	7 (6%)	Isoeugenol 1% pet. 1, hexyl cinnamal 10% pet. 1, Anise alcohol 10% pet. 1, Farnesol 5% pet. 1, Narcissus absolute 2% pet. 1, Cinnamal 1% pet. 1, Citral 2% pet. 1
Textile	114 (23%)	6 (5%)	Amino azobenzene 0.25% pet. 4, Disperse Orange 3 1% pet. 4, 4-aminophenol 1% pet. 3, Disperse Brown 11% pet. 1, Disperse Yellow 31% pet 1, Disperse Red 17 1% pet. 2, Disperse Orange 1 1% pet. 1, Melamine formaldehyde 7% pet. 1
Photopatch – UV filters	113 (23%) Irradiated with 5J UVA in 68 cases (14%)	4(4%) - 2xACD - 2xPhotoallergic	ACD Octocrylene 10% pet. 2 Photoallergic Octyl dimethyl PABA 10% pet. 1, Isoamyl <i>p</i> -methoxycinnamate 10% pet. 1, Ethylhexyl methoxycinnamate 10% pet. 1, Butylmethoxy dibenzoylmethane 10% pet. 1
Bakery	47 (9%)	1 (2%)	Isoeugenol 1% pet 1
Rubber	39 (8%)		Butylatedhydroxyanisole (BHA) 2% pet. 1, 1,3-diphenylguanidine 1% pet. 2, Tetraethylthiuram disulphide 0.25% pet. 1, Tetramethylthiuram monosulphide 0.25% pet. 1
Shoe	35 (7%)	1 (3%)	Ester gum rosin 20% pet. 1
Caine	23 (5%)	2 (9%)	Benzocaine 5% pet. 2
Perineal	22 (4%)	7 (32%)	Amino azobenzene 0.25% pet. 7, Disperse Orange 3 1% pet. 7, Disperse Yellow 3 1% pet. 6, Disperse Blue 3 1% pet. 1, Disperse Red 1 1% pet. 2, Disperse Red 17 1% pet. 1
Steroid cream	20 (4%)	0	

Hair	15 (3%)	10 (67%)	toluene-2,5-diamine sulfate 1% pet. 10, 4-aminophenol 1% pet. 10, 3-aminophenol 1% pet. 7, <i>o</i> -nitro- <i>p</i> -phenylenediamine 1% pet. 6, Pyrogallol 1% pet. 2, Resorcinol 1% pet. 1, Ammonium persulfate 2.5%pet. 1
Plastic	13 (3%)	1 (8%)	<i>p</i> -tertiary butylcatechol 0.25% pet. 1, Benzoyl peroxide 1%pet. 1, BHA 2% pet. 1
Finger tip	11 (2%)	0	
Dental	10 (2%)	2 (20%)	Gold sodium thiosulfate 2% pet. 2, Methyl methacrylate 2%pet. 1, Ethyleneglycol dimethacrylate 2% pet. 1, 2-hydroxyethyl methacrylate 2% pet. 1
Acrylate: adhesive & nail	10 (2%)	1 (10%)	Tetraethyleneglycol dimethacrylate 2% pet. 1, Trimethylolpropane triacrylate 0.1% pet. 1, Triethyleneglycol diacrylate 0.1%pet. 1
Metals	10 (2%)	1 (10%)	Ammoniated mercury 1%pet. 1, Mercury 0.5% pet. 1, Mercuric oxide 1
Plant	7 (1%)	1 (14%)	Chamomile extract 1% pet. 1
Formaldehyde	6(1%)	0	
Ear	5(1%)	0	
Epoxy	5(1%)	2 (40%)	Epoxy resin, bisphenol F 0.25% pet. 1, Hexanediol diglycidylether 0.25%pet. 1
Isocyanates	2 (<1%)	0	
Eye	2 (<1%)	0	
Parabens	1 (<1%)	0	
Own samples	150 (30%)		3 patients where products positive - Soltan® and Simple® sunscreens - Piz Buin® 30 and Vichy® sunscreen - Huggies® Wipes