PhD thesis

Prevention of occupational hand eczema among Danish hairdressing apprentices

Anne Bregnhøj, MD

Research Centre for Hairdressers and Beauticians
and
National Allergy Research Centre
Department of Dermato-Allergology
Gentofte University Hospital
Denmark

REGION H
Gentofte Hospital

Prevention of occupational hand eczema among Danish hairdressing apprentices

PhD Thesis
University of Copenhagen 2011

Anne Bregnhøj, MD

Research Centre for Hairdressers and Beauticians

and

National Allergy Research Centre

Department of Dermato-Allergology

Gentofte Hospital, University of Copenhagen

This PhD thesis is based on the following manuscripts:

Study part I:

I.   **Bregnhøj A**, Søsted H, Menné T, Johansen JD. Healthy worker effect in hairdressing apprentices. Contact Dermatitis. 2011 feb;64(2):80-4

II.   **Bregnhøj A**, Søsted H, Menné T, Johansen JD. Exposures and reactions to allergens among hairdressing apprentices and matched controls. Contact Dermatitis 2011. feb;64(2):85-9

Study part II:

III. **Bregnhøj A,** Søsted H, Menné T, Johansen JD. Validation of self-reported hand eczema among Danish hairdressing apprentices. Accepted for publication in Contact Dermatitis.

IV.   **Bregnhøj A,** Menné T, Johansen JD, Søsted H. Prevention of hand eczema among Danish hairdressing apprentices – an intervention study. Submitted for publication.

Supervisors:

Jeanne Duus Johansen, Professor, MD, DMSc
National Allergy Research Centre
Department of Dermato-Allergology
Copenhagen University Hospital Gentofte
Denmark

Torkil Menné, Professor, MD, DMSc
Department of Dermato-Allergology
Copenhagen University Hospital Gentofte
Denmark

Heidi Søsted, Cand. Pharm., PhD
Research Centre for Hairdressers and Beauticians
Department of Dermato-Allergology
Copenhagen University Hospital Gentofte
Denmark

PREFACE

Occupational hand eczema is one of the most frequent occupational diseases in Denmark, bringing with it a high impact on the affected individuals and society. Hairdressers and hairdressing apprentices are at a particularly high risk, which is why it seems relevant to illuminate preventive strategies in this group.

The work of this thesis was conducted from October 2007 to February 2011 at the Research Centre for Hairdressers and Beauticians, Department of Dermato-Allergology, Copenhagen University Hospital Gentofte.

Gentofte, March 2011
Anne Bregnhøj, MD

ABBREVIATIONS

AD	Atopic Dermatitis
CD	Contact Dermatitis
CI	Confidence Interval
HECSI	Hand ECzema Severity Index
HEROS	Hand eczema score for occupational screenings
NOSQ	Nordic Occupational Skin Questionnaire
NT	Not Tested
OR	Odds Ratio
OHSI	Osnabrück hand eczema score
PPD	*P*-phenylenediamine
PTD	Toluene-2,5-diamine
UK	United Kingdom

TABLE OF CONTENTS

1 SUMMARY

1.1 Summary in English

This PhD thesis deals with prevention of occupational hand eczema among Danish hairdressing apprentices. Hairdressers and hairdressing apprentices have a high incidence of occupational hand eczema. This is mainly because they are exposed to many potentially sensitizing products and have an extensive exposure to wet work due to the nature of their work. Hairdressing apprentices seem to be at a particularly high risk of developing the disease, probably because they often carry out the shampooing and hair dying procedures in the salons.

The main aims of this thesis were to contribute to a better characterisation of hairdressing apprentices and to develop, implement and evaluate an evidence-based educational programme with focus on reducing the incidence of hand eczema among Danish hairdressing apprentices.

The study was a clinically controlled, prospective intervention study. A cohort was established of first-year hairdressing apprentices from all 10 Danish vocational schools in the period August 2008–March 2009. In total, 502 apprentices were included at the time they started their education. All apprentices were examined at three clinical controls: within the first two weeks of their education, after approximately 8 months and after approximately 18 months. At each visit they were examined for hand eczema using the HECSI scoring system, and on all three occasions they completed a questionnaire concerning topics such as previous skin diseases, personal exposures and skin reactions, working habits, use of gloves and development of hand eczema during their education. Half the schools (the intervention schools) underwent a specially developed educational programme, and the teachers were trained in prevention of hand eczema. The remaining schools were control schools.

The thesis consists of two study parts. Study Part I deals with the characteristics of the cohort and is based on a questionnaire study comprising 502 new hairdressing apprentices. The same questionnaire was sent to a reference group of 1870 young people, matched with the hairdressing apprentices on sex, age and postcode. The characteristics primarily concern skin diseases among the hairdressing apprentices prior to the start of their education, with focus on atopic dermatitis and previous hand eczema, and covering, for example, personal exposures to hair dye products and eventual skin reactions. Study Part II deals with the results of the follow-up study. Self-reported hand eczema was validated by using the clinical examination as the golden standard. Lastly, there is an evaluation of a possible effect of the prevention programme in terms of reducing the incidence of hand eczema in the intervention group compared with the control group.

The results from Study Part I showed that fewer hairdressing apprentices had had hand eczema compared with the reference group. In addition, fewer apprentices were classified with atopic dermatitis compared with the reference group. A 'healthy worker effect' was found in connection with this education, when based on eczematous diseases. Study Part I also showed that the hairdressing apprentices were highly exposed to potent sensitizing allergens and that they reported a high frequency of skin reactions. These exposures and reactions were reported significantly more frequently than in the reference group. The exposures were primarily hair dyes, henna tattoos, eyebrow dyes, and piercings.

The results from Study Part II showed good agreement between self-reported hand eczema and the clinical examination, with high predictive values. Study Part II also showed significantly more use of gloves in the intervention group, especially when shampooing and when handling bleaching products. The apprentices in the intervention group used gloves for longer each day and fewer had wet hands for two hours or more during their work day. Additionally, Study Part II showed that significantly fewer apprentices who underwent the focused educational programme experienced hand eczema compared with those who underwent the standard programme. Approximately 20% of apprentices from the intervention group experienced hand eczema compared with approximately 30% of those from the control group (P=0.04).

This study provides important characteristics of hairdressing apprentices' personal exposures, work routines and development of hand eczema. Additionally, we succeeded in reducing the incidence of hand eczema among those apprentices in this study design.

1.2 Summary in Danish

Denne ph.d.-afhandling omhandler forebyggelse af arbejdsbetinget håndeksem blandt danske frisørelever. Frisører og frisørelever har en høj forekomst af arbejdsbetinget håndeksem. Dette grunder i, at de via deres arbejde udsættes for mange allergifremkaldende produkter samt vådt arbejde. Frisørelever synes at være i en særlig høj risiko, sandsynligvis fordi de ofte håndterer hårvask og hårfarvning på kunderne.

Studiets overordnede formål var at give en karakteristik af frisørelever samt at udarbejde, implementere og evaluere et evidensbaseret undervisningsprogram med fokus på nedbringelse af hyppigheden af håndeksem blandt danske frisørelever.

Studiet var et klinisk, kontrolleret, prospektivt interventions studie. Der blev opbygget en kohorte af nystartede frisørelever fra samtlige 10 danske frisørskoler i perioden august 2008 – marts 2009. Der blev i alt inkluderet 502 elever i forbindelse med deres opstart på skolerne. Alle elever blev set til tre kliniske kontroller; indenfor de første to uger af deres uddannelse, efter ca. 8 måneder og efter ca. 18 måneder. Til hver kontrol blev de undersøgt for håndeksem ved hjælp af HECSI score og ved alle tre lejligheder svarede de på et spørgeskema med spørgsmål om bl.a. tidligere hudsygdomme, personlige eksponeringer og hudreaktioner herpå, arbejdsrutiner, brug af handsker og udviklingen af håndeksem under deres uddannelse. Halvdelen af skolerne (interventionsskolerne) modtog et særligt tilrettelagt undervisningsprogram, og lærerne blev specielt uddannet i forebyggelse af håndeksem, den anden halvdel fungerede som kontrolskoler.

Afhandlingen består af to delstudier. Delstudie I omhandler karakteristik af kohorten ved inklusionen, og er baseret på spørgeskemaundersøgelse af 502 nye frisørelever. Et tilsvarende spørgeskema blev sendt til en referencegruppe på 1870 unge mennesker, som var matchet frisøreleverne på køn, alder og geografisk fordeling i landet. Denne karakteristik omhandler primært frisørelevernes hudsygdomme før deres opstart på uddannelsen, med fokus på atopisk dermatitis og tidligere håndeksem, samt deres personlige eksponeringer af bl.a. hårfarveprodukter og eventuelle hudreaktioner herpå. Delstudie II omhandler resultaterne fra follow-up studiet. Ved hjælp af den kliniske undersøgelse valideres selvrapporteret håndeksem i kohorten. Derudover evalueres det om der er opnået en effekt af forebyggelsesprogrammet i form af en reduktion af forekomsten af håndeksem i interventionsgruppen sammenlignet med kontrolgruppen.

Resultaterne fra delstudie I viste, at færre af frisøreleverne havde haft håndeksem sammenlignet med referencegruppen. Ligeledes klassificeredes færre af frisøreleverne med atopisk dermatitis i forhold til referencegruppen. Det blev altså påvist, at der er en ´healthy worker effect´ i forbindelse med valget af frisøruddannelsen, baseret på eksematøse sygdomme. Derudover viste delstudie I, at frisøreleverne eksponerede sig for potente fagrelevante allergener i høj grad og rapporterede en høj forekomst af hudreaktioner i forbindelse hermed. Disse fagrelevante eksponeringer og hudreaktioner blev rapporteret i signifikant højere grad end i referencegruppen. Eksponeringerne drejede sig primært om hårfarvning, hennatatoveringer, bryn- og vippefarvning samt piercinger.

Resultaterne fra delstudie II viste at der var god overensstemmelse mellem selvrapporteret håndeksem og den kliniske undersøgelse, med høje prædiktive værdier. Delstudie II viste desuden signifikant bedre brug af handsker i interventionsgruppen, særligt til hårvask og ved håndtering af blegmidler. Eleverne i interventionsgruppen brugte handsker længere tid hver dag, og færre havde våde hænder i 2 timer eller mere i løbet af deres arbejdsdag. Desuden viste delstudie 2, at signifikant færre af de elever, der havde modtaget den fokuserede undervisning, fik håndeksem, sammenlignet med de elever der modtog den vanlige undervisning. Ca. 20 % af eleverne i interventionsgruppen fik håndeksem sammenlignet med ca. 30 % af eleverne i kontrolgruppen (P=0.04).

Studiet har bidraget med en væsentlig karakteristik af frisørelevers personlige eksponeringer, arbejdsrutiner og udviklingen af håndeksem. Desuden lykkedes det os at nedbringe incidensen af håndeksem blandt frisøreleverne i dette studiedesign.

2 BACKGROUND

2.1 Occupational skin disease

Occupational skin disease is defined as skin diseases caused or aggravated by work conditions [1]. Occupational skin disease is one of the most frequently recognized work-related diseases in Denmark as well as in many other countries [1;2]. Occupational hand eczema comprises 90–95% of all occupational skin disease cases, and several studies have shown that approximately half these cases develop persistent hand eczema with a consequent high risk of sick leave and job change [1-4]. Occupational diseases in Denmark are reported to the Board of Occupational Health and are registered in the Register of Occupational Diseases. Epidemiological studies in Germany based on similar registers estimate an incidence rate of occupational skin disease of 4.9 per 10,000 workers per year, with a decreasing trend [5]. Several studies have found that the prevalence of occupational hand eczema is substantially higher among males than among females [1;4;6] and that a history of hand eczema and atopic dermatitis are risk factors for developing occupational hand eczema in wet-work occupations [7-12]. In Denmark, as in many other countries, high-risk occupations are bakers, hairdressers, dental surgery assistants, kitchen workers and butchers [1;5;6]. Occupational skin disease has a severe personal and socioeconomic impact. In Denmark it is estimated that the annual cost to society is approximately 110 million Euros, which includes costs of treatment, loss of production and exclusion from the labour marked [4;13]. Other European countries have similar expenses due to occupational skin disease [2;14]. Follow-up studies have shown that less than half the occupational skin disease cases improve over a 1–2-year period. Atopic dermatitis, greater age, low socioeconomic status and persistent occupational environment seem to be poor prognostic factors [15-19].

The aetiology of occupational hand eczema is either allergic contact dermatitis or irritant contact dermatitis, or a combination of both. Further inherent conditions, such as atopic dermatitis, may play a role. Approximately 50% of cases reported to the Register of Occupational Diseases have irritant contact dermatitis, 25% have allergic contact dermatitis and those remaining have a combination of irritant contact dermatitis and allergic contact dermatitis [1].

2.2 Hand eczema

Contact dermatitis on the hands occurs as a result of exposure to external factors such as allergens or irritants. Allergens are skin sensitizing molecules (haptens) in the environment, such as perfumes, metals, preservatives and hair dye, whereas skin irritants are most often wet work, detergents, food, gloves, solvents etc [2;4].

Hand eczema is an inflammatory disease limited to the hands. The clinical picture is a polymorphic pattern characterized by erythema, scaling, vesicles, oedema, papules and fissuring. These signs may change over time. The diagnosis relies on the clinical signs and symptoms, such as itching and pain, and exclusion of an alternative diagnosis for example psoriasis or fungal infection. For sub-classification, signs of atopic dermatitis and environmental exposures to various agents need to be clarified and a patch test performed.

Hand eczema is a disease characterized by relapsing symptoms, which makes a period prevalence more informative than point prevalence for determining the frequency of the disease in a cohort or

population. In Scandinavia, in the general adult population the 1-year prevalence of hand eczema has been estimated as 8.0–11.8% [20-24] and in younger generations 7–10% [25-27].
Risk factors for developing hand eczema have been investigated in several studies, with most studies agreeing on atopic dermatitis or familiar disposition to atopic diseases, occupational exposures, female sex and wet work for two hours or more per day as being risk factors [7;8;10;11;28-30]. It is currently under debate whether filaggrin null mutations are contributors to the manifestation of hand eczema [31-34].

A Danish follow-up study on patients with hand eczema referred to dermatological clinics showed that being an unskilled worker, frequent eruptions and delay in seeking medical attention were associated with a poor prognosis [35;36].

2.3 Hairdressing apprentices

Hairdressers and hairdressing apprentices belong to a high-risk occupation with a high incidence of both irritant and allergic occupational hand eczema owing to excessive wet work and extensive exposure to chemical substances, such as hair dyes, bleaching products and permanent wave solutions [1;37-40]. Hairdressing apprentices seem to have a particularly high risk of developing hand eczema [1], probably because they often perform the shampooing and application and rinsing-off of chemicals in the salons. According to the Danish Register of Occupational Diseases, hairdressers with recognized occupational hand eczema include the highest proportion of apprentices (71%) compared with other high-risk occupations [1]. Hairdressing apprentices have an average onset of hand eczema at the age of 19–21 years, which is younger than among apprentices in other occupational settings [2;41]. In several studies the lifetime prevalence of hand eczema among hairdressing apprentices has been estimated to 27.2%–58% [37;40;42-44]. In Germany, Uter et al found an incidence of hand eczema in a prospectively followed cohort of hairdressing apprentices of 43.3% over three years [45], and in a Danish survey, hairdressing apprentices had an estimated 1-year prevalence of 37% [37]. In comparison, trained hairdressers in Copenhagen had an estimated 1-year prevalence of hand eczema of 20% [37], and in Sweden the 1-year prevalence has been estimated as 18% [39]. Hairdressers are classically exposed to intensive wet work; accordingly, they are prone to irritant contact dermatitis. In general, it is accepted that irritant contact dermatitis is more frequent than allergic contact dermatitis in occupational hand eczema [46;47]; nevertheless, a German group found a higher incidence of allergic contact dermatitis than irritant contact dermatitis in hairdressers, probably because hairdressers have a higher degree of exposure to potent allergens than do other occupations [46].

There is a high staff turnover in the hairdressing profession. In Denmark hairdressers work an average of 8.4 years in the profession, including their training period [48;49]. One of the main reasons for leaving the profession is hand eczema [49]; similar results have been shown in a Finnish study [50]. In a prospective follow-up study among German hairdressing apprentices, it was found that hand eczema was the reason for quitting the training in 30.1% of dropouts [30;45]. Change of job due to hand eczema has been reported almost three times more often by hairdressers compared with a matched control group [39].

2.3.1 Exposures

Hairdressing apprentices are considered a high-risk population as they are highly exposed to both allergens and skin irritants in their personal and their professional life [44;51].

The chemical constituents causing most contact allergies among hairdressers are: *p*-phenylenediamine (PPD) and toluene-2,5-diamine (PTD) in hair dyes, glyceryl monothioglycolate in permanent wave solutions and ammonium persulfate in bleaching products [52;53]. Concentrations of hair dye constituents (PPD, toluene-2,5-diamine and resorcinol) able to sensitize and/or elicit an allergic response have been found on the hands of hairdressers both after application of hair dye and after cutting newly-dyed hair [54]. Beside occupational exposure, hairdressers are exposed personally: 95.7% of hairdressers in Copenhagen had dyed their hair, 52.3% within the previous year [51]. Of German hairdressers referred to a dermatological outpatient clinic, 21.7% were allergic to ammonium persulfate, 19.6% to PTD, 18.1% to PPD and 7.5% to glyceryl monothioglycolate. When compared with a control group of referred 'clients', ammonium persulfate and glyceryl monothioglycolate seem to be the main allergens related to the hairdressing profession [52]. Additionally, handling cosmetic products implies exposure to a variety of perfumes and preservatives. Lastly, nickel exposure through work tools such as scissors and crochet hooks has been identified but seems rare [55].

Beside their exposure to allergens, hairdressers and hairdressing apprentices perform a substantial degree of wet work, which is another risk factor for irritant contact dermatitis [30]. The definition of wet work is generally accepted as having wet hands for more than two hours per day, performing more than 20 hand washes per day, or wearing gloves for more than two hours per day [30;56-58]. In a Swedish study it was found that 10% of a random sample of adults reported occupational exposure to water for more than 2 hours and/or 20 times per day; for hairdressers the proportion accounted for 58.7% of the population [59]. In a German study it was found that hairdressers, assessed by observation, were exposed to wet work, defined as wet hands or wearing protective gloves, for an average of 2 hours and 17 minutes during an 8-hour shift [60].

2.3.2 Other occupational-related diseases

Hairdressers are affected by a number of other occupational-related diseases in addition to occupational hand eczema. Leino et al showed that 16.9% of Finnish hairdressers had occupational allergic rhinitis and 4.5 % had asthma [61].

Apart from hand eczema, musculoskeletal disorders are also found to be a risk factor for leaving the profession [50]. Approximately half the Swedish hairdressers had had shoulder complaints the previous year and 15% of Norwegian hairdressers had had severe shoulder pain [62]. The few intervention studies that exist on reducing musculoskeletal pain among hairdressers show different effects [62;63].

Several studies show that hairdressers have an increased risk of bladder cancer, and it is suspected that there is also an elevated risk of other cancers, for instance, breast, lung, and larynx cancer and non-hodgkin lymphoma [64-66]. This is most likely due to hairdressers' exposure to the large number of chemicals present in their work environment, including carcinogens in hair dyes. Moreover, infertility and restricted fetal growth in female hairdressers are under debate [67-69].

2.4 Intervention

The overall goal of intervention research on occupational diseases is to demonstrate the effectiveness of the chosen strategy on work injuries and / or illness. When conducting intervention studies there are three phases to consider: development, implementation and effectiveness evaluation of the intervention [70]. Interventional methods can be viewed as first- or second-line

prevention. First-line prevention includes organizational hazard control in the workplace, for example, exclusion of skin damaging substances, change of behaviour and automation of processes; and second-line prevention is based on individual protective measures such as wearing protective gloves, using moisturizers and undergoing education [71].

In the primary prevention programmes, attempts are made to prevent hand eczema in healthy individuals. Preventing hand eczema will avoid its progression to severe hand eczema and any resulting loss of employment. Secondary prevention programmes deal with reducing and healing symptoms in those already affected and are mainly carried out by dermatologists and nurses as a combined medical and educational intervention. Tertiary prevention programmes deal with severe cases not responding to secondary prevention [71;72].

Previous intervention studies on hand eczema in high-risk occupations have been able to reduce the frequency of hand eczema and to improve the use of personal protective measures to a varying degree. The majority of intervention studies have been conducted in cohorts already in high-risk occupational exposure areas and already affected by hand eczema to a certain degree [73-76]. Held et al improved behaviour and reduced clinical skin symptoms in different wet-work occupations [74;75], and the group of Flyvholm et al reduced the prevalence of hand eczema significantly among gut cleaners in slaughterhouses and cheese dairy workers by implementing skin-protection programmes [73;76;77]. These studies have shown that evidence-based education with specially trained supervisors is an effective tool [73-78]. A skin-protection programme, consisting of evidence-based recommendations directed towards a specific population or work place, should be included in the education [78].

A German study showed that for hairdressers who already had occupational hand eczema, a 6-month educational programme combined with dermatological treatment resulted in significantly more hairdressers from the intervention group remaining at work compared with a control group at a 5-year follow-up (58.7% versus 29.1%, P<0.001) [72].

In Germany a tertiary inpatient individual prevention programme has been implemented targeted at employees at risk of losing their jobs due to occupational skin disease. The programme consists of six weeks of sick-leave, three weeks of inpatient dermatological treatment and education followed by three weeks of outpatient treatment. Although the effect on behaviour and attitude towards using personal protective measures has been good, patients with atopic dermatitis needed more attention [79-81].

2.5 Effect evaluation

Intervention studies need a validated instrument of effect evaluation. In studies to prevent hand eczema, an essential element is a valid instrument to assess the presence of the disease; the optimal setting will include both a clinical assessment and a questionnaire-based assessment.

Self-reported hand eczema is often used in epidemiological studies as it is a cost-effective method of estimating the prevalence of the disease. Several validation studies on self-reported hand eczema have shown fairly good agreement between clinical examinations and the self-report, albeit with some variation in results [82-87]. Using questionnaires and interviews combined with clinical examinations, Meding et al validated self-reported 1-year prevalence of hand eczema and found a high specificity (96–99%), but a lower sensitivity (53–59%) in three different occupational settings [83]. Other validation studies, mainly on point prevalence of hand eczema, have found higher sensitivities (65%–80%) in different occupations, age groups and geographical areas [82;84-87]. Some

validation studies have used symptom-based diagnosis instead of self-reported hand eczema in the questionnaires and have compared it with clinical examinations. This seems to overestimate the true prevalence as the sensitivity equalled 100%, while the positive predictive value was low (38%) [84]. Otherwise, questions on self-reported hand eczema seem to underestimate the true prevalence of hand eczema due to a lower sensitivity [83;84]. In studies relying on self-reported hand eczema, knowing the sensitivity and specificity is essential to be able to calculate the true prevalence.

It is necessary to establish the validity of self-reported hand eczema as there may be differences in interpretation of the question in different occupational settings, age groups and geographical areas.

No standardized system to assess the presence and severity of hand eczema as a clinical diagnosis exists, but a number of scoring systems have been developed in recent years. The Hand Eczema Severity Index (HECSI) scoring system [88] was developed by Held et al in 2005 to provide a standardized system to diagnose hand eczema in a dermatological setting. Validation of the system showed a high inter- and intra-rater reliability based on a one-page scoring tool that could be learned easily. In 2006 Skudlik et al published the Osnabrück Hand eczema Score (OHSI) [89] to be used by occupational physicians and in epidemiological studies. Although the construction of the OHSI is similar to the HECSI, the aim was for it to be simpler and easier, making it suitable for use by non-dermatologists. The most recent scoring system is the Hand Eczema score for Occupational Screenings (HEROS) [90] developed for use in occupational settings for quantifying early and / or minimal signs of hand eczema.

3 AIMS OF THE STUDIES

The aims of the thesis were:

Study Part I:

- To characterize a cohort of Danish hairdressing apprentices regarding hand eczema and atopic dermatitis before entering the hairdressing schools (Manuscript I)

- To characterize a cohort of Danish hairdressing apprentices regarding personal exposures and reactions to relevant allergens before entering the hairdressing schools (Manuscript II)

Study Part II:

- To validate self-reported hand eczema in a cohort of Danish hairdressing apprentices (Manuscript III)

- To investigate whether evidence-based intervention could increase the use of personal protective measures and reduce the incidence of occupational hand eczema in a cohort of Danish hairdressing apprentices (Manuscript IV)

- To identify possible risk factors for development of hand eczema in a cohort of Danish hairdressing apprentices (Manuscript IV)

4 MATERIALS AND METHODS

This thesis relies on a follow-up study on occupational hand eczema among Danish hairdressing apprentices. The study is separated in two parts: Part I relies on baseline data obtained during the inclusion; Part II relies on data obtained during follow-up. The study is approved by the Danish Data Protection Agency and by the Committee on Biomedical Research Ethics of Copenhagen and Frederiksberg, H-B-2007-096, and all participating hairdressing apprentices gave informed consent.

4.1 Study design

The study was a clinically controlled, prospective intervention study. It consisted of an inclusion, 1st follow-up and 2nd follow-up. On all three occasions the hairdressing apprentices completed a self-administered questionnaire and were clinically examined for hand eczema. All three follow-ups were mainly scheduled as visits to the participating vocational schools in Denmark. Four schools were selected as intervention schools and six schools served as control schools. The intervention schools were chosen partly because some degree of education in preventing hand eczema had already been implemented and partly to represent different geographical areas of Denmark and different school sizes.

4.1.1 The education of hairdressing apprentices

In Denmark hairdressing apprentices undergo a 4-year training programme. Training comprises both dedicated school periods providing a combination of theory and practice and dedicated periods in salons consisting of mixed practical hairdressing procedures. Although most apprentices were examined during the school periods, a few were examined while they were working in the salons.

4.2 Study population

Within the first two weeks of their education, 502 hairdressing apprentices were enrolled in this follow-up study on occupational hand eczema. Enrolment was in two phases: in August 2008 (n= 382) and in January 2009 (n=120).

During the first approximately 18 months of their training, all apprentices completed a self-administered questionnaire and had their hands examined for objective signs of hand eczema three times: at the start of their education, after approximately 8 months, and after approximately 18 months. The apprentices were recruited from all ten hairdressing schools in Denmark, each school provided from 8 to 103 subjects. All new apprentices present on the day of inclusion were invited into the study. There were a subsequent number of dropouts and exclusions (Figure 2), as described below.

At inclusion the participation rate was 99.8% (502 of 503 hairdressing apprentices present on the day of inclusion). All completed the questionnaire and only one did not have her hands examined. At the 1st follow-up, data were collected from 294 apprentices of 321 still in education at that time (91.6%); of these apprentices, 3 completed only the clinical examination, not the questionnaire. At the 2nd follow-up the participation rate was 99.6% (283 of 284 hairdressing apprentices still in education); all completed the questionnaire but 21 did not complete the clinical examination. The missing data were mainly due to sick leave or time off on the day of the examination.

Power calculation: Based on the number of new hairdressing apprentices from the previous years, 600 was the approximate number we expected to include. Power calculation was made under the following assumption: 300 apprentices in the intervention group and 300 apprentices in the control group, compared at time = 0, 6 months and 18 months. The expected frequency of hand eczema in the two cohorts, based on literature on the frequency of hand eczema in the general population [21] and among trained hairdressers [39], was 9% in the intervention group and 18% in the control group. On a 5% significance level the power was estimated to 89.7%, which was considered sufficient.

4.3 The intervention

The intervention was planned, implemented and evaluated according to the model described by Goldenhar et al [70] (Figure 1).This model describes three phases of the intervention process in occupational safety and health: development, implementation and effect evaluation. Each phase consists of five central tasks: gathering background information; developing partnership; choosing methods and design; completing development, implementation and evaluation; and reporting and disseminating the process and results. The process described encourages going a step backwards whenever the five tasks in each phase have been completed in order to evaluate and improve the development, implementation and evaluation of the chosen intervention.
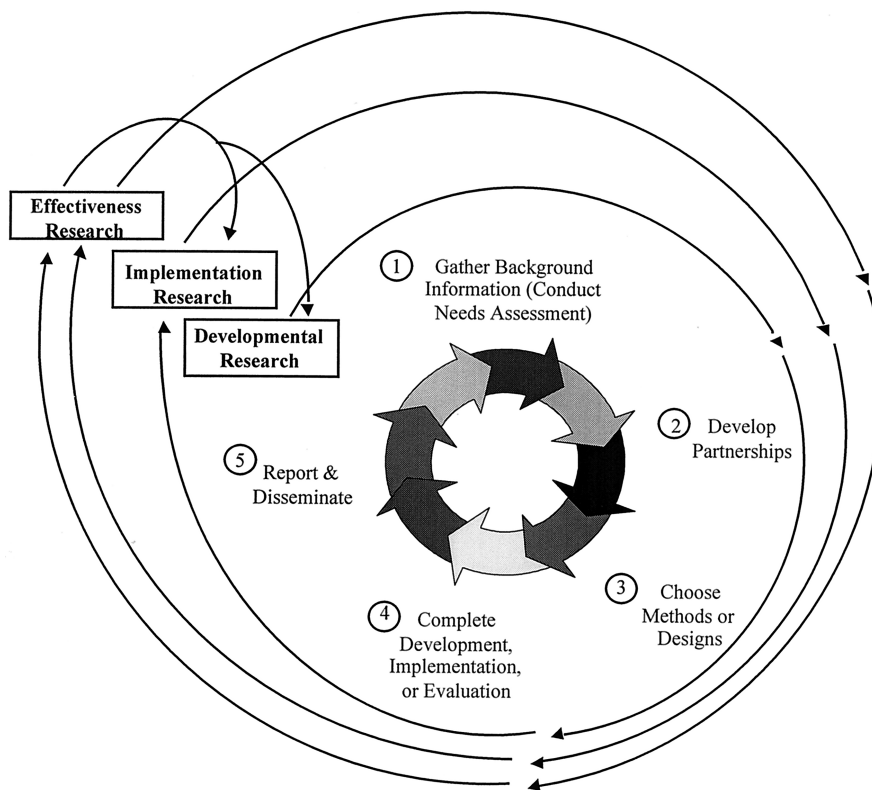
Figure 1: Model described by Goldenhar et al. The intervention process

In this study, background information was gathered through visits to vocational schools. The chief investigator (AB) had the opportunity of teaching both apprentices and teachers in occupational hand eczema and also participated in informal conversations, allowing a culture analysis of the vocational schools and the apprentices. The intervention was based on education of the teachers at the vocational schools (Table 1). Each intervention school provided 2–5 project supervisors. These supervisors underwent special training in prevention of hand eczema among hairdressers and were responsible for the continued education of the apprentices at the schools. We developed an evidence-based educational programme in cooperation with the supervisors from the intervention schools, primarily based on a special skin protection programme for hairdressers (Table 2). The educational programme included three oral presentations, an information pamphlet, group-work exercises, practical training and a glove size measure. This approach has been evaluated as successful in previous intervention studies [73-78]. In addition, an information letter was sent to all salon owners who employed the apprentices from the intervention group, and samples of lipid-rich moisturizers and protective gloves were given to these apprentices.

Table 1. Timetable of the intervention process

December 2007	Telephone contact with all vocational schools educating hairdressers in Denmark. Information was given about the study.
January 2008	Distribution of the schools to intervention- and control group.
February 2008	2-day course held for supervisors at the intervention schools. Education given in skin physiology, allergy and eczema, skin protection and optimizing work place procedures.
March − June 2008	The chief investigator visited all intervention schools, inspected the work places and gave a lesson to all the schools' teachers.
May 2008	Work group meeting: one representative from each intervention school and the chief investigator developed an educational programme for the schools.
December 2008	Follow-up meeting. Supervisors from the intervention schools participated.

Table 2. Evidence-based recommendations for prevention of occupational skin diseases in hairdressers

> **Use gloves when you wash, dye, bleach, and perm** [30;53]
>
> **Cut before you dye the hair** [54;91]
>
> **Mix in a separate, ventilated cabinet** [92]
>
> **Disposable gloves must be clean, new, and dry** [93]
>
> **Never reuse disposable gloves** [93]
>
> **Use cotton gloves underneath protective gloves** [94]
>
> **Use gloves for as long as necessary but for as little as possible** [94;95]
>
> **Use an unscented, rich moisturizer** [96-98]
>
> **Do not wear rings when you work** [99]
>
> **Use gloves when doing wet work in your spare time** [100]
>
> **Use warm gloves outside when it's cold** [101]

4.4 The questionnaires

Two questionnaires were constructed for this study: one for the inclusion and one for the two follow-ups.

4.4.1 Baseline questionnaire

The questionnaire used at the inclusion consisted of 58 items. This questionnaire covered aspects of demographic data, self-reported dermatitis, personal exposures and reactions to potential allergens and previous work experience in the hairdressing profession. Questions concerning a history of hand eczema were adapted from the Nordic Occupational Skin Questionnaire (NOSQ-2002) [102]. The main questions concerning hand eczema were "Have you ever had hand eczema?" (NOSQ question D1), "Have you ever had eczema on your wrists or forearms?" (NOSQ question D2) and "When did you last have eczema on your hands, wrists or forearms?" (NOSQ question D5).

Atopic dermatitis was defined using the UK Working Party's diagnostic criteria. These criteria include five questions concerning specific characteristics of atopic dermatitis, based on the Hanifin and Rajka criteria [103]. To obtain the diagnosis atopic dermatitis a person must fulfil one major ("Have you ever had an itchy skin condition?") and three of five minor criteria (flexural, neck or facial involvement; age of onset below two years; personal history of asthma or hay fever; a history of a generally dry skin; and visible flexural eczema) [104-106].

Questions concerning exposures and adverse skin reactions to hair dye, semi-permanent black henna tattoos, perfumed products and piercings were adapted from large epidemiological studies in Denmark: SUSY [107] and the Copenhagen Allergy Study questionnaires [108;109]. Lastly, questions on previous work experience in the hairdressing profession were constructed for this survey.

4.4.2 Validation of the baseline questionnaire

The questionnaire was developed by the chief investigator (AB) in cooperation with the supervisors. A pilot test was run which included 20 hairdressing apprentices. After completing the questionnaire, there was a panel discussion where the apprentices raised any concerns regarding the wording, response categories etc. The questionnaire was then revised and re-evaluated by another 10 hairdressing apprentices and 5 young people outside the hairdressing profession. The final version was constructed by chief investigator and supervisors.

4.4.3 The follow-up questionnaire

The follow-up questionnaire comprised 46 items. The main focus was on development of hand eczema, use of personal protective measures, workplace procedures and exposure to wet work. Questions concerning development of hand eczema were adapted from NOSQ-2002. The question on development of hand eczema during the educational period was modified from the NOSQ question D1; the question on the cause of hand eczema was modified from the NOSQ question D7; and the question concerning improvement during vacations was modified from the NOSQ question F4.

Specific questions concerning the hairdressers' work procedures, use of gloves and amount of wet work were constructed for this survey.

4.4.4 Definitions

Wet work was defined as having wet hands for two hours or more during a regular work day. It included cutting wet hair, shampooing, dishwashing, cleaning the salon etc without gloves. Use of protective gloves for specific hairdressing procedures was defined as using protective gloves every time the procedure was performed. A black henna tattoo was defined as a temporary tattoo painted on the skin and lasting for 2–3 weeks, often applied while on vacation or attending music festivals.

4.4.5 Validation of the follow-up questionnaire

The questionnaire was developed by the chief investigator (AB) in cooperation with the supervisors. When relevant, questions were adapted from the baseline questionnaire. New questions were evaluated in a pilot test including 19 trained hairdressers; all received the questionnaire by post and after completing it, all were interviewed by telephone. The trained hairdressers raised any concerns regarding wording, response categories etc. The questionnaires were subsequently amended by the chief investigator and the supervisors.

4.5 Clinical examination

Objective signs and severity of hand eczema were assessed by a trained medical doctor (AB) using the Hand Eczema Severity Index (HECSI), which is a validated scoring system with a high inter- and intra-observer reliability, determining the presence, severity and localization of hand eczema [88]. The HECSI scoring system is based on severity of visible clinical signs of hand eczema: erythema, infiltration, vesicles, fissures, scaling and oedema, on a scale from 0 to 3, in combination with measurement of the area affected: wrists, palms, back of hands, fingertips and fingers, on a scale from 0 to 4. The range of the HECSI score is 0–360, where 0 is no eczema and 360 is the most severe eczema. All apprentices were clinically examined on the same days that they completed the

questionnaires. All completed the questionnaire before the clinical examination; therefore, they were unaware of the examination result.

Additionally, all apprentices were examined for flexural eczema at inclusion. This was done to fulfil all minor criteria of the UK Working Party's diagnostic criteria.

4.6 Data entering

Data from both study parts were entered manually by using the SPSS Data Entering Builder[®] (SPSS Inc., Chicago, Illinois, USA). All data from the hairdressing apprentices were entered by the chief investigator (AB) and data from the matched control group (Study Part I) were entered by a trained data operator. Typing error was checked for by retyping 5% of all data entered. The discrepancies between the double typed data were 2.55‰. Each variable was checked for outlying parameters and missing data, and errors and inconsistency were checked against the original questionnaires.

4.7 Study Part I, Manuscripts I and II

Study Part I is based on questionnaire findings from the baseline questionnaire at inclusion.

4.7.1 Matched control group

To obtain a comparable reference group for the hairdressing apprentices, a slightly modified version of the baseline questionnaire, consisting of 67 items, was sent to a matched control group from the general population. Matching was done using the social security number, a unique identifier all Danes have from birth. Each apprentice enrolled in the study in August 2008, except 8 due to an invalid social security number, (n= 374) and was matched to five controls (n=1870). Matching was based on age, sex and postcode. The response rate obtained from this group was 68.3%, after one reminder.

4.7.2 Statistical analysis

The statistical analyses were performed using the Statistical Products and Service Solutions package (SPSS Inc., Chicago, IL, USA) for Windows (Release 17.0).

Conditional logistic regression model was used for analyzing the matched data as it is designed for analyzing responses where one "case" is matched with one or more "controls". The conditional logistic regression was performed in SPSS by using the Cox regression model for comparison of hand eczema, eczema on wrists and forearms, atopic dermatitis, personal exposures and skin reactions in the two cohorts (hairdressing apprentices versus matched controls). Skin reactions were adjusted for atopic dermatitis. A p-value < 0.05 was considered significant.

4.8 Study Part II, Manuscript III

Study Part II relies on the follow-up of the apprentices. Data are based on self-administered questionnaires and clinical examinations.

4.8.1 Statistical analysis

The statistical analyses were performed using the Statistical Products and Service Solutions package (SPSS Inc., Chicago, IL, USA) for Windows (Release 18.0).

To evaluate the agreement between the self-reported hand eczema and the clinical examinations, we calculated the sensitivity and specificity using the clinical examination as the golden standard. The sensitivity is the proportion of positively identified individuals (with hand eczema) who were correctly identified by the questionnaire, i.e. the ability to detect subjects with hand eczema. The specificity is the proportion of negatively identified individuals (with no hand eczema) who were correctly identified by the questionnaire, i.e. the ability to detect subjects without hand eczema. Furthermore, the predictive values of the questionnaire were calculated. The positive predictive value is the proportion of individuals with a positive answer (hand eczema) who were diagnosed with hand eczema by the clinical examination, and the negative predictive value is the proportion of individuals with a negative answer (no hand eczema) who were diagnosed without hand eczema by the clinical examination. Confidence intervals (CI) for the sensitivity and specificity were measured using the following formula [110]:

$$CI = P \pm 1.96 * \sqrt{\frac{P*(1-P)}{n}}$$

where P is the sensitivity or specificity and n is the total number of persons with or without hand eczema according to the clinical examination.

The true prevalence of hand eczema, when the validation is taken into consideration, was calculated from the following formula [111]:

$$\text{True prevalence = measured prevalence + (specificity – 1) / sensitivity + (specificity – 1)}$$

4.9 Study Part II, Manuscript IV

4.9.1 Exclusions

In total 105 hairdressing apprentices were excluded during the study. This was done for different reasons: change of school from intervention school to control school or vice versa (2 cases), change from school apprenticeship to salon apprenticeship (with no formal school classes) (9 cases), and 94 cases did not qualify as an apprentice either in a salon or at the school and, consequently, discontinued their education (Figure 2).
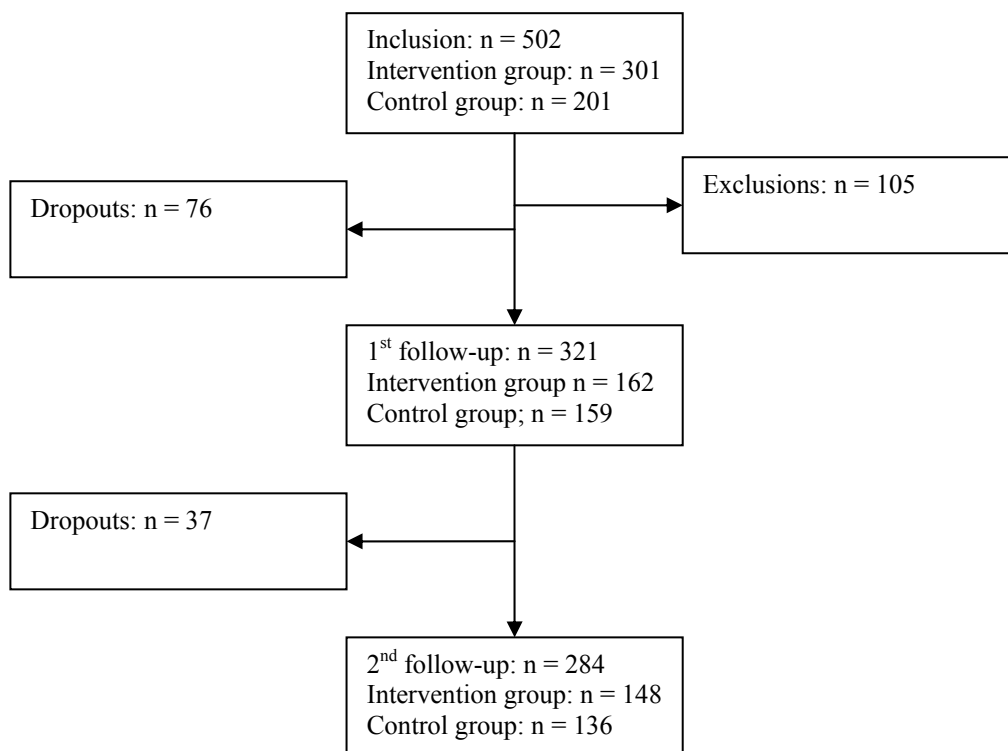
Figure 2. Flow chart

4.9.2 Dropouts

Of the apprentices included, 113 were eligible for continuation of the hairdressing apprenticeship but decided to change career for various reasons. This group is referred to as dropouts. They were all contacted by telephone and if contact was not established, a letter was sent. All were asked whether they had experienced hand eczema while being a hairdressing apprentices, and if so, was hand eczema the main reason for changing career. A response rate of 74.3% (84 of the 113 dropouts) was obtained (Figure 2).

4.9.3 Statistical analysis
The statistical analyses were performed using the Statistical Products and Service Solutions package (SPSS Inc., Chicago, IL, USA) for Windows (Release 18.0).

For comparison of categorical variables, e.g. use of gloves in different routines, the chi-square test was used and because of the number of variables in the category of glove use, a Bonferroni correction was performed. According to this Bonferroni correction, a P-value < 0.003 was considered significant. For the remaining calculations, a P-value < 0.05 was regarded as significant. Time spent wearing gloves in the salons was evaluated by chi-square for trend. Paired quantitative data were analyzed by comparing means with Wilcoxon Signed Rank Test, and for independent data Mann-Whitney Test was used. The severity of hand eczema (HECSI) was evaluated by range, mean and median. A backward stepwise logistic regression model was performed to evaluate eventual risk factors for development of hand eczema. This analysis was performed with hand

eczema as the dependent variable and age, sex, atopic dermatitis, weeks spent in a salon and being in the intervention group as the categorical variables. The logistic regression model was checked by Hosmer-Lemeshow Goodness of fit test. Lastly, odds ratio (OR) and CI were measured for development of hand eczema during the study.

5 RESULTS

5.1 Study Part I, Manuscripts I and II

5.1.1 Descriptive statistics

The study population in Study Part I comprised 374 hairdressing apprentices who were included during the first enrolment in August 2008, and for comparison, 1277 matched controls from the general population. Mean age was 17.5 years (range 15–39 years) for the hairdressing apprentices and 17.4 years (range 15–39 years) for the matched controls. Median age was 17 years for both groups. Both groups consisted mainly of females: 96.3% of the apprentices and 96.9% of the controls.

To a certain extent the hairdressing apprentices were already exposed to the work of hairdressers when they started their education. Among this group, 27.3% had been working in a hairdressing salon, 20.3% within the six months prior to the start of their education. They had worked an average of 18.6 hours per week for ten months in hairdressing salons, mainly cleaning the salon and shampooing customers' hair.

The matched control group consisted mainly of students (76.6%), and only 6.6% had been exposed to wet work for two hours or more per work day.

5.1.2 Non-respondent analysis

Only one hairdressing apprentice present on the day of the first enrolment refused to participate in the study, no reason was given.

In the matched control group the respondents were slightly younger (mean age 17.4 years) than the non-respondents (mean age 17.8 years) (p=0.02). Similarly, there were fewer males among the respondents (3.1%) than among the non-respondents (5.1%) (p=0.04).

Despite the 31.7% of non-respondents in the matched control group, all apprentices were matched to at least one control. In 9 cases, only one matched control responded to the questionnaire, while in 50 cases, all five controls completed the questionnaire (Table 3). This variation in number of controls per apprentice affects the matched analysis only if the two groups differ significantly concerning the variables used for matching (age, sex and postcode).

Table 3. Distribution of the matched groups

Size of the matched groups	Number of groups	Number of persons = number of groups ×size of group
2	9	18
3	62	186
4	118	472
5	135	675
6	50	300
Sum	374	1651 = 374 + 1277

This possible variation can be illustrated by comparing the age distribution of the two groups. There is a tendency towards fewer young persons (age < 17 years) among the apprentices and otherwise more from the control group aged > 18 years. Although there is a weak difference in age distribution when comparing the two groups (P=0.03), it is considered acceptable as a perfect matching is unlikely in real life.

5.1.3 Hand eczema at inclusion

When they began their education, the hairdressing apprentices reported a lifetime prevalence of hand eczema of 8.0%, which is less significant than in the matched control group (12.5 %) (P=0.009). The same pattern applies for the point prevalence and 1-year prevalence of hand eczema (Table 4). No significant differences between the two groups were found in accordance with the frequency of hand eczema, age at onset and time since last episode of hand eczema. This, however, might be due to lack of power.

Lifetime prevalence of eczema on wrists or forearms was reported in 5.3% of the hairdressing apprentices versus 11.9% of the matched controls (P<0.001), and 1-year prevalence in 3.7% versus 7.0% (P=0.02) with no significant difference being found in point prevalence (Table 4).

5.1.4 Atopic dermatitis at inclusion

The matched control group was not clinically examined due to logistic reasons, and therefore the classification of atopic dermatitis in Study Part I was based on the UK Working Party's diagnostic criteria, questionnaire version only (Table 4). Of the hairdressing apprentices, 21.4% were classified with atopic dermatitis versus 29.8% of the matched control group (P=0.001).

Table 4. Self-reported hand eczema and eczema on wrists or forearms and classification of atopic dermatitis

	Hairdressing apprentices (n=374)	Controls (n=1277)	P
Hand eczema			
Point prevalence	1.1% (4)	3.6% (46)	0.008
1-year prevalence	5.9% (22)	8.7% (111)	0.04
Lifetime prevalence	8.0% (30)	12.5% (159)	0.009
Eczema on wrists or forearms			
Point prevalence	1.6% (6)	2.7% (35)	0.15
1-year prevalence	3.7% (14)	7.0% (90)	0.02
Lifetime prevalence	5.3% (20)	11.9% (149)	<0.001
Atopic dermatitis*	21.4% (80)	29.8% (381)	0.001

* The UK Working Party's diagnostic criteria, questionnaire version

5.1.5 Personal exposure at inclusion

It was found that 98.4% of the hairdressing apprentices and 82.2% of their matched controls from the general population had ever dyed their hair (P<0.001); 95.2% versus 66.9% within the previous year (P<0.001). On average, they had dyed their hair 6.6 times versus 3.7 times per year (P<0.001). Median age at time of first hair dye use in the cohort of hairdressing apprentices was 12 years, and in the matched cohort 13 years (p<0.001) (Table 5).

Eyebrow dye was also used to a significant higher degree among the hairdressing apprentices than among the matched controls. More than half the apprentices had dyed their eyebrows within the previous year.

Semi-permanent black henna tattoos had been applied by more apprentices than controls (P<0.001), but age at first tattoo was similar in the two groups.

Lastly, almost all apprentices had had ear piercings (96.8 %) and the majority had also had piercings on other parts of the body (65.0%), which is also significantly more than the controls (Table 5).
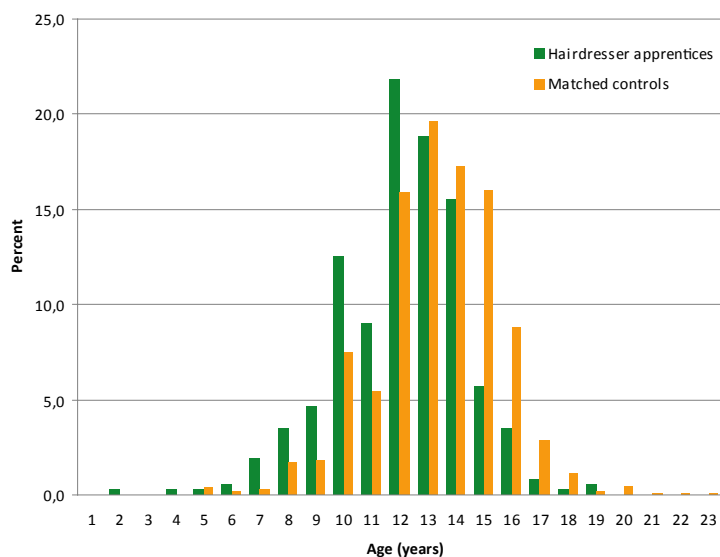
Figure 3. Age at first hair dye use

5.1.6 Skin reactions at inclusion

Apart from skin diseases, such as hand eczema, eczema on wrists or forearms and atopic dermatitis, questions concerning adverse skin reactions towards known allergens were analyzed. As shown in the previous section, there was a significant difference in numbers of persons classified with atopic dermatitis in the two groups, and therefore the frequency of skin reactions was adjusted for atopic dermatitis in the following analyzes. The hairdressing apprentices who at some point had dyed their hair reported significantly more adverse skin reactions to hair dye than did members of the matched

control group, regarding both eczema and oedema of the facial region. Similarly, eczematous reactions to eyebrow dye were reported in more apprentices than controls.

Skin reactions to jewellery and perfumed products were reported by significantly more matched controls than by apprentices (Table 5).

Table 5. Self-reported exposures and reactions

	Hairdressing apprentices (n = 374)	Controls (n = 1277)	P
Hair dye			
Lifetime prevalence	98.4% (368)	82.2% (1050)	<0.001
1-year prevalence	95.2% (356)	66.9% (854)	<0.001
Hair dye pr year	6.6 (1-30 times)	3.7 (1-30 times)	<0.001
Age first hair dye	12.1 years (2-19 years)	13.3 years (5-23 years)	<0.001
Reaction to hair dye (eczematous)	13.7% (50)	10.0% (105)	0.002#
Reaction to hair dye (oedema)	4.9% (18)	2.9% (30)	0.001#
Eyebrow dye			
Lifetime prevalence	62.0% (232)	32.5% (415)	<0.001
1-year prevalence	52.9% (198)	19.3% (246)	<0.001
Eyebrow dye pr year	3.8 (1-35 times)	3.1 (1-24 times)	0.007
Reaction to eyebrow dye (eczematous)	3.9% (9)	3.6% (15)	0.02#
Semi-permanent black henna tattoos			
Lifetime prevalence	48.1% (180)	31.0% (396)	<0.001
Age at first tattoo	12.9 years (4-32 years)	12.7 years (3-22 years)	0.7
Reactions to tattoo	0.0% (0)	2.5% (10)	0.1#
Piercing			
Ear piercing	96.8% (362)	92.1% (1176)	<0.001
Piercing other places	65.0% (243)	35.1% (448)	<0.001
Reactions to jewellery	29.9% (112)	35.2% (449)	0.002#
Perfume-rash			
1-year prevalence	6.1% (23)	11.3% (144)	0.001#
Lifetime prevalence	13.6% (51)	1.8% (278)	<0.001#
Deodorant-rash			
1-year prevalence	8.6% (32)	11.4% (146)	0.004#
Lifetime prevalence	17.4% (65)	24.3% (310)	0.001#

Adjusted for atopic dermatitis

5.2 Study Part II, Manuscripts III and IV

5.2.1 Descriptive statistics

The study population in Study Part II comprised 502 hairdressing apprentices, distributed with 196 apprentices in the intervention group and 201 apprentices in the control group at inclusion, not accounting for the 105 excluded apprentices described in the Material and Method section. The mean age of the apprentices was 17.5 years and the majority were females (95.2%). The distribution of apprentices between the two groups did not differ significantly regarding demographic data such as age, sex, BMI, smoking and alcohol habits, and number of apprentices classified with atopic dermatitis (Table 6).

The education in Denmark is partly organized on an individual level, which reflects the fact that during the study, the apprentices from the intervention group were working in the salons for an average of 32.5 weeks compared with 27.5 weeks for the apprentices from the control group (P=0.01). Otherwise, the apprentices from the control group had more weeks at the schools: an average of 32 weeks compared with 30 weeks for the intervention group (P=0.001). On the day of the final follow-up, more apprentices from the intervention group were clinically examined during their stay in the salons: 20.4% compared with 14.7% from the control group (P=0.03).

5.2.2 Dropout analysis
During the study, 113 apprentices dropped out of school.

The dropouts were almost equally distributed between the intervention group (42.1 %) and the control group (57.9 %). They did not differ in age (P=0.1) from the apprentices who continued their education, but males were more likely to leave the schools than were the females (P=0.008).

Of those dropouts who responded to the questionnaire, there was no significant difference regarding age (P=0.3) or sex (P=0.4) distribution compared with the non-respondents.

Table 6. Baseline characteristics of the cohort

	Intervention group (n/total)	Control group (n/total)	P
Age (years)			
Range	15–32	15–38	
Mean	17.8	17.7	0.2
Median	17	17	
Sex			
Male	6.6 % (13/196)	3.5 % (7/201)	0.2
Female	93.4 % (183/196)	96.5 % (194/201)	
Atopic dermatitis*	10.2 % (20/196)	8.0 % (16/201)	0.4
BMI			
Mean	21.3	22.1	0.2
Underweight (BMI<18.5)	14.6 % (27/185)	14.0 % (26/186)	0.9
Normal weight (18.5–24.9)	75.7 % (140/185)	72.0 % (134/186)	0.4
Overweight (25–29.9)	8.6 % (16/185)	9.7 % (18/186)	0.7
Obese (> 30)	1.1 % (2/185)	4.3 % (8/186)	0.06
Smoking habits			
Yes, daily	29.1 % (57/196)	28.4 % (57/201)	
Yes, but not daily	14.8 % (29/196)	10.4 % (21/201)	
Non-smoker	56.1 % (110/196)	61.2 % (123/201)	0.4
Pack years	1.7 (0-9)	2.3 (0-20)	
Alcohol consumption, mean			
Number of beers per week	6.7	5.2	0.1
Glasses of wine per week	1.7	1.8	0.8
Units of spirits per week	13.5	16.2	0.4
Units of alcohol per week	21.9	23.2	0.9

* The UK Working Party's diagnostic criteria
Data are based on the questionnaire from the inclusion

5.2.3 Validation of self-reported hand eczema

Validation of self-reported hand eczema in terms of sensitivity, specificity and predictive values at inclusion, at the 2nd follow-up and altogether are listed in Table 8. The overall sensitivity of self-reported hand eczema was 70.3% (95% confidence interval: 0.55–0.85) and the specificity was 99.8% (95% confidence interval: 0.995–1.00) when all questionnaire answers and clinical examinations were regarded.

The overall point prevalence of self-reported hand eczema at inclusion was 8.6%, at the 1st follow-up 13.8% and at the 2nd follow-up 24.7% for the whole cohort. The true prevalence of hand eczema, when the sensitivity and specificity were regarded, was estimated to (for details of the formula see the Material and Methods section):

True prevalence at inclusion = 0.086 + (0.998 – 1) / 0.703 + (0.998 – 1) = 0.12 = <u>12 %</u>

True prevalence at the 1st follow-up = 0.138 + (0.998 – 1) / 0.703 + (0.998 – 1) = 0.194 = <u>19.4 %</u>

True prevalence at the 2nd follow-up = 0.247 + (0.998 – 1) / 0.703 + (0.998 – 1) = 0.349 = <u>34.9 %</u>

In total, 37 of the 764 clinical examinations were positive (with hand eczema) in as much as the HECSI value was above 0. More apprentices had clinical signs of hand eczema at the 2nd follow-up (n=20) than at the time of inclusion (n=17) (Table 7).

It was found that only one apprentice of the 27 (3.7 %) who stated in the questionnaire that they had current hand eczema was not clinically diagnosed with hand eczema. This was classified as a false positive. Moreover, 11 apprentices of the 737 (1.4 %) who stated no current hand eczema were classified as false negative.

Table 7. Questionnaire findings compared with clinical diagnoses

Clinical examination

Questionnaire	Hand eczema	No hand eczema	Total
Hand eczema	26 (I*=11, F#=15)	1 (I*=0, F#=1)	27
No hand eczema	11 (I*=6, F#=5)	726 (I*=484, F#=242)	737
Total	37	727	764

The table shows number of subjects with or without hand eczema in accordance with clinical score and questionnaire
* Number of apprentices at the inclusion
# Number of apprentices at the 2nd follow-up

Table 8. Validation of self-reported hand eczema

	Inclusion	2nd follow-up	Total
Sensitivity	64.7%	75%	70.3%
Specificity	100%	99.6%	99.8%
Positive predictive value	100%	93.8%	96.3%
Negative predictive value	98.8%	97.9%	98.5%

5.2.4 Work exposure

The work exposure at the final follow-up was measured based on the question "How many times per week do you perform the following procedures at work in the salon?". The apprentices worked 37 hours distributed over five days per week. The variety of work exposure was wide but was generally high, especially regarding the wet-work procedures (Table 9). No significant differences in work exposures between the intervention group and the control group were found.

Table 9. Work exposure per week

	Range	Mean	SD
Shampooing	1 – 220	49.8	35.6
Hair dying	0 – 75	8.7	9.8
Rinse hair dye	0 – 100	24.6	19.6
Eyebrow dye	0 – 100	16.5	15.3
Bleaching	0 – 50	3.9	6.2
Rinse bleaching	0 – 93	9.3	10.8
Permanent	0 – 50	1.8	5.1
Rinse permanent	0 – 40	5.5	6.4

SD = Standard Deviation

5.2.5 Glove use

The apprentices from the intervention group used gloves to a higher extent than the control group did, particularly when shampooing and while handling bleaching products and eyebrow dye (Table 10). Although the frequency of apprentices using gloves decreased while they were working in the salons, they still used gloves to a higher extent than the control group did during these periods. Overall, the use of gloves increased between the 1st and 2nd follow-up. In particular, the apprentices from the control group increased their glove-wearing for wet work procedures between the 1st and 2nd follow-up.

Gloves were not reused at any school, whereas reuse occurred in some salons. At the final follow-up, gloves were reused by 14.3% (intervention group) and 21.3% (control group) (P=0.1) respectively. Of those who reused gloves at the final follow-up, 61.9% (intervention group) versus 58.6% (control group) (P=0.8) turned them inside out.

Table 10. Use of gloves in the cohort

	1st follow-up		P	2nd follow-up		P
	I[a] (n=145)	C[b](n=149)		I[a](n=147)	C[b](n=136)	
Shampooing*	75.2 %	42.4 %	**<0.001**	70.7 %	46.3 %	**<0.001**
Shampooing#	43.2 %	26.1 %	**0.003**	48.9 %	29.6 %	**0.001**
Hair dying*	98.6 %	97.2 %	0.4	100%	98.5%	0.1
Hair dying#	96.4 %	91.0 %	0.7	97.8%	98.5%	0.6
Rinse hair dye*	89.0 %	79.9 %	0.03	90.5%	85.3%	0.2
Rinse hair dye#	84.9 %	63.4 %	**<0.001**	85.6%	74.8%	0.02
Eyebrow dye*	29.7 %	2.1 %	**<0.001**	13.6%	2.2%	**<0.001**
Eyebrow dye#	11.5 %	1.5 %	**0.001**	5.0%	0.7%	0.04
Bleaching*	77.2 %	60.4 %	**0.002**	89.8%	77.2%	**0.002**
Bleaching#	79.1 %	61.2 %	**0.001**	86.3%	78.5%	0.09
Rinse bleaching*	76.6 %	52.8 %	**<0.001**	83.0%	72.1%	0.03
Rinse bleaching#	82.0 %	55.2 %	**<0.001**	76.3%	68.1%	0.1
Permanent*	49.7 %	50.0 %	0.95	63.9%	52.9%	0.06
Permanent#	43.9 %	28.4 %	0.008	46.0%	39.3%	0.3
Rinse permanent*	62.8 %	59.0 %	0-5	81.0%	72.8%	0.1
Rinse permanent#	69.8 %	49.3 %	**0.001**	72.7%	64.4%	0.1

[a] Intervention group
[b] Control group
* At the school
# In the salons
P< 0.003 was considered significant according to the Bonferroni correction

When working in the salon, apprentices from the intervention group used gloves more hours per day than did members of the control group at the final follow-up (Table 11).

Table 11. Time with glove use per day

	Intervention group (n= 127)	Control group (n= 134)	P
Never	0.0 % (0)	0.0 % (0)	NT*
Less than ½ an hour	3.9 % (5)	11.9 % (16)	0.02
½–1 hour	19.7 % (25)	23.1 % (31)	0.5
1–2 hours	23.6 % (30)	26.9 % (36)	0.5
2–3 hours	30.7 % (39)	24.6 % (33)	0.3
3–4 hours	11.8 % (15)	7.5 % (10)	0.2
More than 4 hours	10.2 % (13)	6.0 % (8)	0.2
Chi-square for trend			0.002

* Not tested

5.2.6 Wet work

All apprentices were exposed to wet work to some extent. At the final follow-up, while working in the salon, significantly more apprentices from the control group reported exposure to wet work for two hours or more per day at work than did the intervention group. Approximately half the apprentices from the intervention group reported exposure to wet work for two hours or more per day, while 67.9% of the apprentices from the control group were exposed to wet work for two hours or more per day (P= 0.004) (Table 12).

Table 12. Exposure to wet work

	Intervention group (n= 127)	Control group (n= 134)	P
2 hours or more	50.4 % (64)	67.9 % (91)	0.004

5.2.7 Incidence of hand eczema

As shown in detail in Table 13, the apprentices from the intervention group had significantly less incidence of hand eczema than had the apprentices from the control group. At the final follow-up, 19.4% of apprentices from the intervention group versus 28.3% of apprentices from the control group had experienced hand eczema during their education (including dropouts) (P=0.04). The odds ratio of getting hand eczema during the study period, not undergoing the intervention, was 1.65 (95% confidence interval 1.02–2.67).

The majority of the affected apprentices from both groups stated that their eczematous disease started during their stay in the salons: 70.0% of the intervention group and 80.0% of the control group (P=0.3). The severity of hand eczema was clearly occupationally related as 76.9% stated that their work aggravated their hand eczema and 59.0% that their hand eczema improved during vacations (with no statistical difference between the two groups).

Of those who experienced hand eczema during the study, 40.6% from the intervention group versus 19.6% from the control group (P=0.04) had consulted their general practitioner, and 15.6% versus 10.8% (P=0.2) a dermatologist. Only a minority of the apprentices with hand eczema, and only apprentices from the intervention group (9.4% versus 0.0%, P=0.04), had their disease reported to the Board of Occupational Health.

The incidence of hand eczema among dropouts was 21.4% in total, distributed with 15.2% in the intervention group and 25.5% in the control group (P=0.3). No correlation between hand eczema and atopic dermatitis among the dropouts was found (P=0.13), but of those who changed career because of hand eczema, significantly more were classified with atopic dermatitis compared with the rest of the dropouts (P=0.04). Hand eczema as the main cause of changing career was stated by 12% of dropouts in the intervention group and 9.8% of dropouts in the control group (P=0.7).

Table 13. Hand eczema in the cohort

	Intervention group %, (n/total)	Control group %, (n/total)	P
Hand eczema			
Lifetime prevalence			
Inclusion	9.2 (18/196)	7.0 (14/201)	0.4
Point prevalence			
Inclusion	1.5 (3/196)	3.0 (5/201)	0.3
2nd follow-up	4.8 (7/147)	5.9 (8/136)	0.5
One-year prevalence			
Inclusion	7.7 (15/196)	6.0 (12/201)	0.5
2nd follow-up	20.4 (30/147)	29.4 (40/136)	0.07
During education			
1st follow-up	11.0 (16/145)	19.2 (28/146)	0.05
2nd follow-up	20.4 (30/147)	29.4 (40/136)	0.07
2nd follow-up and dropouts	19.4 (35/180)	28.3 (53/187)	0.04
Eczema on wrists or forearms			
During education			
1st follow-up	4.1 (6/145)	5.5 (8/146)	0.6
2nd follow-up	8.2 (12/147)	8.1 (11/136)	0.9
Hand eczema and eczema on wrists or forearms			
During education			
1st follow-up	18.6 (27/145)	28.1 (41/146)	0.06
2nd follow-up	21.8 (32/147)	33.8 (46/136)	0.02
2nd follow-up and dropouts	20.5 (37/180)	31.5 (59/187)	0.02

Self-reported hand eczema and eczema on wrists and forearms. Self-reported hand eczema has previously been validated in the cohort [112]

5.2.8 Risk factors for hand eczema at the final follow-up

In a logistic regression model, atopic dermatitis and belonging to the control group were found to be associated with development of hand eczema in the cohort, including dropouts (Table 14). Sex, age and weeks spent in the salons had no significant influence on the incidence of hand eczema in the cohort.

Additionally, BMI, smoking and alcohol habits had no significant influence on development of hand eczema in the cohort when controlled for in a logistic regression model, and neither had wet hands for two hours or more per day (not shown in this thesis).

Table 14. The relationship of potential risk factors and the prevalence of hand eczema

	Total % (n/total)	Hand eczema % (n/total)	Crude OR (95% CI)	Adjusted OR (95% CI)	Final model OR* (95% CI)
Intervention					
Control group	51.0 (187/367)	60.2 (53/88)	1.00	1.00	1.00
Intervention group	49.0 (180/367)	39.8 (35/88)	0.61 (0.38-0.99)	0.62 (0.35-1.09)	0.59 (0.36-0.95)
Atopic dermatitis					
No	90.5 (332/367)	87.5 (74/88)	1.00	1.00	1.00
Yes	9.5 (35/367)	15.9 (14/88)	2.32 (1.13-4.79)	2.16 (0.87-5.35)	2.47 (1.19-5.14)
Sex					
Female	95.6 (351/367)	97.7 (86/88)	1.00	1.00	
Male	4.4 (16/367)	2.3 (2/88)	0.44 (0.09-1.98)	0.48 (0.06-3.96)	-
Weeks in salon					
0-20	26.3 (72/274)	27.5 (19/69)	1.00	1.00	
21-40	49.3 (135/274)	47.8 (33/69)	0.90 (0.47-1.74)	0.87 (0.44-1.70)	-
>40	24.4 (67/274)	24.6 (17/69)	0.95 (0.44-2.03)	0.98 (0.45-2.16)	
Age (years)					
15-17	67.0 (246/367)	62.5 (55/88)	1.00	1.00	
18-24	29.7 (109/367)	32.9 (29/88)	1.26 (0.75-2.11)	1.41 (0.77-2.59)	-
> 25	3.3 (12/367)	4.6 (4/88)	1.74 (0.50-5.98)	2.19 (0.49-9.73)	

* The final model is based on the adjusted model, analyzed using backward stepwise logistic regression
OR = Odds ratio
CI = Confidence intervals

5.2.9 Clinical severity of hand eczema

The mean HECSI score at inclusion was 5.7 / 3.2 points (range 3–13 / 1–7) for the intervention group and the control group, respectively, increasing to 7.0 / 9.1 points (range 3–21 / 2–20) at the final follow-up. The most severe cases of hand eczema, according to the HECSI score, were found at the final follow-up, with HECSI 20–21 points.

Table 15. Clinical characteristics of the cohort

| | HECSI Scores | | | |
	Inclusion	1st follow-up	2nd follow-up	P
Clinical hand eczema (n)*	7/10	9/17	7/13	
Mean*	5.7/3.2	5.1/5.2	7.0/9.1	0.3/0.3#
Median*	4.0/3.0	2.0/4.0	5.0/7.0	
Range*	3-13/1-7	2-14/2-12	3-21/2-20	

* Intervention group / Control group
\# Comparison of means between inclusion and 2nd follow-up was analyzed by Wilcoxon Signed Rank Test in the two paired groups

5.2.10 Personal exposure at final follow-up

At the final follow-up, all apprentices, except one, had been exposed to personal use of hair dye and the majority to personal use of eyebrow dye within the previous year, with no significant difference between the two groups. Compared with personal exposure at inclusion (Table 5), more apprentices had been exposed to eyebrow dye within the previous year, whereas use of hair dye had already been implemented among almost all apprentices at inclusion.

Table 16. Exposure to hair dye and eyebrow dye at final follow-up

	Intervention group	Control group	P
Hair dye§			
1-year prevalence	100 % (147/147)	99.3 % (135/136)	0.1
Hair dye per year	10.5 times (1-60)	10.4 times (1-40)	0.1
Eyebrow dye§			
1-year prevalence	77.6 % (114/147)	83.1 % (113/136)	0.1
Eyebrow dye per year	8.0 times (1-48)	9.3 times (1-29)	0.2

§ Measured at the 2nd follow-up

6 DISCUSSION

6.1 General discussion

In the following section the results from the studies included in the thesis are discussed; methodological topics are considered in a separate section.

6.1.1 Study Part I, Manuscripts I and II

6.1.1.1 Hand eczema

A 1-year prevalence of hand eczema of 5.9% and a lifetime prevalence of 8.0% were found among Danish hairdressing apprentices at the time they started their education. This is significantly lower than that found in the matched control group (1-year prevalence of 8.7% and lifetime prevalence of 12.5%) and must also be considered slightly lower than previously published data on the prevalence of hand eczema in various populations [20-24;113].

A study among adolescents from technical schools in Sweden estimated the 1-year prevalence of hand eczema to be approximately 10.0% [27], which is in fairly good agreement with the results from the matched control group in this study. Only a few studies reporting the prevalence of hand eczema in adolescence exist [26;27], but the results are comparable with those found in studies of the adult general population, indicating that early adolescence might be the period of life when development of hand eczema starts.

6.1.1.2 Atopic dermatitis

The prevalence of atopic dermatitis among the hairdressing apprentices (21.4 %) was significant lower than among the matched controls (29.8 %) (P=0.001). The prevalence of atopic dermatitis in both cohorts is relatively high compared with studies from the general population, as they estimate the prevalence of atopic dermatitis to be 15–24% [26;114-116]. A number of studies have described a difference in the proportion of atopic dermatitis in males versus females, with a predominance of females [26;115;117;118]. As this study mainly relies on female participants, this may be the explanation of the high prevalence. Due to logistic reasons the data on atopic dermatitis in Study Part I are based on the UK Working Party's diagnostic criteria questionnaire version only, whereas the full criteria are taken into consideration in Study Part II. Inclusion of the minor criterion "visible flexural eczema" decreases the prevalence of atopic dermatitis among the hairdressing apprentices to approximately 9% (Table 6). While this is probably a more precise estimate, it also illustrates the need for more clinically-based prevalence studies of atopic dermatitis.

These results, in combination with the lower prevalence of hand eczema among the apprentices, indicate a healthy worker effect in the hairdressing profession in Denmark. 'Healthy worker effect' is defined as a selection of relatively healthy people to become or remain workers, whereas those out of active work are, as a group, less healthy [119].

The risk of skin diseases in wet-work occupations is well described and a concern both among the public and among professionals. It is assumed that career guidance based on present or former skin conditions is carried out by general practitioners, dermatologists and healthcare professionals at the secondary school or high school. The health authorities have provided these schools with career guidelines concerning former skin diseases and risk of occupational hand eczema. This could

explain why the hairdressing apprentices have fewer skin symptoms compared with the matched control group from the general population. It is unknown whether this tendency is limited to Denmark or whether it is an international trend.

6.1.1.3 Personal exposure and skin reactions

The hairdressing apprentices were intensively exposed to personal use of permanent hair dyes, black henna tattoos and to piercings. This is in line with the general trend in society and probably also reflects the special interest they have in the hairdressing profession. It was found that the hairdressing apprentices were exposed to these known sensitizing products and procedures to a higher extent than were the matched control group from the general population (Table 5). When compared with the literature, they are also more exposed to hair dye and black henna tattoos than skilled hairdressers and the adult general population of Copenhagen [51]. In addition to the extensive exposure to these products, a higher prevalence of self-reported skin reactions was found among the apprentices compared with the matched control group. Early and extensive exposures to allergens have shown to increase the risk of sensitization and thereby allergic reactions [120-123], although some of the reported skin reactions may have been irritant reactions.

Hair dyes, eyebrow dyes and black henna tattoos all contain permanent hair dye ingredients [124-126], and are able to sensitize and may lead to cross-reactivity to local anaesthetics, textile dyes and black rubber [53;127-129]. Median age of first hair dye was 12 years among the hairdressing apprentices and the 1-year prevalence of hair dye use was 95.2%; for comparison, 52.3% of the skilled hairdressers in Copenhagen had dyed their hair within the last year [51]. In this study 13.7% of those hairdressing apprentices who had ever dyed their hair reported eczematous reactions from this private use of hair dye. This is in accordance with the more extensive use and is significantly more than among the matched control group (10.0 %, p=0.002) when adjusted for atopic dermatitis. In a previous study the prevalence of eczematous reactions in relation to hair dye in the general adult population in Denmark has been estimated to 4.9%, and several patch test studies have estimated the prevalence of allergy to hair dye ingredients to 0.1–4.0% in the general population [107;109;130;131]. These results indicate a possible increase in exposure to and incidence of hair dye allergy in the younger generations.

Since the 1980s, ear piercings have been popular, and in the last decade body piercings have become increasingly widespread. The positive correlation between piercings and nickel allergy has been shown in several studies [132;133]. Despite the EU Nickel Directive (1994/27/EC) [134], nickel allergy is still frequent, also among hairdressers in Denmark [55;135]. The frequency of piercings was high both among the hairdressing apprentices and the matched controls, although significantly more hairdressing apprentices were pierced in the ears and other parts of the body than were members of the matched control group. About one third of both cohorts had experienced dermatitis from metallic items, which correlates well with results on nickel allergy and nickel dermatitis in a population of young women in Denmark who had had their ears pierced after the introduction of the nickel regulation in 1990 [132].

Otherwise, the matched control group reported significantly more skin reactions to jewellery, perfume and perfumed deodorant. These results point towards a deselecting of persons with a rash from perfumed products and jewellery, as has been shown with eczematous diseases [25], at the time of entry to the hairdressing schools.

Hairdressing apprentices seem to be a special subgroup of their generation, who may require special attention and care to avoid severe skin problems.

6.1.2 Study Part II, Manuscripts III and IV

6.1.2.1 Validation of self-reported hand eczema

In large epidemiological studies it is necessary to base measurement of actual hand eczema on self-reported hand eczema, both current and previous. Clinical examination allows for more exact assessment but limits the number of participants. Self-reported hand eczema is expected to be of varying validity in different occupational settings, age groups and geographical area, as previous validation studies have shown some variation in results [82-87;136]. Self-reported hand eczema has not previously been validated in a population of hairdressers, hairdressing apprentices or in a Danish cohort. Validity is defined as lack of systematic error and can be divided into internal and external validity [119]. In this study the internal validity was measured to demonstrate any systematic errors in measuring hand eczema in the cohort.

This study demonstrates a fairly good sensitivity and a very high specificity at inclusion, the 2nd follow-up and all together (Table 8). The sensitivity increased from 64.7% to 75% during the study, but the specificity and the predictive values were equally high on both occasions. The positive and negative predictive values are probably the most valuable measures in evaluating a questionnaire but also depend on the population and the prevalence of disease in this population. These results indicate that self-reported hand eczema is a valid method to estimate the point prevalence of hand eczema among Danish hairdressing apprentices, although it may underestimate the true prevalence due to the sensitivity of 70.3%. In the cohort of hairdressing apprentices, 96.3% of the cases with self-reported hand eczema were confirmed by the clinical examination (positive predictive value). Of the apprentices who reported no hand eczema, the clinical diagnosis was established in only 1.4% (11 of 737). When comparing data published on validation of self-reported hand eczema, it seems that point prevalence is easier to survey than 1-year prevalence using questionnaires [83]. Considering hand eczema is a disease with great variation due to exposure and seasonal variation, discontinuous course and long duration, the 1-year prevalence is often of greater interest.

Our results are in good agreement with the study of Yngveson et al, who evaluated self-reported point prevalence of hand eczema in a cohort of adolescents in Sweden [87]. This indicates that young people could be aware of changes in their health status. Our impression is that the false-negative answers were given mainly by apprentices with mild symptoms of hand eczema or by apprentices with moderate hand eczema in a "good" period with fewer symptoms. The range of HECSI score in persons with false-negative answers was 1–7 points, considered to be mild symptoms.

6.1.2.2 Change of behaviour due to intervention

The main outcome of the intervention was the frequency of protective glove use, the amount of wet work and the incidence of hand eczema in the cohort. The overall goal in change of behaviour was to increase the use of gloves in specific procedures and to decrease the time with wet hands during work.

When analyzing the overall time with glove use, the chi-square for trend shows that the apprentices from the intervention group wore gloves for more hours per day than did the control group (P=0.002). A relatively high percentage of apprentices from the intervention group wore gloves when shampooing customers' hair (70.7%) compared with apprentices from the control group

(46.3%) at the schools (P<0.001). When working in the salons, the use of gloves when shampooing hair decreased to 48.9% versus 29.6 % (P=0.001) respectively. When applying hair dye to customers' hair, virtually all apprentices from both groups used gloves both at the school and in the salons (97.8% versus 98.5% in the salons, P=0.6) (Table 10). For comparison, 90.2% of Australian hairdressing apprentices used gloves when dying customers' hair, while only 6.3% wore gloves when shampooing hair [137]. In the UK, similar results have been found: 9% of apprentices wore gloves when shampooing and approximately 95% when dying hair[138], and in a German study, 18.5% of hairdressing apprentices wore gloves regularly when shampooing and 87.1% when colouring hair [139]. These results indicate that certain preventive strategies focusing on glove use in wet-work procedures have already been implemented at vocational schools in Denmark. In both Denmark and other countries, glove wearing seems to be generally accepted and adopted when applying hair dye. The results from the present study indicate difficulties in maintaining the good behaviour in the salons, probably because salons are busier, and because the salon owners have diverging attitudes towards glove use.

It is widely accepted that exposure to wet work for two hours or more is a risk factor for irritant contact dermatitis [30]. More than half of all apprentices , but fewer of the apprentices in the intervention group reported wet hands for two hours or more per day compared with the control group (P=0.004) while working in the salons (Table 12). A German study found that hairdressers, assessed by observation, were exposed to wet work, defined as wet hands or wearing protective gloves, for an average of 2 hours and 17 minutes in an 8-hour shift [60]. The duration of wet work seems to be difficult to estimate in questionnaires. Jungerbauer et al showed that duration of wet work was overestimated by a factor two compared with the duration assessed by observation in a cohort of nurses [56]. Based on these observations, duration of wet work should be interpreted with caution.

6.1.2.3 Incidence of hand eczema
The intervention group reported significantly less hand eczema compared with the control group. During the 18-month study period, the apprentices, including dropouts, reported an incidence of hand eczema of 19.4% (intervention group) versus 28.3% (control group) (P=0.04). The odds ratio for developing hand eczema during the study period was 1.65 being in the control group instead of the intervention group (Table 13). The incidence of hand eczema in the control group correlates well with other studies on occupational hand eczema among hairdressing apprentices. In several studies the lifetime prevalence of hand eczema of hairdressing apprentices has been estimated to 27.2%–58% [37;40;42;43]. In Germany Uter et al found an incidence of hand eczema in a prospectively followed cohort of hairdressing apprentices of 43.3% over three years [45]. For comparison the 1-year prevalence of hand eczema in the general population of young people is estimated to be 9–10 % [25;27]. Uter et al also found that hand eczema was the reason for leaving the education in 30.1% of dropouts [30;45]. In this study hand eczema as the main reason of changing career was approximately 10%.

During the study the intervention group spent on average significantly more weeks in the salons, and thereby under high exposure conditions, and shorter time at the schools. This could move the results towards a higher incidence of hand eczema in the intervention group, thereby impairing the outcome of the intervention. In addition, significantly more apprentices from the intervention group were examined in the salons at the 2nd follow-up. This could increase the point prevalence in the group as they typically experience flare up of their symptoms under high exposure conditions.

This study is one of the few intervention studies to date focusing on primary prevention of hand eczema. The main focus of the intervention was evidence-based education including: a skin protection programme, optimizing of workplace procedures, practical training etc, with a high involvement from dedicated supervisors. All levels of the organization involved in educating hairdressers in Denmark were informed and took part in the process: the Danish Hairdressers' and Beauticians' Union, the schools' heads, teachers and apprentices. The approach chosen in this study was based on previous intervention studies with a substantial effect on the prevalence of hand eczema in other occupational settings.

This study included many vocational schools and an even greater number of small hairdressing salons situated throughout the country. This setup was a challenge in spreading and maintaining the intervention, especially in the periods where the apprentices worked in the salons. When working with primary prevention in an educational setting, it is important to start the intervention at an early stage and to repeat the main messages from time to time. Already at the 1st follow-up, an increasing number of the apprentices from the control group reported hand eczema, indicating a rapid development.

Despite the healthy worker effect found in Study Part I, a substantial number of apprentices in the cohort developed hand eczema.

6.1.2.4 Risk factors for hand eczema

According to the logistic regression model, the main risk factor for hand eczema in the cohort was atopic dermatitis, despite intervention (Table 14). The role of atopic dermatitis as a risk factor for developing hand eczema in high-risk occupations is under debate [28;30;40], although the majority of studies on occupational hand eczema verify atopic dermatitis as a risk factor. Wet hands for two hours or more per day was not a risk factor for hand eczema in the cohort. As previously discussed, assessment of wet work is associated with certain unreliability and the result should be interpreted with caution.

6.2 Methodological considerations, Manuscripts I - IV

6.2.1 Study design

This study was a clinically controlled, prospective intervention study. The design has both strengths and limitations. The limitations were mainly due to it being non-randomized and non-blinded.

Non-blinded: The study was neither blinded to the apprentices nor the investigator due to practical and logistic reasons. All participating apprentices completed the questionnaires and were examined for hand eczema three times. It is possible that they were aware of the result from the previous examinations. This could have affected the self-reported diagnosis and would thereby improve the results of the validation of self-reported hand eczema at the 2nd follow-up. To minimize this eventual influence from former examinations, the apprentices were instructed to answer the questions according to their own experiences. As seen in Table 7, the apprentices were fairly good at predicting eventual hand eczema, both at the inclusion and at the 2nd follow-up, with no major differences between the two occasions. The apprentices were also aware of which group they belonged to (intervention or control). It could be assumed that the apprentices from the intervention

group were more likely to report hand eczema as they had received the special training with focus on signs and symptoms of hand eczema.

The non-blinded investigator was not aware of the results of the questionnaires until after completing the clinical examinations. Good correlation was obtained between questionnaire answers and clinical examinations.

Non-randomized: The non-randomized design was chosen due to practical considerations, primarily as some schools were already planning or conducting education concerning preventive measures. In addition, a distribution of the schools according to school size and geographical location was considered. One of the benefits of a randomized design is that it diminishes confounding, whereas the disadvantages are difficulties in recruiting participants, disparities between the "real world" and the trial population and that participants prefer to be in the intervention group, which brings the risk of withdrawing from the trial if they are allocated to treatment as usual [119;140]. It is important in clinical trials that the outcome of the intervention group is compared with the outcome of a control group that is similar on baseline data and possible confounders.

The strengths of this study design were the control group, which did not differ from the intervention group in any of the important demographic parameters including already existing risk factors such as atopic dermatitis and previous hand eczema, the prospective collection of data with a relatively long follow-up period and that all apprentices were clinically examined for hand eczema, allowing the questionnaire answers to be successfully validated in the cohort.

6.2.2 Study population

This study comprised all new hairdressing apprentices over a 1-year period in Denmark. The only inclusion criteria were that the participants had just started their education and were willing to participate in three follow-ups. The only exclusion criteria were change of school from intervention school to control school or vice versa, change from school apprenticeship to salon apprenticeship, and finally if the apprentices were not able to qualify for an apprenticeship either in a salon or at the school and were therfore not able to continue their education. This study set-up reflects real life without any concern regarding age, sex, ethnicity etc.

Matched control group at inclusion: Only a few studies present data on younger generations, and then only on eczematous diseases [26;27]. No previous studies present data on personal exposures and skin reactions among adolescents. In cross-sectional studies, such as Study Part I, it is important to have a reference group for comparison of data to draw any reliable conclusions. In this study the matched control group is an advantage as it takes into account both the young age and the predominance of females in the cohort of hairdressing apprentices.

Selection bias: Study Part I showed that the hairdressing apprentices were a specially selected group with a 'healthy worker effect' and a different pattern of personal exposure. Within the cohort, selection bias is noticeable reduced due to the limited inclusion and exclusion criteria. The participation rate among the hairdressing apprentices was high at inclusion and the 1st and 2nd follow-up (91.6–99.8%), which also reduces any selection bias. In the matched control group, a satisfactory response rate of 68.3% was obtained at inclusion and, similarly, a high response rate of 74% was obtained among the dropouts.

Dropout analysis of the matched control group in Study Part I detected a slight difference regarding age and sex distribution between the respondents and non-respondents. Persons of female sex and younger age were more likely to respond to the questionnaire. Persons with special interest in hair dye exposures and experiences with skin reactions and eczematous diseases may be more likely to participate. The absolute values of previous eczematous diseases, personal exposure and skin reactions may be biased towards higher frequencies in the matched control group.

The non-respondents among the dropouts did not differ from the respondents regarding age and sex distribution. Most of the responses from the dropouts were obtained by telephone. All those contacted by telephone answered the questions asked, which reduced the selection bias. Of those who had the questionnaire sent, apprentices with hand eczema may have been more likely to respond, and the results may be biased towards a higher frequency of hand eczema among dropouts.

Confounding: The reference group at inclusion was matched on age, sex and geographical distribution to minimize any confounding effect of these parameters. No differences in age, sex, atopic dermatitis or previous hand eczema were detected between the intervention and control group at baseline in the follow-up study. Other possible confounding effects, for example, filaggrin null mutations, were not measured and may have differed between the intervention and the control group.

Several studies have shown that seasonal variation and air humidity, in terms of low temperature and low absolute humidity, have an influence on the development of irritant hand eczema. It is expected that the frequency of hand eczema is higher during the winter time [101;141]. This possible confounder was reduced in Study Part I as no subjects (neither the apprentices nor the reference group) completed the questionnaire during the winter. A potential overestimation of point prevalence of hand eczema in any of the groups was thereby minimized. In the follow-up study the clinical controls for both the intervention and the control group were distributed over different seasons, including both winter and summer seasons. That may have contributed to a confounding effect.

6.2.3 Validity of questions

The outcome of this study was based on self-reports. The main outcome was development of hand eczema during training. In epidemiological studies hand eczema has traditionally been measured as self-diagnosed, as symptom-based hand eczema has lower predictive values [84]. The question concerning self-reported hand eczema was validated in the cohort, using the clinical examination as the golden standard [112]. This makes the self-reported prevalence of hand eczema in this study design a valid method, with a sensitivity of 70.3%, a specificity of 99.8%, and high predictive values. The questions used and validated were adapted from NOSQ-2002 and based on previous validation studies concerning current hand eczema in different occupational settings and geographical areas [21;83-85;87;102]. This study was based on a relatively large number of subjects. We examined 501 persons and had 764 sets of clinical examinations and questionnaires. All participants completed the questionnaire before the clinical examination, and they were all examined on the same day that they completed the questionnaire. Hand eczema can change manifestation over a relatively short period, and a lag time between the self-reported hand eczema and the clinical examinations could have influenced the results. This potential bias was eliminated in the present study design.

The UK Working Party's diagnostic criteria were used to assess the occurrence of atopic dermatitis in the cohort. It was possible to fulfil all minor criteria as all participating apprentices were clinically examined for flexural eczema at inclusion. The UK Working Party's diagnostic criteria have been validated both in adult and child populations as well as in hospital setting and in general populations [105;106]. Validation of the criteria showed that they worked well with a sensitivity of 80% and a specificity of 97% in a population setting. Alternative ways to assess atopic dermatitis could be by asking "Have you ever suffered from childhood eczema?", but the validity of this question was reduced to a sensitivity of 90% and a specificity of 71% [142].

Questions on personal exposures and reactions were adapted from other large epidemiological studies, but were not validated. Questions concerning specific hairdressing procedures were developed for the study and tested in a pilot test.

6.2.4 Bias in connection with questionnaires

Information bias: When collecting information on exposures and effects in questionnaires there is always a risk of information bias as some effect measures are subjective. In the process of constructing and validating the questionnaires attempts were made to minimize information bias. People with a particular disease are more likely to report certain exposures, for instance, simply because they are more aware of them [110]. Conversely, in this study it could have been that new hairdressing apprentices underreported previous or present hand eczema as they were probably aware that it could increase their risk for hand eczema in relation to the education.

Recall bias: Recall is the ability to address retrospective information. Recall bias is a general problem but is suspected to increase with age. As all participants in this study were young, we expected to reduce recall bias, thereby giving a more precise result than studies in the general adult population. It must be assumed that an adolescent can remember more precisely at what age he or she had his or her first hair dye compared with an adult. It may be suspected that apprentices from the intervention group were more aware of exposures and disease because of their training and, accordingly, had better recall than the control group did. This may be a differential recall bias and may lead to overestimation of, for example, development of hand eczema in the intervention group.

6.2.5 Definitions

The definition of wet work does not correlate with the generally accepted definition [30;56-58]. Wet work in this study covered only wet hands for two hours or more per work day and did not cover number of hand washes or time spent wearing protective gloves. Glove use in specific hairdressing procedures was a part of the intervention, and the apprentices were encouraged to use gloves for all wet-work procedures and procedures involving chemicals. Our definition of wet work may have influenced the results towards less wet work than if all the generally accepted criteria had been used. In this study glove use was considered positive, but it limits the possibility of comparing the results with other studies that defined wet work the generally accepted way.

Glove use in specific hairdressing procedures was defined as procedures where gloves were used every time. This is considered a more precise estimate than 'most of the time' or 'regularly' and is expected to diminish information bias.

Black henna tattoo was defined as a temporary tattoo painted on the skin and lasting for 2–3 weeks, and often applied while on vacation or attending music festivals. This very specific definition was given to diminish confusion with a traditional tattoo and thereby reduce information bias.

6.2.6 Clinical examinations

The clinical examination was done using the HECSI scoring system, which is a validated scoring system developed for objective assessment of the clinical severity of hand eczema. Validation of HECSI was carried out by 12 dermatologists grading twice the hand eczema of 15 patients. A high reliability was found with an overall intra-class correlation coefficient for absolute intra-observer agreement of 0.90 and an intra-class correlation coefficient for total HECSI score across the group of dermatologists of 0.84, indicating an overall good inter- and intra-observer reliability. The highest agreement was found for scaling and erythema and the most difficult signs to assess were oedema and vesicles [88]. HECSI contains a number of specific signs of hand eczema (erythema, infiltration, vesicles, fissures, scaling and oedema), which does not eliminate but minimizes the confusion with other dermatoses (psoriasis, tinea infections, pustolosis palmo-plantaris etc). HECSI is based on clinical signs only and does not consider subjective impacts such as pruritus, soreness, functional impairment or quality of life. These parameters are important issues for patients with hand eczema; however, it is problematic to combine objective scales with subjective patient-rated scales [143;144]. As HECSI contains very specific signs and grades of the severity, it is possible to diagnose even mild cases of hand eczema. This is an advantage in this study as most of the hairdressing apprentices with hand eczema had mild symptoms. The range of HECSI scores in this study was 1–31, with a mean score of 5.7 at inclusion and 8.4 at the 2nd follow-up. No clear definition of the range of mild, moderate and severe hand eczema exists, but in a previous study on patients with hand eczema referred to dermatological clinics, mild cases were defined as HECSI score 0–11 points, moderate cases as score 12–27 points and severe cases as score > 28 points [35].

As most of the clinical examinations were done during school periods and thereby under low exposure conditions, most of the apprentices affected by hand eczema were in a stage of recovery and only mild or no hand eczema was present.

All clinical examinations were performed by one observer, which excludes any observer bias.

7 CONCLUSION

The following main conclusions have been drawn from this thesis regarding prevention of occupational hand eczema among Danish hairdressing apprentices:

Study Part I, Manuscript I:

- Hairdressing apprentices report less previous or present hand eczema, eczema on wrists or forearms and atopic dermatitis at the time they begin their education compared with a matched control group from the general population. A healthy worker effect was found among the Danish hairdressing apprentices.

Study Part I, Manuscript II:

- Hairdressing apprentices have exposed themselves to potential allergens to a higher extent at the time they begin their education than has a matched control group from the general population.

- Hairdressing apprentices report more skin reactions to hair dyes, black henna tattoos, eyebrow dye and piercings at the time they begin their education compared with a matched control group from the general population.

Study Part II, Manuscript III:

- Self-reported hand eczema among hairdressing apprentices is a valid method to estimate the point prevalence of hand eczema as good agreement between self-reported hand eczema and clinical examination was found.

Study Part II, Manuscript IV:

- Evidence-based education is an effective approach in prevention of occupational hand eczema among hairdressing apprentices. We recommend offering hairdressing apprentices more education.

- Atopic dermatitis is a risk factor for development of occupational hand eczema among hairdressing apprentices, despite intervention.

8 PERSPECTIVES AND FUTURE STUDIES

This thesis verifies that it is possible with evidence-based education to improve the use of personal protective measures and to reduce the incidence of occupational hand eczema in hairdressing apprentices. This is an inexpensive and fairly easy way to prevent a disease that has a substantial impact on the individual and on society.

To secure the health of the future hairdressing apprentices in Denmark in the best possible way, implementation of the education programme in all Danish vocational schools is in progress. In addition, further education of salon owners in corporation with the Danish Hairdressers' and Beauticians' Union is being discussed. The salon owners have a significant influence on the apprentices and have shown to be an important link to the continuation of good occupational behaviour in terms of glove use etc. Lastly, education of the Danish Working Environment Authority is needed and is planned through dialogue.

This study demonstrates the ability to improve the working conditions of the hairdressing apprentices in terms of reducing the amount of wet work and increasing the use of personal protective measures within the study period of 18 months. It would be of great interest to evaluate any long-term effect of the intervention. A future study could be a 5-year follow-up of the cohort.

Improvement of individual career guidance is needed, both prior to education and when affected by occupational hand eczema. Prognostic factors for staying in the profession even when affected by hand eczema are poorly enlightened. Studies on prognosis among hairdressers regarding irritant or allergic hand eczema, and ultimately on the presence of specific allergens, would be of great interest.

Recently, attention has been directed towards the role of filaggrin null mutations as a risk factor for hand eczema. It would be of relevance to measure these mutations in the cohort of hairdressing apprentices as they may influence the risk of severe skin problems and make early intervention necessary. It is suspected that this mutation is overrepresented in patients with atopic dermatitis and irritant hand eczema [32-34;145].

Finally, continuation of improving the hairdressers' work environment and keeping this subject on the agenda politically, in the trade unions and in a scientific perspective is of great importance.

9 REFERENCES

1. Skoet R, Olsen J, Mathiesen B *et al*. A survey of occupational hand eczema in Denmark. *Contact Dermatitis* 2004; **51**: 159-66.

2. Diepgen TL, Coenraads PJ. The epidemiology of occupational contact dermatitis. *Int.Arch.Occup.Environ.Health* 1999; **72**: 496-506.

3. Halkier-Sorensen L. Occupational skin diseases. *Contact Dermatitis* 1996; **35**: 1-120.

4. Halkier-Sorensen L. Occupational skin diseases: reliability and utility of the data in the various registers; the course from notification to compensation and the costs. A case study from Denmark. *Contact Dermatitis* 1998; **39**: 71-8.

5. Dickel H, Kuss O, Blesius CR *et al*. Occupational skin diseases in Northern Bavaria between 1990 and 1999: a population-based study. *Br.J.Dermatol.* 2001; **145**: 453-62.

6. Wall LM, Gebauer KA. Occupational skin disease in Western Australia. *Contact Dermatitis* 1991; **24**: 101-9.

7. Bryld LE, Hindsberger C, Kyvik KO *et al*. Risk factors influencing the development of hand eczema in a population-based twin sample. *Br.J.Dermatol.* 2003; **149**: 1214-20.

8. Lammintausta K, Kalimo K. Atopy and hand dermatitis in hospital wet work. *Contact Dermatitis* 1981; **7**: 301-8.

9. Nyren M, Lindberg M, Stenberg B *et al*. Influence of childhood atopic dermatitis on future worklife. *Scand.J.Work Environ.Health* 2005; **31**: 474-8.

10. Rystedt I. Atopic background in patients with occupational hand eczema. *Contact Dermatitis* 1985; **12**: 247-54.

11. Rystedt I. Factors influencing the occurrence of hand eczema in adults with a history of atopic dermatitis in childhood. *Contact Dermatitis* 1985; **12**: 185-91.

12. Rystedt I. Work-related hand eczema in atopics. *Contact Dermatitis* 1985; **12**: 164-71.

13. Sundhedsstyrelsen. *Forebyggelse af kontakteksemer*, 2nd edn. 2001.

14. Diepgen TL. The costs of skin disease. *Eur.J.Dermatol.* 2006; **16**: 456-60.

15. Cvetkovski RS, Zachariae R, Jensen H *et al*. Prognosis of occupational hand eczema: a follow-up study. *Arch.Dermatol.* 2006; **142**: 305-11.

16. Wall LM, Gebauer KA. A follow-up study of occupational skin disease in Western Australia. *Contact Dermatitis* 1991; **24**: 241-3.

17. Malkonen T, Alanko K, Jolanki R *et al*. Long-term follow-up study of occupational hand eczema. *Br.J.Dermatol.* 2010; **163**: 999-1006.

18. Meding B, Lantto R, Lindahl G *et al*. Occupational skin disease in Sweden--a 12-year follow-up. *Contact Dermatitis* 2005; **53**: 308-13.

19. Malkonen T, Jolanki R, Alanko K *et al*. A 6-month follow-up study of 1048 patients diagnosed with an occupational skin disease. *Contact Dermatitis* 2009; **61**: 261-8.

20. Thyssen JP, Johansen JD, Linneberg A *et al*. The epidemiology of hand eczema in the general population--prevalence and main findings. *Contact Dermatitis* 2010; **62**: 75-87.

21. Meding B. Epidemiology of hand eczema in an industrial city. *Acta Derm.Venereol.Suppl (Stockh)* 1990; **153**: 1-43.

22. Lerbaek A, Kyvik KO, Mortensen J *et al*. Heritability of hand eczema is not explained by comorbidity with atopic dermatitis. *J.Invest Dermatol.* 2007; **127**: 1632-40.

23. Meding B, Liden C, Berglind N. Self-diagnosed dermatitis in adults. Results from a population survey in Stockholm. *Contact Dermatitis* 2001; **45**: 341-5.

24. Meding B, Jarvholm B. Hand eczema in Swedish adults - changes in prevalence between 1983 and 1996. *J.Invest Dermatol.* 2002; **118**: 719-23.

25. Bregnhoj A, Sosted H, Menne T *et al*. Healthy worker effect in hairdressing apprentices. *Contact Dermatitis* 2011; **64**: 80-4.

26. Mortz CG, Lauritsen JM, Bindslev-Jensen C *et al*. Prevalence of atopic dermatitis, asthma, allergic rhinitis, and hand and contact dermatitis in adolescents. The Odense Adolescence Cohort Study on Atopic Diseases and Dermatitis. *Br.J.Dermatol.* 2001; **144**: 523-32.

27. Yngveson M, Svensson A, Isacsson A. Prevalence of self-reported hand dermatosis in upper secondary school pupils. *Acta Derm.Venereol.* 1998; **78**: 371-4.

28. Meding B, Swanbeck G. Predictive factors for hand eczema. *Contact Dermatitis* 1990; **23**: 154-61.

29. Simpson EL, Thompson MM, Hanifin JM. Prevalence and morphology of hand eczema in patients with atopic dermatitis. *Dermatitis* 2006; **17**: 123-7.

30. Uter W, Pfahlberg A, Gefeller O *et al*. Hand dermatitis in a prospectively-followed cohort of hairdressing apprentices: final results of the POSH study. Prevention of occupational skin disease in hairdressers. *Contact Dermatitis* 1999; **41**: 280-6.

31. Lerbaek A, Bisgaard H, Agner T *et al*. Filaggrin null alleles are not associated with hand eczema or contact allergy. *Br.J.Dermatol.* 2007; **157**: 1199-204.

32. Molin S, Vollmer S, Weiss EH *et al*. Filaggrin mutations may confer susceptibility to chronic hand eczema characterized by combined allergic and irritant contact dermatitis. *Br.J.Dermatol.* 2009; **161**: 801-7.

33. Thyssen JP, Carlsen BC, Johansen JD *et al*. Filaggrin null-mutations may be associated with a distinct subtype of atopic hand eczema. *Acta Derm.Venereol.* 2010; **90**: 528.

34. Thyssen JP, Carlsen BC, Menne T *et al*. Filaggrin null mutations increase the risk and persistence of hand eczema in subjects with atopic dermatitis: results from a general population study. *Br.J.Dermatol.* 2010; **163**: 115-20.

35. Hald M, Agner T, Blands J *et al*. Clinical severity and prognosis of hand eczema. *Br.J.Dermatol.* 2009; **160**: 1229-36.

36. Hald M, Agner T, Blands J *et al*. Delay in medical attention to hand eczema: a follow-up study. *Br.J.Dermatol.* 2009; **161**: 1294-300.

37. Hansen HS, Sosted H. Hand eczema in Copenhagen hairdressers--prevalence and under-reporting to occupational registers. *Contact Dermatitis* 2009; **61**: 361-3.

38. Holm JO, Veierod MB. An epidemiological study of hand eczema. I. Prevalence and cumulative prevalence among hairdressers compared with a control group of teachers. *Acta Derm.Venereol.Suppl (Stockh)* 1994; **187**: 8-11.

39. Lind ML, Albin M, Brisman J *et al*. Incidence of hand eczema in female Swedish hairdressers. *Occup.Environ.Med.* 2007; **64**: 191-5.

40. Roberts H, Frowen K, Sim M *et al*. Prevalence of atopy in a population of hairdressing students and practising hairdressers in Melbourne, Australia. *Australas.J.Dermatol.* 2006; **47**: 172-7.

41. Valks R, Conde-Salazar L, Malfeito J *et al*. Contact dermatitis in hairdressers, 10 years later: patch-test results in 300 hairdressers (1994 to 2003) and comparison with previous study. *Dermatitis* 2005; **16**: 28-31.

42. Majoie IM, von Blomberg BM, Bruynzeel DP. Development of hand eczema in junior hairdressers: an 8-year follow-up study. *Contact Dermatitis* 1996; **34**: 243-7.

43. Holm JO, Veierod MB. An epidemiological study of hand eczema. V. Prevalence among hairdresser trainees, compared with a general population of hairdressers. *Acta Derm.Venereol.Suppl (Stockh)* 1994; **187**: 23-5.

44. Krecisz B, Kiec-Swierczynska M, Chomiczewska D. Dermatological screening and results of patch testing among Polish apprentice hairdressers. *Contact Dermatitis* 2011; **64**: 90-5.

45. Uter W, Pfahlberg A, Gefeller O *et al*. Prevalence and incidence of hand dermatitis in hairdressing apprentices: results of the POSH study. Prevention of occupational skin disease in hairdressers. *Int.Arch.Occup.Environ.Health* 1998; **71**: 487-92.

46. Dickel H, Kuss O, Schmidt A *et al*. Importance of irritant contact dermatitis in occupational skin disease. *Am.J.Clin.Dermatol.* 2002; **3**: 283-9.

47. Elsner P. Irritant dermatitis in the workplace. *Dermatol.Clin.* 1994; **12**: 461-7.

48. Handelshøjskolens efteruddannelsescenter i København. Undersøgelsesrapport til frisørfagets faglige ordning om årsager til frisørsvendenes afgang fra frisørfaget. 1999.

49. Lysdahl SH, Søsted H, Andersen KE, and Johansen J.D. Hand Eczema in hairdressers
- a Danish cohort study of the prevalence of hand eczema and its career consequences. Submittet for publication . 2011.

50. Leino T, Tuomi K, Paakkulainen H *et al*. Health reasons for leaving the profession as determined among Finnish hairdressers in 1980-1995. *Int.Arch.Occup.Environ.Health* 1999; **72**: 56-9.

51. Hansen HS, Johansen JD, Thyssen JP *et al*. Personal use of Hair Dyes and Temporary Black Tattoos in Copenhagen Hairdressers. *Ann.Occup Hyg* 2010.

52. Uter W, Lessmann H, Geier J *et al*. Contact allergy to hairdressing allergens in female hairdressers and clients--current data from the IVDK, 2003-2006. *J.Dtsch.Dermatol.Ges.* 2007; **5**: 993-1001.

53. Uter W, Lessmann H, Geier J *et al*. Contact allergy to ingredients of hair cosmetics in female hairdressers and clients--an 8-year analysis of IVDK data. *Contact Dermatitis* 2003; **49**: 236-40.

54. Lind ML, Boman A, Sollenberg J *et al*. Occupational dermal exposure to permanent hair dyes among hairdressers. *Ann.Occup.Hyg.* 2005; **49**: 473-80.

55. Thyssen JP, Milting K, Bregnhoj A *et al*. Nickel allergy in patch-tested female hairdressers and assessment of nickel release from hairdressers' scissors and crochet hooks. *Contact Dermatitis* 2009; **61**: 281-6.

56. Jungbauer FH, Lensen GJ, Groothoff JW *et al*. Exposure of the hands to wet work in nurses. *Contact Dermatitis* 2004; **50**: 225-9.

57. Flyvholm MA, Lindberg M. OEESC-2005--summing up on the theme irritants and wet work. *Contact Dermatitis* 2006; **55**: 317-21.

58. Fartasch M. [Skin protection. From TRGS 401 to guidelines on "occupational skin protection products"]. *Hautarzt* 2009; **60**: 702-7.

59. Anveden B, I, Alderling M, Jarvholm B *et al*. Occupational skin exposure to water: a population-based study. *Br.J.Dermatol.* 2009; **160**: 616-21.

60. Kralj N, Oertel C, Doench NM *et al*. Duration of wet work in hairdressers. *Int.Arch.Occup.Environ.Health* 2010.

61. Leino T, Tammilehto L, Hytonen M *et al*. Occupational skin and respiratory diseases among hairdressers. *Scand.J.Work Environ.Health* 1998; **24**: 398-406.

62. Veiersted KB, Gould KS, Osteras N *et al*. Effect of an intervention addressing working technique on the biomechanical load of the neck and shoulders among hairdressers. *Appl.Ergon.* 2008; **39**: 183-90.

63. Arokoski JP, Nevala-Puranen N, Danner R *et al*. Occupationally Oriented Medical Rehabilitation and Hairdressers' Work Techniques--A one-and-a-half-year follow-up. *Int.J.Occup.Saf Ergon.* 1998; **4**: 43-56.

64. Dryson E, 't MA, Walls C *et al*. Case-control study of high risk occupations for bladder cancer in New Zealand. *Int.J.Cancer* 2008; **122**: 1340-6.

65. Takkouche B, Regueira-Mendez C, Montes-Martinez A. Risk of cancer among hairdressers and related workers: a meta-analysis. *Int.J.Epidemiol.* 2009; **38**: 1512-31.

66. Gago-Dominguez M, Castelao JE, Yuan JM *et al*. Use of permanent hair dyes and bladder-cancer risk. *Int.J.Cancer* 2001; **91**: 575-9.

67. Axmon A, Rylander L. Birth weight and fetal growth in infants born to female hairdressers and their sisters. *Occup.Environ.Med.* 2009; **66**: 198-204.

68. Hougaard KS, Hannerz H, Bonde JP *et al*. The risk of infertility among hairdressers. Five-year follow-up of female hairdressers in a Danish national registry. *Hum.Reprod.* 2006; **21**: 3122-6.

69. Axmon A, Rylander L, Lillienberg L *et al*. Fertility among female hairdressers. *Scand.J.Work Environ.Health* 2006; **32**: 51-60.

70. Goldenhar LM, LaMontagne AD, Katz T *et al*. The intervention research process in occupational safety and health: an overview from the National Occupational Research Agenda Intervention Effectiveness Research team. *J.Occup.Environ.Med.* 2001; **43**: 616-22.

71. Bauer A, Schmitt J, Bennett C *et al*. Interventions for preventing occupational irritant hand dermatitis. *Cochrane.Database.Syst.Rev.* 2010; CD004414.

72. Skudlik C, Wulfhorst B, Gediga G *et al*. Tertiary individual prevention of occupational skin diseases: a decade's experience with recalcitrant occupational dermatitis. *Int.Arch.Occup.Environ.Health* 2008; **81**: 1059-64.

73. Flyvholm MA, Mygind K, Sell L *et al*. A randomised controlled intervention study on prevention of work related skin problems among gut cleaners in swine slaughterhouses. *Occup.Environ.Med.* 2005; **62**: 642-9.

74. Held E, Wolff C, Gyntelberg F *et al*. Prevention of work-related skin problems in student auxiliary nurses: an intervention study. *Contact Dermatitis* 2001; **44**: 297-303.

75. Held E, Mygind K, Wolff C *et al*. Prevention of work related skin problems: an intervention study in wet work employees. *Occup.Environ.Med.* 2002; **59**: 556-61.

76. Mygind K, Borg V, Flyvholm MA *et al*. A study of the implementation process of an intervention to prevent work-related skin problems in wet-work occupations. *Int.Arch.Occup.Environ.Health* 2006; **79**: 66-74.

77. Sell L, Flyvholm MA, Lindhard G *et al*. Implementation of an occupational skin disease prevention programme in Danish cheese dairies. *Contact Dermatitis* 2005; **53**: 155-61.

78. Agner T, Held E. Skin protection programmes. *Contact Dermatitis* 2002; **47**: 253-6.

79. Matterne U, Diepgen TL, Weisshaar E. Effects of a health-educational and psychological intervention on socio-cognitive determinants of skin protection behaviour in individuals with occupational dermatoses. *Int.Arch.Occup.Environ.Health* 2010; **83**: 183-9.

80. Matterne U, Diepgen TL, Weisshaar E. Differential effects of a tertiary individual prevention programme for patients with occupational skin disease depending on diagnosis. *J.Eur.Acad.Dermatol.Venereol.* 2010; **24**: 1089-93.

81. Wulfhorst B, Bock M, Gediga G *et al*. Sustainability of an interdisciplinary secondary prevention program for hairdressers. *Int.Arch.Occup.Environ.Health* 2010; **83**: 165-71.

82. Carstensen O, Rasmussen K, Ponten A *et al*. The validity of a questionnaire-based epidemiological study of occupational dermatosis. *Contact Dermatitis* 2006; **55**: 295-300.

83. Meding B, Barregard L. Validity of self-reports of hand eczema. *Contact Dermatitis* 2001; **45**: 99-103.

84. Smit HA, Coenraads PJ, Lavrijsen AP *et al*. Evaluation of a self-administered questionnaire on hand dermatitis. *Contact Dermatitis* 1992; **26**: 11-6.

85. Susitaival P, Husman L, Hollmen A *et al*. Dermatoses determined in a population of farmers in a questionnaire-based clinical study including methodology validation. *Scand.J.Work Environ.Health* 1995; **21**: 30-5.

86. Vermeulen R, Kromhout H, Bruynzeel DP *et al*. Ascertainment of hand dermatitis using a symptom-based questionnaire; applicability in an industrial population. *Contact Dermatitis* 2000; **42**: 202-6.

87. Yngveson M, Svensson A, Isacsson A. Evaluation of a self-reported questionnaire on hand dermatosis in secondary school children. *Acta Derm.Venereol.* 1997; **77**: 455-7.

88. Held E, Skoet R, Johansen JD *et al*. The hand eczema severity index (HECSI): a scoring system for clinical assessment of hand eczema. A study of inter- and intraobserver reliability. *Br.J.Dermatol.* 2005; **152**: 302-7.

89. Skudlik C, Dulon M, Pohrt U *et al*. Osnabrueck hand eczema severity index--a study of the interobserver reliability of a scoring system assessing skin diseases of the hands. *Contact Dermatitis* 2006; **55**: 42-7.

90. Weistenhofer W, Baumeister T, Drexler H *et al*. How to quantify skin impairment in primary and secondary prevention? - HE. *Br.J.Dermatol.* 2010.

91. Hueber-Becker F, Nohynek GJ, Dufour EK *et al*. Occupational exposure of hairdressers to [14C]-para-phenylenediamine-containing oxidative hair dyes: a mass balance study. *Food Chem.Toxicol.* 2007; **45**: 160-9.

92. Moscato G, Pignatti P, Yacoub MR *et al*. Occupational asthma and occupational rhinitis in hairdressers. *Chest* 2005; **128**: 3590-8.

93. Lind ML, Johnsson S, Meding B *et al*. Permeability of hair dye compounds p-phenylenediamine, toluene-2,5-diaminesulfate and resorcinol through protective gloves in hairdressing. *Ann.Occup.Hyg.* 2007; **51**: 479-85.

94. Ramsing DW, Agner T. Effect of glove occlusion on human skin (II). Long-term experimental exposure. *Contact Dermatitis* 1996; **34**: 258-62.

95. Ramsing DW, Agner T. Effect of glove occlusion on human skin. (I). short-term experimental exposure. *Contact Dermatitis* 1996; **34**: 1-5.

96. Held E, Agner T. Comparison between 2 test models in evaluating the effect of a moisturizer on irritated human skin. *Contact Dermatitis* 1999; **40**: 261-8.

97. Held E, Johansen JD, Agner T *et al*. Contact allergy to cosmetics: testing with patients' own products. *Contact Dermatitis* 1999; **40**: 310-5.

98. Held E, Agner T. Effect of moisturizers on skin susceptibility to irritants. *Acta Derm.Venereol.* 2001; **81**: 104-7.

99. Hansen KS. Occupational dermatoses in hospital cleaning women. *Contact Dermatitis* 1983; **9**: 343-51.

100. Nilsson E, Mikaelsson B, Andersson S. Atopy, occupation and domestic work as risk factors for hand eczema in hospital workers. *Contact Dermatitis* 1985; **13**: 216-23.

101. Agner T, Serup J. Seasonal variation of skin resistance to irritants. *Br.J.Dermatol.* 1989; **121**: 323-8.

102. Susitaival P, Flyvholm MA, Meding B *et al*. Nordic Occupational Skin Questionnaire (NOSQ-2002): a new tool for surveying occupational skin diseases and exposure. *Contact Dermatitis* 2003; **49**: 70-6.

103. Hanifin JM, Rajka G. Diagnostic features of atopic dermatitis. *Acta Derm.Venereol.Suppl (Stockh)* 1980; **92**: 44-7.

104. Williams HC, Burney PG, Hay RJ *et al*. The U.K. Working Party's Diagnostic Criteria for Atopic Dermatitis. I. Derivation of a minimum set of discriminators for atopic dermatitis. *Br.J.Dermatol.* 1994; **131**: 383-96.

105. Williams HC, Burney PG, Pembroke AC *et al*. The U.K. Working Party's Diagnostic Criteria for Atopic Dermatitis. III. Independent hospital validation. *Br.J.Dermatol.* 1994; **131**: 406-16.

106. Williams HC, Burney PG, Pembroke AC *et al*. Validation of the U.K. diagnostic criteria for atopic dermatitis in a population setting. U.K. Diagnostic Criteria for Atopic Dermatitis Working Party. *Br.J.Dermatol.* 1996; **135**: 12-7.

107. Sosted H, Hesse U, Menne T *et al*. Contact dermatitis to hair dyes in a Danish adult population: an interview-based study. *Br.J.Dermatol.* 2005; **153**: 132-5.

108. Thyssen JP, Linneberg A, Menne T *et al*. The prevalence and morbidity of sensitization to fragrance mix I in the general population. *Br.J.Dermatol.* 2009; **161**: 95-101.

109. Nielsen NH, Linneberg A, Menne T *et al*. Allergic contact sensitization in an adult Danish population: two cross-sectional surveys eight years apart (the Copenhagen Allergy Study). *Acta Derm.Venereol.* 2001; **81**: 31-4.

110. Altman DG. *Practical statistics for medical research.* 1991.

111. Stenberg B, Meding B, Svensson A. Dermatology in public health--a model for surveillance of common skin diseases. *Scand.J.Public Health* 2010; **38**: 368-74.

112. Bregnhoj, A., Søsted H, Menné T., and Johansen, J. D. Validation of self-reported hand eczema among Danish hairdressing apprentices. Accepted for publication . 2011.

113. Hald M, Berg ND, Elberling J *et al*. Medical consultations in relation to severity of hand eczema in the general population. *Br.J.Dermatol.* 2008; **158**: 773-7.

114. Kay J, Gawkrodger DJ, Mortimer MJ *et al*. The prevalence of childhood atopic eczema in a general population. *J Am Acad Dermatol* 1994; **30**: 35-9.

115. Schultz LF, Diepgen T, Svensson A. The occurrence of atopic dermatitis in north Europe: an international questionnaire study. *J Am.Acad.Dermatol.* 1996; **34**: 760-4.

116. Dotterud LK, Kvammen B, Bolle R *et al*. A survey of atopic diseases among school children in Sor-Varanger community. Possible effects of subarctic climate and industrial pollution from Russia. *Acta Derm.Venereol.* 1994; **74**: 124-8.

117. van de V, van den Eijnden RJ, Engels RC. Atopic diseases and related risk factors among Dutch adolescents. *Eur.J Public Health* 2006; **16**: 549-58.

118. Zutavern A, Hirsch T, Leupold W *et al*. Atopic dermatitis, extrinsic atopic dermatitis and the hygiene hypothesis: results from a cross-sectional study. *Clin Exp.Allergy* 2005; **35**: 1301-8.

119. Rothman K J, Greenland S. *Modern Epidemiology*, Second edn. 1998.

120. Basketter DA, Jefferies D, Safford BJ *et al*. The impact of exposure variables on the induction of skin sensitization. *Contact Dermatitis* 2006; **55**: 178-85.

121. Hextall JM, Alagaratnam NJ, Glendinning AK *et al*. Dose-time relationships for elicitation of contact allergy to para-phenylenediamine. *Contact Dermatitis* 2002; **47**: 96-9.

122. McFadden JP, Wakelin SH, Holloway DB *et al*. The effect of patch duration on the elicitation of para-phenylenediamine contact allergy. *Contact Dermatitis* 1998; **39**: 79-81.

123. White JM, Gilmour NJ, Jeffries D *et al*. A general population from Thailand: incidence of common allergens with emphasis on para-phenylenediamine. *Clin.Exp.Allergy* 2007; **37**: 1848-53.

124. Brancaccio RR, Brown LH, Chang YT *et al*. Identification and quantification of para-phenylenediamine in a temporary black henna tattoo. *Am.J.Contact Dermat.* 2002; **13**: 15-8.

125. Le Coz CJ, Lefebvre C, Keller F *et al*. Allergic contact dermatitis caused by skin painting (pseudotattooing) with black henna, a mixture of henna and p-phenylenediamine and its derivatives. *Arch.Dermatol.* 2000; **136**: 1515-7.

126. Sosted H, Rastogi SC, Thomsen JS. Allergic contact dermatitis from toluene-2,5-diamine in a cream dye for eyelashes and eyebrows--quantitative exposure assessment. *Contact Dermatitis* 2007; **57**: 195-6.

127. Ho SG, Basketter DA, Jefferies D *et al*. Analysis of para-phenylenediamine allergic patients in relation to strength of patch test reaction. *Br.J.Dermatol.* 2005; **153**: 364-7.

128. Thyssen JP, Andersen KE, Bruze M *et al*. p-Phenylenediamine sensitization is more prevalent in central and southern European patch test centres than in Scandinavian: results from a multicentre study. *Contact Dermatitis* 2009; **60**: 314-9.

129. Xie Z, Hayakawa R, Sugiura M *et al*. Experimental study on skin sensitization potencies and cross-reactivities of hair-dye-related chemicals in guinea pigs. *Contact Dermatitis* 2000; **42**: 270-5.

130. Thyssen JP, White JM. Epidemiological data on consumer allergy to p-phenylenediamine. *Contact Dermatitis* 2008; **59**: 327-43.

131. Schafer T, Bohler E, Ruhdorfer S *et al*. Epidemiology of contact allergy in adults. *Allergy* 2001; **56**: 1192-6.

132. Thyssen JP, Johansen JD, Menne T *et al*. Nickel allergy in Danish women before and after nickel regulation. *N.Engl.J.Med.* 2009; **360**: 2259-60.

133. Brandao MH, Gontijo B, Girundi MA *et al*. Ear piercing as a risk factor for contact allergy to nickel. *J.Pediatr.(Rio J.)* 2010; **86**: 149-54.

134. Menne T, Rasmussen K. Regulation of nickel exposure in Denmark. *Contact Dermatitis* 1990; **23**: 57-8.

135. Thyssen JP, Menne T. Metal allergy--a review on exposures, penetration, genetics, prevalence, and clinical implications. *Chem.Res.Toxicol.* 2010; **23**: 309-18.

136. Berg M, Axelson O. Evaluation of a questionnaire for facial skin complaints related to work at visual display units. *Contact Dermatitis* 1990; **22**: 71-7.

137. Nixon R, Roberts H, Frowen K *et al*. Knowledge of skin hazards and the use of gloves by Australian hairdressing students and practising hairdressers. *Contact Dermatitis* 2006; **54**: 112-6.

138. Ling TC, Coulson IH. What do trainee hairdressers know about hand dermatitis? *Contact Dermatitis* 2002; **47**: 227-31.

139. Uter W, Gefeller O, Schwanitz HJ. Occupational dermatitis in hairdressing apprentices. Early-onset irritant skin damage. *Curr.Probl.Dermatol.* 1995; **23**: 49-55.

140. Relton C, Torgerson D, O'Cathain A *et al*. Rethinking pragmatic randomised controlled trials: introducing the "cohort multiple randomised controlled trial" design. *BMJ* 2010; **340**: c1066.

141. Uter W, Gefeller O, Schwanitz HJ. An epidemiological study of the influence of season (cold and dry air) on the occurrence of irritant skin changes of the hands. *Br.J.Dermatol.* 1998; **138**: 266-72.

142. Stenberg B, Lindberg M, Meding B *et al*. Is the question 'Have you had childhood eczema?' useful for assessing childhood atopic eczema in adult population surveys? *Contact Dermatitis* 2006; **54**: 334-7.

143. Charman C, Chambers C, Williams H. Measuring atopic dermatitis severity in randomized controlled clinical trials: what exactly are we measuring? *J.Invest Dermatol.* 2003; **120**: 932-41.

144. Finlay AY. Measurement of disease activity and outcome in atopic dermatitis. *Br.J.Dermatol.* 1996; **135**: 509-15.

145. de Jongh CM, Khrenova L, Verberk MM *et al*. Loss-of-function polymorphisms in the filaggrin gene are associated with an increased susceptibility to chronic irritant contact dermatitis: a case-control study. *Br.J.Dermatol.* 2008; **159**: 621-7.

Healthy worker effect in hairdressing apprentices

Anne Bregnhøj[1], Heidi Søsted[1], Torkil Menné[2] and Jeanne Duus Johansen[3]

[1] *Research Centre for Hairdressers and Beauticians, Department of Dermato-Allergology, Copenhagen University Hospital Gentofte, Dk-2900 Hellerup, Denmark,* [2] *Department of Dermato-Allergology, Copenhagen University Hospital Gentofte, DK-2900 Hellerup, Denmark, and* [3] *National Allergy Research Centre, Department of Dermato-Allergology, Copenhagen University Hospital Gentofte, DK-2900 Hellerup, Denmark*

Summary

Background. Hairdressers and hairdressing apprentices have a high incidence of occupational hand eczema, owing to excessive wet work and exposure to chemical substances. Hairdressing apprentices, in particular, seem to be at high risk of developing hand eczema. Previous hand eczema and atopic dermatitis are known risk factors for the development of hand eczema in wet work occupations.

Objectives. To estimate the prevalence of hand eczema, eczema on wrists or forearms and atopic dermatitis in a cohort of hairdressing apprentices at the start of their education, and subsequently evaluate any potential healthy worker effect.

Methods. During the first 2 weeks of training, 382 hairdressing apprentices were enrolled in this study. All apprentices completed a self-administered questionnaire, including previously validated questions regarding, for example, previous and present hand eczema, eczema on the wrists or forearms, and atopic dermatitis. For comparison, the questionnaire was sent to a control group matched for age, gender and city code from the general population ($n = 1870$).

Results. Response rates were 99.7% for the hairdressing apprentices (mean age 17.5 years, range 15–39 years, 96.3% females) and 68.3% for the control group (mean age 17.4 years, range 15–39 years, 96.8% females). Previous or present hand eczema were reported by 8.0% of hairdressing apprentices and by 12.5% of the matched control group ($p = 0.009$), and eczema on the wrists or forearms was reported by 5.3% of the apprentices and by 11.9% of the controls ($p < 0.001$). We classified 21.4% of the hairdressing apprentices as having atopic dermatitis versus 29.8% of the matched control group ($p = 0.001$).

Conclusions. These results indicate a healthy worker effect, as there was a lower reported incidence of hand eczema and eczema on wrists or forearms, and there were fewer cases classified as having atopic dermatitis, among hairdressing apprentices than in a matched control group from the general population.

Key words: adolescent; atopic dermatitis; career guidance; hand eczema; hairdresser; hairdressers; hairdressing apprentices; healthy worker effect; selection.

Correspondence: Anne Bregnhøj, MD, Research Centre for Hairdressers and Beauticians, Department of Dermato-Allergology, Copenhagen University Hospital Gentofte, Niels Andersens vej 65, Dk-2900 Hellerup, Denmark. Tel: +45 3977 7305; Fax: +45 3977 7118. E-mail: annbre03@geh.regionh.dk

Hairdressers and hairdressing apprentices have a high incidence of both allergic and irritant occupational hand eczema, owing to excessive wet work and exposure to chemical substances, such as ingredients in hair dye, bleaching products, and permanent wave solutions (1–5). Hairdressing apprentices seem to be at particularly high risk of developing hand eczema (6–10), probably because they often perform the shampooing, and application and rinsing-off of chemicals, in the salons. The incidence of hand eczema in hairdressing apprentices was, in a previous study, estimated to be 35% in a 2-year period (11). Additionally, a relatively high proportion of

the apprentices in a German study who dropped out of training schools stated that skin problems were the main reason for this (8, 9). For comparison, the 1-year prevalence of hand eczema in the general population is estimated to be 7–11% both in the adult population and among younger people (12–15). Histories of hand eczema and atopic dermatitis are known risk factors for the development of hand eczema in wet work occupations (16–21). A Swedish study showed that atopic dermatitis in childhood did not influence the choice of career, but had a significant influence on job change and tripled the risk of developing hand eczema in future work life (16). To our knowledge, only the work of Uter et al. (7–9) has previously investigated the degree of atopic dermatitis and hand eczema among hairdressing apprentices at the beginning of their career, although they did not include a matched control group from the general population. Therefore, a possible selection of hairdressing apprentices because of skin disorders has not been evaluated, as no comparison with the general population was made.

The aim of this study was to estimate the prevalence of hand eczema, eczema on the wrists or forearms and atopic dermatitis among hairdressing apprentices at the time when they enter the training schools. On the basis of these results, we evaluated a potential healthy worker effect.

Materials and Methods

We conducted a questionnaire study among hairdressing apprentices and, for comparison, among a matched control group from the general population.

Study population

During the first 2 weeks of their education, the hairdressing apprentices were enrolled in a follow-up study on occupational hand eczema. The enrolment took place in two phases: in August 2008 ($n = 382$) and in January 2009 ($n = 120$). The data presented include results from the first of the two enrolments of the hairdressing apprentices ($n = 382$) and from a matched control group ($n = 1870$). The apprentices were recruited from all 10 hairdressing schools in Denmark, and all new apprentices present on the day of the inclusion were invited to participate in the study. All apprentices completed a self-administered questionnaire.

All apprentices gave informed consent, and the Committee on Biomedical Research Ethics of Copenhagen and Frederiksberg approved the protocol (H-B-2007-096). The study was conducted from August 2008 to March 2009.

Matched control group

For comparison, the questionnaire was sent to a matched control group from the general population. Matching was performed with the social security number, a unique identifier that all Danes have from birth. Each apprentice enrolled in August 2008, except for 8 with invalid social security numbers ($n = 374$), was matched to 5 controls ($n = 1870$). Matching was based on age, gender, and city code.

The questionnaire

Questions concerning a history of hand eczema, e.g. time of onset and symptoms during the last 12 months, were previously validated and adapted from the Nordic Occupational Skin Questionnaire (NOSQ-2002) (22). The following questions were asked: 'Have you ever had hand eczema?', 'Have you ever had eczema on your wrists or forearms?', and 'When did you last have eczema on your hands, wrists or forearms?' Atopic dermatitis was defined according to the UK Working Party's diagnostic criteria. These criteria include five questions concerning specific characteristics of atopic dermatitis, based on the Hanifin and Rajka criteria (23). To obtain the diagnosis of atopic dermatitis, one has to fulfil one major criterion ('Have you ever had an itchy skin condition?') and two of four minor criteria (flexural, neck or facial involvement, age of onset below 2 years, personal history of asthma or hay fever, and a history of a generally dry skin) (24–26).

The development of the questionnaire included a pilot test with 25 hairdressing apprentices and 5 young people not involved in the hairdressing trade.

Statistical analysis

For analysis of a matched dataset, the preferable method is conditional logistic regression. In this analysis, Cox regression was used as conditional logistic regression for comparison of hand eczema, eczema on wrists or forearms and atopic dermatitis in the two cohorts. A p-value <0.05 was considered to be significant.

All statistical analyses were performed with SPSS (SPSS, Chicago, IL, USA) for Windows (Release 17.0).

Results

The study population comprised 374 hairdressing apprentices recruited from 10 training schools in Denmark; each school provided from 8 to 103 subjects. The participation rate was 99.7% (374 of 375 hairdresser apprentices present on the day of inclusion). The response rate of the matched controls was 68.3% (1277 of 1870 completed

Table 1. Self-reported hand eczema and eczema on wrists or forearms

	Hairdressing apprentices (n = 374), % (no.)	Controls (n = 1277), % (no.)	P
Hand eczema			
Point prevalence	1.1 (4)	3.6 (46)	0.008
1-year prevalence	5.9 (22)	8.7 (111)	0.04
Lifetime prevalence	8.0 (30)	12.5 (159)	0.009
Eczema on wrists or forearms			
Point prevalence	1.6 (6)	2.7 (35)	0.15
1-year prevalence	3.7 (14)	7.0 (90)	0.02
Lifetime prevalence	5.3 (20)	11.9 (149)	<0.001
Atopic dermatitis*	21.4 (80)	29.8 (381)	0.001

The hairdressing apprentices were all enrolled at the time when they start their education at 10 different technical schools in Denmark. The controls were matched to the hairdressing apprentices by age, gender, and city code. Conditional logistic regression was used for the matched comparison. $P < 0.05$ was considered to be significant. *Atopic dermatitis is based on the UK Working Party's diagnostic criteria.

the questionnaire). Data collected from both cohorts are shown in Table 1.

The mean age was 17.5 years (range 15–39 years) for the apprentices and 17.4 years (range 15–39 years) for the controls, and the median age was 17 years for both groups. Both groups mainly consisted of females: 96.3% of the apprentices and 96.9% of the controls.

In the matched control group, the responders were slightly younger (mean age 17.4 years) than the non-responders (mean age 17.8 years) ($p = 0.02$). Similarly, there were fewer males among the responders (3.1%) than among the non-responders (5.1%) ($p = 0.04$).

The hairdressing apprentices, at the start of their education, reported significantly less hand eczema and eczema on wrists and forearms, concerning both lifetime and 1-year prevalence, than the matched control group. Additionally, the hairdressing apprentices were significantly less often classified as having atopic dermatitis than the matched control group.

To a certain extent, the hairdressing apprentices were already exposed to the work of hairdressers at the time when started their education. Among the hairdressing apprentices, 27.3% had been working in a hairdressing salon, 20.3% within the last 6 months prior to the start of their education. They had worked, on average, for 18.6 hr per week for 10 months in hairdressing salons, mainly cleaning the salon and shampooing the customers' hair.

Discussion

The present study compares the prevalence of atopic dermatitis, hand eczema and eczema on wrists and forearms

in a cohort of hairdressing apprentices, who had just started their education, with that among a matched control group from the general population. To our knowledge, this is the first study to describe the potential healthy worker effect in the hairdressing trade.

The main findings of the study show a significant difference in the prevalence of hand eczema, eczema on wrists and forearms and atopic dermatitis between the two groups. The point prevalence of hand eczema for the apprentices was 1.1%, as compared with 3.6% for the controls ($p = 0.008$), and the 1-year prevalence was 5.9%, as compared with 8.7% ($p = 0.04$). A significant difference was also found for atopic dermatitis.

These results indicate a healthy worker effect in the hairdressing trade in Denmark. There is an ongoing debate, both in public and among professionals, concerning the risk of skin diseases in wet work occupations. It is expected that career guidance will be carried out by general practitioners, dermatologists and healthcare professionals at the primary schools among young people consulting them because of hand eczema or atopic dermatitis. This could explain why the hairdressing apprentices have fewer skin symptoms than the matched control group from the general population.

A previous study among teenagers from the general population estimated the 1-year prevalence of hand eczema to be approximately 10% (14), which is in good agreement with the results from the matched control group in this study. The prevalence of atopic dermatitis in both cohorts in this study is relatively high as compared with studies in the general population. Numerous studies have estimated the prevalence of atopic dermatitis in the general population to be between 15% and 24% (13, 27–29). The relatively high prevalence of atopic dermatitis found in this study could be attributable to the high proportion of females. A sex difference in atopic dermatitis, with a female predominance, has been described in several studies (13, 28, 30, 31). Additionally, the young age of the participants could reduce recall bias, and thereby give a more precise result than studies in the general adult population.

Only a few studies have reported the prevalence of hand eczema in adolescence. In this study, the matched control group is an advantage, as it takes both the young age and the predominance of females in the cohort of hairdressing apprentices into account. All hairdressing apprentices were enrolled in August 2008, and the questionnaires were sent to the matched control group during spring 2009. It is expected that people will have more hand eczema during the winter (32, 33), but as no subjects answered the questionnaire during the winter, this seasonal variation, and thereby a potential overestimation of

the difference in point prevalence of hand eczema, is minimized. The response rate was high in both cohorts. The cohort of hairdressing apprentices is already, to a certain extent, subjected to the specific exposures of hairdressers, which might lead to an increased risk of occupational skin diseases even before they start their education, and thereby contribute to the selection of those who choose to start at the training school. The results are based on self-administered questionnaires, which, although validated, have some limitations. It is possible that the newly started hairdressing apprentices will underreport skin problems, and participation of the controls might be higher among those with a skin disease. This could possibly lead to an increase in the differences between the two groups.

In conclusion, hairdressing apprentices report less hand eczema and eczema on the wrists or forearms, and less often classified as having atopic dermatitis, than a matched control group from the general population. These results indicate a healthy worker effect in the hairdressing trade in Denmark. The hairdressing apprentices are healthier than the control group from the general population with regard to skin diseases. They have a lower risk profile for the development of hand eczema than the control group, and we therefore need to consider very seriously their development of hand eczema.

The cohort of hairdressing apprentices will be followed and examined for hand eczema during the first part of their training. Future publications on the incidence of hand eczema among hairdressing apprentices and possible preventive strategies are planned.

References

1 Lind M L, Albin M, Brisman J et al. Incidence of hand eczema in female Swedish hairdressers. *Occup Environ Med* 2007: **64**: 191–195.

2 Skoet R, Olsen J, Mathiesen B, Iversen L, Johansen J D, Agner T. A survey of occupational hand eczema in Denmark. *Contact Dermatitis* 2004: **51**: 159–166.

3 Hansen H S, Søsted H. Hand eczema in Copenhagen hairdressers – prevalence and under-reporting to occupational registers. *Contact Dermatitis* 2009: **61**: 361–363.

4 Roberts H, Frowen K, Sim M, Nixon R. Prevalence of atopy in a population of hairdressing students and practising hairdressers in Melbourne, Australia. *Australas J Dermatol* 2006: **47**: 172–177.

5 Holm J O, Veierod M B. An epidemiological study of hand eczema. I. Prevalence and cumulative prevalence among hairdressers compared with a control group of teachers. *Acta Derm Venereol Suppl (Stockh)* 1994: **187**: 8–11.

6 Diepgen T L, Coenraads P J. The epidemiology of occupational contact dermatitis. *Int Arch Occup Environ Health* 1999: **72**: 496–506.

7 Uter W, Gefeller O, Schwanitz H J. Occupational dermatitis in hairdressing apprentices. Early-onset irritant skin damage. *Curr Probl Dermatol* 1995: **23**: 49–55.

8 Uter W, Pfahlberg A, Gefeller O, Schwanitz H J. Prevalence and incidence of hand dermatitis in hairdressing apprentices: results of the POSH study. Prevention of occupational skin disease in hairdressers. *Int Arch Occup Environ Health* 1998: **71**: 487–492.

9 Uter W, Pfahlberg A, Gefeller O, Schwanitz H J. Hand dermatitis in a prospectively-followed cohort of hairdressing apprentices: final results of the POSH study. Prevention of occupational skin disease in hairdressers. *Contact Dermatitis* 1999: **41**: 280–286.

10 Valks R, Condé-Salazar L, Malfeito J, Ledo S. Contact dermatitis in hairdressers, 10 years later: patch-test results in 300 hairdressers (1994 to 2003) and comparison with previous study. *Dermatitis* 2005: **16**: 28–31.

11 Nixon R, Roberts H, Frowen K, Sim M. Knowledge of skin hazards and the use of gloves by Australian hairdressing students and practicing hairdressers. *Contact Dermatitis* 2006: **54**: 112–116.

12 Meding B. Epidemiology of hand eczema in an industrial city. *Acta Derm Venereol Suppl (Stockh)* 1990: **153**: 1–43.

13 Mortz C G, Lauritsen J M, Bindslev-Jensen C, Andersen K E. Prevalence of atopic dermatitis, asthma, allergic rhinitis, and hand and contact dermatitis in adolescents. The Odense Adolescence Cohort Study on Atopic Diseases and Dermatitis. *Br J Dermatol* 2001: **144**: 523–532.

14 Yngveson M, Svensson A, Isacsson A. Prevalence of self-reported hand dermatosis in upper secondary school pupils. *Acta Derm Venereol* 1998: **78**: 371–374.

15 Thyssen J P, Johansen J D, Linneberg A, Menné T. The epidemiology of hand eczema in the general population – prevalence and main findings. *Contact Dermatitis* 2010: **62**: 75–87.

16 Nyren M, Lindberg M, Stenberg B, Svensson M, Svensson A, Meding B. Influence of childhood atopic dermatitis on future worklife. *Scand J Work Environ Health* 2005: **31**: 474–478.

17 Rystedt I. Atopic background in patients with occupational hand eczema. *Contact Dermatitis* 1985: **12**: 247–254.

18 Rystedt I. Factors influencing the occurrence of hand eczema in adults with a history of atopic dermatitis in childhood. *Contact Dermatitis* 1985: **12**: 185–191.

19 Rystedt I. Work-related hand eczema in atopics. *Contact Dermatitis* 1985: **12**: 164–171.

20 Lammintausta K, Kalimö K. Atopy and hand dermatitis in hospital wet work. *Contact Dermatitis* 1981: **7**: 301–308.

21 Bryld L E, Hindsberger C, Kyvik K O, Agner T, Menné T. Risk factors influencing the development of hand eczema in a population-based twin sample. *Br J Dermatol* 2003: **149**: 1214–1220.

22 Susitaival P, Flyvholm M A, Meding B, Kanerva L, Lindberg M, Svensson A, Olafsson J H. Nordic Occupational Skin Questionnaire (NOSQ-2002): a new tool for surveying occupational skin diseases and exposure. *Contact Dermatitis* 2003: **49**: 70–76.

23 Hanifin J M, Rajka G. Diagnostic features of atopic dermatitis. *Acta Derm Venereol Suppl (Stockh)* 1980: **92**: 44–47.

24 Williams H C, Burney P G, Hay R J et al. Working Party's diagnostic criteria for atopic dermatitis. I: Derivation of a minimum set of discriminators for atopic dermatitis. *Br J Dermatol* 1994: **131**: 383–396.

25 Williams H C, Burney P G, Pembroke A C, Hay R J. The UK Working Party's diagnostic criteria for atopic dermatitis. III. Independent hospital validation. *Br J Dermatol* 1994: **131**: 406–416.

26 Williams H C, Burney P G, Pembroke A C, Hay R J. Validation of the UK diagnostic criteria for atopic dermatitis in a population setting. UK Diagnostic Criteria for Atopic Dermatitis Working Party. *Br J Dermatol* 1996: **135**: 12–17.

27 Kay J, Gawkrodger D J, Mortimer M J, Jaron A G. The prevalence of childhood atopic eczema in a general population. *J Am Acad Dermatol* 1994: **30**: 35–39.

28 Schultz L F, Diepgen T, Svensson A. The occurrence of atopic dermatitis in north Europe: an international questionnaire study. *J Am Acad Dermatol* 1996: **34** (Pt 1): 760–764.

29 Dotterud L K, Kvammen B, Bolle R, Falk E S. A survey of atopic diseases among school children in Sor-Varanger community. Possible effects of subarctic climate and industrial pollution from Russia. *Acta Derm Venereol* 1994: **74**: 124–128.

30 van de V, van den Eijnden R J, Engels R C. Atopic diseases and related risk factors among Dutch adolescents. *Eur J Public Health* 2006: **16**: 549–558.

31 Zutavern A, Hirsch T, Leupold W, Weiland S, Keil U, von Mutius E. Atopic dermatitis, extrinsic atopic dermatitis and the hygiene hypothesis: results from a cross-sectional study. *Clin Exp Allergy* 2005: **35**: 1301–1308.

32 Agner T, Serup J. Seasonal variation of skin resistance to irritants. *Br J Dermatol* 1989: **121**: 323–328.

33 Uter W, Gefeller O, Schwanitz H J. An epidemiological study of the influence of season (cold and dry air) on the occurrence of irritant skin changes of the hands. *Br J Dermatol* 1998: **138**: 266–272.

Exposures and reactions to allergens among hairdressing apprentices and matched controls

Anne Bregnhøj[1], Heidi Søsted[1], Torkil Menné[2] and Jeanne Duus Johansen[3]

[1] *Research Centre for Hairdressers and Beauticians, Department of Dermato-Allergology, Copenhagen University Hospital Gentofte, DK-2900 Hellerup, Denmark,* [2] *Department of Dermato-Allergology, Copenhagen University Hospital Gentofte, DK-2900 Hellerup, Denmark, and* [3] *National Allergy Research Centre, Department of Dermato-Allergology, Copenhagen University Hospital Gentofte, DK-2900 Hellerup, Denmark*

Summary

Background. Early and extensive exposures to chemical substances such as are found in hair dyes, perfumes and nickel are known risk factors for allergic reactions. Hairdressing apprentices belong to a high-risk group, as they are exposed both occupationally and personally.

Objectives. To estimate the degree of exposure and adverse skin reactions to chemical substances in a cohort of hairdressing apprentices, at the start of their education, as compared with a matched sample from the general population.

Materials. During their first 2 weeks of training, 382 hairdressing apprentices were enrolled in this study. All apprentices completed a self-administered questionnaire that included questions regarding, for example, exposures and skin reactions to hair dye, perfumed products, and piercings. For comparison, the questionnaire was sent to a control group from the general population, matched on age, sex, and postal code ($n = 1870$).

Results. Within the previous year, 95.2% of hairdressing apprentices and 66.9% of the control group had dyed their hair ($p < 0.001$); the apprentices dyed their hair, on average, 6.6 times per year, as compared with 3.7 times per year in the control group ($p < 0.001$). The mean age of the first hair dying among the apprentices was 12.1 years, as compared with 13.3 years for the matched control group ($p < 0.001$). The hairdressing apprentices reported more eczematous reactions to hair dye ($p = 0.002$) than the controls. Semi-permanent so-called 'black henna tattoos' had been carried out in 48.1% of the apprentices, as compared with 31.0% of the controls ($p < 0.001$).

Conclusions. Both hairdressing apprentices and the matched control group of young people from the general population were highly exposed to potent allergens. The hairdressing apprentices were even more exposed to products containing hair dye substances and piercings, and reported more adverse reactions to hair dye products than their matched controls from the general population.

Key words: Adolescent; allergic reactions; dermatitis; exposure; hair dye; hairdresser; hairdressers; hairdressing apprentices; perfume; piercing; semi-permanent black tattoos; temporary tattoo.

Correspondence: Anne Bregnhøj, MD, Research Centre for Hairdressers and Beauticians, Department of Dermato-Allergology, Copenhagen University Hospital Gentofte, Niels Andersens vej 65, Dk-2900 Hellerup, Denmark. Tel: +45 3977 7305; Fax: +45 3977 7118. E-mail: annbre03@geh.regionh.dk

Early and extensive exposures to chemical substances such as are found in hair dyes, perfumes and nickel are risk factors for allergic reactions (1, 2). It has been shown that hairdressers have a higher frequency of allergic reactions to perfumes, hair-bleaching products and permanent wave chemicals than the general population (3). Both hairdressers and hairdressing apprentices are exposed both professionally and personally, and belong to a high-risk occupational group.

Allergic reactions to hair dyes in the general population and in hairdressers have been investigated in several studies (3–5). Information about how hairdressing apprentices and adolescents from the general population expose themselves to hair dyes is missing. However, it is known that hair dye products are used at early ages, and severe allergic reactions in children have been reported (6). In a Danish study from 2004, it was found that the average age at first hair dye use in the general population was 16 years (5). Exposures to hair dye chemicals are achieved by the use of either hair dye or eyebrow/eyelashes dye (7). In addition, semi-permanent so-called 'black henna tattoos', which have become popular among children, teenagers, and adults, may contain hair dye ingredients (8). Several reports on exposure to semi-permanent black henna tattoos and the development of severe allergic reactions have been recently published (4, 9).

The aim of this study was to estimate the degree of exposure and adverse skin reactions to potential allergens in a cohort of hairdressing apprentices just starting their education, as compared with a matched control group from the general population.

Materials and Methods

We conducted a questionnaire study among hairdressing apprentices and, for comparison, a matched control group from the general population.

Study population

During the first 2 weeks of their education, the hairdressing apprentices were enrolled in a follow-up study on occupational hand eczema. The enrolment took place in two phases: in August 2008 ($n = 382$) and in January 2009 ($n = 120$). The data presented include results from the first of the two enrolments of the hairdressing apprentices ($n = 382$) and a matched control group ($n = 1870$). All apprentices completed a self-administered questionnaire.

All apprentices gave informed consent, and the Committee on Biomedical Research Ethics of Copenhagen and Frederiksberg approved the protocol (H-B-2007-096). The study was conducted from August 2008 to March 2009.

Matched control group

For comparison, the questionnaire was sent to a matched control group from the general population. Matching was performed with the social security number, a unique identifier that all Danes have from birth. Each apprentice enrolled in August 2008 (except for eight, because of invalid social security numbers) ($n = 374$), was matched to five controls ($n = 1870$). Matching was based on age, sex, and postal code.

Comparison of study population and matched control group

The participation rate of the hairdressing apprentices was 99.7% (374 of 375 hairdressing apprentices present on the day of inclusion). The response rate of the matched controls was 68.3% (1277 of 1870 completed the questionnaire).

The mean age was 17.5 years (range 15–39 years) for the apprentices and 17.4 years (range 15–39 years) for the controls; the median age was 17 years for both groups. Both groups mainly consisted of females; 96.3% of the apprentices and 96.9% of the controls were females.

In the matched control group, the responders were slightly younger (mean age 17.4 years) than the non-responders (mean age 17.8 years) ($p = 0.02$). Also, there were fewer males among the responders (3.1%) than among the non-responders (5.1%) ($p = 0.04$).

The questionnaire

Questions concerning exposures and adverse skin reactions to hair dyes, semi-permanent black henna tattoos, perfumed products and piercings were previously validated and adapted from large epidemiological studies in Denmark: SUSY (5) and the Copenhagen Allergy Study questionnaires (10, 11) (see Appendix).

The development of the questionnaire included a pilot test with 25 hairdressing apprentices and 5 young people not in the hairdressing trade.

Statistical analysis

For analysis of a matched dataset, the preferable method to use is a conditional logistic regression. In this analysis, Cox regression was used as conditional logistic regression for comparison of exposure and adverse skin reactions in the two cohorts. A p-value <0.05 was considered to be significant. All analyses of adverse skin reactions were adjusted for atopic dermatitis.

All statistical analyses were performed with the Statistical Products and Service Solutions package (SPSS, Chicago, IL, USA) for Windows (Release 17.0).

Results

Data collected from both cohorts are compared in Table 1.

It was found that 98.4% of the hairdressing apprentices and 82.2% of their controls had ever dyed their hair.

Table 1. Self-reported exposures and reactions; comparison between newly started hairdressing apprentices and a matched control group

	Hairdressing apprentices (n = 374)	Controls (n = 1277)	P
Hair dye			
Lifetime prevalence, % (no.)	**98.4** (368)	82.2 (1050)	<0.001
One-year prevalence, % (no.)	**95.2** (356)	66.9 (854)	<0.001
Hair dyes per year	**6.6** (1–30 times)	3.7 (1–30 times)	<0.001
Age at first hair dye (years)	12.1 (2–19)	**13.3** (5–23)	<0.001
Reaction to hair dye (eczematous), % (no.)	**13.7** (50)	10.0 (105)	0.002[a]
Reaction to hair dye (oedema), % (no.)	**4.9** (18)	2.9 (30)	0.001[a]
Eyebrow dye			
Lifetime prevalence	**62.0** (232)	32.5 (415)	<0.001
One-year prevalence, % (no.)	**52.9** (198)	19.3 (246)	<0.001
Eyebrow dye per year	**3.8** (1–35 times)	3.1 (1–24 times)	0.007
Reaction to eyebrow dye (eczematous), % (no.)	**3.9** (9)	3.6 (15)	0.02[a]
Semi-permanent black henna tattoos			
Lifetime prevalence, % (no.)	**48.1** (180)	31.0 (396)	<0.001
Age at first tattoo (years)	12.9 (4–32)	12.7 (3–22)	0.7
Reactions to tattoo, % (no.)	0.0 (0)	2.5 (10)	0.1[a]
Piercing			
Ear piercing, % (no.)	**96.8** (362)	92.1 (1176)	<0.001
Piercing in other places, % (no.)	**65.0** (243)	35.1 (448)	<0.001
Reactions to jewellery, % (no.)	29.9 (112)	**35.2** (449)	0.002[a]
Perfume rash			
One-year prevalence, % (no.)	6.1 (23)	**11.3** (144)	0.001[a]
Lifetime prevalence, % (no.)	13.6 (51)	**21.8** (278)	<0.001[a]
Deodorant rash			
One-year prevalence, % (no.)	8.6 (32)	**11.4** (146)	0.004[a]
Lifetime prevalence, % (no.)	17.4 (65)	**24.3** (310)	0.001[a]

The hairdressing apprentices were all enrolled at the time when they started their education at 10 different technical schools in Denmark. The controls were matched with the hairdressing apprentices by age, sex, and postal code. Conditional logistic regression was used for the matched comparison. $p < 0.05$ was considered to be significant. The results with the highest significance are in bold.
[a] Adjusted for atopic dermatitis.

The median age at first hair dying was 12 years among the hairdressing apprentices and 13 years among their controls (Table 1).

In general, the hairdressing apprentices were more exposed to hair dye, eyebrow and eyelash dye and semi-permanent black henna tattoos at the time when they started their education than the matched control group. Significantly more hairdressing apprentices had dyed their hair within the previous year ($p < 0.001$), and the apprentices were younger at the time of their first hair dye use ($p < 0.001$) (Fig. 1) and dyed their hair more times per year ($p < 0.001$). The hairdressing apprentices who, at some point, had dyed their hair reported significantly more adverse skin reactions to hair dye than members of the matched control group, after adjustment for atopic dermatitis. Similarly, significantly more hairdressing apprentices had dyed their eyebrow and eyelashes and had had semi-permanent black henna tattoos applied than members of the matched control group.

Discussion

To our knowledge, this is the first study to describe the exposures and adverse skin reactions to widely used chemical substances among hairdressing apprentices at the beginning of their education, as compared with a matched control group from the general population.

As expected, the hairdressing apprentices are highly exposed to products containing hair dye substances and to piercings. Almost all new hairdressing apprentices had dyed their hair at any time (98.4% of the apprentices as compared with 82.2% of the controls, $p < 0.001$), 95.2% within the previous year. For comparison, 95.7% of trained hairdressers in Copenhagen had dyed their hair at any time, 52.3% within the previous year (4). The high 1-year prevalence among the apprentices may reflect an interest in hairdressing prior to entering hairdressing school. The apprentices had their first hair dye at the age of 12 years on average, and some at the age of 2 years, which is significantly earlier than the controls (Fig. 1). In this study, 13.7% of the hairdressing apprentices who had
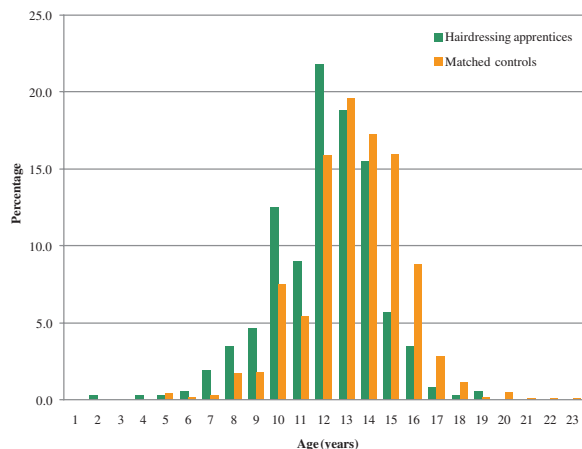
Fig. 1. Age at first hair dying in a cohort of Danish hairdressing apprentices ($n = 374$) at the time when they started their education, as compared with a cohort of Danish adolescents from the general population, matched on age, sex, and city code ($n = 1277$). The median age at time of first hair dying in the cohort of hairdressing apprentices was 12 years, and that in the matched cohort was 13 years ($p < 0.001$).

dyed their hair at any time reported eczematous reactions following personal use of hair dyes, which is significantly more than among the matched control group (10.0%, $p = 0.002$) after adjustment for atopic dermatitis. In a previous study, the prevalence of eczematous reactions in relation to hair dye in the general adult population was estimated to be 4.9%, and several patch test studies have estimated the prevalence of allergy to the hair dye ingredients to be 0.1–4.0% in the general population (5, 11, 12). These results indicate an increase in exposure to and incidence of hair dye allergy in younger people. As hair dying is more fashionable among young people, at least in the northern part of Europe (13), the young age of the participants could reduce recall bias, and thereby give more precise results in comparison with studies in the general adult population.

In addition to hair dye, more hairdressing apprentices used eyebrow/eyelash dye, and had had semi-permanent black henna tattoos, which also might lead to sensitization to hair dye, although some of these eczematous symptoms might be caused by irritant reactions.

The hairdressing apprentices are more exposed to semi-permanent black henna tattoos than the matched control group, skilled hairdressers in Copenhagen, and the Danish adult population. Among the hairdressing apprentices in this study, 48.1% have had a tattoo; in comparison, 38% of trained hairdressers in Copenhagen aged 18–24 years and 33.3% of Danish adult women aged 18–24 years have had a temporary tattoo (4). A previous study indicated increasing exposure to semi-permanent

black henna tattoos in the general population (4), in spite of the attention from both dermatologists and the media concerning the risk of allergic reactions to these temporary tattoos.

According to the data presented, both ear piercing and body piercing are still popular. The positive correlation between piercings and nickel allergy has been shown in several studies (14, 15). Despite the EU Nickel Directive (1994/27/EC)(16), nickel allergy is still frequent, including among hairdressers in Denmark (17). About one-third of both the apprentices and the matched controls have experienced dermatitis from metallic items, which correlates well with results on nickel allergy and nickel dermatitis in a population of young women in Denmark who had their ears pierced after the introduction of the nickel regulation in 1990 (14).

In contrast, the matched control group reported significantly more skin reactions to jewellery, perfumes, and perfumed deodorants. These results indicate that persons who have had a rash caused by perfumed products and jewellery choose not to become hairdressers, as has also been shown with eczematous diseases. In a previous publication, we showed that the cohort of hairdressing apprentices reported less previous or present hand eczema and less atopic dermatitis at the time when they started their education, than the matched control group (18). This underlines the importance of adjusting for atopic dermatitis in the analysis of adverse skin reactions. The results are based on self-administered questionnaires, which, although validated, have some limitations. It is possible that the newly started hairdressing apprentices are likely to under-report, for example, allergic problems, whereas participation as controls might be higher among those with allergic diseases. This could possibly lead to an increase in the differences between the two groups.

In this study, a matched control group is an advantage, as it takes both the young age and the predominance of females among the hairdressing apprentices into account.

In conclusion, both cohorts are highly exposed to potent allergens and frequently report adverse skin reactions. Additionally, at the start of their education, the hairdressing apprentices are more exposed to the allergens investigated in this study, and report more adverse skin reactions to products containing hair dyes than their matched controls from the general population. Regulation of exposure needs to be considered in order to prevent primary sensitization and elicitations in those already sensitized, with a special focus on younger people. Additionally, these young people, and hairdressing apprentices in particular, require information concerning the potential risk of extensive exposure to chemical substances.

References

1 White J M, Gilmour N J, Jeffries D, Duangdeeden I, Kullavanijaya P, Basketter D A, McFadden J P. A general population from Thailand: incidence of common allergens with emphasis on para-phenylenediamine. *Clin Exp Allergy* 2007: **37**: 1848–1853.

2 Hextall J M, Alagaratnam N J, Glendinning A K, Holloway D B, Blaikie L, Basketter D A, McFadden J P. Dose–time relationships for elicitation of contact allergy to para-phenylenediamine. *Contact Dermatitis* 2002: **47**: 96–99.

3 Uter W, Lessmann H, Geier J, Schnuch A. Contact allergy to hairdressing allergens in female hairdressers and clients – current data from the IVDK, 2003–2006. *J Dtsch Dermatol Ges* 2007: **5**: 993–1001.

4 Hansen H S, Johansen J D, Thyssen J P, Linneberg A, Søsted H. Personal use of hair dyes and temporary black tattoos in Copenhagen hairdressers. *Ann Occup Hyg* 2010: **54**: 453–458.

5 Søsted H, Hesse U, Menné T, Andersen K E, Johansen J D. Contact dermatitis to hair dyes in a Danish adult population: an interview-based study. *Br J Dermatol* 2005: **153**: 132–135.

6 Søsted H, Johansen J D, Andersen K E, Menné T. Severe allergic hair dye reactions in 8 children. *Contact Dermatitis* 2006: **54**: 87–91.

7 Søsted H, Rastogi S C, Thomsen J S. Allergic contact dermatitis from toluene-2,5-diamine in a cream dye for eyelashes and eyebrows – quantitative exposure assessment. *Contact Dermatitis* 2007: **57**: 195–196.

8 Brancaccio R R, Brown L H, Chang Y T, Fogelman J P, Mafong E A, Cohen D E. Identification and quantification of para-phenylenediamine in a temporary black henna tattoo. *Am J Contact Dermat* 2002: **13**: 15–18.

9 Jovanovic D L, Slavkovic-Jovanovic M R. Allergic contact dermatitis from temporary henna tattoo. *J Dermatol* 2009: **36**: 63–65.

10 Thyssen J P, Linneberg A, Menné T, Nielsen N H, Johansen J D. The prevalence and morbidity of sensitization to fragrance mix I in the general population. *Br J Dermatol* 2009: **161**: 95–101.

11 Nielsen N H, Linneberg A, Menné T, Madsen F, Frolund L, Dirksen A, Jorgensen T. Allergic contact sensitization in an adult Danish population: two cross-sectional surveys eight years apart (the Copenhagen Allergy Study). *Acta Derm Venereol* 2001: **81**: 31–34.

12 Schäfer T, Bohler E, Ruhdorfer S, Weigl L, Wessner D, Filipiak B, Wichmann H E, Ring J. Epidemiology of contact allergy in adults. *Allergy* 2001: **56**: 1192–1196.

13 Thyssen J P, Andersen K E, Bruze M et al. p-Phenylenediamine sensitization is more prevalent in central and southern European patch test centres than in Scandinavian: results from a multicentre study. *Contact Dermatitis* 2009: **60**: 314–319.

14 Thyssen J P, Johansen J D, Menné T, Nielsen N H, Linneberg A. Nickel allergy in Danish women before and after nickel regulation. *N Engl J Med* 2009: **360**: 2259–2260.

15 Brandao M H, Gontijo B, Girundi M A, de Castro M C. Ear piercing as a risk factor for contact allergy to nickel. *J Pediatr (Rio J)* 2010: **86**: 149–154.

16 Menné T, Rasmussen K. Regulation of nickel exposure in Denmark. *Contact Dermatitis* 1990: **23**: 57–58.

17 Thyssen J P, Milting K, Bregnhoj A, Søsted H, Duus J J, Menné T. Nickel allergy in patch-tested female hairdressers and assessment of nickel release from hairdressers' scissors and crochet hooks. *Contact Dermatitis* 2009: **61**: 281–286.

18 Bregnhøj A, Søsted H, Duus Johansen J, Menné T. Healthy worker effect in hairdresser apprentices. *Contact Dermatitis.* 2010 (In press).

Appendix

Questions concerning the use of hair dye were: 'Have you ever dyed your hair?', 'How old were you, the first time you dyed your hair?', 'Have you dyed your hair during the last 12 months, and how many times?', 'Have you ever experienced redness, scaling and itching in your face, ears, neck or scalp after dying your hair?', and 'Have you ever experienced oedema of your face, scalp or around your eyes, or ulceration in your scalp after dying your hair?' Questions concerning the use of eyebrow or eyelash dye were: 'Have you ever dyed your eyebrows or eyelashes?', 'Have you dyed your eyebrows or eyelashes during the last 12 months, and how many times?', and 'Have you ever experienced redness, scaling and itching around your eyes after dying your eyebrows or eyelashes?'

Questions concerning exposures and reactions to semi-permanent black tattoos were: 'Have you ever had a black henna tattoo (a temporary tattoo that is painted on the skin and disappears after 2–3 weeks)?', 'How old were you the first time you had a black henna tattoo?', and 'Did you get eczema at the site where the tattoo was painted?'

Questions concerning the prevalence of piercings and reactions to jewellers were: 'Have you ever had your ears pierced?', 'Have you ever had piercings in other places on your body?', and 'Have you ever had a rash from jean buttons, metallic buckles or imitation jewellery (e.g. ear rings, piercing jewellery)?'

Finally, two questions concerning rash after the use of perfumed products were asked: 'Have you ever had a rash after the use of perfume (examples: eau de toilette, eau de cologne, aftershave)?', and 'Have you ever had a rash in your armpit after the use of perfumed deodorant?'.

Validation of self-reported hand eczema among Danish hairdressing apprentices

Bregnhøj A*, Søsted H*, Menné T**, Johansen JD***

* Research Centre for Hairdressers and Beauticians, Department of Dermato-Allergology, Copenhagen University Hospital Gentofte, DK-2900 Hellerup, Denmark.
** Department of Dermato-Allergology, Copenhagen University Hospital Gentofte, DK-2900 Hellerup, Denmark.
*** National Allergy Research Centre, Department of Dermato-Allergology, Copenhagen University Hospital Gentofte, DK-2900 Hellerup, Denmark.

Corresponding author:

Anne Bregnhøj, MD
Research Centre for Hairdressers and Beauticians,
Department of Dermato-Allergology, Copenhagen University Hospital Gentofte
Niels Andersens vej 65, Dk-2900 Hellerup, Denmark
Email: annbre03@geh.regionh.dk
Phone: +45 3977 7305
Fax: +45 3977 7118

ABSTRACT

Background: Hairdressing apprentices have a high incidence of hand eczema. Most studies use self-reported hand eczema as a cost-effective method to estimate the prevalence of hand eczema. No validation studies on self-reported hand eczema among hairdressing apprentices exist.

Objectives: To evaluate the validity of self-reported hand eczema among Danish hairdressing apprentices.

Methods: During the first two weeks of training 502 hairdressing apprentices were enrolled in this study. All apprentices completed a self-administered questionnaire including questions regarding e.g. current hand eczema, and they were all clinically examined for hand eczema three times during the first part of their education by using the Hand Eczema Severity Index. The validity of self-reported hand eczema was measured using the clinical examination as the golden standard.

Results: The sensitivity of self-reported hand eczema was 70.3 % and the specificity 99.8 %. The positive predictive value 96.3 % and the negative predictive value 98.5 %.

Conclusions: We found good agreement between self-reported hand eczema and clinical examination. There is a good sensitivity and a high specificity. Self-reported hand eczema among hairdressing apprentices is considered a valid method to estimate the prevalence of hand eczema, although it might underestimate the true prevalence.

INTRODUCTION

Hairdressers and hairdressing apprentices have a high prevalence of occupational hand eczema due to excessive wet work and extensive exposure to chemical substances (1-5). Hairdressing apprentices seem to be in a particular high risk of developing hand eczema (6-10). Several reports on occupational hand eczema among hairdressers and hairdressing apprentices exists, although only a few studies have reported the prevalence of hand eczema among hairdressing apprentices based on clinical examinations (9).

Self-reported hand eczema is often used in epidemiological studies, as it is a cost-effective method to estimate the prevalence of hand eczema. There is a need to establish the validity of this question used in different populations and geographical areas, to be able to rely on self-reported hand eczema. There might be differences in interpretation of the question in different occupational settings, age groups and geographical areas.

To our knowledge self-reported hand eczema has not previously been validated in cohorts of hairdressers or hairdressing apprentices. Validation studies has been carried out among other occupations and other groups of students (11-16), but never in a Danish cohort. Fairly good agreement between clinical examinations and self-reported hand eczema was found in these studies.

The aim of this study was to investigate whether the use of self-reported hand eczema among hairdressing apprentices is a valid method to estimate the prevalence of hand eczema. The results presented are a part of an intervention study on occupational hand eczema in a cohort of Danish hairdressing apprentices, and will be used in future publications on the prevalence and incidence of hand eczema during their training.

MATERIALS AND METHODS

We conducted a follow-up study among Danish hairdressing apprentices. Data presented are based on self-administered questionnaires and clinical examinations.

Study population

During the first two weeks of their education 502 hairdressing apprentices were enrolled in a follow-up study on occupational hand eczema. The enrollment took place in two phases; in August 2008 (n= 382) and in January 2009 (n=120).

During the first 1½ year of their training all apprentices completed self-administered questionnaires and had their hands examined for objective signs of hand eczema three times; at the time they started their education, after approximately eight months and after approximately eighteen months. The apprentices were recruited from all 10 hairdressing schools in Denmark, each school provided from 8 to 103 subjects. All newly started apprentices, present on the day of the inclusion, were invited to the study. During the study the cohort experienced a number of dropouts and exclusions. Of the apprentices included 113 had the opportunity to continue their education, but for different reasons decided to change career (dropouts), and 105 apprentices were excluded during the study due to; change of school (2 cases), change from school apprenticeship to salon apprenticeship (with no formal school classes) (9 cases), and finally 94 cases were not able to achieve an apprenticeship either in a saloon or at the school. In total 284 apprentices completed the study.

The mean age of the apprentices was 17.5 years and the majority was females (95.2 %). The participation rate at inclusion was 99.8% (502 of 503 hairdresser apprentices present on the day of inclusion). They all completed the questionnaire and only one apprentice did not have her hands examined. At the 2. follow-up the participation rate was 99.6 % (283 of 284 hairdressing apprentices still under education), they all completed the questionnaire, but in 21 of these cases we were not able to make a clinical examination, mainly due to sick leave or vacations on the day of examination.

All apprentices gave informed consent and the Committee on Biomedical Research Ethics of Copenhagen and Frederiksberg approved the protocol, H-B-2007-096. The study was conducted from August 2008 – July 2010.

The questionnaire

Questions concerning hand eczema were adapted from the Nordic Occupational Skin Questionnaire (NOSQ-2002)(17). At the inclusion and at the 2. follow-up, the following questions were asked: "Have you ever had hand eczema?" (Yes / No), "Have you ever had eczema on your wrists or forearms?" (Yes / No) and "When did you last have eczema on your hands, wrists or forearms?" (I have it now, within the last 3 months, between 3 -12 months ago, more than 12 months ago). In the validation of

self-reported hand eczema cases who answered "I have it now" to the question: "When did you last have eczema on your hands, wrists or forearms?" were considered in the calculations.

Clinical examination

Objective signs and severity of hand eczema was assessed by a trained medical doctor (AB) using the Hand Eczema Severity Index (HECSI), which is a validated scoring system determining the presence, severity and localization of hand eczema (18). The HECSI scoring system is based on visible clinical signs of hand eczema; erythema, infiltration, vesicles, fissures, scaling and oedema, in combination with measurement of the area affected. The range of the HECSI score is 0 – 360, where 0 is no eczema and 360 is most severe eczema. All apprentices were clinically examined on the same day as they completed the questionnaire. They all answered the questionnaire prior to the clinical examination, and therefore they did not know the result of the examination.

Statistical analysis

In order to evaluate the agreement between the self-reported diagnosis and the clinical examinations, we calculated the sensitivity, specificity and positive and negative predictive values, using the clinical examination as the golden standard. Confidence intervals for the overall sensitivity and specificity were calculated.

The true prevalence of hand eczema, when the validation is taken into consideration, was calculated from the following formula (19):

True prevalence = measured prevalence + (specificity – 1) / sensitivity + (specificity – 1)

The statistical analyses were performed using the Statistical Products and Service Solutions package (SPSS Inc., Chicago, IL, USA) for Windows (Release 18.0).

RESULTS

In total 37 of the 764 clinical examinations were positive (with hand eczema) in the sense that the HECSI value was above 0. More apprentices had clinical signs of hand eczema at the 2. follow-up (n=20) than at the time of inclusion (n=17), and the hand eczema were more severe at the 2. follow-up. See table 1 and 2 for details.

Validation of self-reported hand eczema in terms of sensitivity, specificity and predictive values at inclusion, at the 2. follow-up and altogether are listed in table 3. The overall sensitivity is 70.3 % (95% confidence interval: 0.55 – 0.85) and the specificity is 99.8% (95% confidence interval: 0.995 – 1.00), when all questionnaire answers and clinical examinations are regarded.

The point prevalence of self-reported hand eczema at inclusion was 8.6 %, at the 1. follow-up 13.8 % and at the 2. follow-up 24.7 % of the whole cohort. These data will be analyzed more in detail in a future publication. The true prevalence of hand eczema is estimated to:

At inclusion: $P = 0.086 + (0.998 – 1) / 0.703 + (0.998 – 1) = 0.12 = \underline{12\ \%}$

At the 1. follow-up: $P = 0.138 + (0.998 – 1) / 0.703 + (0.998 – 1) = 0.194 = \underline{19.4\ \%}$

At the 2. follow-up: $P = 0.247 + (0.998 – 1) / 0.703 + (0.998 – 1) = 0.349 = \underline{34.9\ \%}$

It was found that only one apprentice of the 27 (3.7 %) who stated in the questionnaire, that she had current hand eczema, were not clinically diagnosed with hand eczema. This is classified as a false positive. Moreover, 11 apprentices of the 737 (1.4 %) who stated no current hand eczema were classified as false negative.

The incidence of self-reported hand eczema among dropouts were 21.4 % and hand eczema as the main cause of changing career was stated by 10.7 % of the dropouts.

DISCUSSION

In this study, we evaluate the validity of self-reported hand eczema in a cohort of hairdressing apprentices. This validation has been done based on self-administered questionnaires and clinical examinations, with the clinical examination as the reference standard (golden standard).

We demonstrate a fairly good sensitivity and a very high specificity. When we look at each occasion individually (see table 3), we can see that the apprentices´ self-reported hand eczema corresponds well with the clinical examinations both at inclusion and at the 2. follow-up. The sensitivity increases from 64.7 % to 75 % during the study, but the specificity and the predictive values is equally high at both occasions. The positive and negative predictive values are probably the most valuable measures in evaluating a questionnaire, but also dependent on the population and the prevalence of disease in this

population, as they predict the participants' ability to identify whether they have hand eczema correctly. These results indicate that self-reported hand eczema is a valid method to estimate the point prevalence of hand eczema among Danish hairdressing apprentices, although it might underestimate the true prevalence due to the sensitivity of 70.3 % and the higher estimated true prevalence. In the cohort of hairdressing apprentices 96.3 % of the cases with self-reported hand eczema were confirmed by the clinical examination (positive predictive value). Of the apprentices that denied hand eczema, the clinical diagnose was established in only 1.4 % (11 out of 737).

Previous validation studies on hand eczema has shown some variation in results. Meding et al validated self-reported one-year prevalence of hand eczema, based on questionnaires and interviews combined with clinical examinations (12). They found a high specificity (96 – 99 %), but a lower sensitivity (53 – 59 %) in three different occupational settings. Other validation studies, mainly on point prevalence of hand eczema, have found higher sensitivities (65 % - 80 %) in different occupations and geographical areas (11;13-16;20). Some validation studies have used symptom-based diagnosis instead of self-reported hand eczema in the questionnaires, and compared it with clinical examinations. This seems to overestimate the true prevalence as the sensitivity equals 100 %, and the positive predictive value was low (38 %) (13), whereas the self-reported questions seem to underestimate the true prevalence of hand eczema (12;13). Our results are in good agreement with the study of Yngveson et al, who evaluated self-reported point prevalence of hand eczema in a cohort of secondary school children at technical schools in Sweden (11). This might indicate that young people have a good feeling with changes in their health condition. Our impression is that the false-negative answers were mainly given by apprentices with mild symptoms of hand eczema, or by apprentices with moderate hand eczema in a "good" period with fewer symptoms. The range of HECSI score in persons with false-negative answers were 1 - 7, considered to be mild symptoms.

This study is based on a relatively high number of subjects. We have examined 501 persons and have 764 sets of clinical examinations and questionnaires. All participants completed the questionnaire before the clinical examination, and they were all examined on the same day as they answered the questionnaire. Hand eczema is a disease that can change appearance over a relatively short period of time, and a lag time between the self-reported hand eczema and the clinical examinations could have influenced the results. This potential bias was eliminated in the present study design.

Questions concerning hand eczema were adapted from NOSQ-2002, and are based on previous validation studies concerning current hand eczema in different occupational settings and geographical areas (11-13;15;17;21), although never on hairdressers, hairdressing apprentices or in Denmark.

The clinical examination was carried out using the HECSI scoring system, which is a validated scoring system, with a high inter- and intraobserver reliability (17). HECSI contains a number of specific signs of hand eczema (erythema, infiltration, vesicles, fissures, scaling and oedema), which minimizes the confusion with other dermatoses (psoriasis, tinea infections, pustolosis palmo-plantaris ect.). As HECSI contains very specific symptoms and grades of the severity, it is possible to diagnose even mild cases of hand eczema. This is an advantage in this study, as most of the hairdressing apprentices with hand eczema have mild symptoms. The range of HECSI scores in this study was 1 -31, with a mean score of 5.7 at inclusion and 8.4 at the 2. follow-up. No clear definition of the range of mild, moderate and severe hand eczema exists, but in a previous study on patients with hand eczema referred to dermatological care, mild cases was defined as HECSI score 0 – 11, moderate cases as score 12 – 27 and severe cases as score > 28 (22).

This study is not blinded, and because all participants completed the questionnaires and were examined for hand eczema three times, it is possible that they were aware of the result from the previous examinations. This could have affected the self-reported diagnose and thereby improved the results. In order to minimize this eventual influence from former examinations, the apprentices were told to answer the questions in accordance to their own experiences. As seen from table 3, the apprentices were fairly good at predicting eventual hand eczema both at the inclusion and at the 2. follow-up. We found high positive predictive values at both occasions, and there are only slight differences between the two examinations.

In conclusion, we found good agreement between self-reported hand eczema and clinical examination, and self-reported hand eczema among hairdressing apprentices is considered a valid method to estimate the point prevalence of hand eczema.

ACKNOWLEDGEMENT

Reference List

(1) Lind ML, Albin M, Brisman J, Kronholm DK, Lillienberg L, Mikoczy Z, Nielsen J, Rylander L, Toren K, Meding B. Incidence of hand eczema in female Swedish hairdressers. Occup Environ Med 2007: 64(3):191-5.

(2) Skoet R, Olsen J, Mathiesen B, Iversen L, Johansen JD, Agner T. A survey of occupational hand eczema in Denmark. Contact Dermatitis 2004: 51(4):159-66.

(3) Hansen HS, Sosted H. Hand eczema in Copenhagen hairdressers--prevalence and under-reporting to occupational registers. Contact Dermatitis 2009: 61(6):361-3.

(4) Roberts H, Frowen K, Sim M, Nixon R. Prevalence of atopy in a population of hairdressing students and practising hairdressers in Melbourne, Australia. Australas J Dermatol 2006: 47(3):172-7.

(5) Holm JO, Veierod MB. An epidemiological study of hand eczema. I. Prevalence and cumulative prevalence among hairdressers compared with a control group of teachers. Acta Derm Venereol Suppl (Stockh) 1994: 187:8-11.

(6) Diepgen TL, Coenraads PJ. The epidemiology of occupational contact dermatitis. Int Arch Occup Environ Health 1999: 72(8):496-506.

(7) Uter W, Gefeller O, Schwanitz HJ. Occupational dermatitis in hairdressing apprentices. Early-onset irritant skin damage. Curr Probl Dermatol 1995: 23:49-55.

(8) Uter W, Pfahlberg A, Gefeller O, Schwanitz HJ. Prevalence and incidence of hand dermatitis in hairdressing apprentices: results of the POSH study. Prevention of occupational skin disease in hairdressers. Int Arch Occup Environ Health 1998: 71(7):487-92.

(9) Uter W, Pfahlberg A, Gefeller O, Schwanitz HJ. Hand dermatitis in a prospectively-followed cohort of hairdressing apprentices: final results of the POSH study. Prevention of occupational skin disease in hairdressers. Contact Dermatitis 1999: 41(5):280-6.

(10) Valks R, Conde-Salazar L, Malfeito J, Ledo S. Contact dermatitis in hairdressers, 10 years later: patch-test results in 300 hairdressers (1994 to 2003) and comparison with previous study. Dermatitis 2005: 16(1):28-31.

(11) Yngveson M, Svensson A, Isacsson A. Evaluation of a self-reported questionnaire on hand dermatosis in secondary school children. Acta Derm Venereol 1997: 77(6):455-7.

(12) Meding B, Barregard L. Validity of self-reports of hand eczema. Contact Dermatitis 2001: 45(2):99-103.

(13) Smit HA, Coenraads PJ, Lavrijsen AP, Nater JP. Evaluation of a self-administered questionnaire on hand dermatitis. Contact Dermatitis 1992: 26(1):11-6.

(14) Carstensen O, Rasmussen K, Ponten A, Gruvberger B, Isaksson M, Bruze M. The validity of a questionnaire-based epidemiological study of occupational dermatosis. Contact Dermatitis 2006: 55(5):295-300.

(15) Susitaival P, Husman L, Hollmen A, Horsmanheimo M. Dermatoses determined in a population of farmers in a questionnaire-based clinical study including methodology validation. Scand J Work Environ Health 1995: 21(1):30-5.

(16) Vermeulen R, Kromhout H, Bruynzeel DP, de Boer EM. Ascertainment of hand dermatitis using a symptom-based questionnaire; applicability in an industrial population. Contact Dermatitis 2000: 42(4):202-6.

(17) Susitaival P, Flyvholm MA, Meding B, Kanerva L, Lindberg M, Svensson A, Olafsson JH. Nordic Occupational Skin Questionnaire (NOSQ-2002): a new tool for surveying occupational skin diseases and exposure. Contact Dermatitis 2003: 49(2):70-6.

(18) Held E, Skoet R, Johansen JD, Agner T. The hand eczema severity index (HECSI): a scoring system for clinical assessment of hand eczema. A study of inter- and intraobserver reliability. Br J Dermatol 2005: 152(2):302-7.

(19) Stenberg B, Meding B, Svensson A. Dermatology in public health--a model for surveillance of common skin diseases. Scand J Public Health 2010: 38(4):368-74.

(20) Berg M, Axelson O. Evaluation of a questionnaire for facial skin complaints related to work at visual display units. Contact Dermatitis 1990: 22(2):71-7.

(21) Meding B. Epidemiology of hand eczema in an industrial city. Acta Derm Venereol Suppl (Stockh) 1990: 153:1-43.

(22) Hald M, Agner T, Blands J, Veien NK, Laurberg G, Avnstorp C, Menné T, Kaaber K, Kristensen B, Kristensen O, Andersen KE, Paulsen E, Thormann J, Sommerlund M, Nielsen NH, Johansen JD. Clinical severity and prognosis of hand eczema. Br J Dermatol 2009: 160(6):1229-36.

Table 1

Questionnaire findings compared with clinical diagnosis.

Clinical examination

Questionnaire	Hand eczema	No hand eczema	Total
Hand eczema	26 (I*=11, F#=15)	1 (I*=0, F#=1)	27
No hand eczema	11 (I*=6, F#=5)	726 (I*=484, F#=242)	737
Total	37	727	764

The table shows number of subjects with or without hand eczema in accordance to clinical score and questionnaire. The clinical examinations were based on the HECSI scoring system, and the questionnaire was based on the Nordic Occupational Skin Questionnaire.
* Number of apprentices at the inclusion
# Number of apprentices at the 2. follow-up

Table 2

Clinical characteristics of the cohort.

	HECSI, inclusion	HECSI, 2. follow-up
Clinical hand eczema (n)	17	20
Mean	5.7	8.4
Median	4.0	6.0
Range	1 – 31	2 – 21

Table 3

Validation of self-reported hand eczema.

	Inclusion	2. follow-up	Total
Sensitivity	64.7 %	75 %	70.3 %
Specificity	100 %	99.6 %	99.8 %
Positive predictive value	100 %	93.8 %	96.3 %
Negative predictive value	98.8 %	97.9 %	98.5 %

Sensitivity, specificity and positive and negative predictive values at inclusion, 2. follow-up and in total.

Prevention of hand eczema among Danish hairdressing apprentices
–   an intervention study

Anne Bregnhøj*, Torkil Menné**, Jeanne Duus Johansen***, Heidi Søsted*

* Research Centre for Hairdressers and Beauticians, Department of Dermato-Allergology, Copenhagen University Hospital Gentofte, DK-2900 Hellerup, Denmark.
** Department of Dermato-Allergology, Copenhagen University Hospital Gentofte, DK-2900 Hellerup, Denmark.
*** National Allergy Research Centre, Department of Dermato-Allergology, Copenhagen University Hospital Gentofte, DK-2900 Hellerup, Denmark.

Corresponding author:

Anne Bregnhøj, MD
Research Centre for Hairdressers and Beauticians,
Department of Dermato-Allergology, Copenhagen University Hospital Gentofte
Niels Andersens vej 65, Dk-2900 Hellerup, Denmark
Email: annbre03@geh.regionh.dk
Phone: +45 3977 7305
Fax: +45 3977 7118

ABSTRACT

Objectives: To develop an educational programme, implement it at the vocational schools and test if it can reduce the incidence of hand eczema in a cohort of Danish hairdressing apprentices during their training, as hairdressing apprentices are known to have a high risk of developing hand eczema.

Methods: During the first two weeks of training 502 hairdressing apprentices were enrolled in the study. Approximately half of the apprentices were in an intervention group and their teachers were specially trained in prevention of hand eczema; the other half received normal training and served as a control group. All apprentices completed self-administered questionnaires including questions regarding hand eczema, use of gloves and degree of wet work, and they were all clinically examined for hand eczema three times during the study period of 18 months.

Results: More apprentices from the intervention group used gloves in wet work procedures and significantly fewer developed hand eczema compared with the apprentices from the control group (P=0.04). A logistic regression model showed that atopic dermatitis had a significant influence on the development of hand eczema in the cohort despite of intervention.

Conclusions: We were able to increase the use of gloves and to reduce the incidence of hand eczema in hairdressing apprentices by implementing an educational programme at the vocational schools

INTRODUCTION

Occupational hand eczema is one of the most frequent work related diseases in Denmark as well as in many other countries, and is caused by either allergic and / or irritant contact dermatitis [1, 2]. Hairdressers belong to a high-risk occupation with a high incidence of occupational hand eczema [1, 3-6]. Hairdressing apprentices seem to be in a particular high risk [7-11], with an average onset at the age of 19 - 21 years[7, 11], and they have an estimated one-year prevalence of 37 % [4]. In comparison trained hairdressers in Copenhagen had an estimated one-year prevalence for hand eczema of 20 % as shown in a previous Danish study [4], and young people from the general population 9 -10 % [12, 13]. There is a high staff turnover in the profession. In Denmark hairdressers work in average 8.4 years in the profession including their training period, and one of the main reasons for leaving the profession is hand eczema [14]; similar results has been shown in a Finnish study [15]. Occupational contact dermatitis among hairdressers and hairdressing apprentices has severe personal and socioeconomic consequences [16, 17], which is why it seems relevant to illuminate preventive strategies in this group.

Previous intervention studies on occupational hand eczema have shown that evidence-based education is an effective tool [18-23]. The educational programme should contain oral presentations, written information and practical training – all presented by special trained and dedicated supervisors who also serve as teachers.

It is important to evaluate the effect of the intervention with a validated instrument. To our knowledge this is the first controlled intervention study among hairdressing apprentices.

The aim of this study was to investigate whether education in prevention of hand eczema among hairdressing apprentices could reduce the incidence of hand eczema in a controlled design.

MATERIALS AND METHODS

We conducted an intervention study in a cohort of Danish hairdressing apprentices, including two follow-up. Data presented are based on self-administered questionnaires and clinical examinations.

Study design

This study is a clinically, controlled, prospective intervention study. The intervention schools were chosen partly because some degree of education in preventing hand eczema had already been implemented, and partly to represent different geographical areas of Denmark and different school sizes.

All apprentices gave informed consent and the Committee on Biomedical Research Ethics of Copenhagen and Frederiksberg approved the protocol, H-B-2007-096. The study was conducted from August 2008 – July 2010.

Study population

During the first two weeks of their education 502 hairdressing apprentices were enrolled in this study. The enrollment was in two phases; in August 2008 (n= 382) and in January 2009 (n=120).

During the first 1½ year of their training all apprentices completed self-administered questionnaires and had their hands examined for objective signs of hand eczema three times; at the time they started their education, after approximately 8 months and after approximately 18 months. The apprentices were recruited from all 10 hairdressing schools in Denmark, each school provided from 8 to 103 subjects. All new apprentices, present on the day of the inclusion, were invited into the study. During the study the cohort experienced a number of dropouts and exclusions (Figure 1), as described below.

The mean age of the apprentices was 17.5 years and the majority was females (95.2 %). The participation rate at inclusion was 99.8% (502 of 503 hairdresser apprentices present on the day of inclusion). They all completed the questionnaire and only one apprentice did not have her hands examined. At the 1st follow-up data were collected from 294 apprentices of 321 still under education (91.6 %). In three of these cases we only obtained HECSI scores but no questionnaire. At the 2nd follow-up the participation rate was 99.6 % (283 of 284 hairdressing apprentices still

under education), all completed the questionnaire but in 21 of these cases we were not able to make a clinical examination. The missing data were mainly due to sick leave or vacation on the day of the examination.

The Danish training program for hairdressing apprentices varies between dedicated school periods, providing a combination of theory and practice, and dedicated periods in the salons, consisting of mixed practical hairdressing procedures. The duration of the education in Denmark is 4 years. Most apprentices were examined during the school periods, but some while they were working in the salons.

Exclusions

In total 105 apprentices were excluded during the study. This was done for different reasons; change of school from intervention school to control school or vice versa (2 cases), change from school apprenticeship to salon apprenticeship (with no formal school classes) (9 cases), and finally 94 cases did not qualify as an apprentice either in a salon or at the school, and, consequently, discontinue their education.

Dropouts

Of the apprentices included, 113 had the opportunity to continue their education, but for different reasons decided to change career. This group is referred to as dropouts. They were all contacted by telephone and if not reached, a letter was sent. They were all asked if they had experienced hand eczema while being a hairdressing apprentices, and if so, were hand eczema the main reason for changing career. We obtained a response rate of 74.3 % (84 of the 113 dropouts).

Intervention

The intervention was based on education of the teachers at the vocational schools. Four schools were intervention schools and the remaining six schools served as control schools. Each intervention school provided 2 – 5 supervisors to the project. These supervisors underwent special training in prevention of hand eczema among hairdressers, and were responsible for the continued education of the apprentices at the schools. We developed an evidence-based educational programme in cooperation with the supervisors from the intervention schools, primarily based on special advices for hairdressers (Appendix 1). The educational programme contained a number of oral presentations, an information pamphlet, group work exercises, practical training and a glove

size measure. This approach has been evaluated successfully in previous intervention studies [18-23]. Examples of lipid rich moisturizers and protective gloves were given to the intervention group. The intervention was planned, implemented and evaluated according to the model described by Goldenhar et al [24].

The questionnaire

Questions concerning hand eczema were adapted from the Nordic Occupational Skin Questionnaire (NOSQ-2002), and have been validated in different occupations and geographical areas[25-27]. Self-reported hand eczema has also been validated in this cohort, using the clinical examination as the golden standard, and a good agreement and high predictive values were obtained [28]. The following questions were asked: "Have you ever had hand eczema?", "Have you ever had eczema on your wrists or forearms?" and "When did you last have eczema on your hands, wrists or forearms?". Atopic dermatitis was defined using the UK Working Party's diagnostic criteria [29-32]. Finally specific questions concerning procedures in the work of hairdressers, use of gloves and amount of wet work were developed specific to this study (Appendix 2).

The development of the questionnaire included a pilot test with 19 trained hairdressers.

Clinical examination

Objective signs and severity of hand eczema was assessed by a trained medical doctor (AB) using the Hand Eczema Severity Index (HECSI), which is a validated scoring system with a high inter- and intraobserver reliability, determining the presence, severity and localization of hand eczema [33]. The range of the HECSI score is 0 – 360, where 0 is no eczema and 360 is most severe eczema. All apprentices were clinically examined on the same day as they completed the questionnaire. They all completed the questionnaire prior to the clinical examination, and therefore they did not know the result of the examination. Additionally, all apprentices were examined for flexural eczema at the inclusion. This was done to fulfill all minor criteria of the UK Working Party's diagnostic criteria.

Statistical analysis

For comparison of categorical variables, e.g. use of gloves in different routines, the chi-square test was used, and according to the Bonferroni correction a P-value < 0.003 was considered to be significant. Paired quantitative data were analyzed by comparing means with Wilcoxon Signed Rank Test, and for independent data Mann-Whitney Test was used. Time spend with gloves in the saloons was evaluated by chi-square for trend. A backward stepwise logistic regression model was performed to evaluate for any risk factors of development of hand eczema. Finally, odds ratio and confidence intervals was measured for development of hand eczema during the study.

All statistical analyses were performed using the Statistical Products and Service Solutions package (SPSS Inc., Chicago, IL, USA) for Windows (Release 18.0).

RESULTS

Data collected from both cohorts are compared in Table 1 - 3. The demographic data from the two groups does not differ significantly (Table 1).

The education in Denmark is partly organized on an individual level, which deflects that the apprentices from the intervention group, during the study, were working in the saloons on average 32.5 weeks compared with 27.5 weeks for the apprentices from the control group (P=0.01). Otherwise, the apprentices from the control group had more weeks at the schools; on average 32 weeks compared with 30 weeks for the intervention group (P=0.001). At the day of the final follow-up, more apprentices from the intervention group were clinically examined during their stay in the salons; 20.4 % compared with 14.7 % from the control group (P=0.03).

The apprentices from the intervention group used gloves to a higher extend than the control group, particularly when shampooing and while handling bleaching products (Table 2). Although the frequency of apprentices using gloves decreased, while they were working in the saloons, they still used gloves to a higher extend than the control group in these periods. Gloves were not reused at any of the schools, but in some of the salons. At the final follow-up gloves were reused by 14.3 % (intervention group) and 21.3 % (control group) (P=0.1) respectively. Of those who reused gloves at the final follow-up 61.9 % (intervention group) versus 58.6 % (control group) (P=0.8) turned them inside out.

The apprentices from the intervention group used gloves more hours per day, and fewer of the apprentices from the intervention group reported wet hands for 2 hours or more per day (Table 3).

As shown in details in Table 1, the apprentices from the intervention group reported significantly less incidence of eczema than the apprentices from the control group. At the final follow-up 19.4 % of the apprentices from the intervention group versus 28.3 % of the apprentices from the control schools had experienced hand eczema during their education (including dropouts) (P=0.04). The odds ratio of getting hand eczema during the study period, not receiving the intervention was 1.65 (95 % confidence interval 1.02 – 2.67). The majority of the affected apprentices from both groups stated that their eczematous disease started during their stay in the salons; 70.0 % of the intervention group and 80.0 % of the control group (P=0.3). The severity of hand eczema was clearly occupational related, as 76.9 % stated that their work aggravated the symptoms and 59.0 % that their symptoms improved during vacations (with no statistical difference between the two groups).

The incidence of hand eczema among dropouts were 21.4 % in total, distributed with 15.2 % in the intervention group and 25.5 % in the control group (P=0.3). No correlation between hand eczema and atopic dermatitis among the dropouts was found (P=0.13), but of those who changed career because of hand eczema significant more were classified with atopic dermatitis compared with the rest of the dropouts (P=0.04). Hand eczema as the main cause of changing career was stated by 12 % of dropouts in the intervention group and 9.8 % of the control group (P=0.7).

Of those who experienced hand eczema during the study 40.6 % from the intervention group versus 19.6 % from the control group (P=0.04) had consulted their general practitioner, and 15.6 % versus 10.8 % (P=0.2) a dermatologist. Only a minority of the apprentices with hand eczema, and only apprentices from the intervention group (9.4 % versus 0.0 %, P=0.04) had their disease reported to the Board of Occupational Health.

A logistic regression model showed that atopic dermatitis and belonging to the control group were risk factors for development of hand eczema in the cohort (Table 4). Sex, age and weeks spend in the saloons had no influence on development of hand eczema. Wet hands for two hours or more per day was not found to be a risk factor in this group.

DISCUSSION

The present study is a controlled, intervention study with the intention of preventing occupational hand eczema in a cohort of Danish hairdressing apprentices. To our knowledge this is the first published intervention study in a cohort of hairdressing apprentices. The main finding is that we are able to improve the use of gloves and to reduce the incidence of hand eczema in the intervention group, by educating the teachers and thereby the apprentices at the vocational schools. Further atopic dermatitis was a risk factor for developing hand eczema in the cohort despite of intervention.

Previous intervention studies, in high-risk occupations, have also reduced the frequency of hand eczema. The majority of intervention studies have been conducted in cohorts already in high-risk occupational exposures and already affected by hand eczema to a substantial degree [18, 19, 21, 22]. This study is one of the few intervention studies so far focusing on primary prevention of hand eczema. The main focus of the intervention was evidence-based education including: a skin protection program, optimizing of work place procedures, practical training etc, with a high involvement from dedicated supervisors. All levels of the organization involved in educating hairdressers in Denmark were informed and took part in the process: the Danish Hairdressers' and Beauticians' Union, the schools´ head, teachers and apprentices. The approach chosen in this study was based on previous intervention studies with a substantial effect on the prevalence of hand eczema in other occupational settings. Held et al were able to improve behavior and reduce clinical skin symptoms in different wet work occupations [18, 19], and the group of Flyvholm et al reduced the prevalence of hand eczema significantly among both gut cleaners in slaughterhouses and cheese dairies workers by implementation of skin protection programs [21-23].

Only a few studies exist describing the use of protective gloves in high-risk occupations including hairdressers. In this study a relative high percent of the apprentices from the intervention group used gloves when shampooing the costumers' hair (70.7%) compared with the apprentices from the control group (46.3%) at the schools (P<0.001). While working in the salons, the use of gloves, when shampooing hair, decrease to 48.9% versus 29.6% (P=0.001) respectively. When applying hair dye to the costumers´ hair approximately all the apprentices from both groups use gloves both at the school and in the salons (97.8 % versus 98.5 % in the saloons, P=0.6). For comparison 90.2% of Australian hairdressing apprentices use gloves when dying costumers' hair, while only 6.3% wore gloves when shampooing hair [34]. In UK similar results were found; 9% of the apprentices using gloves when shampooing and approximately 95% when dying hair [35],

and in a German study 18.5% of hairdressing apprentices used gloves regularly when shampooing and 87.1% when coloring [8]. These results indicate that certain preventive strategies, with focus on glove use in wet work procedures, have already been implemented at the vocational schools in Denmark. It seems to be generally accepted and adopted to use gloves when applying hair dye both in Denmark and other countries. The results also indicate difficulties in maintaining the good behavior in the salons, probably because they are busier, and because the salon owners have diverging attitudes towards use of gloves.

It is widely accepted that exposure to wet work of two hours or more is a risk factor to irritant contact dermatitis [10]. In a German study it was found that hairdressers, assessed by observation, at average were exposed to wet work, defined as wet hands or wearing protective gloves, 2 hours and 17 minutes in an 8-hour shift [36]. Fewer of the apprentices in the intervention group in the present study reported wet hands for 2 hours or more per day compared with the control group (P=0.004) while working in the salons (Table 3), but it was not found to be a risk factor for development of hand eczema. The duration of wet work seems to be difficult to estimate in questionnaires. Jungerbauer et al showed that duration of wet work was overestimated by a factor 2 compared with the duration assessed by observation in a cohort of nurses [37]. Based on these observations, duration of wet work should be interpreted with caution.

The intervention group in this study reported significant less hand eczema compared with the control group. During the 1½ year study period the apprentices, including dropouts, reported an incidence of hand eczema of 19.4% (intervention group) versus 28.3% (control group) (P=0.04) (Table 1), and the odds ratio for hand eczema during the study period was 1.65 being in the control group instead of the intervention group. The incidence of hand eczema in the control group correlates well with other studies on occupational hand eczema among hairdressing apprentices. In several studies the life time prevalence of hand eczema of hairdressing apprentices has been estimated to 27.2% - 58% [4, 5, 38, 39]. In Germany Uter et al found an incidence of hand eczema in a prospective followed cohort of hairdressing apprentices of 43.3% over a 3 year period [9]. For comparison the one-year prevalence of hand eczema in the general population of young people is estimated to be 9 – 10% [12, 13]. Uter et al also found that hand eczema was the reason for leaving the education in 30.1 % of drop-outs [9, 10], which is more than we found in this study. The role of atopic dermatitis as a risk factor for developing hand eczema in high-risk occupations is under debate [5, 10]. In our study it was found to be a risk factor.

This study is based on questionnaires and clinical examinations with a high participation rate. The question concerning self-reported hand eczema is previously validated in the cohort, using the clinical examination as the golden standard [28]. This makes the self-reported prevalence of hand eczema in this study design a valid method, with a sensitivity of 70.3 % and a specificity of 99.8 %. In addition, atopic dermatitis was diagnosed by the full minor criteria of the UK Working Party´s Diagnostic Criteria. This is possible because all the apprentices were clinical examined for flexural eczema at inclusion. It probably gives a more precise estimate than in many other studies, including a previous study of our own [13], where clinical examinations are not performed. All clinical examinations were performed by one observer, which excludes any interobserver variability.

During the study the intervention group spent on average significantly more weeks in the salons, and thereby under high exposure conditions, and shorter time at the schools. This could affect the results towards a higher incidence of hand eczema in the intervention group and thereby impairment of the outcome of the intervention. In addition, significantly more apprentices from the intervention group were examined in the salons at the 2nd follow-up. This could increase the point prevalence in the group, as they typically experience flare up of their symptoms in high exposed periods.

This study also has some limitations. It is a non-randomized and non-blinded design; this could have some impact on the incidence of self-reported hand eczema. In order to minimize the possible confounding of the non-blinded design, the apprentices were told to answer the questions in accordance to their own experiences. As shown in a previous publication the self-reported hand eczema is a valid method in this study design [28]. The non-randomized design was chosen due to practical considerations, primarily as some of the schools already were planning or conducting education concerning preventive measures.

We conclude that evidence-based education is an effective approach in prevention of occupational hand eczema among hairdressing apprentices. We recommend offering hairdressing apprentices more education. This is a inexpensive and fairly easy way to prevent a disease that has a substantial impact on the individual and on society. It would be interesting to follow the cohort further, to evaluate a long time effect of the intervention.

ACKNOWLEDGEMENT

Reference List

1   Skoet R, Olsen J, Mathiesen B*, et al.* A survey of occupational hand eczema in Denmark. *Contact Dermatitis* 2004;**51** (4):159-66.

2   Agner T. Hand Eczema. In: P.J.Frosch, T.Menné, J.-P.Lepiottevin, eds. *Contact Dermatitis* 2006:335-44.

3   Lind ML, Albin M, Brisman J*, et al.* Incidence of hand eczema in female Swedish hairdressers. *Occup Environ Med* 2007;**64** (3):191-5.

4   Hansen HS, Sosted H. Hand eczema in Copenhagen hairdressers--prevalence and under-reporting to occupational registers. *Contact Dermatitis* 2009;**61** (6):361-3.

5   Roberts H, Frowen K, Sim M*, et al.* Prevalence of atopy in a population of hairdressing students and practising hairdressers in Melbourne, Australia. *Australas J Dermatol* 2006;**47** (3):172-7.

6   Holm JO, Veierod MB. An epidemiological study of hand eczema. I. Prevalence and cumulative prevalence among hairdressers compared with a control group of teachers. *Acta Derm Venereol Suppl (Stockh)* 1994;**187**:8-11.

7   Diepgen TL, Coenraads PJ. The epidemiology of occupational contact dermatitis. *Int Arch Occup Environ Health* 1999;**72** (8):496-506.

8   Uter W, Gefeller O, Schwanitz HJ. Occupational dermatitis in hairdressing apprentices. Early-onset irritant skin damage. *Curr Probl Dermatol* 1995;**23**:49-55.

9   Uter W, Pfahlberg A, Gefeller O*, et al.* Prevalence and incidence of hand dermatitis in hairdressing apprentices: results of the POSH study. Prevention of occupational skin disease in hairdressers. *Int Arch Occup Environ Health* 1998;**71** (7):487-92.

10 Uter W, Pfahlberg A, Gefeller O*, et al.* Hand dermatitis in a prospectively-followed cohort of hairdressing apprentices: final results of the POSH study. Prevention of occupational skin disease in hairdressers. *Contact Dermatitis* 1999;**41** (5):280-6.

11 Valks R, Conde-Salazar L, Malfeito J*, et al.* Contact dermatitis in hairdressers, 10 years later: patch-test results in 300 hairdressers (1994 to 2003) and comparison with previous study. *Dermatitis* 2005;**16** (1):28-31.

12 Yngveson M, Svensson A, Isacsson A. Prevalence of self-reported hand dermatosis in upper secondary school pupils. *Acta Derm Venereol* 1998;**78** (5):371-4.

13 Bregnhoj A, Sosted H, Menne T*, et al.* Healthy worker effect in hairdressing apprentices. *Contact Dermatitis* 2011;**64** (2):80-4.

14 Lysdahl SH, Søsted H, Johansen JD. Hand Eczema in hairdressers - a Danish cohort study of the prevalence of hand eczema and its career consequences. 2010.

15 Leino T, Tuomi K, Paakkulainen H*, et al.* Health reasons for leaving the profession as determined among Finnish hairdressers in 1980-1995. *Int Arch Occup Environ Health* 1999;**72** (1):56-9.

16 Sundhedsstyrelsen. *Forebyggelse af kontakteksemer*. 2001.

17 Diepgen TL. The costs of skin disease. *Eur J Dermatol* 2006;**16** (4):456-60.

18 Held E, Wolff C, Gyntelberg F*, et al.* Prevention of work-related skin problems in student auxiliary nurses: an intervention study. *Contact Dermatitis* 2001;**44** (5):297-303.

19 Held E, Mygind K, Wolff C, *et al.* Prevention of work related skin problems: an intervention study in wet work employees. *Occup Environ Med* 2002;**59** (8):556-61.

20 Agner T, Held E. Skin protection programmes. *Contact Dermatitis* 2002;**47** (5):253-6.

21 Flyvholm MA, Mygind K, Sell L, *et al.* A randomised controlled intervention study on prevention of work related skin problems among gut cleaners in swine slaughterhouses. *Occup Environ Med* 2005;**62** (9):642-9.

22 Mygind K, Borg V, Flyvholm MA, *et al.* A study of the implementation process of an intervention to prevent work-related skin problems in wet-work occupations. *Int Arch Occup Environ Health* 2006;**79** (1):66-74.

23 Sell L, Flyvholm MA, Lindhard G, *et al.* Implementation of an occupational skin disease prevention programme in Danish cheese dairies. *Contact Dermatitis* 2005;**53** (3):155-61.

24 Goldenhar LM, LaMontagne AD, Katz T, *et al.* The intervention research process in occupational safety and health: an overview from the National Occupational Research Agenda Intervention Effectiveness Research team. *J Occup Environ Med* 2001;**43** (7):616-22.

25 Meding B, Barregard L. Validity of self-reports of hand eczema. *Contact Dermatitis* 2001;**45** (2):99-103.

26 Smit HA, Coenraads PJ, Lavrijsen AP, *et al.* Evaluation of a self-administered questionnaire on hand dermatitis. *Contact Dermatitis* 1992;**26** (1):11-6.

27 Yngveson M, Svensson A, Isacsson A. Evaluation of a self-reported questionnaire on hand dermatosis in secondary school children. *Acta Derm Venereol* 1997;**77** (6):455-7.

28 Bregnhoj A, Søsted H, Menné T., *et al.* Validation of self-reported hand eczema among Danish hairdressing apprentices. 2010.

29 Hanifin JM, Rajka G. Diagnostic features of atopic dermatitis. *Acta Derm Venereol Suppl (Stockh)* 1980;**92**:44-7.

30 Williams HC, Burney PG, Hay RJ, *et al.* The U.K. Working Party's Diagnostic Criteria for Atopic Dermatitis. I. Derivation of a minimum set of discriminators for atopic dermatitis. *Br J Dermatol* 1994;**131** (3):383-96.

31 Williams HC, Burney PG, Pembroke AC, *et al.* The U.K. Working Party's Diagnostic Criteria for Atopic Dermatitis. III. Independent hospital validation. *Br J Dermatol* 1994;**131** (3):406-16.

32 Williams HC, Burney PG, Pembroke AC, *et al.* Validation of the U.K. diagnostic criteria for atopic dermatitis in a population setting. U.K. Diagnostic Criteria for Atopic Dermatitis Working Party. *Br J Dermatol* 1996;**135** (1):12-7.

33 Held E, Skoet R, Johansen JD, *et al.* The hand eczema severity index (HECSI): a scoring system for clinical assessment of hand eczema. A study of inter- and intraobserver reliability. *Br J Dermatol* 2005;**152** (2):302-7.

34 Nixon R, Roberts H, Frowen K, *et al.* Knowledge of skin hazards and the use of gloves by Australian hairdressing students and practising hairdressers. *Contact Dermatitis* 2006;**54** (2):112-6.

35 Ling TC, Coulson IH. What do trainee hairdressers know about hand dermatitis? *Contact Dermatitis* 2002;**47** (4):227-31.

36 Kralj N, Oertel C, Doench NM, *et al.* Duration of wet work in hairdressers. *Int Arch Occup Environ Health* 2010.

37   Jungbauer FH, Lensen GJ, Groothoff JW, *et al.* Exposure of the hands to wet work in nurses. *Contact Dermatitis* 2004;**50** (4):225-9.

38   Majoie IM, von Blomberg BM, Bruynzeel DP. Development of hand eczema in junior hairdressers: an 8-year follow-up study. *Contact Dermatitis* 1996;**34** (4):243-7.

39   Holm JO, Veierod MB. An epidemiological study of hand eczema. V. Prevalence among hairdresser trainees, compared with a general population of hairdressers. *Acta Derm Venereol Suppl (Stockh)* 1994;**187**:23-5.

Appendix 1

Special advices for hairdressers
- Use gloves when you wash, dye, bleach, and perm

- Cut before you dye the hair

- Mix in a separate, ventilated cabinet

- Disposable gloves must be clean, new, and dry

- Never reuse disposable gloves

- Use cotton gloves underneath protective gloves

- Use gloves for as long as nescessary, but as little as possible

- Use an unscented, rich moisturizer

- Do not wear rings when you work

- Use gloves when doing wet work in your spare time

- Use warm gloves outside when it's cold

Evidence-based recommendations on prevention of occupational skin diseases in hairdressers.

Appendix 2

Specific questions concerning hairdressing procedures, used in the questionnaire for 1st and 2nd follow-up.

- To which procedures do you always use gloves at the school / in the saloon? (Yes / no)

  Shampooing
  Hair dying
  Rinse hair dye
  Eyebrow dye
  Bleaching
  Rinse bleaching
  Permanent
  Rinse permanent

- How long time do you have wet hands on a regular day at work?
  Including cutting wet hair, shampooing, dish wash, cleaning the saloon etc without gloves.

  Never
  Less than ½ hour per day
  ½ - 1 hour per day
  More than 1 hour but less than 2 hours per day
  2 – 3 hours per day
  More than 3 hour but less than 4 hours per day
  4 hours or more per day

- Do you reuse gloves? (yes / no)

  -   If yes, do you turn them inside out and reuse them?

  Yes, always
  Yes, more than half of the times
  Yes, half of the times
  Yes, less than half of the times
  No, never

- How many hours, on a regular day, do you use gloves at work?

  Never
  Less than ½ hour per day
  ½ - 1 hour per day
  More than 1 hour but less than 2 hours per day
  2 – 3 hours per day
  More than 3 hour but less than 4 hours per day
  4 hours or more per day

Table 1

Demographic characteristics and development of eczematous diseases in the cohort. Comparison of the intervention group and the control group.

	Intervention group (n/total)	Control group (n/total)	P
Age (years)#			
Range	15 – 32	15 – 38	
Mean	17.8	17.7	0.2
Median	17	17	
Sex#			
Male	6.6 % (13/196)	3.5 % (7/201)	0.2
Female	93.4 % (183/196)	96.5 % (194/201)	
Atopic dermatitis# *	10.2 % (20/196)	8.0 % (16/201)	0.4
Hand eczema			
Lifetime prevalence			
Inclusion	9.2 (18/196)	7.0 (14/201)	0.4
Point prevalence			
Inclusion	1.5 (3/196)	3.0 (5/201)	0.3
2nd follow-up	4.8 (7/147)	5.9 (8/136)	0.5
One-year prevalence			
Inclusion	7.7 (15/196)	6.0 (12/201)	0.5
2nd follow-up	20.4 (30/147)	29.4 (40/136)	0.07
During education			
1st follow-up	11.0 (16/145)	**19.2** (28/146)	**0.05**
2nd follow-up	20.4 (30/147)	29.4 (40/136)	0.07
2nd follow-up and drop-outs	19.4 (35/180)	**28.3** (53/187)	**0.04**
Eczema on wrists or forearms			
During education			
1st follow-up	4.1 (6/145)	5.5 (8/146)	0.6
2nd follow-up	8.2 (12/147)	8.1 (11/136)	0.9
Hand eczema and eczema on wrists or forearms			
During education			
1st follow-up	18.6 (27/145)	28.1 (41/146)	0.06
2nd follow-up	21.8 (32/147)	**33.8** (46/136)	**0.02**
2nd follow-up and drop-outs	20.5 (37/180)	**31.5** (59/187)	**0.02**

Data are based on questionnaire from the inclusion, 1st and 2nd follow-up (after exclusions in accordance to the Material and Methods section). Self-reported hand eczema has previously been validated in the cohort [28].

Chi-square test was used for the comparison of frequencies and Mann-Whitney test for comparison of mean in the two independent groups. P<0.05 was considered to be significant. The results which are significant are in bold
* Atopic dermatitis measured by using the U.K. working parties diagnostic criteria including the minor criteria `visible flexural eczema`.
# Measured at inclusion

Table 2

Use of gloves in the cohort at the final follow-up.

	I^a(n=147)	C^b(n=136)	P
Shampooing*	**70.7 %**	46.3 %	**<0.001**
Shampooing#	**48.9 %**	29.6 %	**0.001**
Hair dying*	100 %	98.5 %	0.1
Hair dying#	97.8 %	98.5 %	0.6
Rinse hair dye*	90.5 %	85.3 %	0.2
Rinse hair dye#	85.6 %	74.8 %	0.02
Eyebrow dye*	**13.6 %**	2.2 %	**<0.001**
Eyebrow dye#	5.0 %	0.7 %	0.04
Bleaching*	**89.8 %**	77.2 %	**0.002**
Bleaching#	86.3 %	78.5 %	0.09
Rinse bleaching*	83.0 %	72.1 %	0.03
Rinse bleaching#	76.3 %	68.1 %	0.1
Permanent*	63.9 %	52.9 %	0.06
Permanent#	46.0 %	39.3 %	0.3
Rinse permanent*	81.0 %	72.8 %	0.1
Rinse permanent#	72.7 %	64.4 %	0.1

The percentage of apprentices in each group, who always use gloves to the specific procedures at the schools and in the saloons. Chi-square test was used for the comparison. P<0.003 was considered to be significant according to the Bonferroni correction. The results which are significant are in bold. No missing answers were recorded.
[a] Intervention group
[b] Control group
* At the school
# In the saloons

Table 3

Time with glove use and wet work per day in the saloons at the final follow-up.

	Intervention group (n= 127)	Control group (n= 134)	P
Glove use			
Never	0.0 % (0)	0.0 % (0)	NT*
Less than ½ an hour	3.9 % (5)	**11.9 %** (16)	**0.02**
½ - 1 hour	19.7 % (25)	23.1 % (31)	0.5
1 – 2 hours	23.6 % (30)	26.9 % (36)	0.5
2 – 3 hours	30.7 % (39)	24.6 % (33)	0.3
3 – 4 hours	11.8 % (15)	7.5 % (10)	0.2
More than 4 hours	10.2 % (13)	6.0 % (8)	0.2
Chi-square for trend			**0.002**
Wet work			
2 hours or more	50.4 % (64)	**67.9 %** (91)	**0.004**

* NT = Not tested
Chi-square test was used for the comparison. P<0.05 was considered to be significant. The results which are significant are in bold.

Table 4

The relationship of potential risk factors to the prevalence of hand eczema at the final follow-up, including drop-outs.

	Total % (n/total)	Hand eczema % (n/total)	Crude OR (95% CI)	Adjusted OR (95% CI)	Final model OR* (95% CI)
Intervention					
Control group	51.0 (187/367)	60.2 (53/88)	1.00	1.00	1.00
Intervention group	49.0 (180/367)	39.8 (35/88)	0.61 (0.38-0.99)	0.62 (0.35-1.09)	0.59 (0.36-0.95)
Atopic dermatitis					
No	90.5 (332/367)	87.5 (74/88)	1.00	1.00	1.00
Yes	9.5 (35/367)	15.9 (14/88)	2.32 (1.13-4.79)	2.16 (0.87-5.35)	2.47 (1.19-5.14)
Sex					
Female	95.6 (351/367)	97.7 (86/88)	1.00	1.00	
Male	4.4 (16/367)	2.3 (2/88)	0.44 (0.09-1.98)	0.48 (0.06-3.96)	-
Weeks in saloon					
0-20	26.3 (72/274)	27.5 (19/69)	1.00	1.00	
21-40	49.3 (135/274)	47.8 (33/69)	0.90 (0.47-1.74)	0.87 (0.44-1.70)	-
>40	24.4 (67/274)	24.6 (17/69)	0.95 (0.44-2.03)	0.98 (0.45-2.16)	
Age (years)					
15-17	67.0 (246/367)	62.5 (55/88)	1.00	1.00	
18-24	29.7 (109/367)	32.9 (29/88)	1.26 (0.75-2.11)	1.41 (0.77-2.59)	-
> 25	3.3 (12/367)	4.6 (4/88)	1.74 (0.50-5.98)	2.19 (0.49-9.73)	

Logistic regression analysis with the outcome odds ratio of hand eczema at the final follow-up.

* The final model is based on the adjusted model, analyzed using backward stepwise logistic regression.

OR = Odds ratio

CI = Confidence interval