Female hairdressers - Respiratory symptoms, mechanisms, and health-related quality of life and their views on the work environment

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Abstract

Little is known of respiratory symptoms in female hairdressers, and of the impact on the health-related quality of life (HRQoL), nor of knowledge of their own views on preventive work. The aim of this thesis was to examine the occurrence of asthma, symptoms and mechanism of bleaching-associated nasal symptoms, the effects on HRQoL and how young hairdressers reason about the work environment.

A moderate increased risk of asthma was found during active time in non-smoking hairdressers, and it was somewhat greater for those performing most bleaches and hair spraying. Childhood hay fever and smoking had no effect on this risk. Hairdressers with bleaching-associated nasal symptoms (S+) responded in a challenge study with increasing symptoms and albumin in nasal lavage at a nasal challenge with persulphate, and atopic females to a lesser intent. The reaction of the S+ did not seem to be IgE-mediated. After a month's work S+ reacted with increasing symptoms and an increase in ECP in nasal lavage. HRQoL decreased in S+ parallel to an increase in nasal symptoms. In an interview study young hairdressers had an awareness of the work environment and opportunities to influence it, but shortage of means and strategies made it not an active part of their business. Focus was on customers and working technique. Organization had an impact and teachers were crucial for the preventive work. Hairdressers saw the professional future as uncertain due to work-related health risks and their consequences.

Key words Female hairdressers, Respiratory symptoms, Health-Related Quality of Life, Work environment

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Contents

There is more to life than what you see. From where you are standing, anything is possible.

Lynn Andrews

Abbreviations and definitions

AR	Acoustic rhinometry
BC	Before Christ
CI	Confidence Interval
ECP	Eosinophil Cationic Protein
HRQoL	Health-related Quality of Life
IgE	Immunoglobuline E
IR	Incidence Ratio
IRR	Incidence Rate Ratio
MCA	Minimum Crossectional Area
MID	Miminal Important Difference
MOS	Medical Outcome Study
MPO	Myeloperoxidas
mRNA	Messenger Ribonucleic Acid
NAL	Nasal Lavage
OA	Occupational Asthma
OEM	Occupational and Environmental Medicine (AMM)
OR	Odds Ratio
QoL	Quality of Life
RAST	Radio Allergo Sorbent Test
RQLQ	Rhinoconjunctivitis Quality of Life Questionnaire
SCTDA	Swedish Cosmetic, Toiletry and Detergent Association (KTF)
SF-36	Short Form 36 Questionnaires
SWEA	Swedish Work Environment Authority (AV)
TLV	Threshold Limit Value
TWA	Time Weighted Average
w/v	Weight per volume

Original Papers

This thesis is based on four papers included in the end and referred to in the text according to their Roman numbers.

I. Albin M, Rylander L, Mikoczy Z, Lillienberg L, Dahlman Hoglund A, Brisman J, Toren K, Meding B, Kronholm Diab, K, Nielsen J. Incidence of asthma in female Swedish hairdressers. Occup Environ Med 2002, 59;2:119-123.

II. Kronholm Diab K, Truedsson L, Axmon A, Nielsen J. Persulphate challenge in female hairdressers with nasal hyperreactivity suggests immune cell, but not IgE reaction. Int Arch Occup and Environ Health 2009, 82;771-777. Epub ahead of print 2 December 2008.

III. Kronholm Diab K, Jönsson BAG, Axmon A, Nielsen J. Work related airway symptoms, nasal reactivity and health-related quality of life in female hairdressers – a follow-up study during exposure. Int Arch Occup Environ Health 2014, 87:61–71. Epub ahead of print 23 December 2012.

IV. Kronholm Diab K, Nielsen J, Andersson E. Swedish female hairdressers' views on their work environment – a qualitative study. J Occup Health 2014; 56: 100-110. Epub ahead of print 16 January 2014.

Introduction

The hairdressing profession has a long history, and records from Egypt have been found from as early as 5000 years BC[1)]. Over the past 30 years the development in the profession has been extensive. Most women, and an increasing number of men, embrace hair fashion trends including hair dyeing, bleaching, styling and cutting, which entails a lot of work for hairdressers and which is not without safety risks for this work group.

There is a female domination in the profession with 85-90 % being women[2)]. In 2010 about 20 300 persons worked within hairdressing, 14 600 of whom were self-employed. In 2011 the most common profession among self-employed business women in Sweden was precisely hairdressers including 16 889 persons[2)]. Hairdressers are a highly mobile work group[3)], and in Sweden only about 40 % of the hairdressers are still active eight years after completing their education[4)]. The mean age of this work group is low, just over 30 years[2)]. The reasons for the high drop-out rate of the profession are unknown, but health may be one of them. The Swedish Work Environment Authority (SWEA) performed inspections in the hairdressing sector in 2005-2009. More than 700 demands for improvements were reported; these concerned risk assessments, policies and routines, chemical health risks and also business premises. Hairdressers reported 292 work-related illnesses during this period[5)].

Musculoskeletal disorders are common with a higher risk for work-related pain in hairdressers compared to office controls[3)] [shoulder (OR 11.6), wrist and hand (OR 2.8), back (OR 3.8-4.9) and leg/foot (OR 31)]. Also, stress has been suggested to have an impact on reproduction in hairdressers[6, 7)]. Hair chemicals can possibly cause cancer[8)], and have effects on the reproductive system[9)]; the risk of getting skin diseases[10)], which are frequent in the profession, and hand eczema, is about three times as high for hairdressers as compared to the general population[11)].

Hairdressers with respiratory symptoms are often referred to our clinic. Case studies have described nasal symptoms, mostly blocked noses and dry coughs, but some studies have also found that hairdressers frequently have asthma[12-14)].

Chemical exposure relevant to the respiratory system

Hair fashion implicates a chemical exposure for hairdressers, and the wide diversity of hair chemicals in hair dyes, bleaching products, permanent wave solutions, semi-permanent hair colours, hair sprays and various styling products are potentially harmful agents for the respiratory tract[15,16]. Thirty-five different airborne compounds, each of these possibly including a large number of elements that can be irritants, can be found in a hairdresser's work environment[17,18]. The irritating elements can be in forms of particles or gases, and they may influence the epithelium of the airways.

Aromatic amines in hair dyes may cause occupational asthma, rhinitis and contact urticaria in hairdressers[19]. Reversely, perming seems to cause more skin problems[20], and reproduction hazards[9] than respiratory symptoms. Permanent wave solutions render an exposure of thioglycolates and amines, but do not seem to be the most irritating agents for respiratory symptoms in hairdressers[21]. On the contrary, it has been concluded in research on the effects of hair spray on the airways that it is likely to be an irritating agent in the hairdresser's work environment[21-23].

Bleaching products contain several agents. Most attention has been paid to persulphates, which can be of three kinds - ammonium, sodium and potassium persulphates. In addition to being used as hair bleaching products, persulphates are used as disinfectants and in the manufacture of paper pulp[24]. The hair bleaching products can be in the form of powder, granules or gel, and contain persulphates in concentrations up to 60%[24]. A mixture with an oxidizing agent, typically hydrogen peroxide, is made prior to the application into the hair. While the mixture is being made, powder or granules whirl around in the air and are easily inhaled and distributed to the eyes and the airways. In Sweden there is no threshold limit value for persulphates exclusively, but ACGIH Worldwide (American Conference of Governmental Industrial Hygienists) has concluded the Threshold Limit Value (TLV) for persulphate with an eight hour Time Weighted Average to be 0.1 mg/m^3 [25].

Respiratory symptoms, personal risk factors and mechanisms

The risk of getting various respiratory symptoms is only addressed in a few epidemiological studies[26, 27]. Kogevinas et al. did not find hairdressing to be one of the most vulnerable professions for asthma, but this study was a cross sectional study in the general population dealing with symptoms the last year and present job titles. Only a few symptomatic hairdressers were included. In a retrospective study in Finland of 3484 female hairdressers employed in 1980 a relative risk of asthma was almost twice that of sales women[27]. However, in this study no active hairdressing

time was considered. Leino et al.[16] have equally found the risk for rhinitis to be twice as high for hairdressers. The risk for leaving the profession because of asthma or hand eczema was 3.5 times as great in hairdressers as in a control group[28]. In a prospective intervention study of respiratory symptoms in Norwegian hairdressers 40% left the profession during the four years of follow-up[29]. No major epidemiological studies of respiratory symptoms and exposure to hair chemicals have to my knowledge been published, and thus there is a need for extended research of the occurrence of respiratory symptoms in hairdressers.

Hairdresser research has shown inconsistent results concerning personal risk factors for respiratory symptoms in hairdressers such as atopy and tobacco use. In a Finnish study atopic hairdressers had an increased risk of developing occupational skin and respiratory diseases[30], while in other studies no such risks have been found[31, 32]. Thus, there are few studies of risk estimates of asthma, and also the interaction of personal risk factors as atopy and smoking on respiratory symptoms in hairdressers is still unclear.

Bleaching seems to be the hair treatment that is mostly associated to respiratory symptoms in hairdressers[29], but reliable methods for diagnosing these in hairdressers have been lacking. Several case studies have pointed out persulphates in hair bleach as the reason for asthma in hairdressers[14,33,34], but there are few studies of bleaching powder-associated nasal symptoms in hairdressers[35,36], and the mechanism behind these symptoms remains unclear.

Specific skin prick tests, immunological markers and specific challenges with persulphate have been applied to find the mechanism behind the respiratory symptoms[31,32,34]. Skin prick tests to persulphates have so far shown inconsistent results[14,35]. Munoz et al. found a positive skin prick test to persulphate salts in four out of eight patients with persulphate induced occupational asthma (OA). These four patients had in addition to OA also rhinitis and three of them dermatitis due to persulphates. A positive skin prick test to at least one persulphate was found in seven of 138 tested patients with different symptoms from the skin and the respiratory tract attending a clinic during four years[37]. A positive skin prick test to ammonium persulphate was seen in only two of 35 tested patients in a study of rhinitis in hairdressers, where almost half of the study group had a positive reaction also to common allergens[35].

Moscato et al. concluded from a study of hairdresser patients that there is an underlying immunological mechanism that remains to be elucidated since the involvement of an IgE-mediated mechanism for persulphate-associated asthma could not be confirmed[32]. A dependent IgE mechanism has been suggested to be implicated in the pathogenesis of occupational asthma in hairdressers due to exposure to persulphate, and it has also been suggested that rhinitis could present prior to asthma[34]. An increased level of total IgE was found in six out of eight patients with OA due to persulphate (five hairdressers)[31]. Three of these eight patients had a

positive skin prick test to common allergens, and the highest levels were found in three smokers. Total serum IgE involvement has also been found to be at the highest levels in highly exposed hairdressers[38], but a total of 5.5% of these hairdressers had specific serum IgE antibodies towards latex. Other researchers have not found any association between total IgE and hairdressing activity[39].

It has also been suggested that in some patients a hypersensitivity to persulphates could be IgE-mediated, but out of seven tested patients, only two showed specific IgE antibodies to persulphate and these patients had also urticarial reactions to open application of persulphates[37].

Also, an increased sensitivity to human dandruff in hairdressers[30] could implicate an allergy towards other agents than hair chemicals. Thus, an non specific hypersensitivity could also play a role in the mechanism of bleaching powder-associated rhinitis in hairdressers, which should be further examined.

The work-related respiratory symptoms may vary not only in relation to work and to days off but may also increase over longer working periods. Hairdressers with bleaching powder-associated rhinitis have claimed that their symptoms disappear during time off, but that week-ends are too short for recuperation and that they need frequent vacations to cope with their symptoms[40]. Furthermore, they have felt that they develop more symptoms not only to hair chemicals but to other stimuli outside the hairdressers saloons as well, indicating an increasing non specific nasal reactivity during exposure periods. This problem has to my knowledge not been addressed earlier in studies of hairdressers.

Health-related quality of life

According to the World Health Organization (WHO) health is not only a matter of biological symptoms but also a state of a complete physical, mental and social well-being[41]. Health-related quality of life (HRQoL) is a combination of health and quality of life (QoL), and Juniper[42] emphasized that it is the impairments which are perceived by the person that determine HRQoL. Thus, if we are to obtain a complete picture of a person's health status, HRQoL measurements must be combined with conventional clinical examinations[43].

HRQoL is highly affected among patient with rhinitis and asthma[44-46]. Within occupational medicine such studies are not common, although Blanc stated in 2004 that QoL and working life are linked together and must therefore be of concern to researchers within occupational medicine[47]. QoL has only been studied in few occupational settings, such as in a group of employees sensitized to bell pepper pollen[48] and in persons with occupational asthma due to different agents[49]. There are no such studies of hairdressers. This is important since hairdressers with nasal symptoms are affected in their daily lives by their respiratory symptoms[40].

Hairdressers' views on their work environment with a focus on prevention

Regardless of whether one is self-employed or an employee, the hairdressing profession is complex, and there are many demands from the business, colleagues, and customers as well as regulations from authorities, to take into account in addition to the considerable health risks in the work environment. When the hairdressing program was launched within the Swedish high school system in 1995 it included 50 hours of '*work environment and safety*'[50], and information about preventive measures in the work environment should be included. In an inspection campaign at hair and nail builder salons in southern Sweden by SWEA, a total of 1663 specific demands were noted, 1008 of which concerned chemical risks[4]. However, little is known about the strategies that hairdressers use in the work environment in order to reduce health risk factors and to prevent ill health. However, in an earlier study a large acceptance of work-related respiratory symptoms in hairdressers was found[40]. Knowledge of their strategies for the work environment, for health issues and of their own views on prevention in the work environment is still lacking.

Thus, hairdressers present with respiratory symptoms possibly caused by agents in hair chemicals, but the occurrence and presence, as well as the mechanisms behind these symptoms remain unclear. In order to be able to advise hairdressers there is a need for further knowledge also of the consequences of the symptoms at work and in their daily life, and of their own views on their work environment and their possibilities of work prevention.

Aim

General aim

The overarching aim of this thesis was to gain knowledge of the occurrence of asthma, the mechanism of work-related nasal symptoms, variations in respiratory symptoms and effects on the health-related quality of life during a work period, and of how young hairdressers reason about their work environment.

Specific aims

In female hairdressers …

To examine the risk of asthma (*Study I*).

To examine if hay fever during childhood, smoking and specific hair treatments have an impact on the risk of asthma (*Study I*).

To examine the meaning and the mechanism of persulphate in bleaching powder-associated rhinitis (*Study II*).

To examine how respiratory symptoms, inflammatory markers and nasal reactivity against persulphate develop in hairdressers with bleaching powder-associated rhinitis during one month of exposure after an exposure-free period (*Study III*).

To examine how HRQoL is influenced during this work period and to compare the HRQoL with that of pollen allergic women during the season (*Study III*).

To examine how hairdressers after three to four years of work reason about their physical, social and psychological work environment with a special focus on work related risks, possibilities to influence, implementation of knowledge, financial impact and impact of work-related symptoms (*Study IV*).

Material and methods

Design

This thesis consists of four studies, three quantitative and one qualitative, performed in 1997 and between 2002 and 2011 (Table 1). In the first quantitative study we examined the risk of asthma in female hairdressers in Sweden. In the second study female hairdressers with nasal symptoms mostly associated to bleaching powder and the mechanism behind their symptoms were examined. In the third study nasal symptoms, nasal reactivity and HRQoL were examined during a work month. In the qualitative study we wanted to explore how young female hairdressers who had worked for three to four years reason about their work environment.

Data collection

Selection of participants

The cohort of hairdressers in *Study I* was established from the records of all vocational schools for hairdressers in Sweden. All hairdressers born in 1946 and later and having graduated between 1970 and 1995 were identified, and altogether 7 204 hairdressers were invited. We chose 1946 as earliest year of birth to minimize the risk of age confounding. After two reminders 4 849 (67%) hairdressers had returned the questionnaire. Important reliable data was missing in 892, most of it for several important variables, and thus 3 957 (55%) hairdressers remained as participants. A cohort of referents, 7 355 women, was randomly selected from the general Swedish population, stratified by age and year of birth. After two reminders 5 569 (76%) had returned the questionnaire. Important reliable data was missing in 664 and 4 905 (67%) women participated in the study. The place of residence in 1996 was known for all participants.

A non-responder study was performed, where 25% of the hairdressers and 12% of the referents were randomly selected. Altogether, 393 (n=67%) of the hairdressers and 134 (n=60%) of the referents participated. The most common reasons for not

participating were no phone number (hairdressers 16%, referents 21%) and refusal to participate (hairdressers 11%, referents 10%).

Table 1. Overview of main content, type of study and method of analysis in Papers I-IV.

	Study I	Study II	Study III	Study IV
Year of performance	1996-1998	2002	2004-05	2009-11
Main content	Risk of asthma	Role of persulphate in nasal symptoms associated to bleaching powder	Respiratory symptoms, inflammatory markers, nasal reactivity and health-related quality of life during exposrure	Hairdressers' views on work environment
Type of study	Quantitative Cohort Retrospective study	Quantitative Nasal challenge study	Quantitative Cohort Short term study	Qualitative Open ended interviews
Method of analys	Incidence rate (IR) Incidence rates ratio (IRR)	Comparative statistics between and within groups	Comparative statistics between and within groups over time Odds Ratio (OR)	Manifest and latent content analysis

In *Study II* three groups of participants were enrolled. The target group was female hairdressers with nasal symptoms mainly associated to bleaching powder. Participants in the symptomatic group were deemed to have the worst symptoms associated with bleaching powder out of 33 hairdressers from *Study I* having been skin prick tested to potassium persulphate. Two comparison groups were employed, one of female hairdressers without symptoms, another of atopic females without professional contact to bleaching powder. The inclusion criterion for the target group was clear work-related nasal symptoms from bleaching powder. Asymptomatic hairdressers should have no respiratory symptoms. The exclusion criteria for both hairdresser groups were asthma, smoking and/or history of atopy. The inclusion criteria for the atopic group were nasal symptoms and history of atopy to at least one common allergen, and no exposure to bleaching powder. Exclusion criteria were asthma and regular allergy medication for all groups. The latency time until nasal symptoms in the target group was 8 years (2-19)(median; range).

Table 2. Recruitment of participants for Study I – Study IV (S+ = symptomatic and S-= asymptomatic hairdressers, A = atopic women, PA = pollen allergic women).

	Group	N	Recruitment
Study I	Hairdressers	3 957	Vocational schools, born 1946 and later, graduated 1970-95
	Referents	4 905	General population, randomly selected, stratified for age and year of birth 1946-78
Study II	S+	15	From Study I (n=10), patient (n=1), telephone campaign (n=4)
	S-	14	From Study I (n=6), telephone campaign (n=8)
	A	12	Students (n=4), OEM* staff (n=2), personal knowledge (n=6)
Study III	S+	17	Study II (n=3), patients (n=1), telephone campaign (n=13)
	S-	19	Study II (n=6), telephone campaign (n=13)
	PA	10	Study II (n=1), students (n=5), Dep of Otorhinoloaryongology (n=4)
Study IV	Hairdressers	14	From a prospective follow-up study of graduating hairdressers – seven with and seven without respiratory symptoms

*OEM = Occupational and Environmental Medicine

Hairdressers in *Study II* were recruited among participants from *Study I* residing in the region of southern Sweden, among patients from the department of Occupational and Environmental Medicine in Lund and through a systematic telephone campaign to hairdresser salons in the southern part of Sweden. Asymptomatic hairdressers were also recruited from *Study I* and in the same telephone campaign. Atopics were recruited among students, staff at the department of Occupational and Environmental Medicine and by personal knowledge (Table 2).

In *Study III* three groups of participants were enrolled. The target group was the same as in *Study II*, and also the hairdresser referent group. The inclusion and exclusion criteria were the same as in *Study II* for the hairdresser groups. The inclusion criterion for the atopic group was allergy exclusively to pollen. The Department of Otorhinolaryngology, the division for Allergy, Lund, was contacted and participants from former research projects within this department were enrolled. Because of allergies to multiple agents among the pollen allergic women, only ten females could be identified. The pollen allergic group had nasal symptoms from birch and/or grass and mugwort, and no exposure to bleaching powder. Exclusion criteria were the same as in *Study II*. In *Study III* the latency time for work-related nasal symptoms in the target group was 5 years (1–34) (median; range). In three hairdressers it was not possible to define a latency time. Among the non-symptomatic hairdressers one of twenty was excluded because of respiratory symptoms at study start (*Study III*).

Table 3. Characteristics for participants in *Study II* and *Study III* (S+ = symptomatic and S- = asymptomatic hairdressers, A = atopic women, PA = pollen allergic women).

	Study II			Study III		
Groups	**S+**	**S-**	**A**	**S+**	**S-**	**PA**
	N=15	**N =14**	**N =12**	**N =17**	**N =19**	**N =10**
Age (years;mean;SD)	39 (8)	38 (12)	39 (12)	39 (11)	37 (12)	34 (15)
Atopy by history	0	0	12	0	0	10
Positive skin prick test	4	2	10	1	2	10
Smoking						
- Smokers	3	3	0	2	2	0
- Never smokers	9	9	12	13	17	9
- Ex smokers	3	2	0	2	0	1
Employment years as a hairdresser (years;mean;SD)	17 (6)	17 (12)		20 (13)	17 (12)	

In *Study II* and *Study III* no differences were found concerning age and smoking habits between the groups. Neither was there any difference between the two groups of hairdressers with regard to employment years as a hairdresser, working hours or atopy by skin prick test. Characteristics for participants in *Study II* and *III* are seen in Table 3.

In the qualitative study (*Study IV*) the participants were selected from hairdressers participating in a long term study of a cohort of hairdressers in southern Sweden graduating in 2006 and 2007. The cohort was followed during the first three work years, and the aim of the study was to examine the occurrence of work-related respiratory symptoms in hairdressers, and also their health-related quality of life. Hairdressers having been to a medical examination at the Clinic of Occupational and Environmental Medicine because of work-related respiratory symptoms and the same number of hairdressers from the same region without such symptoms were invited. The original purpose with the subgroups was to see if there would be any differences in the way of reasoning about their work environment among those with and without work related respiratory symptoms. Fourteen hairdressers were finally interviewed, and another ten hairdressers declined to participate due to time constraints, travelling abroad, or too great work load. The characteristics and symptoms in the participants are shown in Table 4.

Table 4. Characteristics of the participants in Study IV.

	Study IV n=14	
Age (Mean;SD)	22.4	(0.65)
	N	**(%)**
Atopy by history	8	(57)
Smoking		
- Never smoked	5	(36)
- Smoker	8	(57)
- Ex smoker	1	(7)
Hand eczema last year	3	(21)
Work-related nasal symptoms	9	(64)
Work-related throat irritation	5	(36)
Work-related wheeze/dyspnea	1	(7)

Questionnaires

Postal questionnaire

In *Study I* all women were asked if they had had asthma and about the year of onset together with a follow up question if the diagnosis was by a physician. Questions were asked about smoking, hay fever or eczema during childhood. Hairdressers were also asked about all employments in the profession lasting more than a year after graduation, the employment time and any time off lasting more than a year. Also the frequency of treatments with bleaching powder and hair spray in specified categories (bleaching powder/week 0-1, 2-7, 8-14, >14, and hair spray/week 0-30, 31-50, 51-70, >70) was asked for.

Telephone interview

The interview of the non-participants was based on a questionnaire and dealt with symptoms and exposure, and hairdressers were asked about employment time as a hairdresser. Everybody answered questions about asthma and the onset of the symptoms, as well as about tobacco use and childhood hay fever or eczema. The wording of the questions was the same as in the postal questionnaire.

Validation study

In *Study I* a validation of exposure was made by comparing answers of the postal questionnaire to the same questions given three years later in another study with a subsample of the hairdressers from this study (n=1038). Same treatments were asked for in both questionnaires, but in the second study the answers were given in absolute numbers. A further validation was made by two occupational hygienists. A total of 19

hair salons were visited in Gothenburg with surroundings during high and low season asking the hairdressers to complete the questionnaire again. They were also asked to fill in a diary for three weeks with the daily number of hair treatments.

Diary

In *Study III* all study subjects completed a diary during four work weeks including ocular and nasal symptoms, throat irritation, dry cough, sputum production, wheezes, dyspnea, cold/flu, medication use, work hours per week and if they had been staying out of work due to their symptoms. The respiratory questions were earlier used in *Study I*[15, 51]. The exposure in the hairdressing work environment was assessed by registration of hair treatments accomplished daily, as bleaching, light colouring, dyeing, toning, perming, spraying, the type of products used; bleaching powder, granules or gel and pump or aerosol hair spray. They also indicated use of ventilation, local exhaust or any other kind of additional ventilation system (fan, roof ventilation, and open door/window). The pollen allergic group filled in the same symptom questions except for the relation to work, and was asked if they were exposed to any occupational irritant agents. They also answered more specified questions about their daily allergy medications. The pollen allergic women started the diary when they subjectively had clear allergic symptoms and they also reported if they reacted to any other agents than pollen.

Health-related quality of life questionnaires

Two questionnaires were used in *Study III* and the participants completed SF-36[52] and RQLQ[42] before the medical examination to avoid influence from the questions posed by the physician. They were instructed according to the guidelines defined by the designers of the questionnaires, and asked if any serious or dramatic event had happened during the observation period to exclude response shift[53]. The pollen allergic women completed the questionnaires at study start before the start of the pollen season.

Generic questionnaire

The Swedish self administered SF-36, version no, 1 was applied in[52]. The items are either answered in yes or no alternatives, or in a three-to-six response scale. SF-36 provides an eight-scale profile of functional health and well-being scores, which are related to physical and mental health dimensions scores[54]. For each of the eight domains the questions are coded, summed and transformed to a scale of zero (worst health) to 100 (best health) and calculated for each domain using a standardized scoring system[52,55]. The questionnaire covers the last four weeks. The Swedish version of the SF-36 has shown good psychometric values in several studies[56,57], and norms for the Swedish population are available [58].

The domains are

PF	Physical Function	10 items
RF	Role Function	4 items
BP	Bodily Pain	2 items
GH	General Health	5 items
VT	Vitality	4 items
SF	Social Functioning	2 items
RE	Role Emotional	3 items
MH	Mental Health	5 items
PCS	Physical Composite Summary	PF, RP, BP, GH
MCS	Mental Composite Summary	VT, SF, RE, MH

We applied PF, RP, VT, PCS and MCS. *Physical Functioning* and *Role Physical* measure limitations in the ability to perform physical activities and the effects on the ability to do work or other regular activities because of physical health problems, while *Vitality* measures an important aspect of the subjective well-being. PCS is a summary index for physical well-being and MCS for mental well-being.

Disease-specific questionnaire

RQLQ, a 28-item questionnaire, is self administered and has been validated to measure the functional impact (physical, emotional and social) of rhino-conjunctivitis in seven domains, which are scored from 0 (= no impairment) to 6 (=severe impairment) as perceived by the person during the last seven days[59-61].

The domains are

Activity limitation	3 items
Sleep	3 items
Non-rhinitis symptoms	7 items
Practical problems	3 items
Nasal symptoms	4 items
Ocular symptoms	4 items
Emotional function	4 items
Overall QoL	

Overall QoL is estimated from the mean score of all seven domains. RQLQ has strong evaluative and discriminatory properties[62]. The minimal important difference (MID), a change in score clinically beneficial for the patient, has been calculated for RQLQ as 0.5. This calculation has been based upon the patients' opinions[63].

We applied *Eye*, *Nasal* and *Non-hayfever symptoms*, *Activities and Overall QoL*. *Eye symptoms* measures the impact of itching, watery, burning and swollen eyes, *Nasal symptoms* the impact of blocked and runny nose, sneezes and mucus draining from the

nose and down the throat. *Non-hayfever symptoms* measure lack of energy, thirst, reduced performance, tiredness, concentration difficulties, headache and feeling worn out, and *Activities* how troubled you have been during three normally performed activities of your own choice.

The participants completed SF-36 and RQLQ before the medical examination to avoid influence from the questions posed by the physician. They were instructed according to the guidelines defined by the designers of the questionnaires, and asked if any serious or dramatic event had happened during the observation period to exclude response shift[53]. The pollen allergic women completed the questionnaires at study start before the start of the pollen season.

Medical examination

A standardized interview was conducted with a medical OEM specialist in *Study II* and *Study III*. This included a medical and occupational history, questions about atopy and smoking habits, and with special attention to respiratory symptoms and their relationship to the workplace. A physical examination was performed including anterior rhinoscopy to exclude any nasal condition that may mimic or generate rhinitis-like symptoms. Nasal symptoms and the results of rhinoscopy were registered during the recruitment procedures, and just before the nasal challenges in both studies. In *Study III* the medical examination for the pollen allergic group took place before the start of the pollen season.

Asthma was asked for using the following question – *Do you have or have had asthma?*

Asthma-like symptoms were defined as having wheeze/chest tightness.

Atopy by history was defined as having had hay fever, asthma, urticaria and/or atopic eczema in childhood or adolescence.

Ocular symptoms were defined as watery, itchy, dry or burning eyes.

Nasal symptoms were defined as blockage, secretion and/or itching/sneezing[64]. The term rhinitis is sometimes used for these symptoms.

Work related symptoms were defined as those associated to work and/or recovery during weekends or holidays away from the workplace.

Nasal symptom score

Nasal symptoms were recorded using a score system[65] before, 15 minutes after each challenge, 2 hours and 5 hours after the last challenge in *Study II*. In *Study III* the symptoms were recorded before and 15 min after each challenge. Nasal blockage and secretions were each rated on a scale 0-3 (no symptoms = 0, mild symptoms = 1,

moderate symptoms = 2, severe symptoms = 3). The rating was performed for each nose cavity and the average was used. The number of sneezes was counted and scored (no sneeze attacks = 0; 1-5=1; 6-15=2; >15=3). A combined nasal symptom score was calculated by addition of the score for each symptom. When the reaction of individual subjects were studied in *Study II* a significant response was defined as a subject increasing in total symptom score more than three standard deviations from the mean change in the asymptomatic group.

Acoustic rhinometry

Acoustic rhinometry (AR) was performed using a RHIN 2000 (RhinoMetrics A/S, Lynge, Denmark)[66]. The anatomical nosepieces were chosen according to the shape of the subject's nostril. The probe was handheld, and the participant sat in an upright position with the neck fixed breathing quietly through the mouth. During the measurement the subjects held their breath. The room was quiet and the room temperature was standardized. The Minimum Crossectional Area (MCA) in cm^2 was measured in the distance of 10-32 mm from the nares before the first challenge, 15 min after this and 15 min, 2h and 5h after the second challenge in *Study II*. In *Study III* the MCA and the volume (VOL) were measured also at 22-54 mm from the nares before the challenge and 15 min after each challenge. Three consecutive approved measurements for each nostril were performed and the mean value was registered for each side of the nose. Data on nasal dimensions are evaluated as the mean value of the values for the right and the left side of the nose.

Specific skin prick tests

Skin prick test with 13 common allergens (ALK, Copenhagen, Denmark) was performed in *Study II* and *Study III*. Furthermore, the hairdressers were tested stepwise with fresh solutions (0.05, 0.1 and 0.5 % (w/v)) of potassium persulphate in sterile water. Skin-prick tests were performed on the volar part of the forearm and read after 15 minutes, for potassium persulphate stepwise in increasing dose. Reaction sizes were recorded in relation to histamine[67]. Positive reactions were scored when the area of the wheal was at least half of that induced by a histamine solution (10 mg/ml), and significantly larger than that induced by the negative control.

Nasal lavage

The nasal lavage (NAL) was performed in *Study II* twice before the first challenge and 20 min, 2h and 5 h after the second challenge directly after the rhinometric measurement. In *Study III* NAL was performed twice before the first challenge and 20

min after the second one. The first lavage was performed to wash out mediators developed by processes before the challenge. The second lavage before the challenge was used as the baseline for the post challenge samples. The lavage was performed with a syringe attached to a nasal olive (Nasaline; ENTpro AB, Stockholm, Sweden). Fifteen ml of sterile isotonic saline solution at 35°C was introduced into the nasal cavity with the patient sitting in a forward flexed neck position. The transmission was stopped when solution appeared in the opposite nostril. The solution was sucked backwards into the syringe and injected again. This procedure was repeated three times in the left and the right nostril alternately. The supernatant was immediately cooled and frozen at -70°C.

In *Study III* another method of NAL was used at study start, after one and after four work weeks for the hairdressers, while for the pollen allergic women at study start and after four weeks of pollen exposure. This lavage method was used, as the intention was to collect cells from the nasal mucosa to analyse Messenger Ribonucleic Acid (mRNA; these analyses are not completed). A sterile isotonic saline solution was sprayed into the nasal cavity using a container of glass and a plastic atomizer nozzle. A centrifuge tube was placed in crushed ice and topped with a plastic funnel. The saline was sprayed three times into each nostril at the nasal conchae. The study subject was instructed to breathe by the mouth and to lean forward and let the fluid drop from the nostrils into the funnel until 10 mL was collected in the tube. The tubes were kept on ice until centrifugation, which was performed within 3 hs[68, 69].

Specific nasal challenge to potassium persulphate

A nasal challenge to potassium persulphate was carried out in *Study II* for all participants, and in *Study III* for the symptomatic hairdressers to see any changes in the nasal reactivity before and after a work period in this group.

The nasal challenge was performed with a 0.001 % fresh solution of potassium persulphate in isotonic saline solution, and after 20 minutes with a 0.01 % solution (w/v) using a De Vilbiss spray (atomizer No. 15)[70]. A total of 300µg of each solution was sprayed into the nasal cavities by turns. The spraying was performed immediately after a maximal inspiration to prevent the solution from entering the lower airways[71]. A positive reaction was defined as a significant increase in nasal symptoms of ≥3 points in total symptom score[66].

Laboratory analyses

Specific IgE antibodies

Venous blood was collected before the challenge and 5 h after the last challenge (*Study II*). One tube without additives was centrifuged and the serum was frozen at -20°C for analysis of specific antibodies of IgE class. Samples were also taken in tubes with heparin and with EDTA respectively for blood cell analysis within 6 hours after blood sampling. Analysis for specific IgE antibodies against persulphates was performed by specific immunoblotting[72]. Aliquots of the conjugate with persulphate and proteins from nasal lavage fluid were separated by 4-12 % sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE). The proteins were blotted to a preconditioned PVDF (polyvinylidene difluoride) membrane (Biorad, Hercules, CA, USA) using a Semidry Electroblotter A (Ancos, København, Denmark) at 150 mA for 3 hours. The membrane was then blocked by incubation in 5 % dried milk. Sera from the hairdressers were used as primary antibodies. The secondary antibody was I^{125} IgE. The membranes were wrapped in cellophane and exposed on CEA RP X-ray film (CEA group, Strängnäs, Sweden) for 1 month.

Albumin, ECP, MPO, Tryptase, Substance P in nasal lavage

In *Study II* the levels of albumin, eosinophil cationic protein (ECP) and myeloperoxidase (MPO) in the supernatants of the nasal lavage fluids were analysed by double antibody radioimmunoassay. The level of tryptase was analysed by a double antibody fluoroenzyme immunoassay.

In *Study III* the supernatant was obtained by centrifugation of the sample volume at 0.3 g for 10 min at 4°C. The samples were kept at -80°C until analysis. For Substance P, one ml of nasal lavage fluid was transferred into a 3.6 mL Nunc cryotube containing 1 mL of inhibitor. For ECP and tryptase analysis, the supernatant was transferred into a 3.6 mL cryotube. We could not exclude blood in the nasal lavage samples, and therefore we did not include the data for albumin. The levels of ECP and tryptase were analyzed by a double antibody fluoroenzyme immunoassay. Substance P was analyzed by an Immuno Linked Immuno Assay, ELISA *(Cayman Chemical Company, Ann Arbor, MI, USA).*

The assays are available as commercial kits (Pharmacia Diagnostics AB, Uppsala, Sweden). The detection limit for albumin was 0.4 mg/L, for ECP 2.0 µg/L, for MPO 2.0 µg/L, for tryptase 1.0 µg/L and for Substance P 8.2 ng/L.

Blood cells

Concentration of leukocytes, lymphocytes and lymphocyte subpopulations were measured using flow cytometry (*Study II*). Leukocyte populations were distinguished

by their light-scattering abilities; forward scatter reflects the cell size and side scatter reflects the complexity/granularity. The different lymphocyte populations distinguished were T cells (CD3+), T helper (Th) cells (CD3+, CD4+), T cytotoxic cells (CD3+, CD8+), B cells (CD19+) and NK cells (CD3-, CD16+ or CD56+). Also HLA-DR expression on lymphocytes and on the T cell subpopulation was determined[73]. In short, samples of 5 µl of fluorescence-labeled monoclonal antibodies were added to 50 µl of blood and incubated for at least 10 min. The erythrocytes were then lysed by Immunoprep (Coulter, Miami, FL, USA) and the sample analysed on a flow cytometer (Coulter Epics II, Coulter Electronics, Hialeah, FL, USA).

Analysis of Th1 and Th2 lymphocytes was done by measurement of the intracellular expression of the cytokines interferon-γ and IL-4 using flow cytometry[74,75]. A minimum of 3000 cells was analysed within the lymphocyte cluster, and the results are expressed as a percentage of cytokine-producing cells in a population of specified T-helper cells, i.e. CD3 and CD4 positive cells[76].

Interviews

The open-ended interviews were conducted by the author, and took place in the informant's home or business premises in accordance to the informant's decision, and an effort to create a comfortable and confidential situation was made[77]. The way the first question is asked creates the possibilities and limitations for how the interview will proceed. Thus, it is essential to have an open approach in the opening question not to miss important aspects. The opening question was – *How is your work environment?* A dialog with the informant was established, where the interviewer used an interview guideline with a few themes:

- The physical, social and psychological work environment
- Environmental issues in the salon
- The future as a hairdresser
- Eventual respiratory symptoms and effects on quality of life

No series of prepared questions was used, as the purpose was to get knowledge of the work environment from the hairdressers' own perspective from different angles defined in the guideline themes. Mishler pointed out that interviews should be seen as a discourse created by the interviewer and the informants together, negotiating an understanding of the context[78]. The research interview thus is an interaction between two people, where the researcher and the informant react and affect each other mutually, and where the purpose is to gain qualitative descriptions of the life world of the informant in order to interpret the meaning[79].

Although the interview represents an interpersonal relation, it is the interviewer who defines the situation and introduces the topics as well as controls the interview

progress[79]. The interviewer deepened the discourse with the hairdressers using probes. Probing is a way to draw more information from the informants by elaborating on what has already been answered. It is frequently used in open interviews to elicit more in-depth information and to fully understand the informant's perspective. The follow-up probes should be appropriate to each given situation and to the aim of the project[77]. The interviewer also summarized what was said at different stages of the interview to deepen and obtain more information. The interviews lasted between approximately 20-70 minutes, were recorded in full using an electronic device technique and transcribed verbatim by a secretary including pauses and emotional expressions. Questions that did not belong to the themes but were raised during the interviews were followed up immediately after the interviews.

Data analysis

Statistical analysis

In *Study I* incidence of asthma was estimated using rate ratios with 95% confidence intervals (95% CI) by a Poisson regression. To determine the effects of risk factors on the incidence of asthma referents (from 18 years of age) were used. Age (six categories; <20, 20–24, 25–29, 30–34, 35–39, and >40 years) had no effect, while the incidence of asthma increased during the period of observation (three categories; 1970–80, 1981–90, and 1991–96). Both hay fever and childhood eczema had an effect, but the effect of the latter almost disappeared [IRR=1.2 (95% CI 0.9 to 1.6)] when hay fever was simultaneously included in a multivariate model. A slightly increased incidence of asthma was found among women who were ever smokers and among women living in the middle and northern regions of the country. The final model thus included calendar year of observation, hay fever, smoking, and region. The estimated univariate effects were, apart from childhood eczema, similar to the estimates obtained from the multivariate model.

To estimate the incidence of asthma among hairdressers those without previous asthma were followed up from the year of certification, usually at the age of 18. Also, the incidence of asthma was calculated only during exposed time, and time not working as a hairdresser was excluded. The effect on incidence of asthma of bleaching (three categories; 0–1, 2–7, and >8 treatments/week) and using hair spray (three categories; 0–30, 31–50, and >51 treatments/week) was evaluated during exposed time.

Mann-Whitney's *U* test was applied for group-level comparisons, and Wilcoxon's signed rank test for paired data in *Studies II – III*. For comparisons of means the Student's *t*-test was applied. Stratification was used to adjust for possible confounding factors (atopy and smoking) in *Study II*. We calculated mean, standard deviation (SD) and 95 % confidence interval (CI) as parameters for the QoL data in *Study III*. Visually assessed p–p-plots suggested that the data were normally distributed. In the comparison analyses for quality of life in *Study III* the number of participants in the asymptomatic group are 18, due to missing questionnaires from one hairdresser at the study end.

Variables with dichotomous outcomes in *Study III* were analyzed with a generalized model with a logit link (i.e., logistic regression). Continuous variables were analyzed

with a linear mixed model with restricted maximum likelihood (REML) estimation and a diagonal covariance matrix. In both models, repeated measures were identified by personal identification number and day in study. For some continuous variables for hair treatments the final Hessian matrix was not positive. These were therefore dichotomized into the categories 0 and C1 and analyzed with the logit link.

In all tests, P value of 0.05 (two-tailed) was considered statistically significant.

Qualitative analysis

When analysing the data we could not detect any differences between the two subgroups, and we thus present the findings for the whole group. The data in the qualitative study was analyzed using a conventional inductive qualitative content analysis as described by Hsieh and Shannon[80]. The aim was to gain information from the hairdressers without imposing preconceived categories or theoretical perspectives. The generated findings of the content analysis are based on the participants' unique perspectives and grounded in the data. Reading a text always implies a certain interpretation, which can be made on different levels of abstraction. Several authors as Graneheim and Lundman[81] and Berg[77] have described qualitative content analysis as the manifest content highlighting the most obvious and visible content in the text, and the latent content in the text showing the underlying and the deep structural meaning of the text. According to Berg it is advisable to use a combination of manifest and latent content analysis[77]. In this study we employed both manifest and latent content analysis as described by Graneheim and Lundman[81], and consider it to be fitted in Hsieh's and Shannon's concept of conventional content analysis[80]. The findings of the manifest and the latent analysis are presented in an integrated way.

The analysis was performed by the interviewer and a co-examiner, who step by step analyzed the text independently and then came together to discuss the findings. The first step started with the reading and re-reading of all the data text several times in order to achieve immersion and obtain a sense of the whole. The impression of the text was then discussed and a structure for the analysis decided. In the next step meaning units related to the aim of the study were identified and collated. The meaning units were re-read again with a focus on identifying codes capturing key concepts of the text as coding refers to the process of transforming texts to analysable representations. Then codes of similar content were grouped and labelled in initial coding schemes. The next step involved sorting the codes into themes and sub themes. The statements in each theme and sub theme were then analyzed critically and questioned, read and compared to arrive to a reasonable interpretation. In the last step the themes and the subthemes were compared with the original text and with each other in a constant movement between the whole and the parts and between the text and the themes, and a main theme was determined[81]. The interviewer and the

co-examiner were both involved in the process of the development of the main theme, themes and the subthemes, and in the final step all three researchers discussed and reached a consensus on the main theme, the themes and the sub themes.

Pre-understanding

As the researcher is a tool in the research process, pre-understanding should always be taken into account. Describing the pre-understanding is common in qualitative, but is equally eligible in quantitative research. To remain open during the whole research process the researcher must recognize and deal with presuppositions[82)]. If we are not aware of the presuppositions or neglect to consider them, we risk obtaining results that are merely a reflection of something already existing in our understanding. It is not easy to capture and to be fully aware of the pre-understanding, as it is partly unconscious. Nevertheless, trough critical reflection, the researcher can show openness and thus be aware of one's own bias[82)].

In this thesis the author's pre-understanding was from working as an occupational and environmental health nurse with patients and research considering work-related symptoms in several professions, also in hairdressers. Other participating researchers in the three quantitative studies had waste experiences from research within work environment, and especially in the one of hairdressers. The pre-understanding improved the design of the included studies, and the researchers were aware of their presuppositions within the field and kept a dialogue about them.

During the analysis process of the qualitative study there was equally an ongoing dialogue about the pre-understanding between the authors to diminish the risk of impact from former experiences and to increase the awareness. The interviewer's pre-understanding was based on the earlier research concerning female hairdressers' respiratory symptoms. The co-examiner had considerable experience of qualitative research methodology, but none from research within work environments. The third researcher had extensive and long experience from the hairdresser work environment and its medical aspects as a senior OEM physician, but none from qualitative research.

Ethical considerations

All four studies in this thesis have been performed with consideration to the ethical principles for research in humans according to the Helsinki declaration[83], the Swedish Act concerning the Ethical Review of Research Involving Humans[84] and the Swedish Personal Data Ordinance[85] and the Swedish Personal Data Act[86]. The studies were approved by the Central Ethical Review board in Lund (*Study I* LU 0501-96, *Study II* LU 376-02, *Study III* LU 987-03 and *Study IV* Dnr 2009/98, 838/2005). The research also followed the ethical principals of respect for autonomy, beneficence, non-maleficence and justice[87].

Autonomy refers to the participants right to independently decide about the participation in the study, and the decision should be based on understanding and be voluntary [87]. This means that the participants must fully understand the information given before accepting to participate. In this thesis the participants were given oral and written information about the studies also stating that any participation was voluntary and that the participants at any time could choose to withdraw from the studies without any further explanation or effect on their care, and that confidentiality was guaranteed. The participants were given possibilities to ask questions about the study to the researchers before the study start. Thus, an informed oral and written consent was obtained in all studies.

Beneficence refers to the benefits of the study for the participants and freedom of exploitation, while *non-maleficence* refers to the risk of doing harm to participants[87]. The patient's best has throughout the studies been in focus. In *Study IV* the hairdressers were asked where they preferred to perform the interviews to ensure their comfort. Any questions arising during the interviews were discussed directly afterwards. To comply with the principle of non-maleficence we treated all data as questionnaires, interview transcripts and records with confidentiality and made sure that no participant could be identified in the presentation of the results. All instruments were coded and the code key stored separately.

The *principle of justice* refers to fairness and privacy, meaning that the selection of research subjects should be done in an ethically good manner[87]. The participants in this thesis were asked for participation regardless of social status, race or nationality. They were continuously informed about their right to withdraw from the studies at any time. The right to privacy can be difficult to follow in qualitative studies due to

the nature of in-depth interviews. The confidentiality was maintained through a coding system, where it was impossible to identify the participating hairdressers.

Participation in the studies has not been expected to have a negative impact on the hairdressers. However, it might be possible that the focus on work-related symptoms could cause worries and rise questions about the profession to be a potential health risk. Any questions from the hairdressers about symptoms or other matters in their work environment were answered directly after the participation in the studies. The participants were also informed that they at any time can contact any of the researchers, and were provided with contact information.

Results with comments

Incidence of asthma and risk factors

The crude incidence of asthma among hairdressers (*Study 1*) was 3.5/1000 person-years, while a higher incidence was found when only years in active hairdressing work was assessed, 3.9/1000 person-years. There was a small difference between the incidence of asthma in the cohort of hairdressers when years not working as a hairdresser were assessed and that among the referents (Table 5).

Table 5. Asthma incidence rates (IR) in female hairdressers (n=3 957) and in referents from general female population (n=4 905).

Cohorts	Cases	Person-year	IR (/1000)
Hairdressers -work active	104	26 729	3.9
-not work active	42	14 883	2.8
Referents	202	64 553	3.1

Table 6. Hair treatments associated to work related wheeze/chest tightness in the female hairdressers.

	Hairdressers N = 3 572	
	N	(%)
Work-related wheeze/ chest tightness	390	(11)
Associated to hair product	282	(72)
- permanent wave solution	98	(35)
- bleaching product	233	(83)
- hair dye	114	(40)
- hair spray	191	(68)
- hair styling product	75	(27)

Non-participating hairdressers reported in the phone interview a higher incidence of asthma (4.9/1000 person-years based on 20 cases) in general and during active work as hairdressers 6.0/1000 person-years (based on 16 cases) than the participants. Non-participating referents also reported a slightly higher incidence of asthma (4.9 per 1000 person-years based on 18 cases) than the participants.

The time to onset of asthma was 6 years among the participating hairdressers (median time from certification), and change of work due to asthma was reported by 0.7% of both hairdressers and referents.

There was an effect on risk for asthma of being active hairdresser compared to referents. Hay fever in childhood did not affect this risk. Smoking increased the risk for asthma in the referents but did add to the risk in hairdressers. However there was an effect of being a hairdresser among the lifelong non-smokers, and an effect of smoking in the referents. The incidence of asthma was slightly higher, but not significant, in the most frequent users of bleaching products and hair spray than in the others. Hair treatments associated to asthma-like symptoms are shown in Table 6.

The exposure of persulphate during mixture with hydrogen peroxide was 15.3 – 48.6 µg persulphate/m^3 during sampling periods of 32-135 minutes (4-7 bleaches). The time for hair bleach from mixture to application was about 15 minutes. No detectable levels of persulphate were measured during application. During the seventies 39% of the hairdressers performed 2-7 hair bleaches/week, which increased to 54% during the eighties and to 57% during the nineties. All together the number of performed bleaches and also the use of hair spay increased during the eighties and nineties.

In the validation of exposure to hair treatments the comparisons between the questionnaires and the diaries indicated a fair to poor agreement. The number of bleaches was in accordance between the questionnaire and the diary, but the use of hair spray was generally overestimated in the questionnaire.

In the same study, but not included in this thesis, incidence and risk factors were analyzed for nasal blockage, dry cough and wheeze. The results showed equally an increased incidence in hairdressers compared to referents in all three studied symptoms, most pronounced for nasal blockage[15] (Table 7).

Table 7. Crude incidence rates (IR) of nasal blockage, dry cough and wheeze in female hairdressers and in referents from the general female population.

	Hairdressers (n= 3 957)			Referents (n= 4 905)		
	Cases	Person-years	IR (/1000)	Cases	Person-years	IR (/1000)
Nasal blockage	634	34 901	18.2	684	60 016	11.4
Dry cough	366	38 276	9.6	419	57 054	7.3
Wheeze	383	38 371	9.9	356	61 823	5.8

Nasal challenge with persulphate

Hairdressers with bleaching powder-associated nasal symptoms reacted to a nasal challenge to potassium persulphate with increased symptoms contrary to asymptomatic hairdressers. Atopic females reacted to a lesser intent (Table 8).

Before the challenge the symptomatic group had a higher total symptom score than the other groups. Both symptomatic hairdressers and atopics differed from the

asymptomatic group in total symptom score. No significant difference was seen between the symptomatic hairdressers and the atopic group before the challenge. The symptomatic hairdressers had a significant increase in the total symptom score after the first and last challenge and 2 h after the last challenge. The atopic group increased significantly but transiently after the first and last challenge. The asymptomatic hairdressers did not react to the challenge (Table 8). There were no IgE antibodies at immunoblotting using persulphate modified nasal proteins as allergens in any of the groups.

The smokers and the skin prick test positive subjects did not differ from the rest of their groups respectively. When individual subjects were studied six subjects in the symptomatic and two in the atopic group reacted significantly to the challenge.

A decrease in MCA of 7% after the first and 14% after the second challenge was seen in the symptomatic hairdressers compared to baseline. In the atopic group, a transient decrease of 14% was noticed after the first challenge but the group returned to baseline after the second one. Otherwise there were no changes in the groups compared to the baseline levels.

Table 8. Total symptoms score (nasal blockage, secretion, number of sneezes; median), before, during, 2 and 5 hours after a nasal challenge with potassium persulphate in symptomatic (S+) and asymptomatic (S-) hairdressers and in atopics (A).

	S+ (N = 15)	S- (N = 14)	A (N= 12)
Baseline	2.0***	0	0.5*
15 min after challenge 1	4.0 ^{aa}	0	1.5 ^{a}
15 min after challenge 2	5.0 ^{aaa}	0	2.5 ^{aa}
2 h after challenge 2	3.0^{a}	0	0.5
5 h after challenge 2	2.0	0	1.5

Significant differences between S- group and S+ and A groups respectively
* P≤0.05 *** P≤0.001
Significant differences within the groups compared to the Baseline
^{a} P≤0.05 ^{aa} P≤0.01 ^{aaa} P≤0.001

A significant increase in albumin in nasal lavage was only observed in the symptomatic hairdressers after the last challenge compared to baseline although a slight increase was noticed in the atopics. Two hours after the last challenge there was a decrease, and after five hours albumin increased again in the symptomatic hairdressers, although not significantly.

No effects of the challenge regarding ECP and MPO in the nasal lavage were observed in any of the groups. For tryptase none of the participants had values above the detection level.

No significant differences were found between the groups for any of the cell populations analysed, neither before nor after the challenges. However, lymphocytes increased significantly in all three groups, but the increase was more pronounced in symptomatic hairdressers than in the other two groups. In these Th 1 cells increased in symptomatic hairdressers after challenge, but not Th 2 cells. In atopics there was a not significant increase, while no increase was seen in asymptomatic hairdressers.

In the same study groups gene expression of cytokines in cells from NAL were studied to examine the mechanism behind the nasal symptoms [88]. This study showed that symptomatic hairdressers increased in expression of interleukin 5 - *IL5*- and interferongamma -*IFNG*, but not interleukin 13 - *IL13*, during challenge. However, atopics showed increased expression of *IL5* and *IL13*, thus indicating a difference in the mechanism behind the nasal symptoms in the two groups. Asymptomatic hairdressers did not show any changes.

Respiratory symptoms, inflammatory markers and nasal reactivity to persulphate during a work period

During a month of work exposure a steady increase in nasal symptoms was seen in symptomatic hairdressers (*Study III*). The symptoms decreased during week ends and increased during work days, especially at the end of the period (Fig. 1). The pollen allergic women had more nasal symptoms from the start than the symptomatic hairdressers, but the symptoms in the pollen allergic group varied from week to week. The eye symptoms varied less than the nasal symptoms. The OR for eye symptoms in the pollen allergic group compared to the symptomatic group was 8.07 (CI%95 - 3.20, -0.98; P<0.001). The symptomatic hairdressers had more throat irritation (OR 1.13, CI%95 -1.12, 1.37; ns) than the pollen allergic women.

The symptomatic hairdressers had lesser sneezing and a tendency to more nasal blockage than the pollen allergic group. No significant differences were seen between the symptomatic hairdressers and the pollen allergic women regarding the lower airways.

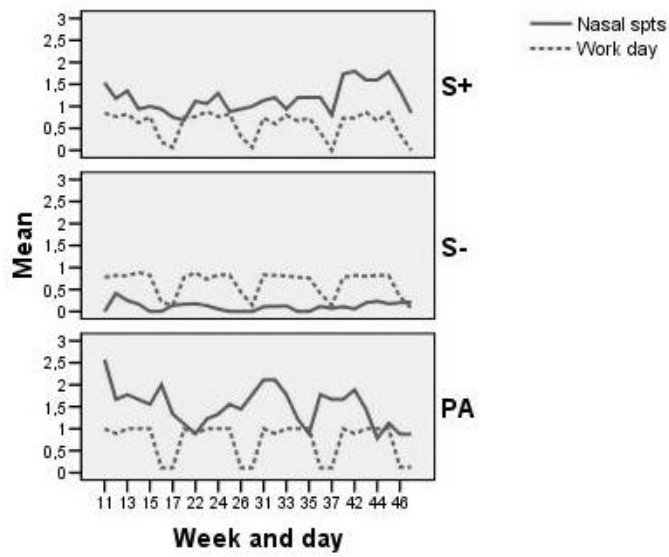

Fig 1. Nasal symptoms (blockage, itching, sneezing, secretion; mean) without infection and work days in symptomatic hairdressers (S+;n=17) and asymptomatic (S-;n=19) hairdressers and pollen allergic women (PA;n=10).

The ECP levels in nasal lavage increased significantly in symptomatic hairdressers from one to four work weeks (Table 9), while the asymptomatics did not change. The ECP level was higher at baseline in pollen allergic women than in both groups of hairdressers, and increased during the observation period although the increase was not significant. However, the level was significantly higher compared to the asymptomatic hairdressers. No significant differences regarding Substance P and tryptase were registered between and in the groups during the study period.

Table 9. ECP levels in nasal lavage fluid in symptomatic (S+) and asymptomatic (S-) hairdressers and pollen allergic women (PA) before (BE), after 1 week (1wAE) and 4 weeks (4wAE) of exposure.

	S+ N =17		S- N =19		PA N =10		P-value	
ECP (µg/L	Median	CI 95%	Median	CI 95%	Median	CI 95%	S+↔S-	S-↔PA
BE	3.8	(1.9-149.0)	4.0	(1.9-22.0)	8.4	(3.7-41.0)	0.523	0.002
1wAE	5.9	(1.9-57.0)	3.7	(1.9-32.0)	--		0.273	
4wAE	7.0[a]	(1.9-141.0)	3.1	(1.9-11.0)	28.0	(1.9-200.0)	0.050	0.002

[a]1wAE ↔ 4wAE *P*=0.05

At the nasal challenge with persulphate of the symptomatic hairdressers the total nasal symptom score at baseline increased significantly from before to after four work weeks from 1 to 2 (median; P=0.022).). After the challenge before the exposure period the symptom score increased from 1 to 2 (P=0.005), and after the exposure period the score increased from 2 to 3 (P=0.006) indicating no change in nasal reactivity. There were no significant changes in MCA or in VOL after both challenges. A significant increase in albumin in NAL was observed after the challenge before the study period, but the increase after a month of work was not significant.

Although the symptomatic hairdressers had a tendency to perform more hair treatments such as bleaching, high-lifting blond and hair dye than the asymptomatic group, the only significant difference was in the use of hair spray with a mean difference of -0.569 (CI 95% -0.917 to -0.221; p=0.001). Neither the type of bleaching product used such as powder, granules and gel, nor the type of hairspray (pump or aerosol propellant) differed between the groups. Local exhaust ventilation was infrequently used in both groups.

Health-related quality of life in hairdressers and pollen allergic women during a work period

Generic questionnaire

Before the study period the two hairdresser groups had significantly better scores than the pollen-allergic group in Physical Functioning (Table 10). There were no significant differences in any of the other health domains between the groups. However, the two hairdresser groups had higher scores (non-significant) than the pollen-allergic group in the mental summary index.

After the exposure the symptomatic hairdressers were significantly worse than the asymptomatic group in Role Physical and Vitality. The symptomatic hairdressers and the pollen-allergic women had worse scores than the asymptomatic hairdressers in Physical Functioning, Role Physical and in Vitality (Table 10).

The symptomatic hairdressers had a significant decrease (P=0.044) in Vitality after the exposure period. The asymptomatic hairdressers and the pollen-allergic group did not have significant changes in any domain after the exposure. The asymptomatic hairdressers increased more or less (non significantly) in all health domains except for Physical Functioning.

Table 10. SF-36 in symptomatic (S+;N=17), asymptomatic hairdressers (S-;N=19) and pollen allergic women (PA;N=10) before (BE) and after 4 weeks (AE) of exposure (Mean; SD).

SF-36[1]	Health domains	Groups	BE	AE	Changes BE and AE		
			mean (SD)	mean (SD)	mean (SD)	95% CI	*P* value
Physical domains	PF (90.7;15.7)[2]	S+	95.0[a] (9.0)	94.1 (14.4)	0.9 (4.8)	-3.8 - 5.5	0.693
		S-	97.2[b] (4.3)	96.3[bb] (6.0)	1.1 (4.8)	-1.5 - 3.2	0.435
		PA	84.9[cc] (14.3)	84.4[cc] (11.8)	0.4 (11.4)	-8.3 - 9.2	0.912
	RP (85.9;29.5)	S+	88.2 (28.1)	70.6[aa] (39.8)	17.6 (41.2)	-3.6 -38.8	0.097
		S-	85.2 (30.2)	97.2 (11.8)	12.0 (29.0)	-26.5 -2.4	0.097
		PA	86.1 (22.0)	77.8[c] (34.1)	8.3 (28.0)	-13.2-29.9	0.397
	PCS (50.9;9.0)	S+	50.6 (8.8)	49.4 (9.2)	1.3 (7.0)	-2.4 – 4.9	0.471
		S-	52.9 (4.6)	53.9 (5.0)	1.0 (4.0)	-3.0 – 1.0	0.312
		PA	50.7 (6.4)	49.1[c] (6.5)	1.5 (4.9)	-2.2 – 5.3	0.373
Mental domains	VT (66.5;23.9)	S+	70.3 (18.4)	59.4[aa] (20.5)	10.9 (20.6)	0.3 – 21.5	0.044
		S-	73.1 (16.2)	77.8[b] (15.6)	4.7 (12.7)	-11.0 - 1.6	0.132
		PA	59.4 (28.8)	52.2[c] (29.3)	7.2 (11.5)	-1.6 - 16.1	0.096
	MCS (49.0;10.8)	S+	51.9 (8.9)	48.7 (9.2)	2.3 (10.6)	-3.2 – 7.7	0.392
		S-	51.6 (6.8)	53.1 (4.5)	1.5 (3.8)	-3.4 – 0.4	0.114
		PA	46.7 (12.7)	45.7 (11.7)	0.8 (6.4)	-4.1 – 5.7	0.713

[1] Higher score means better QoL
[2] In brackets Swedish norms for Females aged 35-44 (PCS, MCS 30-49); (mean;SD; n=1030)

S+ vs S-	[a] $P \leq 0.05$	[aa] $P \leq 0.010$	[aaa] $P \leq 0.001$
S+ vs PA	[b] $P \leq 0.05$	[bb] $P \leq 0.010$	[bbb] $P \leq 0.001$
S- vs PA	[c] $P \leq 0.05$	[cc] $P \leq 0.010$	[ccc] $P \leq 0.001$

Disease-specific instrument

Before the exposure the symptomatic and the pollen-allergic groups were approximately at the same levels (Table 11). Thus, there were no significant differences between the symptomatic hairdressers and the pollen-allergic group, while the asymptomatic hairdressers had significantly better scores than the symptomatic and the pollen-allergic groups in all domains.

After the study period the symptomatic hairdressers were significantly better than the pollen-allergic women in Eye symptoms (Table 11). The asymptomatic hairdressers were better than both the symptomatic and the pollen-allergic groups in all domains.

Within the hairdresser groups there were no significant changes during the observation period, but a MID of ≥0.5 was found for Nasal and Non-hay fever symptoms in the symptomatic group (Table 11). The pollen-allergic group had a significant deterioration with a MID of ≥0.5 in all domains.

Table 11. RQLQ in symptomatic hairdressers (S+;N=17), hairdressers without symptoms (S-;N=19) and pollen allergic women (PA;N=10) before (BE) and after 4 weeks (AE) of exposure (Mean; SD).

RQLQ[1]	Health domains	Groups	BE	AE	Changes BE and AE		
			mean (SD)	mean (SD)	Mean (SD)	95% CI	P value
Physical domain	Nasal spt	S+	1.2[aa] (1.5)	1.7[aaa] (1.0)	0.6 (1.9)	-1.6 - 0.4	0.221
		S-	0.2 (0.5)	0.5 (1.0)	0.3 (1.1)	-0.9 - 0.2	0.211
		PA	1.2[cc] (1.3)	2.0[cc] (1.4)	0.8 (1.0)	-1.5 - -0.1	0.031
	Eye spt	S+	1.0 [aa] (1.0)	1.2[aaa b] (1.4)	0.2 (1.5)	-1.0 - 0.5	0.508
		S-	0.2 (0.5)	0.0 (0.1)	1.6 (4.2)	-0.0 - 0.4	0.119
		PA	0.9[cc] (1.2)	2.3[ccc] (1.4)	1.5 (1.2)	-2.4 - -0.6	0.005
	Non-hay fev spt	S+	1.2[aaa] (1.5)	1.7[aaa] (1.0)	0.6 (1.7)	-1.4 - 0.3	0.183
		S-	0.8 (0.2)	0.2 (0.8)	1.6 (0.9)	-0.6 - 0.3	0.449
		PA	1.3[cc] (1.4)	2.1[ccc] (1.4)	0.8 (0.9)	-1.4 - 1.2	0.021
Mental domain	Activities	S+	1.5[aa] (1.7)	1.8[aaa] (1.1)	0.3 (1.7)	-1.2 – 0.5	0.437
		S-	0.3 (0.2)	0.2 (0.8)	0.1 (1.0)	-0.3 – 0.7	0.523
		PA	1.5 [c] (1.4)	2.8[ccc] (2.0)	1.3 (1.7)	-2.5 - -0.1	0.036
Overall QoL	(Mean of all 7 domains)	S+	1.2[aaa] (1.4)	1.5[aaa] (0.9)	0.4 (1.5)	1.1 – 0.4	0.327
		S-	0.2 (0.3)	0.3 (0.7)	0.1 (0.8)	0.5 – 0.3	0.594
		PA	1.2[cc] (1.2)	2.0[ccc] (1.5)	0.8 (0.8)	1.4 – 0.2	0.014

[1] Higher score means worse QOL

S+ vs S- [a] $P \leq 0.05$ [aa] $P \leq 0.010$ [aaa] $P \leq 0.001$

S+ vs PA [b] $P \leq 0.05$ [bb] $P \leq 0.010$ [bbb] $P \leq 0.001$

S- vs PA [c] $P \leq 0.05$ [cc] $P \leq 0.010$ [ccc] $P \leq 0.001$

Two symptomatic and one asymptomatic hairdressers as well as one participant from the pollen allergic women experienced personal problems during the exposure period. The two symptomatic hairdressers had developed eczema to hairdresser chemicals. We controlled for these events, and they did not influence the results of the questionnaires.

Young hairdressers' views on their work environment with focus on prevention

The overall interpretation in *Study IV* revealed different levels of awareness of the influence on the work environment in the hairdressers and of the possibilities to influence it, but also an inability to achieve the desired preventive improvements.

The awareness included reflections concerning ventilation, respiratory, skin and ergonomic issues, job strain, choice of hair products, financial issues and concern for

having to leave the profession as well as for their approach to working with the work environment. Also, the organization of the enterprise and acceptance of the work environment were important emerging issues. Making the work environment an active part of their business was not a chosen strategy, and the means were not always there. From the overall interpretation, a main theme and integrated themes emerged and are shown in Fig. 2, and main theme, themes and sub themes in Table 12. *Managing one's waste* was only linked with *Seeing one's work environment*, while all the others were linked with each other.

Seeing one's work environment

There was an awareness of the advantages and disadvantages in the work, of the possibilities of influencing the work environment, of applying knowledge and of being able to plan the work to a greater or lesser extent. However, there was often a lack of awareness as to which preventive actions should be taken. Due to the organization with hairdressers as owners, renting a chair and employees major financial investments could be difficult to make, and also to have discussions of serious financial matters with colleagues.

Primary focus at the beginning of the hairdressers' careers was on training and application of techniques. The importance of the role of teachers was seen in hairdressers implementing knowledge from training to a greater extent when good routines had been the norm during their education. The awareness of the preventive work could be more pronounced in hairdressers starting a business of their own in new premises, which thus gave them the opportunity to realize their visions. A more frequent contact with authorities concerning the work environment was expressed.

The awareness of planning of the work in salons varied, and financial awareness and responsibility for the business were influential factors throughout the planning process. An advantage was the possibility to plan the schedule and take time off if needed, but the responsibility of being self-employed or renting a chair in a salon was sometimes felt as being heavy and could in some cases lead to stress.

Seeing one's customers

The customers had an influential position in that they were the foundation of the business, and the hairdressers were aware of the need for the customers to be satisfied with their work. Customers were also important in social terms. Hairdressers were prepared to make compromises and to give way and push themselves further for regulars. Financial issues could impact the business, and putting themselves first and the clients second could lead to some stress if the hairdressers, for example, chose to use scheduling to create some freedom for themselves. Good communication and

good strategies would be indispensable for situations where for example the schedule could not be maintained.

Seeing one's profession

There was an awareness of the advantages and the disadvantages in the profession and what that could lead to in the future, which could be somewhat insecure if symptoms had already occurred in these young hairdressers. They took pride in their profession and wanted to do a good work. Anxiety due to the fact that they caused themselves to be vulnerable to medical or psychological symptoms led to some of them desiring to develop themselves further. The expectations and the possibilities for the future varied either in terms of the level of acceptance of not being able to work more than about ten years, or in terms of finding different solutions to make it possible to stay in the profession the whole of their working lives. The profession provided a number of opportunities for being creative, a major element in hairdressing.

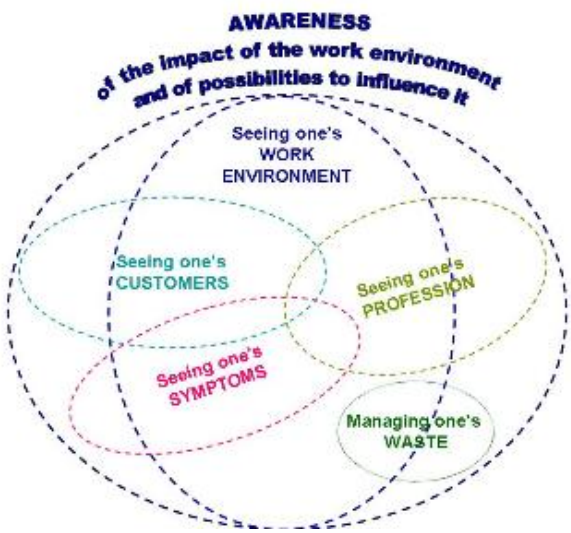

Fig 2. The hairdressers' views on their work environment.

Seeing one's symptoms

The informants described different symptoms varying from mild to severe discomfort. There was a large acceptance of the work situation as such by the hairdressers, who

could feel anxiety about symptoms and their prognosis, but it was not common for them to find means and strategies to prevent the symptoms.

Having symptoms also implied feeling some stress vis-à-vis the customers and the work. The quality of life of the hairdressers was impacted by work-related symptoms, but they were not always aware of the connection between the symptoms and the constraints on their daily lives. The strategies for dealing with the symptoms varied from doing nothing to actually trying to adjust the work environment in a correct way.

Managing one's waste

Good routines were important for managing waste, but seeing the needs and implementing the routines was not self-evident. This issue was seldom discussed among the colleagues. Managing one's waste included different alternatives for the hairdressers, from just sorting the waste to leaving remnants at a waste

Table 12. Interpretation of the hairdressers' work environment.

Main theme	
AWARENESS of the impact of the work environment and of possibilities to influence it	
Themes	**Subthemes**
Seeing one's work environment	Influencing the work environment
	Applying knowledge
	Planning work
Seeing one's customers	Adjusting to the customer's needs
	Caring for the customer
Seeing one's profession	Developing and continuing in the professional role
	Being creative and getting variation at work
Seeing one's symptoms	Accepting one's symptoms
	Managing one's symptoms
Managing one's waste	

disposal site. Rinsing hair products into the ordinary sewage system without using any additional filter was common, even if initiatives to get information from the environmental administration of the municipal authorities had been taken, but without results. Suitable working techniques were also a way of coping with waste products. For example, hair treatments were mixed in smaller quantities several times instead of having to pour out leftover materials.

Discussion

Methodological considerations

In this thesis the study population consists of female hairdresser. There can be objections to the exclusion of male hairdressers, but in Sweden 85-90 % of all hairdressers are women[2)]. For *Study I* information about both male and female hairdressers was acquired, but the male group was too small for it to render reliable results if it were to be included. However, there is a need for studies of male hairdressers.

Incidence of asthma and risk factors

Referents in *Study I* were used in order to determine the effects of common risk factors and a model was tested for possible confounders such as age, hay fever, childhood eczema, smoking and region. The final model included a calendar year of observations of hay fever, smoking and region, and was shown to be well-adjusted to the aim of the study.

Choosing a retrospective design including hairdressers examined 1970-95 could lead to a stronger recall bias in those examined during the seventies than later on. However, it is presumable that an onset of asthma, being a severe disease, is remembered accurately. Recall bias could, however, have affected data on smoking and atopy.

Symptoms and hair treatments were self-reported via questionnaires. This could be questioned[89)], but reported hair treatments were later validated in the diary. The validation confirmed that an overestimation was possible for hair sprays, while hair bleach was correctly reported.

A non-participant study was performed since the response rate in the hairdresser population was, after two reminders, only 67%. One reason for the low percentage of return of the questionnaires could be the busy season before Christmas, and the hairdressers' prioritisation of customers. Also, the response rate from the general population was rather low, 76%. The intention was to mail the questionnaire earlier on in the autumn, which might have increased the return of questionnaires, but this was not practically possible. The questionnaire included many parts and a possibility

to proceed in two steps. An opportunity for screening first and subsequently mailing a complementary questionnaire would possibly have led to more persons returning the questionnaire. However, this would have required extra time and financial resources.

Nasal challenge with persulphate

The selection criterion for the target group was having clearly work-related nasal symptoms associated to hair bleaching, and we chose those having the most serious symptoms in a group of hairdressers tested for potassium persulphate in skin prick tests. We consider the acquired number of participants sufficient for making comparisons between and within the groups, even if larger sample sizes could have strengthened the findings.

Our intension was that the hairdressers had at least one day off before the challenge. This was not always practically possible. However, the two hairdresser groups did not differ from that aspect. Furthermore, some of the atopics may also have been in contact with relevant allergens the day before. Thus, we do not think that such occasional exposures have affected in a systematic way.

We used two different control groups, both asymptomatic hairdressers and atopic women. The inclusion criteria were, for the target group, clearly work-related nasal symptoms from bleaching powder, for the asymptomatic group, no nasal symptoms, and for the atopic group no exposure to bleaching powder, but nasal symptoms and a history of atopy were required. The exclusion criteria were asthma-like symptoms in all groups, and, for the hairdressers, a history of atopy. In spite of this restriction it was revealed that three symptomatic and two asymptomatic hairdressers had a positive skin prick-test to standard allergens, and that there were a few social smokers. We did not exclude these persons as they did not experience any allergic symptoms, and we used stratification to adjust for these possibly confounding factors[90].

Respiratory symptoms, inflammatory markers, nasal reactivity to persulphate and HRQoL during a work period

The participating groups in *Study III* differed in numbers. We wanted more pollen allergic participants, but it turned out to be difficult to find those fulfilling the criteria, for example no regular medication during the season. Another problem was co-allergies. A number of persons reacted to furred animals or mites without being aware of it, and they were thus excluded. However, we consider the acquired numbers of participants sufficient for making comparisons between and within the groups.

In this study we used two different control groups, but we needed to control for the exposure in the atopic group, and thus chose pollen-allergic women. The inclusion and exclusion criteria were the same as in *Study II*. One symptomatic and two

asymptomatic hairdressers had a positive skin prick-test to standard allergens, and there were a few social smokers. These hairdressers did not have any nasal symptoms and were thus not excluded from the study. The baseline characteristics of the groups did not differ, thus strengthening the internal validity[91].

The study period was one month. A longer time period might have rendered more significant results, but it could also have increased the risk of missing data due to drop outs[92]. As short vacancies are frequent in this work group there would also have been a risk for diminished journaling and an impact on the nasal symptoms and the nasal lavage.

To avoid recall bias the participants were instructed to complete the diary daily, but there could be a risk of recall bias concerning symptoms and exposure if they forgot to do so on single days, and completed the diary later. However, they were instructed to mail their diary weekly.

We used one generic, SF-36, and one disease-specific questionnaire, RQLQ, to measure quality of life. Because of the different approaches in generic and disease-specific instruments, it is often advocated to use them simultaneously[93, 94]. SF-36 has been used in Swedish populations[95,96], Swedish referents from the general population[58] are available; both instruments have been psychometrically tested and have shown good results for validity and reliability[58,59,97]. Cronbach's alpha is often used to measure the internal consistency of a questionnaire, referring to the extent to which multi-items are related[98]. We did not make any psychometric analyses, and thus we cannot clarify the internal consistency.

The answers in HRQoL questionnaires may be influenced by exceptional incidents of a serious character not related to the daily way of life in a few number of participants[99]. As the studied group is rather small such incidents may considerably influence our results. We therefore asked the participants if they had experienced such incidents. Two symptomatic and one asymptomatic hairdresser, and one pollen-allergic woman had experienced personal problems, but comparative analyses showed no impact of these incidents on the results.

Contrary to in the case of the hairdressers, it was not possible to define an exact zero point of exposure for the pollen-allergic participants. They started their journaling first after having stated clear allergic symptoms. They may possibly have been exposed to low levels of pollen before start and this may have influenced the symptoms, but not the findings of their HRQoL as these questionnaires were completed before the season.

We conducted nasal lavage three times during the exposure period using a lavage method, which caused nasal bleeding in a number of participants. This had not been previously reported[68], but made it impossible for us to clarify albumin results for these examinations. The methods of using a specific challenge and nasal lavage for

examining and analyzing inflammatory markers are otherwise valid and frequently used[69].

Young hairdressers' views on their work environment with a focus on prevention

In qualitative studies trustworthiness is evaluated using the concepts of credibility, dependability, conformability and transferability[81,100].

Credibility refers to confidence in how well data and processes of analysis address the intended focus[100], and can be increased in different ways[81].

A small number of participants in a qualitative study would not influence the credibility, as there is no actual limit for the sample size. According to Kvale[101] the sample size is usually 15 ±10 depending on the aim, time and available resources. Little new information was obtained from the last few interviews confirming previously obtained data, and thus we do not think that the sample size was insufficient.

Based on our aim we chose the method of interviewing the hairdressers who had worked for 3-4 years. Thus they had had the opportunity to adopt the working conditions in the profession and to find their role in the workplace. Choosing hairdressers with respiratory symptoms as well as hairdressers without such symptoms broadened the selection, and having participants with various experiences increased the possibility of shedding light on the studied phenomenon from different aspects[81].

There is an interaction between the interviewer and the participant in the interview situation, which may have an impact on the outcome[78]. In this study, the interviewees had been participating in a former study performed by the same researcher and were familiar with the context in which the interviewer worked. Thus, the interviewees had confidence in the interviewer and her knowledge of hairdressing, which prevented them from holding back information and contributed towards the opening up of a dialogue and to a certain richness in the interviews.

Another way of enhancing the credibility is to seek agreement among co-researchers, experts and participants[81,100]. The interviewer summed up during the interviews, giving the participants the opportunity to consent to or to oppose the summary. During the analysis, credibility of the results was addressed since the co-examiner took an active part in the data analysis. After this a thorough discussion between the interviewer and the co-examiner took place leading to the refinement of themes and sub-themes. Finally, the third researcher had the opportunity to read some of the interviews and the themes and sub themes so as to agree on the findings. However, a text involves multiple meanings, and approaching a text always includes an interpretation to some degree. To enhance the credibility we used an equal number of

quotations from the interviews covering most of the participants in accordance with Graneheim and Lundman[81].

Dependability is about the stability of data over time and over conditions[81,100]. In this study the interviews were all conducted by the same researcher, which diminished the risk of the questions being posed in different ways. The interviews were carried out during a short period of time in late 2009 and early 2010 as well as late 2010 and early 2011. To ensure that all interviews included the same overall questions, a thematic interview guide was used during the interview sessions.

Confirmability is concerned with the researcher's pre-understanding and the risk of researcher bias by subjectivity[100]. In order to diminish the impact of the interviewer's pre-understanding the researchers had an ongoing discussion in this regard during the data analyses.

The transfer of findings to other groups and settings is the concern of *transferability*. It is up to the reader to decide whether or not the findings are transferable, even if the authors make the suggestions. To enhance the transferability it is important to give a clear description of the context, the selections, the data collection and the analysis process[100], and this has been made. The participants were all young due to the context in the original study from which they were recruited, and it is up to the reader to decide whether or not the results are transferable to other work settings.

General discussion of the results

Incidence of asthma and risk factors

We found that hairdressers have a moderately increased risk of asthma, in line with the results of Leino et al.[27], but a greater increased risk compared to reported rates in female hairdressers (0.13/1000) in another Swedish study[102] as well as in a recent French study of asthma in hairdressers (0.06/1000 py)[103]. However, these studies had a different approach than our study and no consideration was taken to active hairdressing time. Our results showed a higher incidence when looking at asthma during active time in the profession, thus strengthening the impression of an association between asthma and hairdressing.

The risk of asthma in the hairdressers may be underestimated in our study because of a preoccupation selection. Already during training a selection of sensitive students is likely; this was not possible to control for. An ongoing study concerning this problem is in progress in our work group. There may even be a preschool selection. Young females with asthma or hand eczema are presumably advised against entering the hairdressing programme. This was reflected in a reduced rate of dermal atopy in the

hairdresser cohort. Also childhood asthma was lower among hairdressers showing a selection against more serious respiratory atopy.

Of the non-participating hairdressers there were more ever-smokers indicating an underestimation of the number of smokers in the hairdresser group. As smokers in general have a higher risk of asthma[104, 105] this may indicate an underestimation in the hairdresser group. However, the same was observed in the referent group. As the response rate was lower among the hairdressers than among the referents we can not exclude a weak underestimation of asthma in hairdressers compared to referents. Furthermore, it may give some explanation to why we did not find an effect of smoking in hairdressers.

Childhood hay fever did not increase the risk for developing asthma in hairdressers, which is in line with the findings concerning atopy in most studies[26, 103, 106].

Asthma-like symptoms in active hairdressers were related to a higher number of hair treatments with bleaching products and hair spray, although this was not a significant difference. In the validation study the average number of bleaches per week was in concordance between the first questionnaire and the diary three years later. However, the use of hair spray was generally overestimated in the questionnaire. The agreement between the two questionnaires was poor to fair, and an eventual bias could have resulted in an underestimation of the effects of the specific exposures.

Nasal challenge with persulphate

In *Study II* we confirmed the results from earlier studies[32,35] that persulphates can elicit symptoms in hairdressers with bleaching powder-associated nasal symptoms although not all hairdressers reacted significantly. One of the reasons to the lack of reactivity in some participants may be that they are sensitized to persulphates other than potassium persulphate in bleaching products, which was what we used in the present study[31, 32]. However, at least when skin prick testing has been using different persulphates a high degree of cross sensitivity has been shown[31].

Also, other compounds in the bleaching powder may be the reason, but it has not been studied to any extent. Hairdressers may relate their symptoms to the bleaching powder they use when they develop symptoms, while they may be elicited by agents from nearby colleagues, for example hair dyes[19] and latex[38]. However Leino et al. concluded that hairdressers seldom are sensitized to other compounds than persulphates[30].

Another explanation may be that hairdressers may relate the symptoms to the irritative effect of the bleaching powder, while the cause of the symptoms may be another exposure, for example hairdressing products used by other hairdressers in the saloon[32, 38]. Munoz[31] as well as Hytönen[35] have shown that non-specific reactions can be elicited by persulphates, at least in asthmatics. We found the same in the present

study, where the atopic group also increased in nasal symptoms but less than did the symptomatic hairdressers, suggesting a non-specific early response.

We did not find indications of an Ige mediated Type I reaction, neither in the in vivo nor the in vitro examinations. In the recruitment process we systematically tested about 30 hairdressers with nasal symptoms due to hair bleaching with skin prick tests to potassium persulphate, and found no positive reactions although they claimed to have nasal symptoms related to bleaching powder. Of course, this might be due to a non-functioning testing method. However, positive results have infrequently been shown in hairdressers with rhinitis or asthma[32]. Leino et al. found positive reactions to persulphates in seven hairdressers with diagnosed occupational respiratory disease out of 107 tested hairdressers[28]. We tested the hairdressers with fresh mixed solutions of potassium persulphate in water before the challenge, and we did not find any positive reactions in any of the groups.

We found that inflammatory markers, specifically albumin, increased in hairdressers with nasal symptoms associated to hair bleach during the challenge, thus conforming that an immunological reaction took place in the nasal mucosa. Although we did not find any specific IgE antibodies to persulphate using immunoblotting, Th1 cells increased in the symptomatic hairdressers. A lesser, non-significant increase was also seen in the atopic group, but none in the asymptomatic hairdressers. This indicates an effect of the challenge in both the symptomatic hairdressers and the atopic women in spite of the low dose of persulphate. Thus, the increase of Th1 cells may indicate an non-specific hyperreactivity. High exposure to irritants might cause a hyperreactivity[107], even if the mechanism is not clear, but little is known about chronic low-irritant exposure and the development of hyperreactivity[108].

Respiratory symptoms, inflammatory markers and nasal reactivity to persulphate during a work period

Symptomatic hairdressers increased steadily in nasal symptoms during a month of work (*Study III*). The symptoms in the atopic group varied more, and they became worse during week-ends indicating exposure during their time off. The content of pollen/m^3 air and day varied between low, moderate and high during the investigation period of the pollen-allergic group. There were no days recorded with very high pollen content (Personal communication from Åslög Dahl, Department of Plant and Environmental Sciences, Gothenburg). Thus, it is also presumable that had the exposure to pollen been higher, the symptoms in the pollen-allergic group would have been more pronounced. However, the increase in the symptomatic hairdressers was related to work days and thus seemed to be related to the exposure to hair chemicals, as was expected on the basis of the findings in *Study I* and *Study II*. There is to my knowledge no other research with the same design which would enable comparisons.

The clinical picture in hairdressers and pollen-allergic women was different with more nasal blockage in the hairdressers and more eye symptoms, itching and sneezing in the allergic group. Probably, the symptoms in the hairdressers are not elicited through an IgE-mediated reaction as in the allergic women, and no hairdresser in our study presented with a reaction to skin prick tests to persulphate. We cannot exclude the possibility of a sensitization to other agents, although the medical examination did not show any signs of this. Sensitization to latex[38] or human dandruff[30] has been found in hairdressers, even if Leino et al. concluded that persulphate is the far most common agent causing respiratory symptoms in hairdressers. Furthermore, among workers who were exposed to organic acid anhydrides, but were not sensitized, the same clinical picture as for the symptomatic hairdressers was seen, with more nasal blockage contrary to those who were sensitized, who complained of more nasal secretion and sneezing[109].

An increase in ECP was found in the symptomatic hairdressers also indicating a progressive effect on the nasal symptoms due to exposure. However, we did not find an increased nasal reactivity in the persulphate challenge. This could have been expected, irrespective of whether the reaction developed from the irritating effect of persulphate exposure or from something else that increased the non-specific nasal reactivity. The levels of ECP in the pollen-allergic women were higher already at the start of the study indicating an ongoing inflammation. This is difficult to explain, since the pollen-allergic group was examined before the start of the pollen season. However, grass pollen-allergic persons have been found to have higher levels of albumin and ECP than persons with no allergy also out of season[110]. It has also been suggested that in healthy persons female gender and atopy are associated with a significant elevation of eosinophils in induced sputum[111].

Using the persulphate challenge we could not show an increase in nasal reactivity although an increase may have been found by using another method. The tendency of increasing symptoms during the study period could be explained by an increase in exposure. However, we found a significant difference between the two hairdresser groups only in the use of hair spray in line with others[21, 22]. Even if the exposure is low in the very few studies made of exposure levels in hair salons[17, 112], there might be as many as thirty-five different air-borne compounds[17]. Thus, it would be of value to use local exhaust ventilation when mixing the hair products, which, however, we found was infrequently used among all hairdressers.

Health-Related Quality of Life during a work period

HRQoL is an important outcome also in occupational and environmental research[47], and it has been advocated to apply generically together with disease-specific questionnaires, as the questionnaires capture HRQoL from different aspects[94]. In our study the findings from the two questionnaires support each other. The decline in

Vitality comports well with the deterioration in Non-hay fever symptoms in the symptomatic and the pollen allergic groups. Also, the deterioration in the pollen-allergic women in Eye symptoms is in compliance with the findings of more eye symptoms in the diary, as well as for the Nasal symptoms in the symptomatic hairdressers.

We found that hairdressers with respiratory symptoms had a decreased HRQoL compared to the asymptomatic hairdressers, who reversely had a tendency to ameliorate their HRQoL during work. However, the symptomatic hairdressers had a somewhat lower HRQoL already at study start. HRQoL can improve among patients no longer exposed[113)] and become similar to that of healthy controls[114)]. The symptomatic hairdressers may have had a too short time off for a total recovery, which is also supported by the fact that they still had nasal symptoms. At study end the symptomatic hairdressers were at the same inferior level as bell pepper greenhouse workers with rhinitis related to allergen exposure[48)]. The increasing HRQoL in the asymptomatic hairdressers during a month of work could be a sign of satisfaction with their work and life situation. The decrease in the symptomatic hairdressers should be validated with regard to the increase in HRQoL in the asymptomatic group.

Compared to the pollen-allergic women the HRQoL of the symptomatic hairdressers was at a higher level in the generic questionnaire at study start, while the pollen-allergic group had a lower score in both Vitality and Physical Functioning. It has been well established that allergic rhinitis and asthma are indicators for inferior HRQoL[94, 115,116)], but why the pollen allergic group had a lower HRQoL than the hairdressers already before the study period is not clear. The questionnaires were completed long before the pollen season. It could be an effect of the chronic disease, or simply an effect of not having had time off before study start as the hairdressers had had.

However, also compared to the Swedish population[97)] the pollen-allergic group had lower scores in the generic questionnaire at study start, while the hairdresser groups had better scores. These Swedish referents are from the beginning of the nineties, and there may be changes within the society resulting in that these do not fully reflect the HRQoL of today.

In conclusion, the symptomatic hairdressers deteriorated significantly in Vitality and also in most of the domains both in the generic and the disease-specific questionnaires. Vitality is an important aspect of the general health showing how strong or weak, energetic or tired and worn out one feels. However, the pollen-allergic group had a lower HRQoL both before and after the exposure period in line with earlier findings [115, 116)].

Young hairdressers' own views on their work environment with a focus on prevention

In the qualitative study we not only found a varying degree of awareness of the work environment but also an inability to achieve the desired preventive improvements. The mean age of hairdressers in Sweden is low[2)], and the colleagues are often friends, which means that the job of taking preventive measures can easily be disregarded. Hairdressing has been the lowest ranked occupation within occupational health with an affiliation of only about 12-13 %[117)], thus missing this possibility for assistance with the work environment. However, the knowledge from hairdressing education must not be put aside. Hairdressers, who had had teachers who were engaged within the work environment were more aware of the issue. This might not be controversial, but nevertheless important to consider for those responsible for the education of hairdressers[118)]. A constant reminder and showing the students how to handle these issues could be one way of improving the work environment in hairdressing salons. Also, a need for more frequent inspections from the authorities and the municipal environmental administration as a help to focus on the work environment was expressed.

Since the nineties most hairdressers in Sweden are self-employed[119)] and do not have large financial margins; large investments such as an air extraction system could be beyond their means. Salons with one owner and employees seemed more often to have the means for improvements than self-employed hairdressers. The organization of the salons thus appeared to play a crucial part in the work environment issues. As the hairdresser group is highly mobile[3)], a good work environment could be of value to make experienced hairdressers stay in a specific hair salon.

Customers are the indisputable base of the business, and hairdressers endeavoured especially to gain regular customers. In an earlier qualitative study, we have also found that the social interaction with the customers is something very meaningful for hairdressers[40)]. It could be of great value for the hairdressers to see the connection between a healthy work environment and a satisfied customer, since today there is fierce competition[4)]. Hairdressers who become ill due to their work environment are no good publicity for the salons, and customers have also become more conscious of hair chemicals, and tend to worry about their negative effects.

A great pride in the profession was found even if the hairdressers could see the advantages and disadvantages, as well as an insecure future in terms of the numerous occupational health risks. In many issues there were two sides of the coin; being a small-scale entrepreneur provides many positive elements such as independence and opportunities for developing in the profession, but also stressful elements concerning financial issues and giving priority to customers. As a small-scale entrepreneur the hairdresser faces numerous tasks beyond the craft techniques, and the flexibility and

possibility of controlling one's working hours could be important factors in positively affecting health and well-being[120]. Small-scale entrepreneurs have shown an association between good self-reported health and a good social life[121].

Hairdressing is known to be one of the occupations with the highest rate of occupational injuries[4], and a large number of hairdressers leave the profession early in the career due to health issues[4,29,30]. According to SWEA female hairdressers reported more symptoms of allergy and skin hypersensitivity than in any other line of business and stated that hairdressers do have knowledge of the hair chemicals and also of ergonomic issues, but that this knowledge is badly implemented[5]. This is in line with other research findings that hairdressers do not use the information on labels in order to assess health risks[3]. Hairdressers with work-related respiratory symptoms associated to bleaching powder claim that it is mostly the mixing and preparing of the bleach that elicits the symptoms (*Study I*). Also, from an international point of view without considering organization it seems that few salons have a specific ventilated technical area[17,122]. Thus a greater awareness of the work environment and of how to apply preventive measures is crucial for hairdressers to be able to continue in the profession during a whole working life.

Not much consideration was taken concerning the waste in the hairdressing salons, even if a wish for help from authorities was expressed. Implementing good routines concerning waste was not seen as a problem, and could easily be performed. Some municipalities have today established strategies for the management of the waste[123], which could be of value to the hairdressers as guidelines about hair chemicals and waste.

Conclusions

In female hairdressers …

Hairdressing work moderately increased the incidence of asthma. Hay fever during childhood and smoking did not modify the risk from hairdressing work.

Persulphate may elicit symptoms in hairdressers with bleaching powder-associated rhinitis by a Th1 cell activation, and without a specific IgE reaction.

Hairdressers with bleaching powder-associated rhinitis increased in respiratory symptoms and in ECP in nasal lavage, but not in nasal reactivity to persulphate during a month of exposure after vacations.

They may be affected in their HRQoL during a month of work, but still have a better HRQoL than pollen-allergic women during the season.

An awareness of the work environment, but a lack of means and strategies to make it an active part of their business was found in young hairdressers after the first three work years. Main focus was the customers and the working techniques, which various symptoms did not alter. Organization and teachers had a crucial role for the preventive work. The profession was seen with its advantages and disadvantages, but also its insecure future in terms of the occupational health risks and their consequences.

Practical implications and further research

This thesis has pointed out that hairdressers may get asthma and nasal symptoms, and that the mechanism behind their nasal symptoms does not seem to be IgE-mediated. Furthermore, that their health-related quality of life is affected, and that young hairdressers are aware of their work environment to various degrees, but that they do not always have the means and strategies to take preventive measurements.

The risk for respiratory symptoms is not fully elucidated, and we have no knowledge about the selection in the profession. To be able to advise young persons wanting to become hairdressers, we also need to clarify the meaning of personal risk factors. Prospective studies, especially of hairdressing students and in young hairdressers are necessary to clarify this, and such studies are already in progress in our group.

The causes and the mechanisms behind the work-related respiratory symptoms in hairdressers are still unclear. This is important in order to improve the diagnostic instruments and to advise hairdressers who have developed symptoms if they have to stop the exposure or not. Relevant advices are important not only from a medical, but also from a social economic point of view.

To understand the cause of symptoms and to be able to give hygienic advices a more detailed knowledge of the chemical exposure in the hairdressing salons is necessary. In our study group such detailed studies are in progress with regard to bleaching powder, but studies to other hair chemicals should be carried out as well.

Social, cultural, economic, and occupational differences affect workplace safety and, most likely, the health status of hairdressers. It would be of value to perform a comparative interview study of male hairdressers in another context using a similar qualitative assessment tool similar to the one used in this thesis in order to see any differences in the presence of respiratory symptoms, and in their reasoning and their views on the work environment.

Personal considerations

A possibility for hairdressers to get information about issues concerning the work environment could be a forum, where they could also hold discussions and for example share ideas of strategies for the preventive work. As small-scale entrepreneurs they have a very low affiliation to occupational health and many hairdressers are not members of the union, thus not having this possible input for information.

The customers are the foundation of the business, and are asking more and more questions about the hair chemicals. To see the customer and the work environment as one unit could possibly integrate the work environment in the profession. Also, the work environment should be given greater consideration during education in order for it to be an important factor in the hairdresser's working life. Thus, teachers are a target group for information of preventive work within hairdressing.

Measures and initiatives taken by the responsible authorities could also be a way of increasing knowledge and informing the hairdressers of the existing regulations. Another important issue is for suppliers to make efforts to reduce chemicals in their products, while retaining the qualities that the customers desire so that the hairdresser and the customer will both be satisfied with the results.

To avoid respiratory symptoms in the hairdressing work environment we need to continue the dialogue with the hairdressers on how they experience the symptoms and what strategies they themselves find possible to implement. A future collaboration between researchers, hairdressers, suppliers, authorities and schools could possibly achieve improvements for a good hairdressing work environment.

Populärvetenskaplig sammanfattning

Frisöryrket har en lång historia av stolta yrkesutövare, men frisörer arbetar i en komplex arbetsmiljö, där de utsätts för olika risker, inte bara luftvägsbesvär, utan även handeksem, muskelrelaterade besvär och stress. I Sverige är 85 - 90 % av frisörerna kvinnor, varav de flesta är egenföretagare antingen som ensamägare till en salong eller tillsammans med flera frisörer med hyrstolar och anställda. År 2010 fanns 20 300 frisörer, varav 14 600 egenföretagare och 2011 var frisör det vanligaste yrket bland kvinnliga egenföretagare i Sverige.

I denna avhandling ingår fyra studier om kvinnliga frisörer med olika upplägg; *Studie I* var en korhortstudie där vi via frågeformulär studerade insjuknande i astma hos kvinnliga frisörer i Sverige jämfört med kvinnor i den allmänna befolkningen. I *Studie II* gjordes en provokation av näs别emhinnan med kaliumpersulfat, ett ämne som ingår i blekmedel, hos frisörer med näsbesvär främst orsakade av blekmedel, och reaktionerna jämfördes med reaktionerna hos frisörer utan näsbesvär och hos allergiker. *Studie III* var en dagboksstudie där vi följde hur luftvägsbesvär förändrades hos frisörer med blekmedelsutlösta näsbesvär under en arbetsmånad efter minst två veckors semester och jämförde besvären hos besvärsfria frisörer och pollenallergiska kvinnor under pollensäsongen. Vi jämförde även deras hälsorelaterade livskvalitet. I *Studie IV* intervjuades unga nyutbildade frisörer tre till fyra år efter examen om deras syn på sin arbetsmiljö och om hur de kan påverka denna, hur de kan omsätta sina arbetsmiljökunskaper från utbildningen och hur de ser på sin framtid i yrket.

I *Studie I* fann vi en måttligt ökad risk att under aktiv tid som icke-rökande frisör insjukna i astma jämfört med den allmänna befolkningen. Risken var till viss del större för de frisörer som utförde mest blekningar och använde mest hårspray. Hösnuva i barndomen påverkade inte risken att få astma av frisörarbete.

I *Studie II* fann vi att frisörer med blekmedelsutlösta näsbesvär reagerade med ökande besvär vid en provokation av nässlemhinnan med kaliumpersulfat, och även med en ökad mängd albumin i nässköljvätska. Frisörerna utan näsbesvär reagerade inte, medan atopikerna reagerade till viss mån. Frisörernas reaktion verkade vara ospecifik.

I *Studie III* reagerade frisörer med blekmedelsutlösta näsbesvär med ökande besvär parallellt med en sjunkande livskvalitet under en månads arbete. Det fanns även tecken på en ökad inflammatorisk process i nässlemhinnan, men inte på en ökad reaktivitet i nässlemhinnan mot kaliumpersulfat. Livskvaliteten hos de symptomatiska

frisörerna sjönk, men pollenallergikerna påverkades mer. De friska frisörerna hade en tendens att öka i livskvalitet under en månads arbete.

I *Studie IV* fann vi en medvetenhet hos de unga frisörerna om arbetsmiljön och om möjligheter att påverka den, men det saknades brist på medel och strategier för att göra det till en aktiv del av sin frisörverksamhet. Fokus var på kunderna och arbetstekniken, och olika besvär ändrade inte på detta. Lärarna hade en avgörande roll för intresset för preventiva arbetsmiljöåtgärder. Organisationen och finansiella frågor kunde negativt påverka det förebyggande arbetsmiljöarbetet. Frisörerna såg yrket med dess för- och nackdelar, och framtiden som osäker pga de arbetsrelaterade hälsoriskerna.

För att kunna råda unga personer som vill bli frisörer behövs mer forskning för att förstå varför vissa frisörer utvecklar luftvägsbesvär mot hårkemikalier, och hur dessa besvär påverkar frisörerna i arbetet och på fritiden. Vi behöver också förstå vilka specifika ämnen i hårkemikalierna, och i vilka doser, de framkallar besvär och varför frisörerna tidigt lämnar sitt yrke.

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Paper I

ORIGINAL ARTICLE

Incidence of asthma in female Swedish hairdressers

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Objective: To investigate the risk of asthma in hairdressers.
Methods: The incidence of asthma was retrospectively estimated in a Swedish nationwide study including all female hairdressers certified from vocational schools from 1970 to 1995, and a stratified sample of women from the general population were referents. A postal questionnaire included questions on respiratory tract symptoms, atopy, smoking, working periods as a hairdresser, and number of specific hair treatments performed/week. Reported exposures were validated by occupational hygienists. Rate ratios of incidence (IRRs) of asthma were estimated by Poisson regression, adjusted for calendar year of observation, hay fever, smoking, and region of domicile.
Results: The crude incidences of asthma/1000 person-years were: 3.9 during active years as a hairdresser, 2.8 among the hairdressers when not working in the profession, and 3.1 among the referents. The corresponding IRR for being an active hairdresser compared with the referents was 1.3 (95% confidence interval (95% CI) 1.0 to 1.6). Moderate effects on risk of asthma were found both from hairdressing work (IRR=1.6 (1.1 to 2.2) among never-smokers) and from smoking (IRR=1.6 (1.2 to 2.2) among referents). However, the combined effect from hairdressing work and smoking (IRR=1.5 (1.0 to 2.1)) was less than expected (p=0.02). No effect modification by respiratory atopy was found. The hairdressers most often performing hair bleaching treatments (IRR=1.5 (0.7 to 3.0)) or using hair spray (IRR=1.4 (0.8 to 2.4)) had, compared with the most infrequent users, a slightly, but not significantly higher incidence of asthma. Exposure to persulphates in hair bleach was estimated to be 0.04–0.15 mg/m^3 during mixing of the powder. Reported average number of bleaching treatments agreed well with those performed according to a diary.
Conclusions: Active hairdressing work was associated with a moderately increased incidence of asthma among lifelong non-smokers. The results are moderately supportive, but not conclusive, of associations between asthma and exposure to hair bleach or hair spray.

Hairdressers are exposed to several reactive agents with potentially irritant and sensitising effects on the airways. Several case studies on airway symptoms in hairdressers, mostly asthma,[1–7] have been published, but only a few epidemiological studies.[8–11] These indicate an increased risk for development of asthma among hairdressers. However, these studies (except Leino *et al*[10]) are based on few exposed cases or hospital based materials. The European Community Respiratory Health Survey (Kogevinas *et al*[12] and M Kogevinas; personal communication) found no excess in the prevalence of asthma symptoms or medication among hairdressers. Thus, reliable risk estimates are few and inconsistent. Also the interaction with personal risk factors such as atopy and smoking is unknown.

Among possible aetiological agents in hairdressers' asthma, the main focus has been on the persulphates used in bleaching powder,[1 2 5–8 13] but their quantitative contribution to asthma is not known.

We have performed a nationwide study including all Swedish hairdressers certified from 1970 to 1995. They were investigated by a postal questionnaire on exposure and symptoms. The aims of the study were to investigate the incidence of asthma during work as a hairdresser, especially relative to exposure to bleaching powder and hair spray, and effect modification by atopy and smoking.

Main messages

- A moderately increased asthma risk was found among female non-smoking hairdressers.
- The risk was slightly, but not significantly, higher for the hairdressers that were most often performing hair bleaching treatments or using hair spray.
- A moderately increased risk of asthma was found from smoking.
- Surprisingly, the risk of developing asthma among hairdressers who smoked was not higher than among women who either worked as a hairdresser or smoked.
- Atopy did not modify the risk from hairdressing work.

SUBJECTS AND METHODS

Hairdressers

In Sweden, since 1970 there has been a 3 year training for hairdressers. Usually the training starts at the age of 15 or 16. The third year was spent practising in hairdressing salons until 1993 when practice was organised at the school.

From the records of all 29 vocational schools for hairdressers in Sweden, a cohort of female hairdressers born in 1946 or later and who graduated from 1970 to 1995 was established. Altogether 7204 women were identified.

A questionnaire was posted in December 1996. After two reminders 4849 (67%) returned the questionnaires. Reliable data for one or more variables were missing in 892 of the returned questionnaires. Most of these had missing data for several important variables. Thus 3957 hairdressers remain as participants in the final calculations. Descriptive data for participants and non-participants are given in table 1.

Abbreviations: IRR, incidence rate ratio

Table 1 Descriptive data for the cohort of female hairdressers and a cohort of women from the general population (referents)

	Hairdressers			Referents		
		Non-participants			Non-participants	
Variable	Participants n=3957	All n=3247	Interviewed n=393	Participants n=4905	All n=2450	Interviewed n=134
Year of birth (median (range))	1966 (1946–77)	1964 (1946–78)	1966 (1946–77)	1965 (1946–78)	1967 (1946–78)	1965 (1946–78)
Year of certification (median (range))	1987 (1970–95)	1985 (1970–95)	1987 (1970–95)	—	—	—
Region (%, south/middle-north)	49.8/50.2	44.2/55.8	45.8/54.2	46.3/53.7	42.9/57.1	50.0/50.0
Hay fever (%, yes/no)	24.0/76.0	—	—	25.5/74.5	—	—
Smoking (%, ever/never)	50.0/50.0	—	52.4/47.6	45.7/54.3	—	52.2/47.8
Childhood eczema (%, yes/no)	16.0/84.0	—	13.7/86.3	21.0/79.0	—	17.9/82.1

Referents

As referents 7355 women randomly selected from the general Swedish population in 1996, stratified for age and restricted to the year of birth between 1946 and 1978 were identified. After two reminders 5569 (76%) returned the questionnaire. Among the returned questionnaires reliable data for one or more variables were missing in 664, thus 4905 participated in the final calculations (table 1).

Questionnaire

Asthma

All women were asked if they had or had had asthma and about the year of onset of the disease. A follow up question asked if the diagnosis was confirmed by a physician.

Common risk factors

Information about smoking, hay fever with onset before the age of 18, and childhood eczema was also asked for in the questionnaire. Moreover, the place of residence in 1996 was known for all participants. The distributions of these variables are presented in table 1.

Exposure

The hairdressers were asked to state the calendar years of all employments as a hairdresser from the time they graduated. They also stated if they for some reason were not working as a hairdresser for periods of more than a year. For each employment, the number of times specific preformed categories of treatments with bleaching powder and hair spray were performed was asked.

Non-responders

To study the incidence of asthma among non-responders, 589 out of the 2355 hairdressers and 224 out of the 1786 referents (about one fourth and one eighth, respectively) that had not returned the questionnaire were randomly selected. They were contacted in 1998 by a letter in which they were informed that a nurse would later interview them by phone about symptoms and exposure. Altogether, 393 hairdressers (67%) and 134 referents (60%; table 1) were interviewed by telephone. The most common reasons for not performing an interview were: not being listed with a phone number (95 hairdressers (16%) and 47 referents (21%)) and refusal to participate (65 hairdressers (11%) and 23 referents (10%)).

In the telephone interview, based on a questionnaire, hairdressers were asked about periods of employment as hairdressers. Everybody answered questions about asthma and when the symptoms appeared. Also, they were asked about smoking and childhood eczema. The wording of the questions was the same as in the postal questionnaire.

Validation of exposure

We examined the reliability in self reported exposure among the hairdressers by comparing answers of this study to those given 3 years later in another study where a subsample (n=1038) of the hairdressers participated. The same treatments were asked for in both questionnaires, but the answers

Table 2 Asthma incidence rate ratios (IRRs) with 95% CIs in a cohort of active female hairdressers and in a cohort from the general female population (referents), respectively, obtained from multivariate models

	Hairdressers*				Referents†			
Variable	Cases	Person-year	Incidence (/1000)	IRR‡ (95% CI)	Cases	Person-year	Incidence (/1000)	IRR‡ (95% CI)
Calendar year:								
1970–80	6	3 477	1.7	1.0 (—)	12	11 932	1.0	1.0 (—)
1981–90	36	11 548	3.1	1.8 (0.8 to 4.3)	78	27 978	2.8	2.8 (1.5 to 5.1)
1991–96	62	11 704	5.3	3.1 (1.3 to 7.3)	112	24 643	4.5	4.7 (2.6 to 8.6)
Total	104	26 729	3.9		202	64 553	3.1	
Hay fever:								
No	41	20 791	2.0	1.0 (—)	65	51 104	1.3	1.0 (—)
Yes	63	5 939	10.6	5.5 (3.7 to 8.1)	137	13 449	10.2	8.0 (6.0 to 10.8)
Smoking:								
Never	54	12 173	4.4	1.0 (—)	80	31 780	2.5	1.0 (—)
Ever	50	14 556	3.4	0.9 (0.6 to 1.3)	122	32 773	3.7	1.6 (1.2 to 2.2)
Region:								
South	48	13 983	3.4	1.0 (—)	78	30 035	2.6	1.0 (—)
Middle-north	56	12 747	4.4	1.2 (0.8 to 1.8)	124	34 518	3.6	1.3 (1.0 to 1.8)

*Followed up during active years after certification; †followed up since 18 years of age; ‡IRR from a model with all variables included.

Table 3 Effects of cohort affiliation (active female hairdressers and referents, respectively) and smoking on incidence rate ratio (IRR) (95% CI) of asthma

	Smoking			
	Never		Ever	
Cohort affiliation	Incidence (/1000)	IRR* (95% CI)	Incidence (/1000)	IRR* (95% CI)
Referents	2.5	1.0 (–)	3.7	1.6 (1.2 to 2.2)
Hairdressers	4.4	1.6 (1.1 to 2.2)	3.4	1.5 (1.0 to 2.1)

*IRRs are adjusted for calendar year (1970–80, 1981–90, and 1991–96), hay fever (no/yes), and region (south/middle-north).

were given in preformed categories in the first study, and in absolute numbers in the second.

Furthermore, a random sample of 19 salons, stratified by the number of hairdressers in the cohort still working there, was selected from one major city (Gothenburg) and the surrounding region to validate the exposure information. Two occupational hygienists visited the salons during the high and low season, asked the hairdressers to fill in the questionnaire again, and also asked them to complete a diary for 3 weeks stating the number of different treatments each day. Personal and stationary measurements of air concentrations of persulphate were made twice at one salon with 20 employees, using IOM samplers with cellulose acetate filters. The filters were analysed at the Regional Institute for Occupational Health in Tampere, Finland. The detection limit was 1.5 μg persulphate/filter.

Statistics

Effects of common risk factors on incidence of asthma

Rate ratios of incidence of asthma (IRR) with 95% confidence intervals (95% CIs) were estimated by a Poisson regression with EGRET software (Statistics and Epidemiology Research Corporation, Seattle). The referents, followed up from 18 years of age, were used to determine the effects of common risk factors on incidence of asthma. Age (six categories; <20, 20–24, 25–29, 30–34, 35–39, and ≥40 years) had no effect (not in table), whereas the incidence of asthma increased during the period of observation (three categories; 1970–80, 1981–90, and 1991–6). Both hay fever and childhood eczema had an effect, but the effect of childhood eczema almost disappeared (IRR=1.2 (95% CI 0.9 to 1.6)) when hay fever was simultaneously included in a multivariate model. A slightly increased incidence of asthma was found among women who were ever smokers and among women living in the middle and northern regions of the country. The final model thus included calendar year of observation, hay fever, smoking, and region (table 2). The estimated univariate effects were, apart from childhood eczema, similar to the estimates obtained from the multivariate model.

Estimation of incidence of asthma among hairdressers

Hairdressers without previous asthma were followed up from the year of certification, usually at the age of 18. Also, the incidence of asthma was calculated only during exposed time—that is, time not working as a hairdresser was excluded. The effect on incidence of asthma of bleaching (three categories; 0–1, 2–7, and ≥8 treatments/week) and using hair spray (three categories; 0–30, 31–50, and ≥51 treatments/week) was evaluated during exposed time.

RESULTS

Asthma incidence

The crude incidence of asthma among the hairdressers was 3.5/1000 person-years (not in table), whereas a higher incidence was found when only years in active hairdressing work was assessed (3.9/1000 person-years, table 2). There was a small difference between the incidence of asthma in the cohort of hairdressers when years not working as a hairdresser were assessed (2.8/1000 person-years, not in table) and that among the referents (3.1/1000 person-years, table 2).

Hairdressers who did not answer the questionnaire (non-participants) reported a slightly higher incidence of asthma according to the phone interview overall (4.9/1000 person-years based on 20 cases) and during active work as hairdressers (6.0/1000 person-years based on 16 cases) than the participants. Non-participating referents also reported a slightly higher incidence of asthma (4.9 per 1000 person-years based on 18 cases) than the participants.

The median time from certification to the onset of asthma was 6 years among the hairdressers. Change of work due to asthma was reported by 29 hairdressers (0.7%) and 34 referents (0.7%).

Table 4 Effect of spraying and bleaching, respectively, on asthma incidence in a cohort of active female hairdressers. Asthma incidence rate ratios (IRRs) with 95% CIs are shown

Exposure	Cases	Person-year	Incidence (/1000)	IRR* (95% CI)
Model I:				
Spraying (treatments/week):				
0–30	24	7 807	3.1	1.0 (—)
31–50	38	10 457	3.6	1.1 (0.7 to 1.8)
≥51	31	6 619	4.7	1.4† (0.8 to 2.4)
Model II:				
Bleaching (treatments/week):				
0–1	30	8 816	3.4	1.0 (—)
2–7	57	14 419	4.0	1.1 (0.7 to 1.8)
≥ 8	10	2 105	4.7	1.5‡ (0.7 to 3.0)

*IRRs in the models are adjusted for calendar year (1970–80, 1981–90, and 1991–96), hay-fever (no/yes), smoker (never/ever), and region (south/middle-north); †spraying, test for trend p=0.23; ‡bleaching, test for trend p=0.31.

Effects of work as a hairdresser

A moderate cohort effect of being an active hairdresser compared with the referents (IRR=1.3 (1.0 to 1.6), not in table) was found. The effect was, however, modified by smoking (table 3). Thus, we found an effect of being a hairdresser on the incidence of asthma among the lifelong non-smokers, and an effect of smoking in the referents. A negative effect modification (p=0.02) was indicated by the absence of a further increase in risk during smoking and hairdressing.

Validation of exposure

In the subsample of hairdressers who answered the same questions twice, 46 had reported the highest category of treatments/week (≥8) in the first questionnaire, but for the same calendar year only 14 of them reported a similar number in the second questionnaire (κ value 0.24). The corresponding figures for use of hair spray were 112 and 17 in the highest category (κ value 0.17). Thus, the comparisons indicated a fair to poor agreement.[14]

However, the average number of bleaches performed/week according to the diary agreed with the interval stated in the questionnaire among 13 out of 15 hairdressers. The use of hair spray was generally overestimated in the questionnaire compared with the diaries both during the high and low seasons (one category by nine hairdressers, two categories by three hairdressers; correct category three hairdressers).

Personal sampling (three samples) during mixing of bleaching powder with peroxide and application of the mixture gave 15–49 μg persulphate/m^3 for sampling periods of

Policy implications

- Our study, and those of others, indicate an increased risk of asthma in hairdressers, with exposure to persulphates, and possibly also hair spray as the main causal agents.
- Detectable persulphate concentrations in air were found only during mixing, and not during application. We suggest:
  - A change from powder to less dusty (paste or granulate) preparations of hair bleach.
  - Installation of exhaust ventilation in the mixing areas, and improvement of the general ventilation in the salons.
  - That an occupational aetiology is considered when asthma is diagnosed in a hairdresser.

32–135 minutes. Stationary sampling (four samples) in the mixing area over 200–319 minutes gave <4–6.1 μg persulphates/m^3. No detectable concentrations were found at application. To be able to receive detectable amounts of persulphates 5–7 mixings of bleaching powder and peroxide were performed during each sampling period. The mixing of bleaching powder takes 2–5 minutes for each treatment. If it is anticipated that the exposure to persulphates occurs mainly during the mixing periods (5 minutes/mixing) with almost zero exposure during application the exposure during mixing would be 35–150 μg persulphate/m^3 and in the mixing area <23–50 μg persulphate/m^3.

Effects from specific exposures

Among the hairdressers, the incidence of asthma was slightly higher in the most frequent users of bleaching products than in the others, but the difference was not significant (table 4). As in the earlier analyses, the univariate effect estimates were quite close to those in the full model. For the use of hair spray, the pattern was similar to that for the bleaching products—that is, the most frequent users had a moderately non-significantly increased incidence of asthma compared with the others.

DISCUSSION

The salient finding in our study was an increased incidence of asthma among the hairdressers, corresponding to one extra case/1000 person-years. The effect was modified by smoking, and evident only among lifelong non-smokers. A stronger effect, corresponding to two extra cases/1000, was suggested (but not significant) in hairdressers who often used spray or bleaching products.

The validation of reported number of treatments in the questionnaire, compared with diaries, indicated that hair bleach treatments were correctly reported, whereas the hair spray treatments were overestimated. Comparisons of answers in the two questionnaires were not firmly conclusive due to different contexts and designs of the questions, but indicate that the agreement was poor to fair, and thus misclassification may have introduced a bias which is most likely to underestimate the effects of specific exposures.

Experimentally, hair bleach induces airway hyperresponsiveness in rabbits after a single short term (4 hours) exposure to concentrations of persulphates of around 5–10 mg/m^3.[15] We found a mean persulphate exposure during mixing and application 10–700 times lower (0.015–0.49 mg/m^3). The estimated exposure during the mixing periods was 35–250 times lower (0.04–0.15 mg/m^3). Stationary sampling close to the clients during bleaching treatments showed no detectable air concentrations. In a clinical study of hairdressers, hair bleach and the use of aerosol hair spray were the most provocative factors to increase the respiratory symptoms, and 90% of the diagnosed occupational respiratory diseases were judged to be caused by persulphates in bleaches.[16] Our study is weakly supportive of a causal role for hair spray and bleaches in hairdressers' asthma, but it is not conclusive.

The excess rate of asthma in hairdressers in this study is close to that in a Finnish study (0.9/1000[10]) with a similar design, but substantially higher than the rates of reported occupational asthma in hairdressers both in Sweden (0.13/1000[17]) and in Italy (0.20/1000[11]). The time from certification to the onset of asthma (median 6 years) was longer than among workers handling laboratory animals (mean 2–3 years),[18] but similar to that reported in bakers (mean 6.5 years).[19]

Several selective processes may be important among the hairdressers. Sensitive subjects are likely to be selected out of training, tending to give conservative risk estimates, but unfortunately it was not possible for us to identify those who entered the training. It is also likely that young girls with asthma and eczema are advised not to enter the training. Thus, a selection away from dermal atopy was present in the cohort of hairdressers, but it was no longer clearly associated with asthma when hay fever was included in the model. Although the prevalence of hay fever was similar in responders in the two cohorts, the prevalence of childhood asthma was lower among the hairdressers (2.4%) than among the referents (3.9%), showing that a selection against more serious respiratory atopy had taken place. Residual confounding between the cohorts is probably present if a selection by severity of disease has been operating within the hay fever group also, as we could not adjust for this.

We had a fairly low response rate to our questionnaire, especially among the hairdressers. We considered the possibility of a selective participation by interviews with the non-participants. A slightly higher proportion of the non-participants than the participants were ever smokers or had dermal atopy. These two variables were determinants of higher risk of asthma among the participants, and we found accordingly a slightly higher incidence of asthma among non-participants than participants in both cohorts. As the participation rate was lower among the hairdressers, this is most likely to lead to a weak underestimation of the difference between the two cohorts.

Accurate information about asthma and the year of onset is important in this study. Self reports about asthma assessed by questionnaire have been shown to be reliable and have a good specificity, especially for age groups below 50 years.[20] We limited our study to these age groups. The sensitivity is moderate, and selective for severity of the disease.[21] This should give an underestimation of the incidence, especially for mild disease, but the high specificity makes it adequate for comparisons of rates. In the present study the proportions of subjects reporting asthma who had been diagnosed by a physician were high, and similar in hairdressers and referents, but higher among smokers (hairdressers 85%, referents 87%), than among non-smokers (hairdressers 73%, referents 73%; not in results).

In a former study of bakers' asthma, which used a similar approach, Brisman and Järvholm[19] found that when answering a questionnaire on the year of onset of asthma a second time, 47% gave the same year and another 32% ±1 year of the first answer. The incidence of asthma during unexposed time in the hairdressers' cohort was similar to the one among the referents, indicating an acceptable comparability between the two cohorts and no substantial misclassification between exposed and unexposed years.

Time trends are well established for childhood asthma, but have been less studied for asthma of adult onset. However, an increasing trend also for adult asthma has been indicated in some studies.[22–25] Also, regional differences have been found with, for instance a higher prevalence in northern than southern Sweden.[26] We found a strong effect of calendar year of observation, and a moderate effect of region of living, but within our span of 18–49 years of age we found no effect of

age. The effect of calendar-year could also to some extent be due to differential recall for different periods.

We found the expected strong effect on risk of asthma from hay fever as a marker of respiratory atopy in both cohorts,[24 27] but no modification of the cohort effect by respiratory atopy. This is in agreement with overall findings for occupational asthma by Kogevinas *et al*.[9]

The higher proportion of subjects with asthma diagnosed by a physician among smokers than non-smokers in both cohorts may indicate a selective underreporting among the smokers, and thus that the effect on risk of asthma from smoking is underestimated. However, such a differential reporting in smokers and non-smokers should not introduce interaction with exposure, as it was the same in the two cohorts. Furthermore, quantitative smoking habits were not considered in our main analyses, and could, if substantially different between the two cohorts, have confounded our findings. However, a strong bias is not likely, as median age at the start of smoking was 16 years in both cohorts (not in results). Also, the fraction of women among the hairdressers who stopped smoking were 51%, at a median age of 25 years, and the corresponding figures among the referents were 52% and 26 years. Moreover, the distributions of cigarettes smoked/day were almost the same in both cohorts. Overall, a moderate effect of smoking was found, similar to earlier reports.[27 28]

However, we found an interaction between smoking and work as a hairdresser, for which we presently have no explanation. It has been stated that in occupational settings, current smokers have a higher risk of developing sensitisation to high molecular weight agents, whereas non-smokers have a higher risk for developing asthma due to low molecular weight compounds.[29] If so, our findings would fit into this. The biological background for such a possible pattern is not known. If hairdressers' asthma is induced by irritants and not an IgE sensitising process, it is possible that the proportion of people susceptible to developing asthma in the population is limited, and thus once one risk factor is operating, addition of another does not increase the risk.

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Paper II

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ORIGINAL ARTICLE

Persulphate challenge in female hairdressers with nasal hyperreactivity suggests immune cell, but no IgE reaction

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Abstract
Purpose The aim of this study was to examine the effects of persulphate on the nasal mucosa and on the immune cells in hairdressers suffering from bleaching powder associated rhinitis (BAR) versus subjects with rhinitis not previously exposed to bleaching powder.
Methods Fifteen hairdressers (S) with BAR, 14 without symptoms (WS) and 12 atopics (A) with rhinitis but without exposure to bleaching powder were studied. Each performed a nasal challenge with persulphates. Effect parameters were symptom score, acoustic rhinometry, albumin in nasal lavage, subpopulations of lymphocytes in blood and specific serum antibodies.
Results The S group had a post-challenge increase in nasal symptoms and nasal lavage albumin. The A group reacted to a lesser intent. The S and A groups showed an increase in Th1 cells. An HLA class II cell expression was noticed in both groups of hairdressers. No evidence of a type 1 reaction (immediate type) to persulphate was noticed.
Conclusions Persulphate challenge affects hairdressers with BAR, but also atopics. The reaction may be driven by a Th1 cell activation.

Keywords Bleaching powder · Hairdressers · IgE · Nasal challenge · Persulphate · Rhinitis

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Introduction

Hairdressers are frequently exposed to several potential agents which are irritating to the airways and promote immune-mediated reactions. Epidemiological studies have shown an increased risk for work-related airway symptoms in hairdressers (Leino et al. 1997, 1998; Albin et al. 2002; Brisman et al. 2003). Albin et al. (2002) showed that among the hairdressers who could point out a causal agent for the symptoms from the airways, more than 80% named the bleaching powder.

Bleaching powder contains persulphates, agents earlier shown to be associated with occupational asthma although the mechanism has not elucidated (Parra et al. 1992; Macchioni et al. 1999; Mũnoz et al. 2003; Moscato et al. 2005). However, in hairdressers, rhinitis is more frequent than asthma (Albin et al. 2002; Brisman et al. 2003). The association between persulphate exposure and rhinitis has not been extensively studied. The mechanism for development of bleaching powder associated rhinitis is still unclear and relevant diagnostic methods are lacking. These challenges make vocational advising of symptomatic hairdressers difficult.

The aim of this study was to examine the effects of persulphate on the nasal mucosa and on the immune cells in hairdressers who primarily suffer from bleaching powder associated rhinitis versus subjects with rhinitis who has not been previously exposed to bleaching powder.

Material and methods

Subjects

Three groups were studied. The target group consisted of female hairdressers with nasal symptoms mainly related to

Table 1 Criteria of the participating groups, symptomatic (S) and asymptomatic hairdressers (WS) and atopics (A)

	S group (n = 15)	WS group (n = 14)	A group (n = 12)
Inclusion criteria	Only work-related nasal symptoms from bleaching powder	No work-related airway symptoms	No exposure to bleaching powder Nasal symptoms Atopy by history
Exclusion criteria	Asthma Atopy by history	Asthma Atopy by history	Asthma

bleaching powder (S, n = 15). Two comparison groups were employed, one of female hairdressers (WS, n = 14) without symptoms, another of atopic (by history) females without professional contact to bleaching powder (A, n = 12). None of the hairdressers had a history of atopy. At the time of the challenge, no subjects were taking allergy medications. Participants in the S group were chosen as those from a group of 33 hairdressers complaining of nasal symptoms related to bleaching powder. The fifteen S group participants were deemed to have the worst symptoms associated with bleaching powder. The inclusion and exclusion criteria can be seen in Table 1. The study was approved by the local ethical committee. Study participants gave written informed consent.

The mean age in each group was in the S group 39 (SD 8), in the WS group 38 (SD 12), and in the A group 39 (SD 12) years. The hairdressers had been employed as such for 17 years (mean, SD 6 in the S and 12 in the WS group). The exposure time until appearance of symptoms in the S group was 8 years (mean, SD 5). Four subjects in the S group, two in the WS and all but two in the A group showed a positive standard skin prick test. There were no smokers in group A, three in group S and four in group WS. In the S group, 12 subjects had nasal blockage, 11 had a runny nose, and 12 sneezing. The corresponding figures for group A were 12, 10 and 9. Although the inclusion criteria was that the hairdressers should not have any known allergies, four hairdressers in the S and two in the WS groups showed a positive reaction to common allergens. Two participants in the atopic group had no positive reaction in spite of having allergy symptoms.

Medical examination before challenge

A standardized interview was conducted with a physician. This included a medical and occupational history, questions about atopy and smoking habits. Airway related symptoms and their relationship to the workplace were thoroughly discussed. Work-related symptoms were defined as those worsened at the workplace and/or recovery during weekends or holidays away from the workplace. Atopy by history was defined as having a history of hay fever, asthma or atopic eczema in childhood or adolescence. A physical examination was performed including rhinoscopy to exclude any nasal condition that may mimic or generate rhinitis-like symptoms.

Skin prick test with 13 common allergens (ALK, Copenhagen, Denmark) was performed. Furthermore, the hairdressers were tested stepwise with fresh solutions [0.05, 0.1 and 0.5% (w/v)] of potassium persulphate in sterile water. The reaction was read according to Aas and Belin (1973). Positive reactions were scored when the area of the wheal was at least half of that induced by a histamine solution (10 mg/mL).

Specific nasal challenge

The nasal challenge was performed with a 0.001% fresh solution of potassium persulphate in isotonic saline solution, and after 20 min with a 0.01% solution (w/v) using a De Vilbiss spray (atomizer No. 15) as earlier described (Andersson et al. 1987). A total of 300 μg of each solution was sprayed into the nasal cavities by turns. The spraying was performed immediately after a maximal inspiration to prevent the solution from entering the lower airways (Melillo et al. 1997).

Nasal symptoms were recorded using a score system according to Malm et al. (1981) before, 15 min after each challenge, 2 and 5 h after the last challenge. Nasal blockage and secretions were each rated on a scale 0–3 (no symptoms = 0; severe symptoms = 3). The rating was performed for each nose cavity and then the average was used. The number of sneezes was counted and scored (no sneeze attacks = 0; 1–5 = 1; 6–15 = 2; >15 = 3). A combined nasal symptom score was calculated by addition of the score for each symptom.

When the reaction of individual subjects were studied, a significant response was defined as a subject increasing in total symptom score more than three standard deviations from the mean change in the WS group.

Acoustic rhinometry (AR) was performed using a RHIN 2000 (RhinoMetrics A/S, Lynge, Denmark) according to Hilberg and Pedersen (2000). The anatomical nosepieces were chosen according to the shape of the subject's nostril. The probe was handheld; the subject sat in an upright position with the neck fixed breathing quietly through the mouth. During the measurement the subjects held their breath. The room was quiet and the room temperature was

standardized. The Minimum Crossectional Area (MCA) in cm^2 was measured in the distance of 10–32 mm from the nares before the first challenge, 15 min after this and 15 min, 2 h and 5 h after the second challenge. Three consecutive approved measurements for each nostril were performed and the mean value was registered for each side of the nose. Data on nasal dimensions are presented as the mean value of the values for the right and the left side of the nose.

A nasal lavage was performed twice before the first challenge and 20 min, 2 h and 5 h after the second challenge directly after the rhinometric measurement. The first lavage was performed to wash out mediators developed by processes before the challenge. The second lavage before the challenge was used as the baseline for the post-challenge samples. The lavage was performed with a syringe attached to a nasal olive (Nasaline; ENTpro AB, Stockholm, Sweden). Fifteen milliliters of sterile isotonic saline solution at 35°C was introduced into the nasal cavity with the patient sitting in a forward flexed neck position. The transmission was stopped when solution appeared in the opposite nostril. The solution was sucked backwards into the syringe and injected again. This procedure was repeated three times in the left and the right nostril alternately. The samples were immediately cooled and frozen at −70°C.

Analysis of nasal lavage and blood tests

The levels of albumin, eosinophil cationic protein (ECP) and myeloperoxidase (MPO) in the supernatants of the nasal lavage fluids were analyzed by double antibody radioimmunoassay. The level of tryptase was analyzed by a double antibody fluoroenzyme immunoassay. These assays are available as commercial kits (Pharmacia Diagnostics AB, Uppsala, Sweden). The detection limit for albumin was 0.4 mg/L, for ECP 2.0 μg/L, for MPO 2.0 μg/L and for tryptase 1.0 μg/L.

Venous blood was collected before the challenge and 5 h after the last challenge. One tube without additives was centrifuged and the serum was frozen at −20°C for analysis of specific antibodies of IgE class. Samples were also taken in tubes with heparin and with EDTA, respectively, for blood cell analysis within 6 h after blood sampling.

Analysis for specific IgE antibodies against persulphates was performed by specific immunoblotting (Johannesson et al. 2001). Aliquots of the conjugate with persulphate and proteins from nasal lavage fluid (NLF) were separated by 4–12% SDS-PAGE. The proteins were blotted to a preconditioned PVDF (polyvinylidene difluoride) membrane (Biorad, Hercules, CA, USA) using a Semidry Electroblotter A (Ancos, København, Denmark) at 150 mA for 3 h. The membrane was then blocked by incubation in 5% dried milk. Sera from the hairdressers were used as primary antibodies. The secondary antibody was I^{125} IgE. The membranes were wrapped in cellophane and exposed on CEA RP X-ray film (CEA group, Strängnäs, Sweden) for 1 month.

Flow cytometry was used to measure the concentration of leukocytes, lymphocytes and lymphocyte subpopulations. Leukocyte populations were distinguished by their light-scattering abilities; forward scatter reflects the cell size and side scatter reflects the complexity/granularity. The different lymphocyte populations distinguished were T cells (CD3+), T helper (Th) cells (CD3+, CD4+), T cytotoxic cells (CD3+, CD8+), B cells (CD19+) and NK cells (CD3−, CD16+or CD56+). Also HLA-DR expression on lymphocytes and on the T cell subpopulation was determined (Syk et al. 1999). In short, samples of 5 μL of fluorescence-labeled monoclonal antibodies were added to 50 μL of blood and incubated for at least 10 min. The erythrocytes were then lysed by Immunoprep (Coulter, Miami, FL, USA), and the sample analyzed on a flow cytometer (Coulter Epics II, Coulter Electronics, Hialeah, FL, USA).

Analysis of Th1 and Th2 lymphocytes was done by measurement of the intracellular expression of the cytokines interferon-γ and IL-4 using flow cytometry (Jung et al. 1993; Picker et al. 1995). A minimum of 3,000 cells was analyzed within the lymphocyte cluster, and the results are expressed as a percentage of cytokine-producing cells in a population of specified T helper cells, i.e., CD3 and CD4 positive cells (Källström et al. 2002).

Statistical analysis

Wilcoxon's signed rank test was used to compare paired data, whereas Mann–Whitney's *U* test was used in tests between the groups. Stratification was used to adjust for possible confounding factors. *P* value of <0.05 was considered significant (two-tailed). Data were analyzed by SPSS for Windows 12.0 (SPSS Inc., Chicago, IL, USA). Stratification was done using StatXact 6 (Cytel Software Corporation, Cambridge, USA).

Results

In skin prick testing of the hairdressers, there was no reaction to persulphates. Before the challenge, the S group had a higher total score than the other groups. The A group had the next highest and both S and A differed from the WS group (Table 2). The S group had a significant increase in the total symptom score during and 2 h after the last challenge. The A group symptom score increased only during the challenge. No increase was noted within the WS. The smokers and the skin prick test positive subjects did not

Table 2 Total symptoms score (the combined score from nasal blockage, secretion and number of sneezes; median), before, during and 2 and 5 h after nasal challenge with persulphates in symptomatic (S) and asymptomatic (WS) hairdressers and in atopics (A)

	S group (n = 15)	WS group (n = 14)	A group (n = 12)
Baseline	2.0***	0	0.5*
15 min after challenge 1	4.0^{aa}	0	1.5^{a}
15 min after challenge 2	5.0^{aaa}	0	2.5^{aa}
2 h after challenge 2	3.0^{a}	0	0.5
5 h after challenge 2	2.0	0	1.5

Significant differences between WS group and S and A groups, respectively, $^{*}P \leq 0.05$, $^{***}P \leq 0.001$

Significant differences within the groups compared to the baseline $^{a}P \leq 0.05$ $^{aa}P \leq 0.01$ $^{aaa}P \leq 0.001$

Table 4 Concentrations of leukocytes and lymphocytes in peripheral blood (median; range) pre- and 5 h post-challenges with persulphates. Groups like in Table 2

	S group (n = 15)	WS group (n = 14)	A group (n = 12)
Leukocytes $\times 10^9$/L			
Pre-challenge	7.0 (3.4–11.4)	5.8 (4.7–6.9)	6.7 (3.4–8.2)
5-h post-challenge	8.2^{a} (3.7–12.9)	6.9^{aa} (5.1–9.2)	7.2^{aa} (4.6–8.8)
Lymphocytes $\times 10^9$/L			
Pre-challenge	2.6 (1.3–3.7)	2.4 (1.3–4.8)	2.0 (1.1–3.8)
5-h post-challenge	3.3^{aa} (1.4–4.3)	2.5^{a} (1.2–3.9)	2.6^{a} (1.5–3.5)

Significant differences within the groups from pre- to post-challenges $^{a}P \leq 0.05$ $^{aa}P \leq 0.01$

differ from the rest of their groups, respectively, (data not shown). When individual subjects were studied, six subjects in the S and two in the A group reacted significantly to the challenge.

The results of the acoustic rhinometry showed a decrease in MCA of 7% after the first and 14% after the second challenge in the S group compared to the baseline level (0.96; 0.58–1.65 vs. 0.83; 0.53–1.41 cm^2; median and range). In the A group, a transient decrease of 14% was noticed after the first challenge, but the group returned to baseline after the second one. Otherwise there were no changes in the groups compared to the baseline levels.

Albumin in the first lavage fluid was raised in both the S and the A groups compared to the WS group (Table 3). The differences were not statistically significant when adjusted for smoking. At the second pre-challenge lavage, all three groups showed a decrease in albumin levels. Twenty minutes after the second challenge, albumin levels transiently but significantly increased in the S group (Table 3). In the two groups of hairdressers, there was no difference amongst the current smokers and the skin prick test positive subjects.

No statistically significant differences in ECP levels appeared between the groups or in relation to the challenge (Table 3). For MPO, no significant differences were found between the groups at time 0. After the first lavage, a decrease was observed in all three groups. Thereafter a gradual increase was noticed during the observation time. No differences were noticed between the groups (data not shown). None of the subjects had elevations of tryptase levels above the detection level.

No significant differences between the groups were found for any of the cell populations studied (Tables 4, 5, 6). In all three groups, the concentrations of lymphocytes and leukocytes in blood increased significantly from before to after the challenge (Table 4). The result suggests that the increase in lymphocytes was more prominent in group S and A.

The Th1 cells increased after challenge in the S group. The Th2 cells did not increase. The same tendency was observed in the A group although this was not significant. No changes were seen in the WS group (Table 5). With regard to HLA class II expression (DR) on T cells after challenge, there was a significant increase in both the S and the WS group. Thus, there was an increase in HLA-DR expression in T cells, which reflects activation in both groups of hairdressers, but not in the atopics.

Table 3 Albumin (median; range) in nasal lavage fluid

Albumin, mg/L	S group (n = 15)	WS group (n = 14)	A group (n = 12)
Time 0	5.5 (0.4–21.6)	3.4* (0.6–20.2)	13.0 (0.7–39.7)
Baseline	1.9^{b} (0.2–17.0)	1.2 (0.05–4.0)	3.1 (0.7–17.7)
20 min after challenge 2	4.1^{a} (0.0–21.2)	1.5 (0.1–9.3)	2.6 (0.4–14.1)
2 h after challenge 2	2.7 (0.0–35.9)	1.8^{a} (0.3–36.2)	1.9 (0.7–15.9)
5 h after challenge 2	4.8 (0.3–51.1)	2.2 (0.4–45.6)	4.4 (0.6–21.6)

Groups and nasal challenge like in Table 2

Significant differences between the groups WS and A, $^{*}P \leq 0.05$

Significant differences within the groups compared to the baseline, $^{a}P \leq 0.05$

^{b} 14 persons

Table 5 Portion of Th1 and Th2 lymphocytes and HLA-DR expression on T lymphocytes (median; range) pre- and 5-h post-challenges with persulphates

Blood	S group (n = 15)	WS group (n = 14)	A group (n = 12)
Th1 in % of CD4+ cells			
Pre-challenge	17.0 (9.9–30.0)	15.5 (7.8–29.0)	15.5 (11.0–43.0)
5-h post-challenge	19.0[a] (11.0–36.0)	15.0 (11.0–30.0)	19.0 (11.0–38.0)
Th2 in % of CD4+ cells			
Pre-challenge	2.9 (0.8–4.7)	2.4 (1.3–4.8)	2.0 (1.2–9.4)
5-h post-challenge	3.0 (0.8–4.8)	2.5 (0.9–4.5)	2.1 (1.1–8.1)
HLA-DR T cells × 109/L			
Pre-challenge	0.11 (0.04–0.71)	0.10 (0.04–0.28)	0.11 (0.03–0.46)
5-h post-challenge	0.12[a] (0.04–0.81)	0.12[a] (0.02–0.43)	0.10 (0.04–0.61)

Groups like in Table 2

Significant differences within the groups from pre- to post-challenges, [a]$P \leq 0.05$

Table 6 Distributions of lymphocyte subpopulations in peripheral blood pre- and 5-h post-challenges with persulphates

Blood	S group (n = 15)	WS group (n = 14)	A group (n = 12)
CD 3 T cells %			
Pre-challenge	75.0 (67.0–87.0)	75.5 (66.0–86.0)	74.5 (58.0–90.0)
5-h post-challenge	75.0 (68.0–86.0)	74.0 (66.0–87.0)	74.5 (63.0–86.0)
CD 3.4 T helper cells %			
Pre-challenge	48.0 (37.0–58.0)	45.0 (34.0–56.0)	47.0 (37.0–66.0)
5-h post-challenge	48.0 (41.0–59.0)	45.0 (38.0–61.0)	50.0 (37.0–62.0)
CD 3.8 T Cytotox %			
Pre-challenge	28.0 (15.0–34.0)	27.5 (9.1–40.0)	23.5 (12.0–37.0)
5 h post-challenge	25.0[aa] (12.0–36.0)	25.0[aa] (7.8–35.0)	23.0[aa] (9.1–36.0)
CD16 + CD56 NK cells%			
Pre-challenge	11.0 (2.8–19.0)	9.8 (3.4–26.0)	8.5 (4.4–23.0)
5 h post-challenge	11.0 (1.0–16.0)	8.8 (4.2–21.0)	12.5 (6.7–18.0)
CD 19 B cells %			
Pre-challenge	10.0 (3.0–15.0)	8.1 (4.7–17.0)	8.1 (0.6–16.0)
5-h post-challenge	9.0[a] (4.3–18.0)	7.7 (5.5–19.0)	8.5 (0.9–16.0)

Groups like in Table 2

Significant differences within the groups pre- and post-challenges, [a]$P \leq 0.05$ [aa]$P \leq 0.01$

The portion of T helper cells in the circulation remained unchanged after challenge indicating that the increase in lymphocyte concentration was dependent mainly on expansion of the T helper cell population (Table 6). However, the concentration of T cytotoxic cells was unchanged; therefore, the percentage of T cytotoxic cells was decreased after challenge. These changes were seen in all three groups. A small increase in B cell concentration was also seen, although the portion of B cells falls a little due to the increase in T cells. This alteration in cell concentration was significant for both the S and A group. There were no changes in numbers of NK cells (Table 6).

No IgE antibodies were detected at immunoblotting using persulphate modified nasal proteins as allergens in the sera in any of the groups.

Discusssion

To our knowledge, this is the first study that compares the effects of nasal challenge with persulphate in hairdressers with symptoms predominantly associated to bleaching powder to atopics without exposure to persulphates. Nasal symptoms increased in both the symptomatic hairdressers and the atopics, but not in the asymptomatic group. The S group developed the most symptoms and a rise in albumin in the nasal lavage liquid, which was not found in the A group. In spite of a low challenge dose, persulphates had an impact on the mobilization of specific types of immune cells in the blood circulation, such as Th1 cells in the S group, but the change only marginally differed from that of the A group. No subjects reacted to the skin prick test with the persulphate solution. The immune blotting study showed no signs of specific antibodies. Thus, this study does not demonstrate an IgE mediated allergic reaction to persulphate in the symptomatic hairdressers**.**

Because the A group was not earlier exposed to bleaching powder, the reaction in this group is probably not specific. A positive reaction to persulphate in a non-persulphate exposed asthmatic was also reported by Mũnoz et al. (2004). The stronger reaction of the S group may indicate a reaction to persulphate that is different from that of the atopics. However, it is more likely that the hairdressers who had more symptoms before the challenge had a less

specific reaction to persulphates than group A. This point of view supports the results from an earlier study (Hytönen et al. 1997), in which specific reactions to persulphates were rare. Thus, we think that at least most of the reactions among the hairdressers also may be of a not specific nature.

In this study, we only challenged subjects with potassium persulphate. Hairdressers are often exposed to other persulphates as well. Thus, reactions to those types of persulphates may have been missed. However, immunologic differences between the used persulphates have not been indicated (Pang and Fiume 2001). Mũnoz et al. (2004) showed that persulphate sensitive asthmatics reacted in skin prick test equally to potassium and ammonium persulphates.

In spite of the clear association between exposure to bleaching powder and symptoms in the medical history, the hairdressers who did not react significantly in the challenge test may react to agents other than persulphates in the hairdresser environment. Thus, Hollund et al. (2002) found that more than 5% of the hairdressers in a cross sectional study had allergy to latex. The same figure was mentioned by Moscato et al. (2005), even if in this later study persulphate was by far the most frequent causative agent.

None of the participants in the study reacted in the skin prick test to persulphate. In our clinic, we infrequently find positive tests in hairdressers with bleaching powder associated asthma. In the study of Moscato et al. (2005) no positive skin prick test was found, whereas half of the patients with asthma in the study of Mũnoz et al. (2004) were positive. A positive skin prick test may not necessarily mean demonstrable specific antibodies. Aalto-Korte and Mäkinen-Kiljunen (2003) found seven out of 138 patients tested with persulphates to have positive skin prick tests. Only one of five tested sera had demonstrable antibodies. Thus, the mechanism of persulphate associated reactions is not clear even if a positive skin prick test has been recorded.

All three groups had an increase in white blood cells post-challenge, which may be explained by something else other than that of the challenge. However, some differences in lymphocytes subpopulations were noticed. The S group had an increase of T helper cells, particularly Th1 cells. In addition, an increase in activated T cells assessed by HLA class II expression was observed. The changes only marginally differed from those of the A group, whereas the changes in the WS group were minimal. This indicates an effect of the challenge in the two symptomatic groups in spite of the low challenge dose.

An association has earlier been described between levels of Th1 cells and exposure to other reactive low molecular agents in animals (isocyanates and ozone, van Loveren et al. 1996). It was hypothesized that Th1 cells after exposure to these agents may play a role in induction of asthmatic disorders of non IgE origin. Thus, the increase in Th1 cells as noticed in our study may be a part of the process of hyperreactivity. It is well known that high exposure to irritants can cause bronchial as well as nasal hyperreactivity (Rom 1992; Leroyer et al. 1999; Banauch et al. 2005) although the exact mechanism is not clear. However, almost nothing is known about chronic low irritant exposure and the development of hyperreactivity. There is a need for such studies.

In conclusion, we showed that challenge with persulphates can elicit symptoms in hairdressers with bleaching powder associated rhinitis, but also to some degree in atopics without exposure to bleaching powder. No signs of involvement of specific IgE antibodies against persulphate were found. An increase in Th1cells was noticed in both groups indicating a reaction driven by a Th1 cell activation. However, further studies are necessary to understand the mechanism for bleaching powder associated symptoms in hairdressers.

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Paper III

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ORIGINAL ARTICLE

Work-related airway symptoms, nasal reactivity and health-related quality of life in female hairdressers: a follow-up study during exposure

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Abstract
Objectives Hairdressers often complain of work-related rhinitis (WR). They are infrequently sensitized to persulphates. The cause and mechanism of the symptoms and the effects on their health-related quality of life (HRQoL) remains unclear. The objectives were to follow female hairdressers with WR mainly from bleaching powder regarding nasal reactivity to persulphate and to evaluate symptoms, HRQoL and inflammatory markers in nasal lavage during a working period after vacation and compared with hairdressers without symptoms and pollen allergic women.
Methods Skin prick tests to persulphate were performed in the hairdressers. Participants kept a diary of symptoms and of work tasks (hairdressers only). They completed HRQoL questionnaires. Eosinophil cationic protein (ECP) in nasal lavage fluid was examined. The symptomatic hairdressers performed nasal challenges with persulphate before and after the exposure.
Results Skin prick tests were negative. Although the nasal reactivity to persulphate did not change a steady increase in nasal symptoms, especially blockage, and in ECP was noticed in the symptomatic hairdressers. The HRQoL deteriorated in the symptomatic hairdressers indicating an effect on their working situation and daily life. The atopics had more, but varying symptoms (itching, sneezing and secretion).
Conclusions The difference in the clinical picture between the symptomatic hairdressers and the pollen allergic women, the increase in symptoms and ECP in the nasal lavage support the view that a sensitization to hairdresser chemicals by a mechanism not yet understood is operating. The deterioration of the HRQoL in the symptomatic hairdressers indicates a considerable effect on their life.

Keywords Bleaching powder · Work-related nasal symptoms · Nasal lavage · Diary · Health-related quality of life

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Introduction

Hairdressers often complain of work-related airway symptoms. They are exposed to several irritating and sensitizing agents, but they often relate their symptoms to bleaching powder (Albin et al. 2002; Brisman et al. 2003). Persulphates found in bleaching powder have often been blamed because they are irritating and sensitizing agents causing both rhinitis and asthmatic symptoms. Specific challenge to persulphate has been suggested as an useful tool in diagnosis of occupational asthma in hairdressers (Muñoz et al. 2004). However, specific IgE antibodies against persulphates are seldom found (Parra et al. 1992) and another immunologic mechanism not yet elucidated has been suggested (Moscato et al. 2005; Muñoz et al. 2004). Furthermore, the clinical picture is quite complex as hairdressers reacting to bleaching powder very often complain of symptoms associated with exposure to other hairdressers chemicals. In a previous study, we found that hairdressers with nasal symptoms from bleaching powder reacted to a nasal challenge with potassium persulphate in

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the same way as atopics without earlier exposure to bleaching powder (Kronholm Diab et al. 2009). This reaction was associated with a Th1 cell activation, which may be a part of the process of hyper reactivity from low irritant exposure (Banauch et al. 2005; Van Loveren et al. 1996).

In an earlier study (Kronholm Diab 2002), hairdressers claimed that their work-related symptoms increased during periods of exposure and also that they became more sensitive to other stimuli as well, indicating an increasing reactivity in the nasal mucosa. They felt that the reactivity decreased considerably during time away from work. For this reason, frequent periods without exposure were necessary for the hairdressers to be able to continue work.

Health-related quality of life (HRQoL) has been introduced late in occupational medical research compared to care health research in general. HRQoL and working life are linked and must be of concern to occupational health researchers (Blanc 2004). Data indicate that allergic rhinitis may have an important impact on productivity because of symptoms as tiredness, poor concentration and headache (Blanc et al. 2001).

The mechanisms of hairdressers' nasal symptoms and the consequences for their HRQoL are not clear. This is problematic when hairdressers ask for medical advice concerning continued work as a hairdresser. To clarify this issue, further research about the symptom mechanism and the influence of the symptoms on HRQoL during exposure periods is of great need.

The objectives of this study were to follow the development of work-related airway symptoms, HRQoL and inflammatory markers in nasal lavage fluid during a working period after vacation in female hairdressers. Hairdressers with mainly bleaching powder–related nasal symptoms were compared with hairdressers without such symptoms and pollen allergic females during the pollen season. Furthermore, we studied changes in nasal reactivity to persulphate in the symptomatic hairdressers.

Materials and methods

Study design

The study is a short-term prospective study of hairdressers with work-related nasal symptoms from bleaching powder using a diary of symptoms and work tasks during 4 weeks after at least 2 weeks off work. As controls, one group of asymptomatic hairdressers and another one of females with hay fever to pollen were recruited. At the beginning and at the end of the study, the participants filled in HRQoL questionnaires and nasal lavage fluid was obtained for analyzing of albumin, eosinophil cationic protein (ECP), tryptase (for the atopic group) and Substance P. Another nasal lavage was performed in the hairdressers after a week of work. A medical examination was carried out in all participants before study start. The symptomatic hairdressers also performed a specific nasal challenge with potassium persulphate before and after the exposure period. Figure 1 shows the measures in each group and the outcomes.

The study was approved by the Regional Ethical Review Board at Lund University. All subjects were informed of the purpose of the trial and gave their signed informed consent.

Study population

We recruited symptomatic hairdressers among patients from the department of Occupational and Environmental Medicine in Lund and through a systematic telephone campaign to hairdresser salons in southern Sweden. The asymptomatic hairdressers were recruited in the same campaign. The inclusion criteria for the target group of hairdressers (Group S+; $n = 17$) were clear nasal symptoms to bleaching, but they could have symptoms from other hair chemicals as well. The latency time until nasal symptoms was 5 years (1–34) (median; range). In three persons, it was not possible to define a latency time. The comparison group were without symptoms (S−; $n = 19$). Exclusion criteria for all groups were history of atopy and/or asthma. Pollen allergic women were recruited among former research participants and by contact with the Department of Otorhinolaryngology, the division for Allergy, Lund. We included the pollen allergic group because of the well-known mechanism of symptoms, and the established impact on their quality of life. The pollen allergic group (PA; $n = 10$) had nasal symptoms only from birch and/or grass and Chrysanthemum Weed, no exposure to bleaching powder and took no regular medications for allergies. Difficulties to find women with allergy to merely pollen made this group smaller than the hairdresser groups.

The content of pollen/m^3 air and day (alder, hazel, birch, grass and Chrysanthemum Weed) varied between low, moderate and high (1–1,000 pollen/m^3 for trees and 1–100 pollen/m^3 for grass and Chrysanthemum Weed) during the investigation period of the PA group. No days with very high pollen content occurred during the exposure period (Personal communication from Åslög Dahl, Department of Plant and Environmental Sciences, Gothenburg).

No differences were found concerning age and smoking habits between the groups. There was also no difference between the two groups of hairdressers with regard to employment years as a hairdresser, working hours or atopy by skin prick test (Table 1).

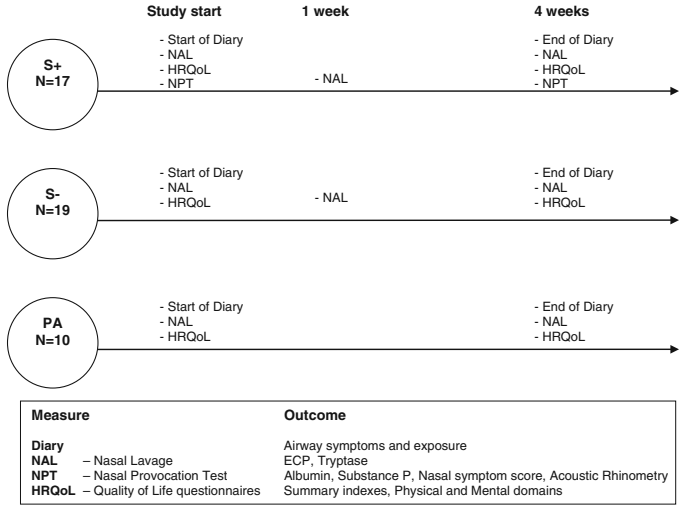

Fig. 1 Flow chart of the study design, the measures and the outcomes (*S+* symptomatic hairdressers, *S−* asymptomatic hairdressers, *PA* pollen allergic women)

Table 1 Characteristics of the symptomatic (S+) and asymptomatic hairdressers (S−) and pollen allergic women (PA)

Study groups	S+ $n = 17$	S− $n = 19$	PA $n = 10$
Age (years; mean; SD)	39 (11)	37 (12)	34 (15)
Employment years as a hairdresser (mean; SD)	20 (13)	17 (12)	–
Working activity as a hairdresser (*n*)			
<50 %	3	2	–
51–75 %	6	6	–
76–100 %	8	11	–
Smoking habits (*n*)			
Smokers	2	2	0
Never smokers	13	17	9
Ex smokers	2	0	1
Atopy–by history test (*n*)	0	0	10
Positive skin prick test (*n*)	1	2	10

Clinical examination

A physician (JN) conducted a standardized interview including a medical and occupational history, questions about atopy and smoking habits. Special attention was given to airway-related symptoms and their relationship to the workplace. Work-related rhinitis was defined according to the position paper for occupational rhinitis by Moscato et al. (2008) and by Sublett and Bernstein (2010). Atopy by history was defined as having a history of hay fever, asthma or atopic eczema in childhood or adolescence.

A physical examination was performed including an anterior rhinoscopy and a skin prick test with 13 common allergens (ALK, Copenhagen, Denmark) and potassium persulphate in fresh solutions with sterile water [0.05, 0.1 and 0.5 % (w/v)]. The reaction was read according to Aas and Belin (1973). The medical examination for the atopics including the quality of life questionnaires took place before the start of the pollen season.

Diary

During 4 weeks of exposure, all study subjects filled in a diary including symptoms from the eyes, nose, throat, cough, sputum production, wheezes, dyspnea, cold/flu symptoms, medication use and if they had been staying out of work due to their symptoms. The hairdressers also stated what hair treatments they accomplished daily, such as bleaching, hair dyeing, hair spraying, applying permanent and the type of products used. They indicated use of ventilation and other protective products such as gloves and apron. The PA group started the diary when having clear allergic symptoms and documented if they reacted to any other agent than pollen. In the results section, symptoms caused by infection are excluded.

Nasal lavage

A nasal lavage was performed before the exposure period for all subjects. Repeat nasal lavage was performed after 1 week and again after 4 weeks of exposure for the hairdressers. Allergic subjects had repeat nasal lavage only

after 4 weeks. The lavage was performed using sterile isotonic saline solution. This was sprayed into the nasal cavity using a container of glass and a plastic atomizer nozzle. A centrifuge tube was placed in crushed ice and topped with a plastic funnel. The saline was sprayed three times into each nostril at the nasal conchae. The study subject was instructed to breathe by the mouth and to lean forward and let the fluid drop from the nostrils into the funnel until 10 mL was collected in the tube. The tubes were kept on ice until centrifugation, which was performed within 3 h (Naclerio et al. 1983; Quirce et al. 2010).

Analysis of the nasal lavage

The supernatant was obtained by centrifugation of the sample volume at 0.3 g for 10 min at 4 °C. The samples were kept at −80 °C until analysis. For Substance P, one ml of nasal lavage fluid was transferred into a 3.6 mL Nunc cryotube containing 1 mL of inhibitor. For ECP and tryptase analysis, the supernatant was transferred into a 3.6-mL cryotube. We could not exclude blood in the nasal lavage samples, and therefore, we did not include the data for albumin.

The levels of ECP and tryptase were analyzed by a double antibody fluoro enzyme immunoassay. These assays are available as commercial kits (Pharmacia Diagnostics AB, Uppsala, Sweden). Substance P was analyzed by an Immuno Linked Immuno Assay, ELISA (Cayman Chemical Company, Ann Arbor, MI, USA). The detection limit for albumin was 0.4 mg/L, for ECP 0.5 μg/L, for Substance P 8.2 ng/L and for tryptase 1.0 μg/L.

Specific nasal challenge

A specific nasal challenge was performed before and after 4 weeks of exposure in the S+ group. The challenge was made with a 0.001 % fresh solution of potassium persulphate in isotonic saline solution and after 20 min with a 0.01 % solution (w/v) using a de Vilbiss spray (atomizer No. 15) as earlier described (Nielsen et al. 1994). A total of 300 μg of each solution was sprayed into the nasal cavity by turns. The spraying was performed immediately after a maximal inspiration to prevent the solution from entering the lower airways (Mellilo et al. 1997).

Nasal symptoms (blockage, running nose) were recorded using a score system from 0–3 (0 = no symptoms, 3 = severe symptoms) before and 15 min after each challenge. The rating was performed for each nostril, and the average was used. The number of sneezes was counted and scored as "no sneeze attacks" = 0; 1–5 = 1; 6–15 = 2; >15 = 3. A combined nasal symptom score was calculated from nasal blocking, secretions and sneezes (Malm et al. 1981).

Acoustic rhinometry (AR) was performed using a RhinoScan v. 2.5 (Interacoustics A/S, Assens, Denmark) according to Hilberg and Pedersen (2000). The measurements were made as earlier described in Kronholm Diab et al. (2009). The Minimum Crossectional Area and the volume were measured in the distance of 10–22 mm (MCA1 and VOL1) and 22–54 mm (MCA2 and VOL2) from the nares before the challenge and 15 min after each challenge. Data are presented as the mean of the values for the right and the left side of the nose. Nasal reactivity was defined as a significant increase in nasal symptoms of ≥ 3 points in total symptom score (Kronholm Diab et al. 2009) and/or a significant decrease in AR measures of the anterior part of the nasal cavity (Hilberg and Pedersen 2000).

A nasal lavage was performed twice before the first challenge and 20 min after the second one directly after the rhinometric measurement. The first lavage (Time 0) was performed to wash out mediators due to the general environmental exposure before the challenge. The second lavage (Baseline) before the challenge was used as the baseline for the post-challenge samples. The lavage procedure was made as earlier described in Kronholm Diab et al. (2009).

Quality of life questionnaires

The study participants filled in the Short Form 36 Health Survey (SF-36) (Ware and Sherbourne 1992; Ware et al. 1993) and the Rhinoconjunctivitis Quality of Life Questionnaire (RQLQ) (Juniper and Guyatt 1991; Juniper et al. 1996) before the medical examination to avoid influence from the questions posed by the physician. The participants were instructed according to the guidelines defined by the designers of the questionnaires. As proposed by several authors, we used a combination of generic and disease specific quality of life scales (Leong et al. 2005; Terreehorst et al. 2004). The study participants were asked if any serious or dramatic event had happened during the observation period to exclude response shift (van Gerth Wijk 2002). In the comparison analyses for quality of life, the number of participants in the S− group is 18, due to missing questionnaires from one hairdresser at the study end.

SF-36

The SF-36 was given to analyze the hairdressers last 4 weeks. We used the Swedish self-administered version (Sullivan et al. 2002). SF-36 comprises 36 items within eight health domains related to physical and mental health dimensions: PF (Physical Functioning, 10 questions), RP (Role Physical Functioning, 4 questions), BP (Bodily Pain, 2 questions), GH (General Health, 5 questions), VT

(Vitality, 4 questions), SF (Social Functioning, 2 questions), RE (Role Emotional, 3 questions) and MH (Mental Health, 5 questions). The domains are scored on a scale of 0 (worst) to 100 (best) points and calculated for each domain using a standardized scoring system (Sullivan et al. 2002; Ware et al. 1993). On the basis of the eight scales, it is also possible to estimate a physical (PCS) and a mental component summary (MCS) score (Ware et al. 1995). The Swedish version of the SF-36 has shown good psychometric values in different studies (Taft et al. 2004), and there are norms for the Swedish population available (Sullivan and Karlsson 1998).

RQLQ

Rhinoconjunctivitis quality of life questionnaire (RQLQ) evaluates QoL in a particular disease state (Juniper and Guyatt 1991). This 28-item questionnaire is self-administered and has been validated to measure the functional impact of rhinoconjunctivitis in seven domains: activity limitation, sleep, Non-rhinitis symptoms, practical problems, nose and eye symptoms and emotional function. The domains are scored from 0 (=no impairment) to 6 (=severe impairment) as perceived by the subject during the previous week. The RQLQ has strong evaluative and discriminatory properties (Juniper et al. 2002).

Statistical analysis

For all statistical analyses, SPSS version 15.0 and PASW 18.0 (SPSS Inc., Chicago, IL, USA) were used.

The eight health indices in SF-36 were calculated according to a SAS program provided by the HRQL group at the Sahlgrenska University hospital in Gothenburg (www.hrql.se), who handles the Swedish version of SF-36. We calculated mean, standard deviation (SD) and 95 % confidence interval as parameters for the QoL data, as the SAS program delivers mean values and SD. Visually assessed p–p-plots suggested that the data were normally distributed. For comparisons between groups, the Mann–Whitney U test was employed, and for changes within the groups, the Wilcoxon signed-ranks test. This is also valid for the analysis of biomarkers and symptoms. The significance level was set at 5 %.

Variables with dichotomous outcomes were analyzed with a generalized model with a logit link (i.e., logistic regression). Continuous variables were analyzed with a linear mixed model with restricted maximum likelihood (REML) estimation and a diagonal covariance matrix. In both models, repeated measures were identified by personal identification number and day in study. For the continuous variables "High-lifting blond," "Hair Dye," "Blond Hair Dye" and "Brown Hair Dye," the final Hessian matrix was not positive. These were therefore dichotomized into the categories 0 and ≥ 1 and analyzed with the logit link.

Results

Diary

Symptoms and medication used

The S+ group had increased nasal symptoms steadily during the exposure period. The PA group had more nasal symptoms (running, itching nose, sneezes) from the start than the S+ group, and the symptoms varied from week to week (Table 2). The eye symptoms varied less than the nasal symptoms. The OR for eye symptoms in the PA group compared to the S+ group was 8.07 (CI 95 % −3.20, −0.98; $P < 0.001$). In relation to the working days, the number of symptoms in the S+ group decreased during weekends and had a clear increase during the work days, especially at the end of the study period contrary to the PA group whose symptoms increased during days off work (Fig. 2). When the different nasal symptoms were studied separately, the S+ group had less sneezing and a tendency to more blockage than the PA group (Table 3). Nasal decongestants were consumed in the S+ group only during two percent of the study days. The PA group took antihistamines during 30 % of the study days. Furthermore, 8.2 % of the days they took antihistamines in combination with other allergy medications (data not shown). No significant differences were seen between the symptomatic hairdressers and the pollen allergic women regarding throat irritation, hacking cough, sputum or wheeze. However, the symptomatic hairdressers had more throat irritation (OR 1.13, CI 95 % −1.12, 1.37; ns) than the pollen allergic women (data not shown).

Exposure

Although the S+ group had a tendency to perform more hair treatments such as bleach, high-lifting blond and hair dye than the S− group, the only significant difference was in the use of hair spray (Mean S+ 3.0, S− 2.3; Mean difference −0.569, CI 95 % −0.917 to −0.221; $P = 0.001$). Within the S+ group, there was a tendency to less numbers of hair treatments during the last part of the study period (data not shown). There were no significant differences in the type of bleaching powder used such as dust, granules and crème, nor the type of hairspray (pump or aerosol propellant). Local exhaust ventilation was infrequently used in both groups (data not shown).

Table 2 Total nasal symptoms per week during the observation period (median; range) in symptomatic (S+) and asymptomatic (S−) hairdressers and pollen allergic women (PA)

Study groups	S+ $n = 17$	S− $n = 19$	PA $n = 10$	*P* values		
				S+ ↔ S−	S+ ↔ PA	S− ↔ PA
Week 1	7 (0–18)	0 (0–9)	14 (0–20)	0.001	0.011	<0.001
Week 2	8 (0–16)	0 (0–7)	8.5 (0–21)	<0.001	ns	<0.001
Week 3	8 (0–18)	0 (0–3)	15.5 (0–22)	0.001	ns	0.001
Week 4	11 (0–25)	0 (0–14)	7.5 (0–19)	<0.001	ns	0.001

Blocking, secretion, itching, sneezing. Symptoms caused by present infection are excluded

ns non-significant

Nasal lavage and specific nasal challenge

Inflammatory markers

The S+ group increased in ECP during the study period, and the S− group did not. The PA group had a higher level ECP, but no significant increase during the study period was noticed (Table 4). No significant differences regarding Substance P and Tryptase were registered between the S+ and S− groups during the study period. There was no significant difference in tryptase levels before and after the study period in the PA group (data not shown).

Specific nasal challenge

At the specific nasal challenge in the S+ group, the total nasal symptom score before challenge increased from 1 before work started to 2 after 4 weeks (Median; $P = 0.022$). After the first challenge, the symptom score increased from 1 to 2 ($P = 0.005$) and after 4 weeks of exposure the score increased from 2 to 3 ($P = 0.006$) indicating no change in nasal reactivity. The sub-group of those who reacted significantly at the first challenge did not react more at the second challenge compared to the non-reactors. No significant changes were found in acoustic rhinometry (data not shown). Before work started, albumin increased significantly from baseline to after the second challenge, while after 4 weeks of work the same increase was not significant (Table 5).

Health-related quality of life

Summary indexes

Before the exposure, the S+ and the PA groups had approximately the same Overall QoL. The S− had a better score compared to the other two groups (Table 6). After the study period, the hairdresser groups did not change significantly, whereas the PA group was significantly worse with a mean difference of 0.8. In the SF 36 before the

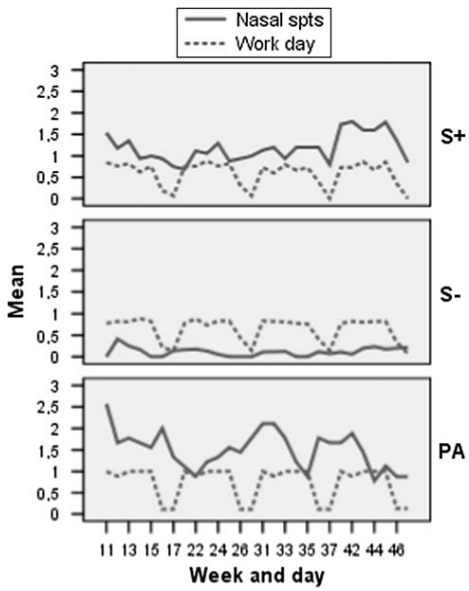

Fig. 2 Nasal symptoms (blockage, itching, sneezing, secretion; Mean) without infection and work days in symptomatic (S+; $n = 17$) and asymptomatic (S−; $n = 19$) hairdressers and pollen allergic women (PA; $n = 10$)

Table 3 OR, CI 95 % and *P* values for nasal symptoms in the symptomatic (S+) and the asymptomatic hairdressers (S−) compared to the pollen allergic women (PA) during the observation period

Nasal symptoms	S+ $n = 17$		S− $n = 19$		*P* value	
	OR	CI 95 %	OR	CI 95 %	S+	S−
Blockage	1.23	(0.41–3.70)	0.04	(0.01–0.15)	ns	<0.001
Itching	0.69	(0.26–1.85)	0.05	(0.01–0.33)	ns	<0.001
Sneezing	0.30	(0.12–0.74)	0.06	(0.02–0.25)	0.010	<0.001
Secretion	0.52	(0.18–1.52)	0.02	(0.0–0.06)	ns	<0.001

Table 4 Eosinophil cationic protein (ECP, μg/L) in nasal lavage fluid in symptomatic (S+) and asymptomatic (S−) hairdressers and pollen allergic women (PA) before (BE), after 1 (1wAE) and 4 weeks (4wE) of exposure

ECP (μg/L)	S+ $n = 17$		S− $n = 19$		PA $n = 10$		P value	
	Median	CI 95 %	Median	CI 95 %	Median	CI 95 %	S+↔ S−	S− ↔ PA
BE	3.8	(1.9–149.0)	4.0	(1.9–22.0)	8.4	(3.7–41.0)	0.523	0.002
1wAE	5.9	(1.9–57.0)	3.7	(1.9–32.0)	–		0.273	
4wAE	7.0[a]	(1.9–141.0)	3.1	(1.9–11.0)	28.0	(1.9–200.0)	0.050	0.002

[a] 1wAE ↔ 4wAE $P = 0.050$

Table 5 Albumin (mg/L) and Substance P (μg/L) (median; range) in nasal lavage fluid at specific challenge with per sulphate in symptomatic hairdressers ($n = 17$) after vacation and after four weeks of exposure

	BE		AE	
Albumin (mg/L)				
Time 0	4.2	(0.3–57.0)	4.7	(0.6–22.0)
Baseline	2.0	(0.6–17.0)	2.4	(0.3–14.0)
20 min after challenge 2	4.0[a]	(0.5–19.0)	3.7	(0.3–11.0)
Substance P (μg/L)				
Time 0	9.5	(4.3–44.4)	12.2	(6.4–34.8)
Baseline	8.9	(0.0–29.3)	12.6	(4.2–33.0)
20 min after challenge 2	10.9[b]	(3.9–60.7)	12.1	(3.9–40.6)

BE before and *AE* after four weeks of exposure

P value: [a] 0.047 baseline ↔ after challenge 2, [b] 0.030 baseline ↔ after challenge 2

study, the two hairdresser groups did not differ and had a higher score than the PA group in the mental summary score, though not significantly. No significant changes were noticed within the groups after the observation period (data not shown). During the exposure period, two S+ and one S− hairdressers as well as one participant from the PA group had experienced personal problems. Two S+ hairdressers had developed eczema to hairdresser chemicals. These events did not influence the results of the questionnaires, which we tested for by analyzing and comparing the data including and excluding these persons.

Physical domains

RQLQ Before the exposure period, the S+ and the PA groups were at the same level in the RQLQ physical items. The S− had better scores than the other two groups (Table 5). The most notable change during the study period in the S+ group was a slight deterioration in Nasal and Non-hay fever symptoms. The S− tended to become better after the work weeks except for in the category of nasal symptoms. The PA group had significant deteriorations in Eye, Nasal and Non-rhinitis symptoms (Table 6). There was a significant difference between the S+ and the PA groups in Eye symptoms after the exposure, and between the PA and the S− groups before and after in all three items ($P < 0.050$).

SF-36 The two hairdresser groups had significantly better scores than the PA group in the Physical Functioning before as well as after the study period (Table 6). For the other domains, there were no significant differences between the groups before the study. After the study period, the S+ and the PA group tended to decrease and the S− group increased in Role Physical. Thus, significant differences were found between the S−, S+ and PA, respectively (Table 6). No significant changes were noticed within the groups from before exposure to after (data not shown).

Mental domains

RQLQ The S+ and the PA groups were at the same levels before the exposure, while the S− had a better quality of life within the mental items (Table 6). There were significant differences between the S groups in Activities, Practical problems, and Emotions before and after the observation period, and also in Sleep after the exposure. Between the S− and the PA groups, there were significant differences in all items both before and after the work weeks ($P \leq 0.050$). No significant changes were noticed within the groups during the study period except for the PA group who showed a significant deterioration in Activities (Table 6).

SF-36 Before the work period, the two S groups had about the same scores in the mental health domains, whereas the PA group tended to have a lower score (Table 6). After the work period, the S+ and the PA groups showed a decrease and the S− group an increase in Vitality. Thus, significant differences were found between the S− and the S+ and the PA groups, respectively. The mean difference for Vitality in the S+ group after the study

Table 6 Selected domains from the RQLQ and the SF-36 before (BE) and after (AE) the study period in symptomatic (S+) and asymptomatic (S−) hairdressers and pollen allergic women (PA)

Measures	Health domains	Groups	BE		AE		Changes BE to AE		
			Mean	SD	Mean	SD	Mean	SD	*P* value
Overall QOL									
RQLQ[1]	Overall QoL (Mean of all 7 domains)	S+	1.2[c]	1.4	1.5[aaa]	0.9	0.4	1.5	0.327
		S−	0.2	0.3	0.3	0.7	0.1	0.8	0.594
		PA	1.2[ccc]	1.2	2.0[ccc]	1.5	0.8	0.8	0.014
Physical domains									
RQLQ[1]	Non-hay fever spt	S+	1.2[a]	1.5	1.7[aaa]	1.0	0.6	1.7	0.183
		S−	0.8	0.2	0.2	0.8	1.6	0.9	0.449
		PA	1.3[cc]	1.4	2.1[cc]	1.4	0.8	0.9	0.021
	Nasal spt	S+	1.2[aa]	1.5	1.7[aaa]	1.0	0.6	1.9	0.221
		S−	0.2	0.5	0.5	1.0	0.3	1.1	0.211
		PA	1.2[ccc]	1.3	2.0[cc]	1.4	0.8	1.0	0.031
	Eye spt	S+	1.0[aa]	1.0	1.2[aaab]	1.4	0.2	1.5	0.508
		S−	0.2	0.5	0.0	0.1	1.6	4.2	0.119
		PA	0.9[cc]	1.2	2.3[cc]	1.4	1.5	1.2	0.005
SF-36[2]	Physical Functioning (91;16)[3]	S+	95.0[a]	9.0	94.1[a]	14.4	0.9	4.8	0.693
		S−	97.2[b]	4.3	96.3[b]	6.0	1.1	4.8	0.435
		PA	84.9	14.3	84.4	11.8	0.4	11.4	0.912
	Role–Physical (86;30)[3]	S+	88.2	28.1	70.6	39.8	17.6	41.2	0.097
		S−	85.2	30.2	97.2	11.8	12.0	29.0	0.097
		PA	86.1	22.0	77.8[cc]	34.1	8.3	28.0	0.397
Mental domains									
RQLQ[1]	Activities	S+	1.5[aa]	1.7	1.8	1.1	0.3	1.7	0.437
		S−	0.3	0.2	0.2	0.8	0.1	1.0	0.523
		PA	1.5[c]	1.4	2.8	2.0	1.3	1.7	0.036
SF-36[2]	Vitality (67;2)[3]	S+	70.3	18.4	59.4[aa]	20.5	10.9	20.6	0.044
		S−	73.1	16.2	77.8	15.6	4.7	12.7	0.132
		PA	59.4	28.8	52.2[c]	29.3	7.2	11.5	0.096

[1] Higher score means worse QOL

[2] Higher score means better QOL

[3] Numbers in brackets are the Swedish norms for Females aged 30–49; $n = 1731$

S+ versus S−; [a] $P \leq 0.050$, [aa] $P \leq 0.010$, [aaa] $P \leq 0.001$

S+ versus PA; [b] $P \leq 0.050$, [bb] $P \leq 0.010$, [bbb] $P \leq 0.001$

S− versus PA; [c] $P \leq 0.050$, [cc] $P \leq 0.010$, [ccc] $P \leq 0.001$

period was 10.9, while no significant differences were seen in the other groups.

Discussion

In this study, we wanted to take a comprehensive look at the physical and psychological impact of chemical exposures hairdressers have at work. The hairdressers' nasal symptoms, mainly nasal blockage, increased steadily during the observation period, although they improved during weekends. There was an increase in ECP in nasal lavage fluid but the nasal reactivity to persulphate did not increase. The HRQoL deteriorated in the physical as well as in the mental domains in the symptomatic hairdressers especially in Vitality (SF-36). Notably, the asymptomatic hairdressers tended to ameliorate their HRQoL during work, while the pollen allergic group was more impacted than both hairdresser groups.

Methodology

The participants in the S+ group were recruited from current patients at the clinic fulfilling the inclusion criteria. As very few refused to participate, we think that a selection

bias is less likely. Furthermore, our groups were rather small; thus, we may miss some weak correlations. Our study period was also short. However, the risk of missing data would have increased as the loss of participants in prospective studies is a well-known problem (Kristman et al. 2004). In our case, the hairdressers used to have frequent short vacancies; thus, longer observation periods with exposure was not possible. Another reason we chose a relatively short study period was to ensure compliance with journaling among participants.

The hairdressers were compared to a group of pollen allergic women. It was not practically possible to define a zero point with regard to exposure for the PA group in the same way as for the hairdressers. This affected the results in the study of the mediators and the symptoms at the start of the diary.

We examined the HRQoL by choosing the SF-36 questionnaire, an extensively used generic quality of life questionnaire with acceptable discriminative but poorer evaluative properties for measuring rhinoconjunctivitis specific quality of life, and the RQLQ, which has strong discriminative and evaluative properties (Juniper et al. 2002). Specific questionnaires seem to be more sensitive to changes in HRQoL over time. However, the SF-36 has shown to be a complement of good value to the disease specific RQLQ (Leong et al. 2005; Terreehorst et al. 2004). The results of SF-36 are compared to the Swedish norms (Sullivan and Karlsson 1998). However, these are from 1991–1992 and may not be fully relevant due to changes in the society. Thus, our comparisons to these norms should not be over interpreted.

Diary and inflammatory markers

The clinical picture differed between the symptomatic hairdressers and the pollen allergic women. The hairdressers reported less symptoms from the eyes and more nasal blockage than the atopics, who had more itching, sneezing and secretion. The mechanism of the hairdressers' symptoms is not clear. The meaning of specific IgE against persulphates in the mechanism of hairdressers' nasal symptoms and also the use of skin prick testing in the diagnostics are controversial. We did not in an earlier study (Kronholm Diab et al. 2009) find specific antibodies using immunoblotting, and neither did we find any positive skin prick tests in that study, nor in the present one. Thus, the hairdressers' nasal symptoms may not be elicited through an IgE-mediated reaction to persulphates contrary to the symptoms in the pollen allergic group. Of course, IgE-mediated reactions could be elicited by other agents in the hairdressers salons, and in fact Hollund et al. (2002) found increased levels of total IgE in highly exposed hairdressers, but not after adjustment for age, atopy and smoking. Sensitization to latex was found by Hollund et al. (2002) and Leino et al. (1998) in some hairdressers, but the latter concluded that sensitization to agents other than persulphates is not common among hairdressers. The present hairdressers did not use latex gloves. Furthermore, in another study of nasal symptoms associated with exposure to organic acid anhydrides, those subjects who were not IgE sensitized to the anhydrides complained of nasal congestion and the sensitized ones of nasal secretion and sneezing (Nielsen et al. 2006). Thus, the difference in the clinical picture in hairdressers and in pollen allergic women may be due to different mechanisms.

The group of symptomatic hairdressers showed a slight but stable increase in nasal symptoms during the study period with transient decreases during days off. Furthermore, the increase in ECP during the study period indicated a progressive effect on the nasal mucosa from exposure. In the pollen allergic group, the symptoms varied during the observation period probably due to the level of exposure but the ECP level in nasal lavage increased. The reactivity to potassium persulphate in the nasal challenge test did not increase during the observation period in the symptomatic hairdressers all together. Looking at the sub-groups of those having an increase in nasal symptoms at the first challenge or not, neither of the sub-groups had a significant increase in nasal symptoms at the challenge after 4 weeks of work. Thus, it may be due to a too short observation period or that other agents than the persulphates may be the cause of the symptoms (Mounier-Geyssant et al. 2006; Ronda et al. 2009). It is possible that the reactions in the symptomatic group may simply be due to a higher level of exposure to chemicals and not to a sensitization to one or more chemicals. Opposed to this view, the hairdressers had a tendency to decrease the number of treatments during the study period. Furthermore, in an earlier study by our group, we have shown that there is a clear difference in reactivity between symptomatic and asymptomatic hairdressers when challenged with potassium persulphate indicating some form of sensitization (Kronholm Diab et al. 2009). Therefore, the mechanism behind the hairdresser's symptoms needs to be further examined.

Health-related quality of life

The results of this study indicated a better HRQoL in the two groups of hairdressers at study start compared to the Swedish female references for SF-36 except for General Health in the symptomatic hairdressers. The symptomatic hairdressers had a somewhat lower HRQoL than the asymptomatic ones. Two earlier studies have shown that the HRQoL among patients no longer exposed improves (van Gerth Wijk et al. 2011) or becomes similar to that of healthy controls (Airaksinen et al. 2009). In the present

study, the symptomatic hairdressers may have had a too short time off for a total recovery, which is also supported by the fact that they still had nasal symptoms at the study start.

Before the study period, the pollen allergic women had a decreased Vitality, an important aspect of the General Health showing how strong or weak, energetic or tired and worn out one feels, compared both to the hairdresser groups and to the Swedish norms. The same was true regarding Physical Functioning pointing out limits in the function of physical activities. The reason the pollen allergic group had a lower HRQoL than the hairdressers before the study period is not clear. They were either working or studying; thus, there should not be any healthy worker effect. It may be an effect of a chronic disease in the atopics, may represent the hairdressers' overall job satisfaction or simply an effect of the hairdressers having at least 2 weeks off work at study start, which the atopics did not (Riise and Moen 2003).

The asymptomatic hairdressers had an improvement in their HRQoL during the study period contrary to the symptomatic group who deteriorated parallel to the increase in symptoms. The symptomatic group finished the study period with the same inferior level as bell pepper greenhouse workers with rhinitis related to allergen exposure (Groenewoud et al. 2006). The pollen allergic women decreased significantly during the study period in both physical and mental domains in accordance with earlier studies (Camelo-Nunes and Sole 2010; Valovirta et al. 2008).

Juniper et al. (1996) have provided evidence for the minimal important difference (MID) to be 0.5 in RQLQ indicating that changes in the score of $\geq$0.5 can be considered of clinical importance. The symptomatic hairdressers showed a MID $\geq$ 0.5 in Non-rhinitis symptoms (lack of energy, thirst, reduced performance capacity, tiredness, concentration difficulties, headache, feeling of worn out) and in Nasal symptoms indicating most clinical effects in these domains. The deterioration in Non-rhinitis symptoms conforms well to the decrease in Vitality in the SF-36, thus the two results supporting each other. This strengthens our conclusion that there was a negative effect on the HRQoL of the symptomatic hairdressers during work.

In conclusion, the difference in the clinical picture between the symptomatic hairdressers and the pollen allergic females, and the increasing rates of symptoms and inflammation markers in the nasal mucous membrane during the study period support the view that a sensitization to hairdresser chemicals by a mechanism not yet understood is operating. Although the symptomatic hairdressers had a better HRQoL than the atopics before the study period/season, they had a considerable deterioration during exposure contrary to the asymptomatic hairdressers.

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Conflict of interest The authors declare that they have no conflict of interest.

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Paper IV

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Swedish Female Hairdressers' Views on Their Work Environment—A Qualitative Study

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Abstract: Swedish Female Hairdressers' Views on Their Work Environment—A Qualitative Study: Kerstin KRONHOLM DIAB, *et al*. Division of Occupational and Environmental Medicine, Lund University, Sweden—Objectives: Hairdressers have several work-related health hazards. Little is known of their strategies for the work environment. The aim of this study was to explore female hairdressers' own views on their physical, social and psychological work environment and possibilities of influencing it, implementation of their knowledge, financial impacts and how work-related symptoms affect their views. **Methods:** Fourteen hairdressers working for four years were subjected to open-ended interviews covering aspects of the physical, social and psychological work environment. Content analysis was applied. **Results:** An awareness of the impact of the work environment and the possibilities of influencing it emerged, but also an inability to achieve preventive improvements. This included reflections concerning ventilation, health issues, job strain, hair products, financial issues, knowledge from school and concern for having to leave the profession. The organization and acceptance of the work environment were important issues. Making the work environment an active part of their business was not common. **Conclusions:** Female hairdressers had an awareness of their work environment but lacked the means and strategies to make it an active part of their business. The main focus was on the customers and the work techniques. Having various symptoms did not alter this. Organizational and financial issues could put limitations on the work environment. Teachers were crucial in making the work environment interesting. Hairdressing was seen with advantages and disadvantages, and its future was seen as being insecure in terms of the occupational health risks. The hairdressers expressed a great pride in their profession providing possibilities for development.

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Key words: Content analysis, Hairdressing, Health risks, Prevention, Strategies, Work environment

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Hairdressers constitute an occupational group whose work has been shown to contain a number of work-related health risk factors. Studies of the occupation of hairdressing have been performed both nationally and internationally during the last 10–15 years. A number of articles stem from a Swedish context and concern respiratory symptoms[1–4], skin symptoms[5, 6] and reproduction[7–9]. Little is, however, known about the strategies that hairdressers use in their work environment to reduce health risk factors and to prevent ill health.

The magnitude of the problem was emphasized when the Swedish Work Environment Authority (SWEA) performed 169 inspections in the sector in the years 2005–2009[10]. More than 700 demands for improvements were reported, concerning risk assessments, policies and routines, chemical health risks and also business premises. Hairdressers reported 292 work-related illnesses during this period, and women reported approximately 90% of these. Injuries related to physical strain were the most common, but female hairdressers reported more symptoms of allergy and skin hypersensitivity than in any other business field.

Approximately 25% of the reported work-related illnesses were associated with chemicals, and more than 50% of these concerned skin diseases. Hairdressers often state that chemicals, such as hair dye and bleaching powder are the cause of skin diseases and allergies[10]. SWEA also performed an inspection campaign at hairdresser and nail builder salons in 2011 in southern Sweden, which resulted in 1,158 inspections. A total of 1,663 specific demande were noted in 585 reports, of which 1,008 concerned chemical risks[11]. Statistics Sweden has reported that 23% of hairdressers had work-related symptoms

due to difficult working postures in a twelve month period[12]. These results confirm those from a recent British study of self-reported work-related symptoms in hairdressers showing that they have a greater prevalence of work-related symptoms in the shoulders, wrists, hands and lower and upper back, pain in the legs and feet and work-related coughs and asthma. The authors of the report maintain that professional training for hairdressers must include appropriate health education in addition to health risk assessment[13].

Hairdressers in Sweden are an occupational group that is predominantly female (87%)[12]. There were 2,400 workplaces in 2010 where there were one or more employees, and the national average was three employees per workplace. There were also approximately 15,000 active one-person enterprises. Approximately 2,600 students graduated from the different hairdressing programs in 2010, and 40% of the hairdressers are still active as hairdressers eight years after completing their education[11].

Despite hairdressers having frequent health complaints and occupational symptoms impacting their health-related quality of life (HRQoL)[4], there is a lack of studies focusing on hairdressers' views on and strategies concerning their work environment. We thus wanted to study the perceptions of young female Swedish hairdressers regarding their work environment and how they cope with it.

Objectives

The overall aim was to explore female hairdressers' views on their physical, social and psychological work environment and possibilities of influencing it, implementation of their knowledge, financial impact and how work related symptoms affect their view.

Table 1. Characteristics and respiratory symptoms of the participants (N=14)

		Mean	SD
Age		22.4	0.65
		N	%
Atopy		8	57
Tobacco	Never smoked	5	36
	Ex smoker	1	7
	Smoker	8	57
Hand eczema		3	21
Nasal symptoms	Work related	9	64
Throat symptoms	Work related	5	36
Wheeze/ shortness of breath	Work related	1	7

Methods

A qualitative method was chosen for this study in order to gain subjective experiences and hairdressers' views on their work environment. This is an approach that includes methods for interviewing, analyzing and interpreting the studied phenomenon[14]. The interviewer's pre-understanding was based on earlier research within the hairdressing field concerning female hairdressers' respiratory symptoms[1, 4, 15]. The second author had experience from the hairdresser work environment, while the third author had considerable experience of qualitative research methodology.

Data collection

Fourteen participants from a group of recently graduated female hairdressers who had worked for three to four years were selected. Seven of these had work-related respiratory symptoms, and seven did not. This division into two subgroups was made based on the nature of the original project, the aim of which was to discover if there were any differences between the two groups of hairdressers. The analysis of the data did not reveal any differences, and thus the results are presented for the whole group. A further ten hairdressers declined to participate due to travelling abroad or too great a work load. The characteristics of the participant hairdressers are provided in Tables 1, 2 and 3.

The data were collected in open interviews taking place in the participants' home or business premises in accordance with their wishes. The first author conducted all the interviews using an interview guide covering the physical, social and psychological work environments. The opening question was, *How is your work environment?* The interviews were

Table 2. Working hours and working conditions of the participants (N=14)

		Median	Min-Max
Working hours/week		38.3	20–50
Working conditions		N	%
Number of hairdressers/ salon	1–2	6	43
	3–4	6	43
	6–13	2	14
Type of employment	Self employed	3	21
	Renting a chair	7	50
	Employee	4	29
Ventilation	Local air extraction	2	14
	Extra roof ventilation	7	50
	Air condition	2	14
Regular use of protective gloves		14	100

Table 3. Hair treatments performed by the participants (N=14)

Hair treatments	Times/week	N	%
Bleaching	1–2	1	7
	3–5	8	57
	6–10	5	36
High lighting blonde	1–2	7	50
	3–5	3	21
Hair dyes	1–2	1	7
	3–5	7	50
	6–10	3	21
	>10	3	21
Hair spray	3–5	1	7
	6–10	2	14
	>10	11	79

performed as an open conversation in which the interviewer probed further by using follow-up questions in order to ensure that the total work environment was covered. The interviews lasted 22–69 minutes and were tape-recorded and transcribed verbatim including pauses and emotional expressions.

Data analysis

The text was analyzed using a conventional inductive qualitative content analysis. The aim was to gain information from the informants without imposing preconceived categories or theoretical perspectives. The generated findings of the content analysis are based on the participants' unique perspectives and grounded in the data[16]. Both manifest and latent content analyses were used in this study. The focus in a manifest analysis is on the most obvious meanings in the text, while in a latent content analysis, the text is interpreted in order to discover its deep structural meaning[14]. In this study, we present the manifest and the latent findings in an integrated way.

The analysis started with the first and the third authors reading and re-reading the interviews independently in order to achieve immersion and obtain a sense of the whole. The authors then discussed their impressions of the text and decided on a structure for the analysis. Meaning units related to the aim of the study were identified and collated. The meaning units were re-read and coded according to the content of the text. Codes of similar content were then grouped and labelled as themes and subthemes. The statements in each theme were analyzed critically and questioned, read and compared. In the last step, the themes were compared with the original text and with each other in a constant movement between the whole and the parts and between the text and the themes, and a main theme was determined[17]. The first and third authors were both involved in the process of development of the themes and subthemes.

The credibility of the results was addressed through critical judgment in which the first and third authors took an active part in the data analysis, and this was discussed thoroughly in the process leading to refinement of the themes and subthemes. The second author did not take an active part in analysis of all the interviews but agreed on the themes after having read a number of the interviews.

Ethical considerations

After providing them with written and oral information, informed consent was obtained from the participants, who could withdraw from the study at any time; these procedures were performed in accordance with the principals of research ethics and approved by the Regional Ethical Review Board in Lund (Dnr 2009/98, 838/2005).

Findings

Awareness of the impact of the work environment and of possibilities to influence it

The overall interpretation revealed different levels of awareness of the influence of the work environment on the hairdressers and of the possibilities for them to influence it but also revealed an inability to achieve the desired preventive improvements. The awareness included reflections concerning ventilation, respiratory, skin and ergonomic issues, job strain, choice of hair products, financial issues and concern for having to leave the profession as well as for their approach to working with the work environment. Furthermore, the organization of the enterprise and acceptance of the work environment were important emerging issues. Making the work environment an active part of their business was not a chosen strategy, and the means were not always there. The themes in the findings were *seeing one's work environment*, *seeing one's customers, seeing one's profession*, *seeing one's symptoms*, and *managing one's waste*. The latter was only linked with *seeing one's work environment*, while all the others were linked with each other (Fig. 1). From the overall interpretation, a main theme and integrated themes emerged and are shown in Fig. 1; Table 4 shows the subthemes. These are further described below with illustrative quotations from the interviews.

Seeing one's work environment

The work environment was fundamental for the hairdressers in many respects, and most of the hairdressers spoke of the possibility of perhaps not being able to continue in the profession for the whole of their working lives. There was an awareness of the

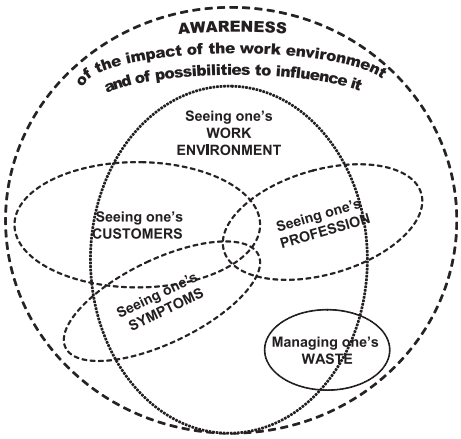

Fig. 1. The hairdresser's views on their work environment.

Table 4. Interpretation of the hairdressers' work environment

AWARENESS of the impact of the work environment and of possibilities to influence it.	
Themes	Subthemes
Seeing one's work environment	Influencing the work environment
	Applying knowledge
	Planning work
Seeing one's customers	Adjusting to the customer's needs
	Caring for the customer
Seeing one's profession	Developing and continuing in the professional role
	Being creative and getting variation at work
Seeing one's symptoms	Accepting one's symptoms
	Managing one's symptoms
Managing one's waste	

advantages and disadvantages in the work, of the possibilities of influencing the work environment, of applying knowledge and of being able to plan the work to a greater or lesser extent. Seeing one's work environment was described as *influencing the work environment*, *applying knowledge* and *planning work*.

1) Influencing the work environment

There was an awareness of the need for measures to prevent illness due to the work environment, but the hairdressers often failed to take steps to make improvements because of a number of factors. Acceptance of the work environment itself and the existence of symptoms was extensive, but there was often a lack of awareness as to which preventive actions should be taken. Some hairdressers tried, however, to find solutions to the problems. The financial situation and the organization of the salon were also important factors; for example, major financial investments would be difficult to make for those hairdressers who rented a chair and were not the owner of the salon, which was the most common organizational solution. The responsibility for the premises and the equipment would then be in the hands of others. Other strategies, for example, changes in work technique or physical training, were then employed, or the situation was accepted as one that could not be influenced.

> "Yes, but it's important, it is. Your work environment has a lot to do with how long you can work, particularly in this profession, where there are so many who don't work until their pension. There are so many injuries and a lot of allergies and such. It's very important." [Interview person (Ip) 8]

Concern for the customers was important for the hairdressers, while in turn, colleagues and customers were important for the comfort and well-being of the hairdressers. There could also be difficulties in discussing serious financial matters such as the cost of preventive measures in the premises with colleagues who were also one's friends. Preventive actions could be important, but were not always carried out due to the lack of knowledge or funds. A change in products used in the salon could be one way of improving the work environment and also of caring for the customer. Better products such as those containing less harmful hair chemicals were desired, and a conscious effort to introduce organic products was made in some salons. Having respiratory or skin symptoms contributed to the hairdressers' desire to change products.

> "Nothing will happen, it feels as though nothing came of those things, it was just talking, and being as everything was between friends so nothing came of it, …" (Ip 11)

2) Applying knowledge

The informants spoke of the importance of using preventive measures at work in the same way as had been done during their training. Those who had recently qualified and started to work in salons used strategies that included either accepting and applying the way their colleagues worked, or trying to implement the knowledge gained during their training. This would be applied to a greater extent when good routines had been the norm during their education. Teachers had either been persistent in encouraging students to use preventive measures and thus in implementing an awareness of the work environment,

or had practiced a laissez-faire mentality, allowing the students to take this responsibility themselves. The importance of the role of teachers in training was thus evident.

The primary focus at the beginning of the hairdressers' careers was on training and application of techniques, and preventive work was given second place. However, practicing good routines from a work environmental perspective depended on a number of factors, such as colleagues, one's own knowledge, routines learnt during training and existing symptoms. The hairdressers' awareness of the preventive work would be put into practice to a greater extent if they started a business of their own in new premises, which thus gave them the opportunity to realize their visions. Furthermore, their search for more knowledge would increase in this type of situation.

> "Yes, because this business with the work environment and safety as it's called is so much more than we had at school. Oh, of course we had hair dryers that hung from the ceiling, but we never discussed why. That is why it was so, why it was important that it was this way or that way." (Ip 2)

3) Planning work

The awareness of planning of the work in salons varied, and it was not always possible for the hairdressers to carry it out the way they wanted to. The responsibility of being self-employed or renting a chair in a salon was sometimes felt as being heavy for the young businesswomen and could in some cases lead to stress. On the other hand, this could be an advantage in terms of planning one's schedule or time off. There was also a desire to be employed in order to avoid having such responsibility at the beginning of their careers. Moving directly from a school environment and living with one's parents to being on one's own both in business, and maybe in one's personal life, could be seen as a major step to take. However, a desire to start one's own business and to have the possibility of designing the salon and the way work is done was also expressed, which could thus provide an opportunity to work in a preventive manner. The hairdressers' colleagues in the salon were important for the planning of the work. Planning work schedules together could be of importance, but this was something that was not made visible at the work place. Issues concerning prevention were seldom discussed at meetings in salons. The work situation in salons where several hairdressers worked could be tiring due to the level of noise, odors and heat generated by there being many hairdressers and clients in a confined space at one time. Financial awareness and responsibility for the business were influential factors throughout the planning process, affecting the customer timetable, purchases, and relationship with and competition among colleagues and other salons.

> "I think that you should be able to sit down, and you have to be able to eat etc. That's important because otherwise you won't manage it. There are those who work nonstop and then you don't feel well in the evening when you get home" (Ip 3)

Seeing one's customers

The customers had an influential position in that they were the foundation of the business, and the hairdressers were aware of the need for the customers to be satisfied with their work; this was seen in their desire for it to be so. It was thus important to care about the customers, who were also important in social terms. This awareness was described as *adjusting to the customer's needs* and as *caring for the customer*.

1) Adjusting to the customer's needs

The priority was to make it easy and to provide good value for the customers of the salon. To provide good value, the hairdressers were prepared to make compromises in e.g. scheduling, and to give way and push themselves further for regulars. Price could also be significant for the business but were dependent on the situation of the salon. Financial issues could thus impact the business, and putting themselves first and the clients second could lead to some stress if the hairdressers, for example, chose to use scheduling to create some freedom for themselves.

> "I can stand here. Now this is my third 12-hour day this week. Oh, but I only have one haircutting per hour, partly because I want to do a proper job and partly because I appreciate a 15-minute break between each customer, and then I don't feel the same stress. At the same time, so I don't earn as much money ….." (Ip 14)

2) Caring for the customer

Being available to meet the customer's needs was essential, and giving them priority was the norm. This could lead to stress for the hairdressers, for example, by having two parallel appointments. Similarly, caring for the customer could lead to stress if the hairdresser was not able to keep the appointment times. Good communication and good strategies to manage such situations were thus indispensable. Providing refreshments in the salon could be important in certain situations, thus making the customers feel cared for, as could having products to sell that the individual hairdresser could recommend. However, the strategies could vary, and the organization of the salon could be the determining factor for the choice of strategy.

> "…I have a little experience of other hairdressers who push in as much as possible in as short a time as possible and do it carelessly and stress themselves, and I don't want to do that. Instead I always have my usuals if there isn't anything very special, because I want to give to the customer and be relaxed myself." (Ip 12)

Seeing one's profession

There was an awareness of the advantages and the disadvantages in the profession and what that could lead to in the future, which could be somewhat insecure if symptoms had already occurred after three to four years of being a hairdresser. The hairdressers took pride in their profession and wanted to do a good job—it was the work they liked and wanted to continue doing. Perfectionism was not uncommon among the hairdressers, which affected them and could increase the risk of stress. Seeing one's profession was described as *developing and continuing in the professional role* and *being creative and getting variation at work*.

1) Developing and continuing in the professional role

The hairdressers expressed a desire to attend courses in order to create a niche for themselves or to be able to become a mentor for colleagues. Anxiety due to the fact that they caused themselves to be vulnerable to medical or psychological symptoms led to some of them desiring to develop themselves further, to create new concepts or to specialize within a field such as hair arrangements for weddings or teaching. There was also an element of being wise about the disadvantages of the profession. The expectations and the possibilities for the future varied either in terms of the level of acceptance of not being able to work more than about ten years, or in terms of finding different solutions to make it possible to stay in the profession the whole of their working lives.

> "…Oh, partly because I'll start to think it's boring. I'll always enjoy the contact with the customers, but I think I'll think it's boring. And if I consider my health, the allergy has deteriorated noticeably the last year, so it doesn't have to do with this, but there are many reasons for me to think that my work can make me weaker, which leads me to see that I don't want to be doing this perhaps in ten years time …." (Ip 14)

2) Being creative and getting variation at work

Creativity was a major element in hairdressing, and the profession provided a number of opportunities for being creative or for finding a new vocation. Being self-employed entailed having a responsibility for the business, with the more "glamorous" work elements concerning hair combined with other more menial duties such as cleaning, ordering products, reception and financial work. All these duties also generated a variation within the profession.

> "Thus when the customers are satisfied, when you see that you have really, that you've done something to make another person happy, absolutely, it's the best. … I think most of it is enjoyable actually. I think it's good that there is variation. I wouldn't like to be with one who only cuts for example …." (Ip 6)

Seeing one's symptoms

The informants described symptoms such as headaches, tiredness, nose blocks, nasal secretion, throat irritation, shortness of breath, coughs, watery eyes, skin irritation that even generates pain, and musculoskeletal stress and pain varying from mild to severe discomfort. Tiredness often accompanied the other symptoms. Headaches could be caused when the air was filled with chemicals, scents and odors and there were high noise levels due to large numbers of clients and hairdressers being in the same premises at the same time. The effect on their quality of life appeared mostly as tiredness, but sleep was also affected. Preventive measures to reduce symptoms were mostly focused on the skin and the musculoskeletal system and consisted of the use of good products, gloves, physical training, and even regular massages. Seeing one's symptoms was described as *accepting one's symptoms* and *managing one's symptoms*.

1) Accepting one's symptoms

There was a large acceptance of the work situation as such by the hairdressers, who could feel anxiety about symptoms and their prognosis if they continued their work in a salon. However, it was still not common for them to find means and strategies to prevent the symptoms, except for minor steps like use of gloves or physical training. Having symptoms also implied feeling some stress vis-à-vis the clients and the work and could sometimes be associated with a stressful period of work. The quality of life of the hairdressers was impacted by work-related symptoms, but they were not always aware of the connection between the symptoms and the constraints on their daily lives.

> "I've thought about changing my job, but I don't know what I'd do otherwise. So I'll carry on. I've thought that it's been quite difficult with my hands and always having problems and pain with that. But then I don't know what I'd do instead, and thus I carry on." (Ip 8)

2) Managing one's symptoms

Changes in the work environment, such as a change in the use of hair products, a change of salon, a change in planning work, a change in time off and a

change in the number of colleagues working at the same time, had an impact on the symptoms. The approach of colleagues could vary greatly from being very understanding to making fun of the hairdresser with symptoms. The strategies for dealing with the symptoms varied from doing nothing to actually trying to adjust the work environment in a correct way. The use of gloves and nasal spray were easy ways of managing symptoms of the skin and the nose.

> "Yes the days when it's hot outside and both of us are working a lot with dyeing and chemical treatments, then we become very tired and feel it in our throats and bodies, and it's not good to stand like that. And then we go out and call attention to the ventilation, but it's not always possible to rectify it." (Ip 11)

Managing one's waste

Managing waste included different alternatives for the hairdressers, from just sorting the domestic waste into paper, metals and plastics to sorting hair dye and bleaching powder remnants from the rest and leaving it at a waste disposal site. The possibility of buying this service from an entrepreneur who could collect the sorted waste was rarely utilized, but some owners took the sorted waste to the disposal site themselves, while others were not very concerned as to what happened with the waste. Rinsing hair dye, bleaching powder, high lightening and other hair products into the ordinary sewage system without using any additional filter was common. Initiatives to get information from the environmental administration of the municipal authorities had been taken, but without results. Good routines were important for managing waste, and some of the hairdressers expressed that it would be easy to adjust but that they had not given it much consideration. If fixed routines had been available, they would have followed them, but seeing the needs and implementing the routines had not been self-evident. There were, however, hairdressers who were aware and actively adhered to good working routines to diminish the waste of hair chemicals etc. The greatest responsibility for waste products was taken by the owner of the salon, but when renting a chair in a salon, such a responsibility did not seem obvious. The issue was seldom discussed among the colleagues. Suitable working techniques were also a way of coping with waste products when, for example, hair dyes and bleaching powder were mixed in smaller quantities several times instead of having to pour out leftover materials. The management of waste products was also a financial issue.

> "….but there were no regulations for that, which surprised me a little. I would have thought that it would be particularly suitable for all hairdressers to have something in the drain. Waste that can be burnt, that perhaps doesn't matter, but there's so much else that is, or well, doesn't matter and doesn't matter. But I think that there's so much more that is just as dangerous, but I don't really think that it's good just to flush everything down as we do,…" (Ip 12)

Discussion

Methodological aspects

There was a small number of participants in this study due to the outcome of the original study. Ten hairdressers declined to participate because of travelling abroad or too much work. This could have affected the findings in that those who claimed they had too great a work load to participate could have perceived more stress at work. We chose to have participants both with and without respiratory symptoms, as our aim was to discover if there were differences in how they perceived and reflected upon the work environment. No differences were found when reading the interviews, and the decision was made to analyze all the interviews together. Hairdressers without respiratory symptoms in the original project could, at the time of the interviews, have had other work-related symptoms that affected them, just as those hairdressers who had respiratory symptoms also had other symptoms. The interviews were performed either in participants' homes or salons. As the participants were able to make this choice themselves, we do not believe that the place where the interview took place had any influence on the results, as they were comfortable in the situation.

The present study was designed and written in accordance with the consolidated criteria for reporting qualitative research, COREQ[18]. The methodology in this study is thus thoroughly described, which contributes to its credibility. The researchers' pre-understanding might, however, have influenced the interviews and the data analysis. In the interview situation, the interaction between the interviewer and the informant may influence the outcome. According to Malterud, "*personal issues can be valuable sources for relevant and specific research*", and the perspective of the researcher always shapes the research[19]. In the present study the researchers' pre-understanding was important in terms of being able to ask questions that were well-grounded in the field, and this was also taken into account and reflected upon during the analysis. The interviews were read by the third author in order to provide feedback to the interviewer as a support for developing interview skills in order to increase the trustworthiness of the data and the findings. To further improve the trustworthiness, the second author, who had not previously participated in

the study, read a number of interviews and agreed on the themes and the subthemes. The participants did not have this opportunity, which could be a disadvantage, but the inclusion of relevant quotations from the transcribed text enhanced the trustworthiness of the findings[17].

The use of qualitative content analysis can be criticized, but the advantage of the conventional approach to content analysis is the ability to gain direct information from the participants without imposing preconceived categories or theoretical perspectives. This was found to agree well with the aim of this study. This method has been described as being useful in gaining information based on the participants' unique perspectives grounded in the data, thus allowing the researcher to get a broader understanding of the phenomenon[16]. We found it the most suitable method to gain information from the participants for our study.

Main findings

The overall findings indicate that the hairdressers were aware of their work environment, but not of all the possible measures to prevent illness. There was a focus on the working techniques and the impression the salon gave but not on the possibility of using the work environment as a way to market the salon and care about the clients. The possibilities of influencing the work environment differed due to the organization of the salon, financial reasons or lack of knowledge. The hairdressers thus constitute a professional group, who largely accept their work environment as it is, and this may be due to experiences of positive elements in the profession[15].

The level of awareness of the work environment varied with regard to the different parts of the work environment. Most hairdressers in Sweden are self-employed and do not have large financial margins, and thus investment in an air extraction system could well be beyond their means. Preventive measures were taken in smaller and less costly matters such as the use of gloves and aprons, choice of products, participating in sports and use of a chair, but where larger investments were necessary, it was the salons with one owner and a number of employees that were able to carry out improvements. This is, however, not specific to hairdressers in Sweden. Iwatsubo *et al*. found that only about half of the salons in their French study had a specific ventilated technical area[20]. The organization of the salons appeared to play a crucial part as well. Managing a hairdresser salon with one or more owners, with a number of hairdressers renting a chair and perhaps one or two employed hairdressers is not a simple task. This together with the fact that the mean age of hairdressers in Sweden is 34 years[21], and the fact that the colleagues are often friends, means that the job of taking preventive measures in terms of the work environment is something that can easily be disregarded.

The findings showed that the attitude and knowledge of the teachers during training were of great importance for the future interest in and the strategies concerning measures to improve the work environment. This interest and knowledge are factors that have an impact on the preventive measures. Perkins and Farrow found a positive association between the prevalence of skin problems and the frequent use of protective measures, suggesting a reaction to the incidence of problems instead of the use of precautions[22], and Ling and Coulson also emphasized the practical aspects of hand dermatitis prevention in the hairdressing curriculum[23]. The schools and the teachers should put greater efforts into developing the awareness of the work environment for the students and into reminding them constantly throughout their training/internship. Hairdressers thus need to be constantly reminded of the importance of preventive measures by teachers and colleagues in order to increase their awareness of the work environment.

That the foundation for the hairdressing profession is the customers was evident in the findings, and customer comfort and satisfaction were the main priorities. The hairdresser herself, her health and her well-being were more or less neglected where the customers were concerned, in particular in the case of the regulars. This could be due to financial reasons, ignorance or a lack of interest in one's own health. The core of regulars was treated with special care, as there was a need to have them in order to keep the business solvent. The focus on the satisfaction of the customer could lead to stress for the hairdressers, and mental strain and a large number of customers have been seen to increase work-related upper limb disorders in hairdressers[24]. The social impact of the customers as a positive element for the hairdressers should, however, not be ignored, and caring for the customer would increase this[15]. It would be of great value for the hairdressers to see the connection between a healthy work environment and a satisfied customer from an occupational health perspective. A hairdresser who does not feel well due to her work is not good publicity for the salon, and customers today have become more aware of the chemicals used in hairdressing salons and have expressed worries and questions about the health effects of these chemicals. The high number of hairdresser salons in Sweden generates fierce competition between salons[11]. This might lead to the work environment being ignored because of the need to fill the time schedule to keep the business financially solvent. The competition could be coped with by increasing the awareness of

the work environment instead, which could also form the foundation for good marketing for the hair salons.

Little discussion took place among hairdressing colleagues about the work environment, and no forum for the hairdressers to debate and to get help in finding knowledge, strategies and manageable solutions has been established in Sweden. Many young hairdressers are not members of an organization for hairdressing businesses or union, as they see this as being too costly, and are not aware of the possibilities that occupational health can offer them[11]. The SWEA performed inspections in hairdresser salons in Southern Sweden in 2011, and more than 870 working sites, including nail builders and schools, were visited. This inspection increased the awareness of the work environment, the safety risks and the regulations among the hairdressers. It also increased the knowledge of how to improve the work with the occupational environment. However, the SWEA stated that the hairdressers had knowledge of the chemicals used in hairdressing salons and also ergonomic issues, but that this knowledge was not always implemented. Furthermore, the SWEA reported that the information from the Swedish Cosmetic, Toiletry and Detergent Association and their safety instructions were not widely read[11]. This concurs with the findings from an English study, in which it was found that most hairdressers used information from labels on chemical products to assist product preparation and to determine whether the product would suit a particular client, but not for eventual health risk information[25]. The present study suggests the need for frequent inspections to stimulate interest and awareness in the profession with regard to existing regulations, which is an important issue for the authorities to deal with. It thus indicates that greater knowledge and help for small business premises would be important.

That the hairdresser profession has both advantages and disadvantages became evident in this study, but an insecure future was also noticeable in terms of the number of occupational health risks. Pride in the profession was expressed together with its many positive elements, such as the possibility of developing within the profession, independence, social context and creativity. The possibility of developing within the profession might constitute a strategy to cope with health issues and to avoid exposure to occupational risks but also constitutes a desire to become more skilled and educated in order to be able to find one's own niche within the hairdressing profession. Being a small entrepreneur was positive in terms of independence, but could also be stressful regarding financial issues and giving clients priority, which could increase symptoms. The flexibility and possibility of controlling one's working hours, which are elements of the independence in the profession, could be important factors in positively affecting health and well-being, as was also found by Costa *et al*.[26]. Hairdressers are part of a social context together with their clients, which is important for them. A study of small-scale entrepreneurs showed an association between good self-reported health and a good social life[27], and in an earlier qualitative study, we found that the social interaction with the clients is something that is very meaningful for hairdressers[15]. Creativity is a basic element in hairdressing, and offers opportunities to the hairdressers to find ways to vary their work or even to find other approaches if leaving the profession. The latter contains many positive elements, but there is at the same time a need for preventive measures in the work environment to reduce health risks; a strong awareness of this among the hairdressers is essential.

Conclusions and implications

This qualitative study showed that hairdressers are aware of their work environment, but lack the means and strategies to make it an active part of their business. The main focus for hairdressers is their customers and the working techniques within hairdressing. Having various symptoms did not alter this, and hairdressers with respiratory symptoms in the original project could have other physical symptoms at the time of the interview as was the case for the hairdressers, who in the original project did not have respiratory symptoms. We have also found that schools and teachers have a crucial role in making the work environment be as interesting an issue as the hairdressing techniques are, and that organization or financial issues could impact the work environment negatively. The occupation of hairdressing could be seen to have advantages and disadvantages, but also its future as insecure in terms of the occupational health risks and their consequences; there was, however, a great pride in the profession providing opportunities for development.

It would be of value for hairdressers to have a forum where they could gain information and have the possibility of discussing issues concerning the work environment. The role of the customer as the foundation for the business makes it necessary for the profession to see the customer and the work environment as one unit, and to integrate the work environment in the profession. It could also be of value to consider how hairdressing salons are organized, as it can be difficult to properly grasp the problem of the work environment if the management is weak.

Appropriate health education and risk assessment are important for hairdressing students if we are to see a reduction of occupational illnesses in the profession. Measures and initiatives taken by the respon-

sible authorities would also be a way to increase knowledge and to inform the hairdressers of the existing regulations. It is also important that suppliers use fewer chemicals in their products, while retaining the qualities that the customers desire so that the hairdresser and the customer will both be satisfied with the result. The work environment should be given greater consideration than is done at present in order for it to be an important factor in the hairdresser's working life.

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