Finnish Institute of Occupational Health
University of Helsinki, Department of Public Health

*Timo Leino*

# *Epidemiology of Skin and Respiratory Diseases among Hairdressers*

ACADEMIC DISSERTATION

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*Timo Leino*

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Author: Timo Leino
Research and Development Department in Occupational Health Services
Finnish Institute of Occupational Health
Topeliuksenkatu 41 aA, 00250, Finland
Tel. +358-9-4747 2396
Fax. + 358-9-4583092
E-mail: Timo.Leino@occuphealth.fi

Supervisors: Professor Lasse Kanerva
Department of Occupational Medicine
Finnish Insitutute of Occupational Health

Henrik Nordman, Docent
Department of Occupational Medicine
Finnish Insitutute of Occupational Health

Professor Matti Klockars
Department of Public Health
University of Helsinki

Reviewers: Professor Jouni Jaakkola
The Nordic School of Public Health
Göteborg, Sweden

Professor Hannu Tukiainen
Department of Pulmonary Diseases
University of Kuopio

Opponent: Sakari Tola, Docent
Varma-Sampo Mutual Insurance Company
Helsinki, Finland

Editing: Minna Pernaa
Cover Design: Arja Tarvainen

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# Summary

Skin and respiratory disorders are a serious problem to hairdressers. They can reduce work capacity and lead to permanent inability to work. We present five epidemiologic studies using representative population samples. The studies focused on the working conditions in salons and perceived health of the hairdressers (*Study I*), prevalence, incidence and risk of skin and respiratory symptoms and diseases among hairdressers (*Study II–IV*), and the risk and causes of leaving the profession (*Study V*).

The physical conditions and chemicals in the ambient air were measured in 20 hairdressing salons. Health of the hairdressers were inquired with a questionnaire (*Study I*). In *Study II*, a stratified random sample of 15–54–year-old hairdressers and saleswomen (referents), working in the greater Helsinki area were drawn from the labour unions' membership registers. Personal, exposure, and outcome variables were inquired with a computer-assisted telephone interview method (CATI). Hairdressers with work-related skin or respiratory symptoms were examined for occupational diseases at our clinic (*Study III*). The study populations of hairdressers and saleswomen for *Study IV* & *V* were drawn from the Longitudinal Census Data File of Statistics Finland. The data was gathered with a mail questionnaire.

The peak concentrations of persulfates, thioglycolates, organic solvents and ammonia were 6–100 times higher in the breathing zone of hairdressers as compared with the ambient air of the salons (*Study I*). TLVs were not exceeded. Bleaches, hair dyes, permanent solutions and aerosol sprays were causing discomfort and illhealth, especially in small salons with less ventilation (Ar ≤ 3.6 1/h). Air exhange rate of 5–7 times per hour reduced markedly dustiness and chemicals in the atmosphere. Better general ventilation reduced also health complaints, but only slightly.

The prevalence of chronic bronchitis was increased about 5–fold and rhinitis and eye symptoms about 1.5–fold among hairdressers as compared with the referents (*Study II*). In *Study IV*, the relative risk of chronic bronchitis was doubled among hairdressers. 10% of the hairdressers had asthma in 1995,

which is double the prevalence of asthma in the general population in Finland, and similar to other high risk jobs. Also the incidence of asthma (2.2 cases per 1000 person years vs. 1.3 among the referents) and the relative risk to develop asthma (OR 1.7, 95% CI 1.1–2.5) were increased among hairdressers during the 15–year follow-up. The attributable fraction of asthma due to exposures in hairdressing was 41% (95% CI 9%–60%).

The prevalence of occupational diseases was 2.8% for dermatitis, 1.7% for rhinitis and 0.8% for asthma. Previously diagnosed atopic diseases increased the risk for occupational skin and respiratory diseseas 3–fold (OR 2.9. 95% CI 1.1–7.9). 90% of the respiratory diseases and 30% of the hand dermatitis cases were caused by ammonium persulfate. Other causative agents were wet work, PPDA and NRL. Sensitization to human dandruff (8.6%) and *Pityrosporum ovale* (12.1%) was high among hairdressers as compared with the occupationally non-exposed referents (0.3% for human dandruff and 3.5% for *P. ovale*).

During a 3–year follow-up, one third of the hairdressers diagnosed as having an occupational disease were forced to change her occupation (***Study III***). In the 15–year follow-up (***Study V***), atopic diseases in the medical history increased the risk of leaving the profession by 20%. The highest risk of leaving the profession was with hairdressers suffering from asthma (3.5 times higher compared with the referents), hand dermatitis (2.7 times higher), a strain injury of wrist or tennis elbow, and neck or shoulder disorders (1.7 times higher).

The working conditions in hairdressing salons are satisfactory according to Finnish indoor air criteria (***Study I***). High peak concentrations during hair treatments cause discomfort and illhealth to hairdressers and should be controlled with, e.g. local exhaust ventilation. Hairdressers' risk of having asthma and chronic bronchitis and of developing asthma is increased (***Study II*** & ***IV***). Occupational skin and respiratory diseases are more common than expected from the official register data of occupational diseases in Finland (***Study III***). Ammonium persulfate caused most of the occupational skin and respiratory diseases. Exposure to it should be minimized. Occupational skin or respiratory disease, atopic diseases, hand dermatitis and musculoskeletal strain disorders increase the risk of leaving the profession (***Study V***).

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# Abbreviations

| | |
|---|---|
| Ar | Air exchange rate |
| BMRC | British Medical Research Council |
| CATI | Computer-assisted telephone interview |
| CI | Confidence interval |
| $CO_2$ | Carbon dioxide |
| dB(A) | A-weighted sound level in decibels |
| $FEV_{1.0}$ | Forced expiratory volume in one second |
| FIOH | Finnish Institute of Occupational Health |
| GMTG | Glyceryl monothioglycolate |
| I | Illumination |
| IAQ | Indoor air quality |
| ICDRG | International Contact Dermatitis Research Group |
| INCI | International nomenclature of chemical ingredients in cosmetic products |
| NRL | Natural rubber latex proteins |
| OR | Odds ratio |
| PEF | Peak expiratory flow |
| PPDA | Paraphenylenediamine |
| ppm | Parts per million |
| PVP | Polyvinylpyrrolidone |
| RH | Relative humidity |
| RR | Risk ratio |
| S1, S2, S3 | Finnish indoor air quality classes (S1 is the highest) |
| SEM | Scanning electron microscope |
| SRR | Standardized risk ratio |
| STEL | Short time exposure limit |
| $T_a$ | Air temperature |
| $\Delta T_a$ | Vertical air temperature difference |
| TLV | Threshold limit value |
| TWA | Time-weighted average |
| $V_a$ | Air velocity |
| VOC | Volatile organic compound |

# Contents

# List of original publications

This thesis is based on the following publications, which are referred to in the text by their Roman numerals:

I Leino T, Kähkönen E, Saarinen L, Henriks-Eckerman M-L, Paakkulainen H. Working conditions and health in hairdressing salons. *Applied Occupational and Environmental Hygiene* 1999; 14:26–30.

II Leino T, Tammilehto L, Luukkonen R, Nordman H. Self-reported respiratory symptoms and diseases among hairdressers. *Occupational and Environmental Medicine* 1997; 54(6):452–455.

III Leino T, Tammilehto L, Hytönen M, Sala E, Paakkulainen H, Kanerva L. Occupational skin and respiratory diseases among hairdressers. *Scandinavian Journal of Working Environment and Health* 1998; 24(5):398–406.

IV Leino T, Tammilehto L, Paakkulainen H, Orjala H, Nordman H. Occurrence of asthma and chronic bronchitis among female hairdressers – A questionnaire study. *Journal of Occupational and Environmental Medicine* 1997; 39(6):534–539.

V Leino T, Tuomi K, Paakkulainen H, Klockars M. Health reasons for leaving the profession as determined among Finnish hairdressres in 1980–1995. *International Archives of Occupational and Environmental Health* 1999; 72(1):56–59.

# 1 Introduction

Hairdressing and barbering are in some countries almost entirely done by men. This is not the case in Finland. According to cencus data 96% of the 12568 hairdressers in 1993 were women. Very few hairdresser nowadays cut only men's hair, i.e. barbers. Most of the Finnish hairdressers do both men's and women's hair. Today, both female and male customers ask for various hair treatments, such as coloring, bleaching and permanenting. Thorough washing of the hair with a conditioner is needed for a good endresult, and for the same reason, some type of finishing product is used for almost every customer. This means that during a typical work week a hairdresser can be exposed to hundreds of different chemicals through the skin and via the respiratory system.

One distinctive difference in Finland compared to, say the U.S.A., is that cosmetologic services are available in only few beauty salons. The Finnish cosmetologists have special training and prefer to work in their own salons. If a beauty salon offers both hairdressing and cosmetologic services, the cosmetologist's room is normally separated from the hairdressing salon. This situation simplified the design of our study, and is good to know when interpreting the results.

Hairdressing salons are typically small shops with one to five hairdressers working in them. There are about 7000 registered hairdressing enterprises in Finland. Most of the shops are situated at street level or in shopping malls. Salons employing more than 20 hairdressers are rare. Some specialization is possible, but generally hairdressers do all kinds of hair treatments already from the beginning of their career. Their vocational training takes one to three years, depending on the institute.

From the published clincal studies and other surveys, and from our own experience of studying occupational diseases among hairdressers at the clinic of occupational medicine of FIOH, the biggest health problems in hairdressing fall into three categories: 1) musculoskeletal strain disorders, 2)

skin irritation and hand dermatitis and 3) upper and lower respiratory symptoms and illnesses. Annually 30–50 new cases of occupatioanal skin and respiratory diseases among hairdressers are registered in the Finnish Register of Occupational Diseases.

We decided to concentrate on the two last-mentioned problems, as only few epidemiologic studies have been published on the occurrence and risk of hairdressers' skin and respiratory diseases based on a representative sample of the population base. We studied working conditions in hairdressing salons, and their influence on the health and well-being of the workers. Two of the studies focused on the occurrence of and risk for respiratory and skin symptoms and diseases, and the prevalence of occupational skin and respiratory diseases and their causes. Finally, we studied the effect of atopic diseases, respiratory and skin diseases and other health reasons on staying in the hairdressing profession.

Our hope is that this series of studies would help to draw attention to hairdressers' work, which is creative work but also causes unnecessary strain, discomfort and illnesses to those who perform it. The ultimate aim is, as always in occupational medicine, prevention.

# 2 Review of the literature

## 2.1 Exposure to hairdressing chemicals

Apart from being exposed to hair, human dandruff and saprofytes of the scalp, hairdressers are exposed to hundreds of different hairdressing chemicals capable of causing skin and airway irritation and sometimes also allergic diseases (Dahl 1990). Today, less irritative and sensitizing products are used, but the basic active ingredients of oxidative hair dyes, bleaches and permanent wave preparations have remainend the same from the beginning of the 19th century when they were first introduced to the markets. Shellac, methylene chloride and freons are no longer used in aerosol lacquers. Several substances are banned in hair dyes because of their carcinogenic and toxic properties, and concentrations of certain substances are restricted to a level regarded to be safe in professional and home use of the products (IARC 1993). An inventory of cosmetic ingredients, coveing also hair cosmetics, has been prepared by the European Community (Cosmetics Directive 76/768/EEC).

### 2.1.1 Chemicals in hairdressing products

A short description is given of the principal ingredients of the products used in hairdressing. *Shampoos* are made of water and surfactants. Foam builders, refatting agents, thickeners, opacifiers, coloring agents, fragrances, buffers and various preservatives (mainly parabens, formaldehyde and Kathon CG) are used to achieve desirable qualities of a product. *Conditioners* are meant to restore manageability, softness and shine to the hair. Conditioning agents fall into three categories: cationic detergents, film foamers, and hydrolyzed proteins. *Hair bleaches* are made of ammonium, sodium, and potassium persulfates (30–70%). The bleaching powders are mixed with hydrogen peroxide (6–12%) just before application to accelerate the oxidizing action of peroxide. Ammonia releasers are added to bleaches to improve their penetration into the hair. *Hair dyes* can be classified as temporary, semi-permanent, and permanent dyes. The permanent dyes are generally p-

phenylenediamines and p-aminolphenols and their derivatives. Their nitro derivates are used in semi-permanent dyes together with a selected number of azo dyes and aminoanthraquinone dyes. The temporary dyes are water-soluble acid or basic dyes. The coloring lotion usually contains 1–5% dye, ethanol or isopropanol as solvent, and ammonia or monoethanolamine as pH-adjusting agent. *Permanent waves* solutions contain up to 11% salts of thioglycolic acid. In principle, the cold waves contain mainly glyceryl monothioglycolate, and the ordinary wave preparations ammonium thioglycolate. But mixtures of them and other waving agents, such as thiolactate and cysteine amine are frequent in both categories. Ammonia or amines are added to adjust pH. Hydrogen peroxide (0.5–3%) is used to fix the waves. *Hair-styling products* are mainly setting lotions and hair sprays in aerosol and nonaerosol form. Waxes, wet gels, and aerosol foams (mousse) are also used. Hair-styling products contain polymeric resins such as polyvinylpyrrolidone (PVP), vinylacetate copolymers, or polyquaternium-4 diluted in solvent (50–95%), such as ethanol, isopropanol and acetone. Phthalates (e.g. diethyl- and dibuthyl derivates) are sometimes used as plasticizers, and butane or dimethylether as propellants.

### 2.1.2 Exposure studies

The reports on the chemical concentrations in hairdressing salons and operations are summarized in Table 1. The concentrations of organic solvents, ammonia, hydrogen sulfide, hair dyes, PVP and particulates have been low compared with the threshold limit values. The highest concentrations of ammonia (25 mg/m$^3$) and organic solvents (59 mg/m$^3$) have been observed in the hairdressers' breathing zone during the mixing and application of chemicals to the hair. The exposure time is usually quite short, varying from tens of seconds (hair sprays) to tens of minutes (permanent solutions and dyes). The total personal exposure can still be considerable, because work tasks in high exposure are repeated many times a day. Local exhaust ventilation reduces effectively the level of chemicals in the salons, but is seldom used.

Table 1. Reports on chemical concentrations in hairdressing salons and operations

| Work task/chemical | Reference |
|---|---|
| Permanenting | |
| Ammonia | Hollund 1998, Van der Wal 1997, Rajan 1992, Hakala 1979 |
| Hydrogen sulfide | Hakala 1979 |
| Hydrogen peroxide | Van der Wal 1997 |
| Organic solvents | |
| Ethanol | Almaguer 1992, Rajan 1992, Gunter 1976 |
| Isopropanol | Hollund 1998, Rajan 1992 |
| Toluene | Hollund 1998 |
| Dyeing | |
| Parafenylenediamine | Hollund 1998, Gagliardi 1992 |
| Diaminotoluene | Hollund 1998 |
| Ammonia | Hollund 1998 |
| Hydrogen peroxide | Van der Wal 1997 |
| Bleaching | |
| Ammonium persulfate | |
| Ammonia | Hollund 1998 |
| Hydrogen peroxide | Van der Wal 1997 |
| Hair lacquering | |
| Organic solvents | |
| Ethanol | Van der Wal 1997, Gunter 1976 |
| Isobutane | Gunter 1976 |
| Butane | Van der Wal 1997 |
| Polyvinylpyrrolidone | Gunter 1976 |
| Particulates | Van der Wal 1997 |
| Ambientl air in salons | |
| $CO_2$ | Van der Wal 1997 |
| VOCs | Van der Wal 1997 |
| Ethanol | Van Muiswinkel 1997, Van der Wal 1997, Hakala 1979 |
| Ammonia | Hollund 1998, Van der Wal 1997 |
| Hydrogen peroxide | Van der Wal 1997 |
| Total dust | Van der Wal 1997, Palmer 1979 |
| Particulates | Van der Wal 1997 |

## 2.2 Dermatoses

### 2.2.1 Prevalence and incidence

The prevalence of occupational dermatoses among hairdressers in different study populations varies greatly (10–50%) (Stovall 1983, Meding 1990b, Rivett 1990, Guerra 1992b, Diepgen 1993, Holm 1994a,d). Over 90% of the dermatoses are on the hands (Holness 1990a, Guerra 1992b, Pilz 1994a, Holm 1994d). In a three-year prospective cohort study of 495 apprentice hairdressers, 40% developed mild and 23% moderate hand dermatitis during the follow-up (Diepgen 1993). The one-year cumulative incidence of hand dermatitis in two prospective cohort studies of apprentice hairdressers was 27.9% and 28.5%, respectively (Smit 1994, Uter 1998c). The incidence rate for hand dermatitis was 15.2 cases/100 person years and 32.8–34.3 cases/100 person-years when the mild cases were included.

According to the Finnish Register of Occupational Diseases, the incidence of occupational dermatoses has varied between 20–40 cases/10 000/year. The incidence of allergic contact dermatitis was only 10 cases/10 000/year among hairdressers in 1997 (Jolanki 1997). The incidences are low compared with the incidence of hand dermatitis in North-Bavaria, Germany, where it was 194 cases/10 000/year (Diepgen 1994). Based again on register data, the incidence of contact urticaria was 1.2 cases/10 000/year among hairdressers.

When the frequencies of registered cases of dermatitis in different occupations were compared, the standardized risk ratio (SRR) was found to be 2.0 (95%CI 1.2–3.4) for allergic contact dermatitis among hairdressers, compared to the highest SRR 6.4 (95%CI 3.8–11) among dentists (Jolanki 1997).

### 2.2.2 Irritant contact dermatitis and its etiology

Irritant skin symptoms are common among hairdressers. Often their skin irritation symptoms start already in the beginning of the career during vocational training. The symptoms correlate well with the frequency of hand washing and duration of wet work (Von Kienlein-Kletschka 1984, Kristensen 1986, Uter 1995a,c). Several follow-up studies of hairdressing

apprentices and hairdressers show that up to two thirds of them have had irritant skin damage during a follow-up of 3–8 years. (Borelli 1965, Von Kienlein-Kletschka 1984, Von Budde 1991, Holm 1994b, Smit 1994, Uter 1995a,c, Majoie 1996b, Zelger 1999, John 2000). Wet work for over 4 hours per day (OR 2.1, 95% CI 1.4–3.0), and permanent waving for over one hour per day (OR 1.7, 95% CI 1.1–2.4) increased the risk of occupational hand dermatitis (Diepgen 1996). In another study on hairdressing apprentices wet work, for over 2 hours per day was also a significant risk factor (OR 1.8, 95% CI 1.2–2.6) of irritant hand dermatitis (Uter 1999).

Hairdressers wash the clients' hair frequently with shampoos that remove natural moisture and lipids from the hands. Alcohol-containing hair-finishing products, hydrogen peroxide, ammonia in hair dyes, and irritation of persulfates and thioglycolates in bleaches and permanent wave solutions have the same effect (Table 2). Additional strain to the skin of the hands is caused by the friction of hair when it slides through the fingers, and by heat when a hair blower is used. Hardening and callosities of the skin, and small cuts are common among hairdressers, too (Hannuksela 1980, Guo 1994). Small pieces of hair can stick into the skin and predispose to interdigital granulomas, pilonidal sinuses and abcesses (Duperrat 1966, Gartmann 1967, Hunziger 1970, Gannon 1988, Hogan 1988). Softening and curving of the nails, i.e. koilonychia caused by long-term use of permanent wave solutions has also been reported (Hannuksela 1980, Alanko 1997).

### 2.2.3 Allergic contact dermatitis and its etiology

Allergic contact dermatitis usually starts somewhat later in a hairdresser's career than irritant contact dermatitis (Von Budde 1991, Uter 1998, Zelger 1999). The reports of contact allergies in hairdressers are summarized in Table 2. For decades the most common causative agents have been paraphenylenediamine and other oxidative hair dyes (Ludwig 1982), salts of thioglycolic acid used in permanent solutions, which have been found to remain in the hair for several weeks after application (Storrs 1984, Lynne 1988, Reygagne 1991), and persulfates in bleaches. Resorcinol and pyrogallol, which are used as couplers in oxidative hair dyes, preservatives (e.g. Kathon CG, formaldehyde, quaternium 15) in shampoos and other

hairdressing products, and rubber chemicals in gloves and utensils have caused allergic contact dermatitis among hairdressers.

### 2.2.4 Contact urticaria and its etiology

Itching, wheals, flare, and sometimes microvesicles appear as symptoms of contact urticaria immediately or soon, usually within an hour, after skin contact with a substance. Persulfates in bleaches and natural rubber latex in rubber gloves are the two agents in hairdressing that cause most often urticaria (Leino 1997). Other agents that have caused urticaria are protein hydrolysates in shampoos and conditioners, parafenylendiamine and its oxidative intermediates, diaminotoluene, para-aminodiphenylamine, basic blue, and henna (Table 2). Human hair can cause contact urticaria. One hairdresser got pruritic vesicles on her hands from each contact with the clients' hair and dandruff. In a scratch test, human dandruff induced a positive reaction in her (Mikkelsen 1978). In a Japanese study, 62% of atopic dermatitis patients reacted positively in a scratch test to crude extract of human dandruff and a fraction of 10–13 kD proteins (Yu 1988). It is not clear what the antigen in human dandruff is. It is possible that extracts made of human dandruff have been contaminated with *Pityrosporum ovale* yeast – a common saprofyte of the scalp – which is associated with atopic dermatitis and seborrhea (Shuster 1988, Jensen-Jarolim 1992).

### 2.2.5 Predisposing factors

#### Atopy

Atopy is a strong determinant of work-related hand dermatitis. Several studies have shown that atopic hairdressers have irritant hand dermatitis more frequently than their non-atopic colleagues (Von Hornstein 1985, Szliska 1991, Smit 1994, Uter 1995a–c). In a three-year prospective study of hairdressing apprentices the odds for occupational hand dermatitis was 2.1 (95% CI 1.4–3.2) if a person had atopic skin diathesis (Diepgen 1996). In another similar type of study among German hairdressing apprentices (Uter 1998), the risk ratio (RR) for hand dermatitis was 1.55 (95% CI 1.03–2.31) if the atopy score (Diepgen 1991, Schnuch 1994) was more than seven points. It is worth noting that many atopics can work in hairdressing without

developing hand dermatitis. In the study of Uter et al. (1998), 25% of atopics managed without symptoms. Understanding of the risks associated with atopy, good treatment and careful hand protection can decrease the risk of hand dermatitis (Lammintausta 1993, Diepgen 1996). No difference has been found between atopic and non-atopic hairdressers with regard to sensitization to hairdressing chemicals or occurrence of allergic contact dermatitis in several cross-sectional studies (Sutthipisal 1993, Pilz 1994a, Coenraads 1998).

## Nickel allergy

Nickel is capable of causing both delayed and immediate allergic reactions (Estlander 1993). Allergy to nickel has increased rapidly among young women in Finland as well as in other countries. In the ’70s 1–2% of young women in Finland were allergic to nickel, whereas in the 80s and ’90s already 10–30% were sensitized (Peltonen 1979, Peltonen 1989, Kerosuo 1996). Nickel allergy among hairdressers and hairdressing apprentices examined for occupational dermatoses has been very prevalent: 30–50% or even higher in several studies (Wahlberg 1975, Marks 1977, Wahlberg 1981, Lindemayr 1984a, Gehse 1989, Guerra 1992b, Diepgen 1994, Von Peters 1994, Majoie 1996b, Özkaya-Bayazit 1997, Shah 1998, Zelger 1999). In other studies, the difference between hairdressers and the reference population has not been so evident (Landthaler 1981, Menné 1982, Schubert 1982, Holness 1990b).

Small amounts of nickel can be released from the metal utensils used in hairdressing (Dahlquist 1979). Hair dyes, permanent wave solutions, bleaches and shampoos can also contain trace amounts of nickel (Lindemayr 1984b, Basketter 1993). These exposures are, however, unlikely to explain totally the high prevalence of nickel allergy in hairdressers. It is more propable that nickel allergy in hairdressers is a result of the common use of nickel-containing jewellery and piercing of ears or other body parts at an early age (Boss 1982, Van der Burg 1986, Kerosuo 1996). When the endogenous and external factors were simultaneously analysed in a logistic regression model, a history of nickel sensitivity was not associated with an elevated risk of hand dermatitis (Diepgen 1996).

### 2.2.6 Prognosis of occupational hand dermatitis

According to several follow-up studies, the longest follow-up time being 8 years (Majoie 1996b, Zelger 1999), the prognosis of hand dermatitis is poor in hairdressers. Of those diagnosed as having hand dermatitis, 11–66% were forced to leave the profession because of skin problems (Cronin 1979, Lindemayr 1984a, Jarisch 1985, Nethercott 1986, Holness 1990a, Längle 1990, Meding 1990a, Rivett 1990, Von Budde 1991, Majoie 1996b, Shah 1996, Cavin-Milhaud 1998, Uter 1998, Zelger 1999). The prognosis of hand dermatitis is poorer among atopic hairdressers compared with non-atopic hairdressers. When an atopic hairdresser gets an occupational hand dermatitis, it is likely to lead to a change of occupation, but not necessarily to the clearing of the dermatitis. (Wilkinson 1978, Lindemayr 1984a, Rystedt 1985, Majoie 1996b).

Continued contact with an allergy-causing agent and with skin irritants in hairdresser's work are usual reasons for non-clearing of hand dermatitis. Good skin protection can reduce skin symptoms, but if protective gloves are not used properly, they may predispose to or even worsen already existing dermatitis. For example, some hairdressers have a habit of using the same pair of disposable gloves several times before throwing them away. Protection capacity studies of gloves show that none of the gloves typically used in hairdressing can give full protection against hairdressing chemicals, such as permanent wave solutions (Storss 1984, Tosti 1985, Savaides 1990, Von Wulfhorst 1992).

Nickel allergy seems to be an effect modifier (possibly associated with age and atopy) rather than the direct cause of hand dermatitis in hairdressers. Nickel allergy does not always lead to hand dermatitis, but when a nickel allergic hairdresser gets work-related hand dermatitis, its prognosis seems to be poorer than among hairdressers who are not allergic to nickel (Wahlberg 1975, Lindemayr 1984a, Pilz 1994a, Diepgen 1996).

Screening for persons with atopic dermatitis has been proposed to decrease the incidence of hand dermatitis among apprentice hairdressers (Von Mattheus 1986, Längle 1990). However, in a large study of 1042 prospective hairdressers followed from 1990 to 1997, the evaluation of occupational

suitability with the help of personal and family history, atopic skin, serum IgE, patch and prick tests did not seem to have a very good prognostic value (Zelger 1999).

A summary of studies on skin diseases by causative agents among hairdressers is given in Table 2.

Table 2. Reports of occupational and non-occupational skin diseases and their cause among hairdressers

| Disease | Cause | Causative ingredient | Reference | Remarks |
|---|---|---|---|---|
| Irritant Contact Dermatitis | Wet work | | Diepgen 1996, Uter 1995a, Uter 1995c, Von Pilz 1994a, Wall 1991, Jarisch 1986 | |
| | Use of blow dryers (heat) | | Von Pilz 1994a | |
| | Shampoos, soaps and detergents | Tensides, surfactants, preservatives, anti-dandruff agents | Adams 1999, Guo 1994, Von Pilz 1994b, Von Gloor 1985, Nagaki 1985, Cronin 1979, Czarnecki 1977, Black 1973, von Borelli 1965 | |
| | Hair and instruments | Friction and pressure | Guo 1994, Von Pilz 1994a, Hannuksela 1980 | |
| | Hair colorants | Ammonia<br>Hydrogen peroxide | | |
| | Permanent wave solutions | Glyeceryl monothioglycolate | Nagaki 1985*, Springer 1985, Rapaport 1983, Von Borelli 1957 | *Thio-glycolates not specified |
| | | Ammonium thioglycolate | Marks 1986, Czarnecki 1977*, Von Borelli 1957 | |
| | | Ammonia<br>Hydrogen peroxide | | |
| | Bleaches | Persulfates<br>Hydrogen peroxide | Adams 1999 | |
| | Hair finishing products | Organic solvents, plastic polymers | Adams 1999 | |

| | | | | |
|---|---|---|---|---|
| | | Not specified/several | Uter 1998, Conde-Salazar 1995, Diepgen 1993, Holness 1990b, Schubert 1982, Czarnecki 1977, Wahlberg 1975 | |
| Allergic Contact Dermatitis | Shampoos and conditioners | Cocamidopropyl betaine (CAPD)<br>Cocamide diethylamine<br>3-Dimethylaminopropylamine (DMAPA) | Uter 1999*, Zelger 1999, Leino 1998, Su 1998, Straube 1998, Kanerva 1996, De Groot 1995, Holm 1994e, Von Peters 1994, Van der Walle 1994a, Gonzalez 1992, Korting 1992, Wall 1991, Frosch 1990 | *Lack of DMAP positivity in 7 CAPD positive hairdressers |
| | | Captan | Aguirre 1994a, Guo 1994, Van der Walle 1994a, Vilaplana 1993, Gonzalez 1992 | |
| | | Not specified | Czarnecki 1977, Wahlberg 1975 | |
| | Hair lotions | Quinine | Tapadinhas 1994 | A 31–year-old mechanic |
| | Hair growth stimulators | Minoxidil | Veraldi 1992 | |

| | | | |
|---|---|---|---|
| | Hair colourants | Paraphenylenediamine | Lodi 2000, Armstrong 1999, Zelger 1999, Calvin-Milhaud 1998, Leino 1998, Gall 1997, Özkaya-Bayazit 1997, Matsunaga 1996, Shah 1996, Conde-Salazar 1995, Higashi 1995, Katsarou 1995, Von Gründer 1994, Von Peters 1994, Van der Walle 1994a, Frosch 1993, Sutthipisal 1993, Gonzalez 1992, Guerra 1992, Korting 1992, Wehrmann 1992, Von Szliska 1991, Frosch 1990, Holness 1990b, Gehse 1989, Matsunaga 1988, Brandão 1986, Mattheus 1986, Nethercott 1986, Itoh 1985, Kellet 1985, Nagaki 1985, Tosti 1985, Edwards 1984, Lindemayr 1984a, Storrs 1984, Yamasaki 1984, Lynde 1982, Landthaler* 1981, Cronin 1979, Czarnecki 1977, Marks 1977, Wahlberg 1975, Laubstein 1974, Von Borelli 1958 |
| | | m-Phenylenediamine | Matsunaga 1996, Higashi 1995 |

*Patch test positives also for Pellidol

| | | |
|---|---|---|
| | 2-Nitro-4-phenylenediamine | Lodi 2000, Zelger 1999, Leino 1998, Özkaya-Bayazit 1997, Shah 1996, Conde-Salazar 1995, Higashi 1995, Katsarou 1995, Von Gründer 1994, Von Peters 1994, Frosch 1993, Sutthipisal 1993, Guerra 1992, Gonzalez 1992, Wehrmann 1992, Von Szliska 1991, Frosch 1990, Holness 1990b, Gehse 1989, Frosch 1987, Nethercott 1986, Nagaki 1985, Tosti 1985, Lindemayr 1984a, Lynde 1982 |
| | 4-Aminodiphenylamine hydrochloride | Zelger 1999, Leino 1998, Gall 1997, Özkaya-Bayazit 1997, Conde-Salazar 1995, Higashi 1995, Katsarou 1995, Guo 1994, Von Peters 1994, Frosch 1993, Guerra 1992, Frosch 1990, Gehse 1989, Nethercott 1986, Lindemayr 1984a, Landthaler 1981, Von Borelli 1958 |
| | N-phenyl-N'-isopropyl-phenylendiamine | Özkaya-Bayazit 1997, Lindemayr 1984a |

| | | |
|---|---|---|
| | Toluene-2,5-diamine | Lodi 2000, Zelger 1999, Leino 1998, Gall 1997, Özkaya-Bayazit 1997, Shah 1996, Matsunaga 1996, Conde-Salazar 1995, Higashi 1995, Holm 1994e, Von Gründer 1994, Von Peters 1994, Van der Walle 1994a, Gonzalez 1992, Wehrmann 1992, Von Szliska 1991, Frosch 1990, Holness 1990b, Gehse 1989, Matsunaga 1988, Frosch 1987, Brandão 1986, Lindemayr 1984a, Lynde 1982, Wahlberg 1975, Von Borelli 1958 |
| | p-Toluenediaminesulfate | Zelger 1999, Leino 1998, Özkaya-Bayazit 1997, Katsarou 1995, Von Peters 1994, Frosch 1993, Sutthipisal 1993, Guerra 1992, Frosch 1990, Holness 1990b, Van Joost 1991, Nethercott 1986, Kellet 1985, Nagaki 1985, Tosti 1985, Lynde 1982 |
| | m-Toluenediamine | Von Borelli 1958 |
| | o-Aminophenol | Matsunaga 1996, Matsunaga 1988 |
| | p-Aminophenol | Zelger 1999, Gall 1997, Özkaya-Bayazit 1997, Matsunaga 1996, Katsarou 1995, Von Peters 1994, Frosch 1990, Holness 1990b, Gonzalez 1992, Gehse 1989, Matsunaga 1988, Frosch 1987, Nagaki 1985, Von Borelli 1958 |

| | | | |
|---|---|---|---|
| | m-Aminophenol | Matsunaga 1996, Higashi 1995, Guo 1994, Von Peters 1994, Gonzalez 1992, Frosch 1990, Holness 1990b, Von Borelli 1958 | |
| | 2-Aminomethyl-p-amino-phenol-2HCl, Oxamitol | Wedi 2000 | Client of a hairdresser |
| | 4-Aminoazobenzene | Leino 1998, Conde-Salazar 1995 | |
| | Disperse yellow 3 | Conde-Salazar 1995 | |
| | Disperse orange 3 | Conde-Salazar 1995 | |
| | Quinazoline yellow SS | Matsunaga 1988, Monk 1987* | *Hair cream used by a 50–year-old man |
| | Solvent red 23 (Sudan III) 1-(p-Phenylazophenylazo)-2-naphthol | Matsunaga 1996, Uter 1991 | Cross-reaction with PPDA (Okada 1991) |
| | Hydroquinone | Von Peters 1994, Gonzalez 1992, Korting 1992, Frosch 1990 | |
| | Pyrogallol | Zelger 1999, Özkaya-Bayazit 1997, Shah 1996, Von Peters 1994, Frosch 1993, Sutthipisal 1993, Guerra 1992, Frosch 1990, Holness 1990b, Gehse 1989, Frosch 1987 | |
| | Resorcinol | Zelger 1999, Özkaya-Bayazit 1997, Katsarou 1995, Guo 1994, Frosch 1993, Guerra 1992, Gonzalez 1992, Vilaplana 1991, Frosch 1990, Von Borelli 1958 | |

| | | |
|---|---|---|
| Bleaches | Ammonium persulfate | Lodi 2000, Zelger 1999, Calvin-Milhaud 1998, Leino 1998, Özkaya-Bayazit 1997, Shah 1996, Conde-Salazar 1995, Katsarou 1995, Guo 1994, Holm 1994e, Von Peters 1994, Van der Walle 1994a, Frosch 1993, Sutthipisal 1993, Guerra 1992, Gonzalez 1992, Korting 1992, Von Szliska 1991, Van Joost 1991, Frosch 1990, Holness 1990b, Gehse 1989, Cronin 1979, Marks 1977, Widström 1977 |
| | Potassium persulfate | Gall 1997, Conde-Salazar 1995, Van Joost 1991 |
| | Hydrogen peroxide | Kanerva 1998, Aguirre 1994b, Gonzalez 1992 |
| Permanent wave solutions | Ammonium thioglycolate | Lodi 2000, Zelger 1999, Leino 1998, Gall 1997, Özkaya-Bayazit 1997, Conde-Salazar 1995, Katsarou 1995, Guo 1994, Von Peters 1994, Frosch 1993, Sutthipisal 1993, Von Szliska 1991, Van Joost 1991, Frosch 1990, Holness 1990b, Guerra 1992, Gonzalez 1992, Wehrmann 1992, Gehse 1989, Matsunaga 1988, Brandão 1986, Itoh 1985, Kellet 1985, Nagaki 1985, Tosti 1985, Lindemayr 1984a, Storrs 1984, Yamasaki 1984, Lépine 1971 |

| | | | |
|---|---|---|---|
| | Glyceryl monothioglycolate | Zelger 1999, Leino 1998, Straube 1998, Calvin-Milhaud 1998, Özkaya-Bayazit 1997, Shah 1996, Conde-Salazar 1995, Katsarou 1995, Guo 1994, Holm 1994e, Peters 1994, Van der Walle 1994a, Frosch 1993, Sutthipisal 1993, Guerra 1992, Gonzalez 1992, Korting 1992, Von Szliska 1991, Van Joost 1991, Wehrmann 1992, Frosch 1990, Holness 1990b, Gehse 1989, Lynne 1988, Frosch 1987, Burry 1985, Nagaki 1985*, Tosti 1985, Storrs 1984, Lynde 1982, Warshawshki 1981, Laubstein 1974 | *Thio-glycolates not specified |
| | Thiolactic acid | Straube 1998 | |
| | Sodium and ammonium bisulfite | Fisher 1989a | A 36–year-old woman |
| | Other thioglycol acid derivates | Czarnecki 1977, Schulz 1961, Voss 1958 | |
| Several hair products, most reports on shampoos | Fragrances | | |
| | Balsam of Peru | Lodi 2000, Zelger 1999, Gonzalez 1992, Landthaler 1981, Von Szliska 1991, Gall 1997, Kellet 1985, Lynde 1982, Marks 1977 | |
| | Oak moss | Kanerva 1999 | Permanent wave solution |
| | Lavender oil | Matsunaga 1996, Brandão 1986, Ménard* 1961 | *Eau de cologne |

| | | | |
|---|---|---|---|
| | Other/not specified | Leino 1998, Özkaya-Bayazit 1997, Matsunaga 1996, Shah 1996, Conde-Salazar 1995, Guo 1994, Holm 1994e, Sutthipisal 1993, Guerra 1992, Van Joost 1991, Lindemayr 1984a, Wahlberg 1975 | |
| | Preservatives | | |
| | Chloroacetamide | Assier-Bonnet 1999*, Zelger 1999, Katsarou 1995, Von Peters 1994, Gonzalez 1992 | Hair dye* |
| | Methylchloroisothiazolinone – methylisothiatzolinone (Kathon CG) | Zelger 1999, Leino 1998, Conde-Salazar 1995, Katsarou 1995, Guo 1994, Holm 1994e, Van der Walle 1994a, Sutthipisal 1993, Guerra 1992, Gonzalez 1992,Von Szliska 1991, Van Joost 1991 | |
| | Parabens | Zelger 1999, Gall 1997, Guo 1994, Van der Walle 1994a, Lindemayr 1984a | |
| | Formaldehyde and its releasers | Zelger 1999, Leino 1998, Gall 1997, Conde-Salazar 1995, Katsarou 1995, Guo 1994, Holm 1994e, Van der Walle 1994a, Sutthipisal 1993, Guerra 1992, Gonzalez 1992, Von Szliska 1991, Holness 1990b, Nethercott 1986, Kellet 1985, Lindemayr 1984a, Storrs 1984, Lynde 1982, Landthaler 1981, Wahlberg 1975, Laubstein 1974 | |

| | | | | |
|---|---|---|---|---|
| | | Not specified | Leino 1998, Özkaya-Bayazit 1997, Von Peters 1994, Frosch 1990, Nagaki 1985 | |
| | | Rosin (colophony) | Leino 1998, Gall 1997, Katsarou 1995, Conde-Salazar 1995, O'Reilly*, Guo 1994, Von Szliska 199, Kellet 1985, Landthaler 1981 | *Depilatory wax |
| | Rubber gloves and utensils made of rubber | Rubber chemicals<br>Thiuram sulfides<br>Mercaptobenzothiazole (MBT)<br>Zinc-diethyldithiocarbamate | Zelger 1999, Leino 1998, Gall 1997, Özkaya-Bayazit 1997, Conde-Salazar 1995, Itoh 1985, Nagaki 1985, Katsarou 1995, Holm 1994e, Van der Walle 1994a, Sutthipisal 1993, Guerra 1992, Von Szliska 1991, Lindemayr 1984a, Marks 1977, Wahlberg 1975, Laubstein 1974 | |
| | | Natural rubber latex proteins | Van der Walle 1995 | |
| | Scissors, hair clips, combs and other utensils made of metal alloys | Nickel sulfate<br>Cobolt chloride | Zelger 1999, Diepgen 1996, Gehse 1989, Van der Burg 1986, Lindemayr 1984b, Schubert 1982, Landthaler 1981, Dahlquist 1979, Wahlberg 1975 | Primary sensitization largely non-occupational |
| Contact urticaria | Hair and dandruff | Human proteins | Leino 1995, Mikkelsen 1978 | |
| | Rubber gloves | Natural rubber latex proteins | Kanerva 1999, Van der Walle 1995, Guerra 1992 | |
| | Shampoos and conditioners | Protein hydrolyzates<br>Stearyl trimethylammonium<br>Hydroxypropyl trimonium hydrolyzed collagen (Crotein Q) | Freeman 1996, Pasche-Koo 1992 Niinimäki 1998 | |

| | | | |
|---|---|---|---|
| | Quaternized hydrolyzed milk protein (Hydrolactin Quaternized Powder) | Niinimäki 1998 | |
| | Quaternized collagen hydrolyzate | Freeman 1996, Kousa 1990 | |
| | Hydrolyzed keratin | Freeman 1996 | A 22–year-old student |
| | Hydrolyzed bovine collagen | Pasche-Koo 1992, Pfeiff 1989 | |
| | Tilia (lime) | Picardo 1985 | A 25–year-old woman |
| | Eugenol | Picardo 1985 | |
| | Papaya | Fisher 1993b | A 9–year-old girl |
| | Sorbic acid | Rietschel 1978 | A 22–year-old college student |
| | Egg proteins | Braun-Falco 1984 | |
| Hair colourants | Para-phenylenediamine | Edwards 1984, Temesvári 1984, Calnan 1967 | |
| | N'N' -bis-(4-aminophenyl)-2,5-diamino-1,4-quinonediimine (PPDA's oxidation product) | Goldberg 1987 | Anaphylaxis |
| | Paratolunediamine's oxidation product | Pasche-Koo 1998 | Anaphylaxis |
| | p-Aminodiphenylamine | Von Liebe 1979 | |
| | Basic Blue 99 | Jagtman 1996*, Wigger-Alberti 1996 | *A 71–year-old woman |

| | | | |
|---|---|---|---|
| | Henna | Majoie 1996a, Frosch 1986, Nethercott 1986 | Anaphylaxis in tatooing (Gupta 1986), can cause ACD (Nigam 1988, Pasricha 1980), and asthma |
| Bleaches | Ammonium persulfate | Guerra 1992, Schwaiblmair 1990, Kleinhans 1989, Pepys 1987, Fisher 1985a, Fisher 1985b, Widström 1977, Fisher 1976, Brubaker 1972, Von Meindl 1969, Gaultier 1966, Calnan 1963 | Can cause anaphylaxis, asthma and rhinitis |
| Permanent wave solution | | Von Liebe 1979 | Causative ingredient not specified |
| Fixative fluid for permanent wave | | Von Liebe 1979 | Causative ingredient not specified |
| Hair spray | | Fisher 1973 | Causative ingredient not specified |

## 2.3 Respiratory diseases

### 2.3.1 Prevalence and incidence of asthma

Palmer et al. studied 262 cosmetologists and 213 graduate cosmetologists practising hairdressing in Utah, U.S.A (Palmer 1979). The non-occupationally exposed control group consisted of 569 people matched for age, smoking and region. The test battery included the British Medical Research Council respiratory symptom questionnaire, chest X-ray, pulmonary function tests and sputum analyses. The prevalence of physician-diagnosed asthma and chronic bronchitis was not reported. The hairdressers suffered more frequently from asthmatic symptoms, i.e. cough with sputum production, dyspnea, and wheezing (12%) compared with the referents (7.6%). The difference was statistically significant only after including borderline cases. Smokers and atopics had more symptoms. Hairdressers had more respiratory symptoms, obstruction in the small airways, and atypical sputum cytology (class II) as compared with the occupationally non-exposed referents. These increases were related to the size of a salon, particulate concentration and length of time in the occupation. No differences in X-ray findings were detected between the study groups.

Blainey at al. studied 23 hairdressers in a large salon specializing in hair coloring and bleaching in England (Blainey 1986). According to BMRC seven (30%) hairdressers had symptoms consistent with a diagnosis of asthma. All of them related their respiratory symptoms to the daily use of hair bleach powders. Respiratory symptoms were significantly associated with increased bronchial reactivity and smoking. Extensive immunological tests, pulmonary function tests and specific bronchial provocation tests revealed four occupational asthma cases (17%) caused by persulfates in bleaches. Only one out of four occupational asthma cases had a positive prick test to persulfate salts. The neutrophil chemotactic activity rose in the subjects with a positive challenge test indicating possible mast cell involvement. Two hairdressers with no symptoms or diagnosed asthma had over 20% variation in PEF during the work day.

Based on the Finnish register data, the annual incidence rate for occupational asthma among female hairdressers was one tenth (37 cases/100,000 employed workers) compared with the highest annual incidence rate among female bakers (408 cases/100,000 employed workers) (Karjalainen 2000). Hairdressers had the sixth highest risk for asthma among all occupations in Finland. The standardized risk ratio (SRR) for occupational asthma was 3.9 (95% CI 1.5–10) in hairdressers compared with the highest SRR of 17 (95% CI 14–21) for asthma among bakers (Keskinen 1997).

As a part of the EC Respiratory Health Survey, Kogevinas et al. (1996) studied the risk of asthma among subjects in the 20–44–year age range attributable to occupational exposure in Spain. The OR for asthma among hairdressers varied between 0.8 (95% CI 0.27–2.39) and 2.4 (95% CI 0.60–9.54) depending on the definition of the disease. When the data on 12 industrial countries and 15,637 people aged 20–24 years were pooled together, the proportion of asthma attributed to occupation was 5–10% (Kogevinas 1999).

### 2.3.2 Occupational asthma and its etiology

Persulfate salts in bleaching powders are the commonest cause of occupational asthma among hairdressers. Henna is also considered to be capable of causing asthma (see Table 3). The mechanism of persulfate-induced asthma is still unclear. The direct action of persulfate salts to release histamine from mast cells, or chemical irritation by oxygen radicals have been suggested (Calnan 1963, Parsons 1979, Mensing 1998). Positive prick and scratch tests with persulfate salts in some patients point to an allergic mechanism (Pankow 1989, Schwaiblmair 1990, Parra 1992). However, no specific IgE antibodies have been detected (Schwaiblmair 1990, Parra 1992). It is also postulated that T-lymphocytes specific for low molecular compounds could mediate direct inflammatory proceses in the airways (Yawalkar 1999). In a rabbit model, a concentration of ammonium and potassium persulfate aerosol (≥10.9 mg/m$^3$ in the air) mixed with hydrogen peroxide (≥ 1.36 mg/m$^3$ in the air) caused airway hyperresponsiveness to

acetylcholine after 4 h of exposure. Hydrogen peroxide (≥ 37 mg/m$^3$) or ammonium persulfate (5 mg/m$^3$) alone did not increase bronchial reactivity (Mensing 1995, Mensing 1998). In a group of 25 hairdressers presumed to suffer from occupational asthma, 10 showed bronchial hyperresponsiveness in a methacoline challenge test, but the specific challenge test with ammonium persulfate was positive only in two of them. The authors concluded that the methacoline challenge test alone cannot reliably sort out asthma cases from occupationally exposed nonasthmatic symptomatic subjects, or differentiate between occupational and nonoccupational asthma (Baur 1998b).

### 2.3.3 Occupational rhinitis and its etiology

Nokso-Koivisto et al. (1984) studied self-reported respiratory symptoms among 127 female hairdressers compared to 117 department store saleswomen. Attacks of sneezing were experienced by 54% of the hairdressers, 47% had a blocked nosed, and 25% a runny nose. The hairdressers had more upper and lower respiratory symptoms than the referents, but only the odds ratio (OR 1.87, 95% CI 1.07–3.39) for rhinorrhea was significantly elevated. Respiratory symptoms were most common among hairdressers making more than three permanents per day. Blainey et al. (1986) reported a similar prevalence (43%) of nasal symptoms in a study of 23 hairdressers. Hytönen et al. (1997) examined a series of 40 hairdressers suspected of having occupational rhinitis. The nasal symptoms were in order of frequency: sneezing (90%), rhinorrhea (70%), itching (70%) and nasal blockage (53%). Half of the hairdressers said nasal symptoms forced them to interrupt their work daily. 40% associated severe nasal symptoms with hair bleaching, 23% with permanent waving and 10% with hair cutting. Specific nasal provocation tests with ammonium persulfate, ammonium thioglycolate and human dandruff revealed two cases of occupational rhinits caused by ammonium persulfate, and one case caused by human dandruff. Ammonium thioglycolate did not elicit positive reactions in the prick tests. All the 31 nasal provocation tests done with it were negative. Although permanent solutions have been shown to cause occupational rhinitis to some individuals, it has been considered unlikely that

ammonium thioglycolate is the causative constituent (Schwartz 1990, Sala 1996).

According to the register data on occupational diseases in Finland, hairdressers had the 13th highest risk (SRR 4.0, 95% CI 1.8–9.1) of occupational rhinitis among all occupations (Hytönen 1997).

### 2.3.4 Occupational laryngitis and its etiology

Reports on occupational laryngitis are rare. In a series of 20 patients with laryngeal symptoms, Sala et al. (1996) reported four hairdressers diagnosed of having occupational laryngitis. The methods employed were prick tests and specific nasal or chamber provocation tests with observation of laryngeal status. In three of the hairdressers the causative agent was ammonium persulfate. One case was caused by permanent wave solution.

### 2.3.5 Other respiratory diseases among hairdressers

The health hazards of hair sprays were studied extensively in the '60s, '70s and '80s. Hair lacquers were shown to decrease cilia activity and mucus transport in the upper and lower respiratory tract (Friedman 1977, Borum 1984). The laquers irritate the mucous membranes and obstruct the small airways (Swift 1976, Palmer 1979, Zuskin 1981), particularly, in individuals with bronchial hyperreactivity (Schlueter 1979, Blainey 1986). Hair sprays contain polyvinylpyrrolidone, which has been suspected to cause alveolitis (Stringer 1977, Gebbers 1979) and granular lesions in the lungs called thesaurosis (Bergmann 1958, Bergmann 1962). However, the results of the clinical and epidemiologic studies of thesaurosis are controversial, and the evidence of the occurrence of thesaurosis among hairdressers is inconclusive (Palmer 1979, Ameille 1985).

### 2.3.6 Predisposing factors

The atopy of hairdressers seem to be related to an increased frequency of induced by bleaching powder (Schwaiblmair 1997). This is in agreement with other studies, which indicate that the frequency of asthma from low-molecular chemical substances is similar in atopics and non-atopics (Quirce 1998). In a German study, a positive bronchial provocation test with methacholine did not predict the outcome of a specific challenge test with ammonium persulfate (Schwaiblmair 1997). In the same study no relationship was found between the occurrence of respiratory disease and preceding skin symptoms.

Tobacco smoking has been found to increase the risk of sensitization and asthma among workers exposed to platinum salts and acid anhydrides (Banks 2000). It may have an effect in hairdressers, too. In the study of Palmer et al. (1974) the prevalence of cough and phlegm associated with the use of hair sprays was highest among hairdressers who currently smoked. In the study of Schwaiblmair et al. (1997), 60% of the hairdressers who had a positive bronchial provocation test with ammonium persulfate were smokers, compared with 29% in the group with a negative challenge test (Schwaiblmair 1997). The prick test with ammonium persulfate was positive in 60% of the hairdressers in the challenge test group and in 15% of the hairdressers in the negative challenge test group.

### 2.3.7 Prognosis of occupational asthma

In a Finnish study of occupational asthma patients, four to six years after the diagnosis was made, one third had dyspnea daily and used regular asthma medication; this was markedly less than the propotion of those who were diagnosed as having non-occupational asthma (Antti-Poika 1991). The social consequences of occupational asthma are variable and depend on many factors, including the social security system of a country. In two follow-up studies, one in France (Ameille 1997) and one in Finland (Antti-Poika 1991), hairdressers were included in the study population. The results were very similar. About one third continued in their previous work, being still

exposed to the causative agent, and 44% had changed to another job in both studies. About half of the French patients diagnosed as having occupational asthma had undergone a reduction in income during the three-year follow-up. In France, 25% were unemployed three years after the diagnosis of occupational asthma, compared with 7% in Finland.

A summary of the studies on respiratory diseases among hairdressers is given in Table 3

Table 3. Reports on occupational respiratory diseases and their causes among hairdressers

| Disease | Cause | Reference | Remarks |
|---|---|---|---|
| Alveolitis | Trichosporum cutaneum | Kawane 1992 | Epidemic in Japanese homes during the warm seasons |
| Thesaurosis (hypersensitivity pneumonitis) | Hair lacquer | Ameille 1985, Attilio 1980, Bergmann 1962, Bergmann 1958, Stringer 1977, Nagata 1997 | Clinical, epidemiological and experimental data controversial, PVP and Shellac suspected causes |
| Asthma | Ammonium and potassium persulfate | Macchioni 1999, Yawalkar 1999, Schwaiblmair 1997, Leino 1994, Parra 1992, Agustin 1992, Escudero 1992, Schwaiblmair 1990, Pankow 1989, Therond 1989, Gamboa 1989, Zelger 1989, Blainey 1986, Hardel 1978, Pepys 1976, Von Meindl 1969, Gaultier 1966 | Mechanism unknown, immediate and delayed responses reported |
| | Henna | Starr 1982, Pepys 1976 | |
| | Sericine | Sidi 1967,Charpin 1966 | |
| | Cold wave solution | Gelfand 1963 | Intracutaneus tests with monoethanolamine and ammonium thioglycolate positive, symptoms followed only in the specific bronchial challenge test |
| Laryngitis | Ammonium persulfate | Sala 1996 | |
| | Permanent wave solution | Sala 1996 | Causative ingredient not specified |
| Rhinitis | Ammonium persulfate | Hytönen 1997, Sala 1996, Schwaiblmair 1990, Zelger 1989, Pepys 1976 | |
| | Henna | Starr 1982, Pepys 1976 | |
| | Permanent wave solution | Sala 1996, Schwartz 1990, Nokso-Koivisto 1984, Gelfand 1963 | Causative ingredient not specified |
| | Dandruff | Hytönen 1997 | Specific antigen unclear, *P. ovale* suspected |

# 3 Aims of the study

The general aim of this work was to study the occurrence and risk, and causes and consequences of respiratory and skin diseases among hairdressers.

The specific objectives were to examine:

1. the work environmental factors and their effect on the perceived health (*Study I*)

2. the prevalence and causes of respiratory and skin symptoms and diseases (*Study II*, *Study III*)

3. the incidence and risk of asthma and chronic bronchitis (*Study IV*)

4. the risk of leaving the profession due to health reasons (*Study V*)

# 4 Material and methods

## 4.1 Definitions

### Allergic rhinitis

In *Study II* allergic rhinitis was asked with two questions: "Have you had hay fever or other type of allergic rhinitis", and "Has a physician diagnosed you as having allergic rhinitis?"

### Asthma

In *Study II* a subject was considered as having asthma if the answer was affirmative to the question: "Have you suffered from physician-diagnosed asthma within the past 12 months?" In *Study IV* the same question was asked also regarding the year 1980.

### Atopy

In *Study II* atopy was considered to be present if the subject reported that she had had asthma, allergic rhinitis, or atopic dermatitis at any time in her life. In *Study IV* a subject was defined atopic if her answer was affirmative to the question: "Has a physician ever diagnosed you as having asthma, allergic rhinitis or atopic dermatitis?"

### Chronic bronchitis

In *Study II* chronic bronchitis was considered present if a person had cough and phlegm production on most days for at least three months of the year for at least two years, which had not been caused by asthma. (BMRC 1960). In *Study IV* chronic bronchitis was considered present if a subject answered

positively to the question: "Have you suffered from physician-diagnosed chronic bronchitis within the past 12 months (in 1980)?"

### Hand dermatitis

In *Study II* hand dermatitis was inquired with the questions: "Have you ever had or do you have now dermatitis in the hands or forearms that has lasted over 3 weeks?, and "Have you had it within the past 12 months". In *Study IV* hand dermatitis was considered present if the aswer was affirmative to the question: "Has a physician diagnosed you as having hand dermatitis within the past 12 months (in 1980)?".

### Laryngitis

Laryngitis was inquired with the question: "Do you have hoarseness, dysphonia or aphonia, which has not been caused by common cold?", and with a direct question: "Has a physician diagnosed you as having laryngitis within the past 12 months?"

### Occupational disease

According to the Act (No. 1343/88) and Ordinance (No. 1347/88) on Occupational Diseases "an occupational disease… is a disease that is mainly caused by physical factor, chemical substance or biological agent encountered in the course of work…" The causality between exposure and disease is required to be *probable* if the causative agent is known and *evident* if the factor at work causing the disease is new and previously unknown.

### Rhinitis

In *Study II* rhinitis was asked with a direct question: "Have you had rhinitis?" i.e. nasal discharge, blockage and sneezing/itching for at least one hour on most days, which has not been caused by common cold. (International Rhinitis Management Working Group 1994)

### Sensitization

Sensitization to a specific occupational agent was detected by performing prick tests with commercial allergen solutions and with self-made extracts (natural rubber latex glove, disperse violet, pigment blue CI 77007, ammonium and potassium persulfate, ammonium thioglycolate, human dandruff, *Pityrosporum ovale*), and by patch tests with commercial allergens or products used by the hairdresser.

### Smoking

Smokers were defined as subjects currently smoking at least one cigarette, cigar, or pipe each day. Ex-smokers were defined as subjects who had smoked daily but had given up smoking. The time of quitting was not specified. A subject was defined as a non-smoker if she had not smoked daily for at least one year.

## 4.2 Study design and populations

The study on working conditions and health in hairdressing salons (*Study I*) investigated the physical environment and chemical exposures in 20 typical hairdressing salons in the Helsinki metropolitan area during the winter months from November 1994 to March 1995. The *Study I* included a questionnaire-based evaluation of the perceived health of 85 workers (72%) in the salons.

The setup of the telephone interview study (*Study II*) was cross-sectional. It compared the prevalence of respiratory and skin diseases and symptoms of hairdressers to those of saleswomen (Figure 1). The source population consisted of all the female hairdressers and saleswomen in the Helsinki metropolitan area registered in the trade union membership registers. To be included, the subject had to meet the following criteria: i) woman, ii) aged 15–54 years, and iii) working in the profession during the three months prior to the study. After exclusion of the 60 subjects who had not been working as

a hairdresser for three months before the study, the 76 who were not traceable, and the 10 who refused to be interviewed, the hairdressers' study population consisted of 355 subjects. The interviews were carried out between February and April 1994 by the CATI unit of the Regional Institute of FIOH in Kuopio. 81% of the hairdressers and 82% (583) of the saleswomen completed the interviews.

The prevalence of occupational respiratory and skin diseases (***Study III***) was based on the same study population of hairdressers as in ***Study II***. The subjects who reported skin or respiratory symptoms related to hairdressing (189) were invited for an occupational medical interview (Figure 2). One reminder was sent. 130 subjects came to the interview, of whom 109 met the inclusion criteria – the skin or respiratory symptoms had to i) have started at work, ii) be related to a specific exposing agent at work, and iii) become worse during the work – for further clinical examinations. All the interviews were performed by the same doctor (TL). The clinical studies were continued only when an independent specialist in occupational medicine agreed with the researcher (TL) that the inclusion criteria were met. The 59 subjects who did not want to continue in the study were asked, by phone, the reason for non-participation. The clinical studies were carried out at the Department of Occupational Medicine, Finnish Institute of Occupational Health, during the years 1994–1995.

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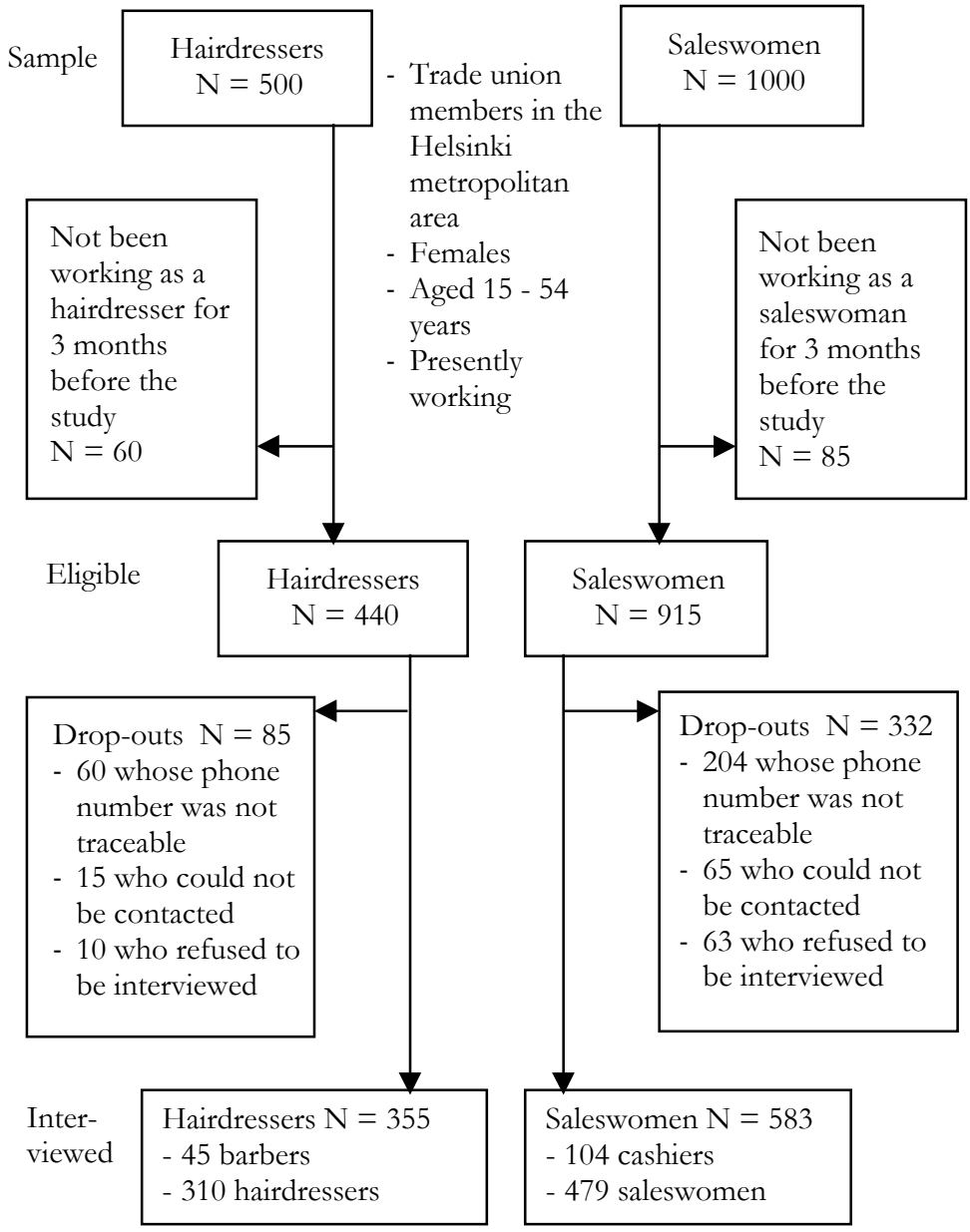


Figure 1. CATI interview protocol

The study on the risk of hairdressers to develop asthma and chronic bronchitis (*Study IV*) and of the reasons for leaving the profession (*Study V*) were based on a retrospective cohort of 4433 female hairdressers and an equal number of saleswomen. The samples were drawn from the Longitudinal Census Data File of Statistics Finland. The size of the population base was 8866 for the hairdressers and 73 267 for the female shop personnel in 1980. The reference group was frequency-matched with the hairdressers by stratifying the population of shop personnel by province, age and status in employment. The follow-up time was 15 years from 1980 to 1995. After two reminders, a total of 82% (3484) of the hairdressers and 79% (3357) of the referents responded to the questionnaire mailed to them in August 1995.

## 4.3 Ethical considerations and data protection

A letter of invitation stating the aim and protocol of each study was mailed or handed personally (*Study I*) to the study subjects. The participation in the studies was voluntary. The written consent of the study subjects was obtained for the clinical studies. The data were coded, analyzed and restored in non-identifiable form.

The protocols of the studies were approved by the Ethical Committee of the Finnish Institute of Occupational Health, and of the *Studies III* & *V* also by the Data Protection Board of Statistics Finland.

## 4.4 Data collection

### 4.4.1 Computer-assisted telephone interview (CATI)

The telephone interview provided data for *Studies II* & *IV*. The CATI included questions on respiratory symptoms and diseases, hand dermatitis, past and current atopic diseases, and chronic illnesses, medication, personal smoking habits, work history, exposure to hairdressing chemicals at work and in personal use, and the use of protective gloves and respiratory

protectors at work and at home. The researcher checked the logistics and suitability of the questions in the pilot interviews of hairdressers. The hairdressers in the pilot study did not participate in the actual study. The questions were arranged stepwise. First, the presence and duration of a symptom or a disease were inquired, then the effects of environmental factors, and last, the specific questions were asked on the effect of work factors. The interview was programmed with the CASES software package. Only trained and qualified inteviewers were used. Open answers were coded by the researchers.

### 4.4.2 Mail questionnaire

The questionnaire inquired about the occupation at baseline in 1980 and in 1995, the status in employment in 1980 and 1995, and time and reasons – including listed diseases – for leaving one's profession (*Study V*). The physician-diagnosed diseases during the past 12 months and in 1980 provided data for the analysis of asthma and chronic bronchitis in *Study IV*. Atopic diseases and smoking habits were asked in a similar manner as in the CATI survey. The researchers checked the questionnaire for logical errors and coded the open answers.

### 4.4.3 Questionnaire used in hairdressing salons

The data on the perceived health of hairdressers in 20 salons in *Study I* were collected with a self-administered questionnaire. The questionnaire was designed to be short and simple to encourage answering it. It aimed at finding the work factors and chemicals causing most discomfort and illhealth in hairdressers working in the selected salons. The key questions were: "Have the following factors at your work caused discomfort or a disease for you?" and "Have the following hair cosmetic products caused discomfort or a disease for you?". Four answering options were given: 1) no effect, 2) caused some discomfort, 3) caused a lot of discomfort, and 4) caused a disease. The work factors were working postures, repetitive movements, standing, tools, chemicals, indoor air quality, smoking at work, dust, noise, inadequate illumination, draft, temperature, and mental stress. The hair

cosmetic products were shampoos, conditioners, bleaches, hair dyes, permanent solutions, and aerosol hair sprays. The questionnaire included also questions on personal characteristics, smoking habits, physician-diagnosed skin, respiratory and musculoskeletal diseases, and the length of time worked in the present workplace and in the occupation.

### 4.4.4 Measurements in the salons

The measurements in the salons were performed during the winter time in Finland when the outside tempearature varied from –7 to+4°C in Helsinki. Eleven of the salons were located at street level, eight were in shopping centers, and one in a hospital. Fifteen salons had mechanical ventilation and five of the small salons had natural ventilation. The small salons varied in size from 42m$^2$ to168 m$^2$ and the large salons from 233 m$^2$ to 837 m$^2$. The hairdressers in the salons were asked to keep a record of their daily tasks during two weeks' time. With the assistance of the owners of the salons, the researches did an inventory of the used haircare products and their contents. In each salon, the thermal environment, ventilation and dust were measured during one day. VOCs were collected passively during two weeks, and other chemicals during one workday. The peak concentrations of persulfates, organic solvents and ammonia were measured when a hairdresser was setting a permanent, applying oxidative dye, bleaching hair, or spraying aerosol lacquer. A detailed description of the measurements is given in Table 4.

Table 4. Measurement methods used in the hairdressing salons

| Parameter | Sampling method | Sampling time | Analysis / detection method | Remarks |
|---|---|---|---|---|
| Illumination | | Direct reading | Hagner S1 illuminance-luminance meter | Whole salon and individual work sites |
| Noise | | Direct reading | Brüel & Kjær 2225 integrating sound level meter | During the use of blow dryer and hair liner |

| | | | | |
|---|---|---|---|---|
| Air temperature<br>Air velocity<br>Relative humidity | | One day | Brüel & Kjær 1213 Climatic Analyzer | $T_a$ at ankle and neck level<br>$V_a$ at neck level |
| Air exchange rate | Concentration decay method: sulfur hexafluoride gas 1303 Multipoint sampler | One day | Brüel & Kjær 1302 Multigas Analyzer | At 2–3 measurement points depending on the size of the salon |
| Carbon dioxide<br>Carbon monoxide | Sample tubes: Dräger $CO_2$/0.01%<br>Dräger CO 5/c | Direct reading | Dräger Multiwarn Indoor CO-$CO_2$ instrument | Detection limit 1 mg/$m^3$<br>Repeatability 25% |
| Volatile organic compounds | Sample tubes: passive absorption in Tenax TA 35/60 mesh | 2 weeks | Gas chromato-graphic detection: Perkin Elmer automatic thermal desorption system ATD 400<br>HP 5890 series II gas chromatograph<br>HP 5971A mass-selective detector | Sample tubes were attached to the exhaust ventilation openings and grids |
| Organic solvents | Photovac TIP I | 2 hours | | Peak concentrations during permanenting, dyeing, and aerosol lacquering |
| Ammonia | | Direct reading | Detection tubes: Dräger $NH_3$/A2 | Peak concentrations during permanenting, dyeing, and bleaching |
| Total dust | Stationary membrane pump: Millipore AAWP 0037 filter | 2 shifts | SFS 3860 method<br>JEOL 6400 scanning electron microscope | |

| | | | | |
|---|---|---|---|---|
| Particles | Climet CI-500 particle analyzer | | Climet CI-500 particle analyzer | The analyzed particle sizes were 0.5 and 5.0 μm |
| Persulfates | Stationary membrane pump: Millipore AAWP 0037 filter | 2 shifts | Ionchromatographic detection: IC-PAK A column borate-gluconate eluent Waters model 430 conductivity detector | Detection limit was 0.02 $mg/m^2$ for a sample of 100 $dm^3$ air volume |
| Thioglycolates | Stationary membrane pump: Millipore AAWP 0037 filter | 2 shifts | Liquid chromatographic detection: Varian 5000 chromatograph Waters Bondapak column Acetonitrile-water eluent UV-detection | Detection limit was about 15 μg per sample |

### 4.4.5 Clinical measurements

The clinical measurements consisted of a clinical interview and examination by the researcher, clinical examination by an otorhinolargyngologist, a phoniatrist, a pulmonologist or a dermatologist, allergy tests, X-ray examination of paranasal sinuses, lung function tests, challenge tests (nasal and lung provocation) and PEF follow-up at work for those who had work-related asthma symptoms. The clinical interview was structured in order to minimize variation between individual interviews. The specialists were experienced clinicians at the Department of Occupational Medicine. Skin prick tests were performed with 21 common environmental allergens and 8 hairdressers' allergens. In the *Pityrosporum ovale* prick tests 311, and in the human dandruff tests 711 occupationally non-exposed control subjects were examined. Patch tests were performed according to the recommendations of the International Contact Dermatitis Research Group (ICDRG) with a

modified European standard series (30 substances), a hairdressers' series (15 chemicals), and a combined cosmetic, preservative and perfume series (29 chemicals). The hairdresser's own substances were tested when needed. The numbers of haidressers examined by type of investigation are presented in Table 5, in which also the criteria for a positive test are given.

Table 5. Clincal examinations of hairdressers

| **Type of investigation** | **Number of hairdressers examined** | **Criteria for a positive test** | **Reference** |
|---|---|---|---|
| Clinical interview | 130 | Occupational disease was suspected if the symptoms: i) had started at work, ii) were related to specific exposing agent at work, and iii) had become worse during the work; two independent examiners had to agree on the suspicion | |
| Allergy tests | | | |
| Phadiatop® | 123 | > 0.35 IU/l | Pharmacia & Upjohn, Sweden |
| Prick tests | 107 | ≥ 3 mm wheal and greater than 50% of the histamine chloride (10 mg/ml) wheal | Kanerva 1991, Dreborg 1989 |
| Patch tests | 54 | ICDRG criterion; 1+, 2+ and 3+ reactions were considered allergic | Cronin 1980, Pirilä 1975 |
| X-ray of paranasal sinuses | 72 | Radiologist's judgement of a normal X-ray status | |
| Lung function tests | | | |
| Spirometry | 89 | The spirometric reference values of women in Finland | Viljanen 1982 |
| Bronchodilatation test | 86 | Increase of $FEV_{1.0}$ > 15% of the predicted value and exceeding 200 ml | Quanjer 1993 |

| | | | |
|---|---|---|---|
| Histamine test | 89 | Histamine dose that caused decrease of $FEV_{1.0}$ > 15% expressed as $PD_{15}$ value | Sovijärvi 1993 |
| Challenge tests | | | |
| Nose | 79 | Rhinorrhea and blockage in nose, the sum of status change score ≥ 4 points or increase in nasal airway resistance > 50% | Hytönen 1996 |
| Larynx | 39 | Redness and swelling in vocal cords, status change in both signs at least one point in the scale of 0–3 | Sala 1996 |
| Lungs | 10 | 20% decrease in $FEV_{1.0}$ or PEF value | Maestrelli 1992, Keskinen 1981 |
| PEF follow-up at work | 9 | 15% decrease of PEF values related to specific exposure situations at work | Burge 1982 |

## 4.5 Statistical methods

Statistical power calculations were used to estimate the size of the study populations in *Studies II* & *IV*. The multivariate logistic regression models were used to estimate relative risk (risk-odds ratios) for the outcomes in concern, and the 95% confidence intervals. The known confounders were controlled in the analyses. All the analyses of *Studies I–V* were carried out using SAS statistical programs (SAS Institute Incorporation 1990). A summary of the statistical methods used in *Studies I–V* is given in Table 5. The attributable fraction among the exposed in *Study IV* was calculated from the following formula: $AF_e = (RR-1)/RR$, where RR is the risk ratio (Rothman 1997).

Table 5. Statistical methods in *Studies I–V*

| Study | Exposure | Outcome | Statistical method |
|---|---|---|---|
| *I* | Physical conditions in the salons<br>Use of cosmetic products<br>Work strain | Work-related discomfort and ill-health | Comparison of point prevalences |
| *II* | Work as a hairdresser (referents were female salespersons) | Perceived respiratory symptoms<br>Self-reported respiratory diseases diagnosed by a physician | Logistic regression analysis: ORs were adjusted for age, smoking and atopy |
| *III* | Use of hairdressing chemicals that may cause occupational disease | Occupational skin and respiratory diseases diagnosed at FIOH | Logistic regression analysis: ORs were adjusted for atopy, age and time in occupation |

| | | | |
|---|---|---|---|
| *IV* | Work as a hairdresser (referents were female salespersons) | Development of self-reported asthma and chronic bronchitis diagnosed by a physician during the follow-up in 1980–1995 | Logistic regression analysis for periodic prevalences and cumulative incidences: ORs for periodic prevalences were adjusted for age, smoking and atopy |
| *V* | Hairdressers vs. women engaged in commercial work | Changes in the professional status and leaving the profession for health and other reasons during the follow-up in 1980–1995 | Logistic regression analysis: ORs of leaving the profession for health reason adjusted for age and employment status |

# 5 Results

## 5.1 Working conditions and exposure to hairdressing chemicals (*Study I*)

In *Study I* the tasks performed during one shift and during a work week varied markedly between the hairdressers and for an individual hairdresser from one shift to another. The mean number of customers per worker in one shift was 5. During one shift a hairdresser did on average 3 hair washings (variation 1–12), 5 cuttings (1–10), 0.2 hair dyeings (0–1) with oxidative hair dyes, 1 permanent wave (1–10), 0.3 hair bleachings (0–1), and used hair sprays on 4 (1–9) customers. In *Study III* the median was 6 hair cuts (variation 2–15) per day, 8 (0–30) hair dyeings, 5 (0–23) permanent waves and 3 (0–14) bleachings per week. Of the examined hairdressers (*Study III*), 70% washed their hands more than 10 times and 25% over 20 times a day. Only 3% used gloves when washing a client's hair, and a half when setting a permanent.

The principal chemical ingredients and their concentrations in the products used in the 20 hairdressing salons visited are given in Table 6.

Table 6. Chemicals used in the hairdressing products

| Chemical | Product | Concentration |
|---|---|---|
| Ethanol<br>Isopropanol | hair styling products | 50–95% |
| Paraphenylenediamine | oxidative hair dyes | < 12% |
| Persulfates | hair bleaches | 30–70% |
| Thioglycolates | permanent waves | < 11% |
| Ammonia | hair dyes and permanent waves | < 10% |
| Hydrogen peroxide | permanent fixes, hair dyes and bleaches | 2–12% |

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Low concentrations (usually less than 1%) of other chemicals, some of which are known allergens and irritants, were used as preservatives, fragrances, surfactants, anti-static and anti-dandruff agents in the products. Rubber chemicals in work tools, natural rubber latex in protective gloves, as well as dandruff and *Pityrosporum ovale* in the clients' scalps were also considered potential allergens in hairdressing work.

The physical conditions and concentrations of chemicals in the ambient air of 10 small and 10 large salons, as well as peak concentrations of organic solvents during permanenting, dyeing and hair lacquering, and ammonia during permanenting, dyeing and bleaching are shown in Tables 7 and 8.

Table 7. Physical conditions in hairdressing salons

| Parameter | Small salons (N = 10) | | Large salons (N = 10) | | Finnish indoor air criteria | Remarks |
|---|---|---|---|---|---|---|
| | Mean | Range | Mean | Range | | |
| Temperature | | | | | | |
| $T_{a\ 0.1m}$ (°C) | 20.6 | 16–23 | 21.7 | 19–23.5 | 20–24 | S3 (winter)* |
| $T_{a\ 1.7m}$ (°C) | 22.2 | 19–25 | 21.5 | 19–23.5 | $\Delta T_a < 4$ | S3 |
| Air velocity | | | | | | |
| $V_a$ (m/s) | 0.09 | 0.02–0.21 | 0.13 | 0.05–0.33 | < 0.15 | S3 (winter) |
| Relative humidity | | | | | | |
| RH (%) | 30 | 18–42 | 27 | 18–37 | 25–45 | S1 (winter) |
| Carbon dioxide | | | | | | |
| $CO_2$ (ppm) | 1000 | 600–1600 | 620 | 400–800 | < 1000 | S1 (winter) |
| Air exchange rate | | | | | | |
| Ar (1/h) | 2.7 | 1.2–5.8 | 4.6 | 2–11 | > 0.4 | S3 (apartment) |
| Illumination | | | | | | |
| I (lux) | 530 | 50–1100 | 720 | 200–2000 | 300–750 | Indoor illumination recommendation for work stations by the Finnish Association of Lighting Technics |
| Noise | | | | | | |
| $L_{Aeq60s}$ (dB) | | | | | | |
| Blow dryer (n = 20) | 77 | 60–83 | | | | |
| Hair liner (n = 6) | 69 | 62–82 | | | | |

* Finnish indoor air quality classes (S1 is the highest)

Table 8. Chemical concentrations in hairdressing salons in different work tasks

| Work task | Present study | Other studies | Remarks | Reference |
|---|---|---|---|---|
| Permanenting | | | | |
| ATG | 0.5–10 μg/m³ | | | |
| GMTG | 0–1.8 μg/m³ | | | |
| Ammonia | 1.4–3.5 mg/m³ | | TLV 18 mg/m³ (8–h TWA) | |
| | | 0.5–4.4 mg/m³ | | Hollund 1998 |
| | | 105 mg/m³(2 min) | 40% of STEL (35 mg/m³) | Van der Wal 1997 |
| | | 5–25 mg/m³ | | Rajan 1992 |
| | | 0.7–7.2 mg/m³ | | Hakala 1979 |
| Hydrogen sulfide | | | TLV 14 mg/m³(8–h TWA) | |
| | | 0.14–0.7 mg/m³ | | Hakala 1979 |
| Hydrogen peroxide | | | TLV 1.4 mg/ m³(8–h TWA) | |
| | | 0.014–0.14 mg/m³ | Spot measurement | Van der Wal 1997 |
| Organic solvents | 45 mg/m³ | | Peak | |
| Ethanol | | | TLV 1900 mg/m³(8–h TWA) | |
| | | 2–36 mg/m³ | | Almaguer 1992 |
| | | 2–30 mg/m³ | | Rajan 1992 |
| | | 0–3 mg/m³ | Breathing zone | Gunter 1976 |
| Isopropanol | | | TLV 245 mg/m³(8–h TWA) | |
| | | 0–9 mg/m³ | | Rajan 1992 |
| | | 0.4–14.8 mg/m³ | | Hollund 1998 |
| Toluene | | | TLV 94 mg/m³(8–h TWA) | |
| | | 0.04–0.11 mg/m³ | | Hollund 1998 |
| Dyeing | | | | |
| Paraphenylenediamine | 0 | | 1.0 μg/m³ (detection limit) | Gagliardi 1992 |
| | | | 1.0–0.1 μg/m³ (detect. limit) | Hollund 1998 |

| | | | | |
|---|---|---|---|---|
| Diaminotoluene | 0 | | 1.0–0.1 μg/m³(detect. limit) | Hollund 1998 |
| Ammonia | 1.4–3.5 mg/m³ | 0.4–4.5 mg/m³ | | Hollund 1998 |
| Hydrogen peroxide | | 0.007 mg/m³ | Spot measurement | Van der Wal 1997 |
| Organic solvents | 25 mg/m³ | | Peak | |
| Bleaching | | | | |
| Ammonium persulfate | | | TLV 5 mg/m³(8–h TWA) | |
| | 0–4.7 μg/m³ | | | |
| | 30 μg/m³ | | Peak | |
| Ammonia | 1.4–3.5 mg/m³ | 0.3–10 mg/m³ | | Hollund 1998 |
| Hydrogen peroxide | | 0.014 mg/m³ | Spot measurement | Van der Wal 1997 |
| Hair lacquering | | | | |
| Organic solvents | 45 mg/m³ | | Peak | |
| Ethanol | | 150 μl/l | <05% of STEL (2000 μl/l) | Van der Wal 1997 |
| | | 0.007–3 mg/m³ | | Gunter 1976 |
| Isobutane | | 373–1935 mg/m³ | | Gunter 1976 |
| Butane | | 30 μl/l (1 min) | 0.2% of STEL (1200 μl/l) | Van der Wal 1997 |
| Polyvinylpyrrolidone | | 7–70 μg/m³ | | Gunter 1976 |
| Particulates | | 100 mg/ m³ (5 s) | 5% of STEL (10 mg/m³) | Van der Wal 1997 |
| Ambient air in salons | | | | |
| $CO_2$ | | 400–4500 μl/l | TLV 5000 μl/l (8–h TWA) | Van der Wal 1997 |
| VOCs | 0.084–0.465 mg/m³ | | IAQ-target 0.6 mg/m³ | |
| | | 0.14–0.66 mg/m³ | 8–h TWA ($C_6$–$C_{16}$) | Van der Wal 1997 |
| Ethanol | | 0.1–56.6 mg/m³ | 8–h TWA (pers. samples) | van Muiswinkel 1997 |
| | | 0.1–43 mg/m³ | 8–h TWA (ambient air) | van Muiswinkel 1997 |
| | | 4.4–57 mg/m³ | 8–h TWA (breathing zone) | Van der Wal 1997 |
| | | 2.3–26 mg/m³ | 8–h TWA (stationary) | Van der Wal 1997 |
| | | 2–59 mg/m³ | | Hakala 1979 |

| | | | | |
|---|---|---|---|---|
| Ammonia | | 0.1–1.2 mg/m³ | IAQ-target 0.05 mg/m³ | Hollund 1998 |
| | | 2.6–4.9 mg/m³ | 8–h TWA (breathing zone) | Van der Wal 1997 |
| | | 0.02–0.44 mg/m³ | 8–h TWA (winter) | Van der Wal 1997 |
| Hydrogen peroxide | | 0.01–0.069 mg/m³ | 8–h TWA | Van der Wal 1997 |
| Total dust | 0.066–0.133 mg/m³ | | IAQ-target 0.06 mg/m³ | |
| | | | 8–h TWA 10 mg/m³ | |
| | | 0.28–2.7 mg/m³ | 8–h TWA (breathing zone) | Van der Wal 1997 |
| | | 0.11–1.01 mg/m³ | 8–h TWA (stationary) | Van der Wal 1997 |
| Particulates | | | 8–h TLV 5 mg/m³ | |
| | 8500–17000 /l | | > 0.5 μm | |
| | 160–400 /l | | < 0.5 μm | |
| | | 0.03–0.39 mg/m³ | 8–h TWA (stationary) | Van der Wal 1997 |
| | | 0.3–0.6 mg/m³ | 8–h personal samples | Palmer 1979 |

ATG = ammonium thioglycolate, GMTG = glyceryl monothioglycolate

More dust and particles were found in small salons than in larger and better ventilated salons. The mixing of bleaching powder, permanenting, dyeing and spraying of aerosol lacquer produced peaks of ammonium persulfate, VOCs and ammonia in the breathing zone of hairdressers. These concentrations were 6 to 100 times higher than those in the air of the salons on average.

## 5.2 Experienced working conditions (*Study I*) and prevalence of work-related respiratory and skin symptoms (*Studies II & III*)

The quality of the physical working conditions (temperature, humidity, draft, poor ventilation, dustiness, odors and noise) in hairdressing salons and in the reference group of saleswomen were asked in the telephone interview (unpublished results of *Study II*). The only work environment factor which differed unfavorably for the hairdressers was odors; 28.9% of the hairdressers reported daily discomfort, compared with 12.4% of the saleswomen. One third suffered from draft and about 15% from the other physical factors of the work environment.

In *Study I* the top ranking factors that had caused a lot of discomfort were repetitive movements (14.6%), awkward working postures (14.3%), draft (13.4%), chemicals (13.3%), and temperature (11.1%). Bleaches, hair dyes, permanent solutions and aerosol hair sprays were the products causing a lot of discomfort most frequently (7.3–9.5%). A lower air exchange rate (≤ 3.6 l/h) was associated with more frequent complaints of discomfort and ill-health caused by bleaches, hair dyes, permanent solutions and hair sprays. In *Studies II & III* the use of these products was also associated with work-related respiratory and skin symptoms (Table 9) and difficulties in performing work tasks (Table 10).

Table 9. Work-related respiratory and skin symptoms of hairdressers
(N = 355)

| **Symptom** | **Hairdressers with symptoms** | | **Hairdressers relating symptoms to work** | | **Work tasks that worsened the symptoms** |
|---|---|---|---|---|---|
| | N | % | N | % | |
| Cough and phlegm | 127 | 35.9 | 65 | 18.8 | Bleaching, lacquering, setting permanents, dyeing |
| Dyspnea | 57 | 16.1 | 34 | 9.7 | Lacquering, bleaching, setting permanents, dyeing |
| Rhinitis | 221 | 62.6 | 137 | 39.9 | Bleaching, lacquering, setting permanents, dyeing |
| Hoarseness | 105 | 29.9 | 68 | 19.7 | Bleaching, lacquering, setting permanents, dyeing |
| Hand dermatitis | 60 | 16.9 | 45 | 12.7 | Setting permanents, washing, bleaching, dyeing |

Table 10. Hairdressers reporting marked difficulties to work due to respiratory or skin symptoms

| **Symptom** | **Hairdressers (N = 130)** | |
|---|---|---|
| | N | % |
| Cough | 3 | 2.3 |
| Dyspnea | 10 | 7.7 |
| Rhinitis | 18 | 13.8 |
| Hoarseness | 3 | 2.3 |
| Hand dermatitis | 16 | 12.3 |

## 5.3 Risk of respiratory symptoms and diseases (*Studies II & IV*)

Based on the respiratory symptom questions in CATI (***Study II***), hairdressers have an increased risk for cough and phlegm (OR 1.4, 95% CI 1.1–1.9), for dyspnea (OR 1.5, 95% CI 1.0–2.2), for rhinitis (OR 1.7, 95% CI 1.–2.3), for a combination of dyspnea with cough (OR 1.6, 95% CI 1.0–2.7), and for rhinitis with eye symptoms (OR 1.9, 95% CI 1.4–2.6). The prevalence of chronic bronchitis was 6.8% among hairdressers and only 1.9 % in saleswomen. The risk for chronic bronchitis was considerably higher in hairdressers than in saleswomen (OR 4.8, 95% CI 2.2–10.1) even after adjustment for age, smoking and atopy. The effect of age, atopy and smoking on the odds of contracting asthma, chronic bronchitis, laryngitis and allergic rhinitis yielded by the logistic regression model is shown in Table 11. Hairdressing did not associate with asthma, laryngitis and allergic rhinitis in this cross-sectional setup.

Table 11. Odds of contracting a respiratory disease

| Disease | Determinant | OR | 95% CI |
|---|---|---|---|
| Asthma | Hairdressing | 0.9 | 0.5–1.7 |
| | Smoking | 0.9 | 0.5–1.6 |
| | Age | 1.0 | 1.0–1.1 |
| | Atopy | 6.5 | 3.1–13.7 |
| Chronic bronchitis | Hairdressing | 5.5 | 2.5–12.0 |
| | Smoking | | |
| | never smoker | 1.0 | |
| | ex-smoker | 0.6 | 0.1–2.8 |
| | 1–19 cigarettes / day | 1.7 | 0.7–4.3 |
| | ≥ 20 cigarettes / day | 6.2 | 2.4–15.8 |
| | Age in years | 1.0 | 1.0–1.1 |
| | Atopy | 2.1 | 1.0–4.3 |
| Laryngitis | Hairdressing | 0.8 | 0.5–1.6 |
| | Smoking | 1.1 | 0.6–2.0 |
| | Age | 1.0 | 0.9–1.0 |
| | Atopy | 2.2 | 1.2–3.9 |
| Allergic rhinitis | Hairdressing | 0.8 | 0.5–1.1 |
| | Smoking | 0.8 | 0.6–1.3 |
| | Age | 1.0 | 0.9–1.0 |
| | Atopy | 3.2 | 2.2–4.5 |

In *Study IV* the prevalence of asthma among hairdressers increased from 5.6% in 1980 to 10.1% at the end of the follow-up in 1995. The corresponding figures for chronic bronchitis were 3.9% in 1980 and 5.6% in 1995. The incidence rate per 1000 person-years was 2.2 for asthma and 1.1 for chronic bronchitis among hairdressers compared with the referents; 1.3 asthma cases and 0.9 chronic bronchitis cases per 1000 person-years.

The relative risk for both asthma (OR 1.7, 95% CI 1.3–2.3 in 1980; and OR 1.7, 95% CI 1.4–2.2 1995) and chronic bronchitis (OR 2.2, 95% CI 1.5–3.2 in 1980; and OR 1.9, 95% CI 1.4–2.6 1995) was elevated among hairdressers and almost twice that in the reference group. The same was observed when only the never-smokers in the study groups were compared. The crude

relative risk for asthma was 1.8 (95% CI 1.3–2.4) and for chronic bronchitis 2.1 (95% CI 1.2–3.4) among the never-smoked hairdressers in 1995. The relative risk during the 15 years' observation time for developing asthma (OR 1.7, 95% CI 1.1–2.5), but not for chronic bronchitis (OR 1.2, 95% CI 0.7–1.9), was also increased among hairdressers. The fraction of asthma attributable to hairdressing was 41% (95% CI 9%–60%).

## 5.4 Risk of hand dermatitis (*Studies II & IV*)

In *Study II* the life-time prevalence of atopic dermatitis was 12.7% for hairdressers and 14.4% for saleswomen. The one-year prevalence of physician-diagnosed atopic dermatitis was 6.5% for hairdressers and 7.6% for saleswomen, compared with 4.6% for hairdressers and 3.7% for women in commercial work in 1995 in *Study IV*.

In *Study II* 16.9% (60/355) of the hairdressers and 15.1% (88/583) of the saleswomen had never had hand dermatitis lasting more than three weeks. The one-year prevalence of hand dermatitis was 13.8% (49/355) for hairdressers and 12% (70/583) for saleswomen. In *Study IV* 13.0% of hairdressers and 7.0% of women in commercial work reported suffering from physician-diagnosed hand dermatitis during the past 12 months.

The risk odds did not reveal marked differences between the study groups.

## 5.5 Results of the clinical study (*Study III*)

The numbers of work-related respiratory and skin symptoms, suspected occupational diseases and the number of diagnosed occupational diseases in the study group of 355 hairdressers are given in Figure 2 (*Study III)*

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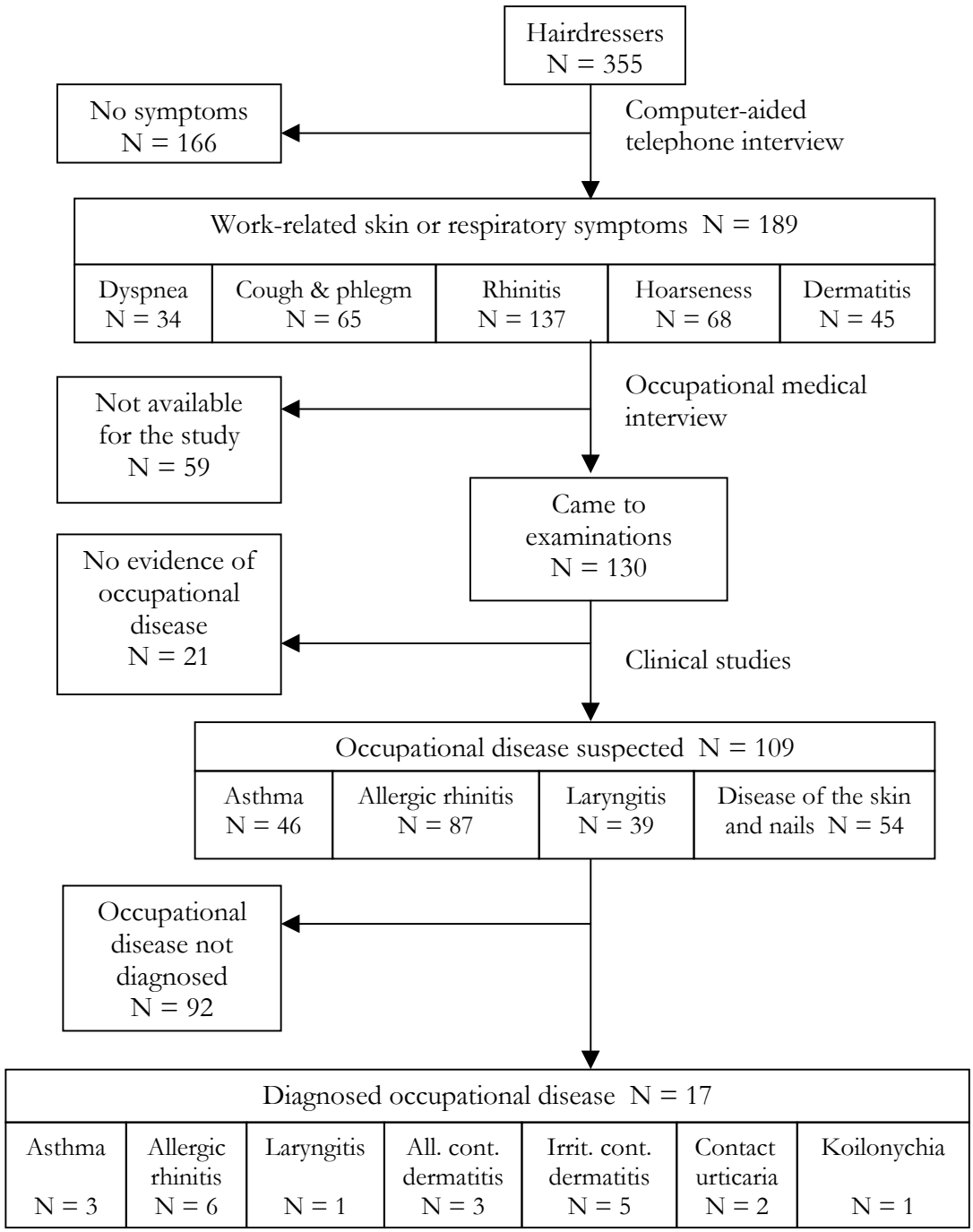


Figure 2. Flow chart of the clinical studies

Altogether 21 diagnoses of occupational skin and respiratory diseases were made in 17 hairdressers. 18 (85%) of the diagnoses were new ones. No marked difference was found in exposure time or work load between the diseased and healthy subjects. The average age of the diseased hairdressers was 39 years (range 23–55), time in occupation 17 years (3.5–35) and exposure time to hairdressing chemicals before the onset of symptoms 9 years (0.5–20). Atopic disease in the medical history was a stong determinant for occupational skin or respiratory disease (OR 2.9, 95% CI 1.1–7.9). Atopic persons were also clearly over-represented in the clinical study group (Table 12), i.e. patients who reported symptoms.

Table 12. Percentage of atopic persons in the hairdressers' study groups

| **Atopy** | **CATI group** | **Symptomatic group** | **Non-sympt. group** | **Clinical interview group** | **Clinical study group** |
|---|---|---|---|---|---|
| | **N=355** | **N=189** | **N=166** | **N=130** | **N=109** |
| | % | % | % | % | % |
| Own judgement | 43.4 | 53.5 | 32.5 | 56.3 | 59.3 |
| Diagnosed | 33.4 | 42.8 | 23.8 | 50.8 | 55.0 |

The Phadiatop® was positive for 26% of the examined 123 hairdressers in the clinical interview group. The prick test results of the hairdressers' series and the patch test results of the standard and extended hairdressers' series are given in Table 13. The patch tests yielded two occupationally relevant reactions to paraphenylenediamine and one to ammonium persulfate.

Table 13. Prick and patch test results

| **Allergen** | **No. of allergic reactions** | **%** |
|---|---|---|
| Prick tests (N = 107) | | |
| Hairdressers' series | | |
| Human dandruff (Bencard) | 5 | 4.7 |
| Human dandruff 75 μg/ml (FIOH) | 3 | 2.8 |
| Human dandruff 150 μg/ml (FIOH) | 3 | 2.8 |
| Ammonium persulfate 2% | 3 | 2.8 |
| Potassium persulfate 2% | 4 | 3.7 |
| Natural rubber latex | 3 | 2.8 |
| Ammonium thioglycolate 10% | 0 | |
| Pigment blue CI 77007 | 0 | |
| Disperse violet 4% | 0 | |
| Pach tests (N = 54) | | |
| Standard series | | |
| Nickel sulfate | 19 | 35.2 |
| Cobalt chloride | 7 | 13.0 |
| Neomycin | 4 | 7.4 |
| Balsam of Peru | 3 | 5.6 |
| PPDA | 2 | 3.7 |
| Fragrance mix | 2 | 3.7 |
| Kathon CG | 2 | 3.7 |
| Colophony, Epoxy resin, Dequalone chloride | 1 | 1.9 |
| Hairdressers' & cosmetic, preservative and perfume series | | |
| Chloroacetamide | 1 | |
| Pyrocatechol | 1 | |
| Ammonium persulfate | 1 | |
| Toluene disulfonamide formaldehyde resin | 1 | |
| Amerchol L101® | 1 | |
| Oleamidopropyldimethylamine | 1 | |
| Cocamidopropylbetadine | 1 | |
| Oak moss | 1 | |

Human dandruff produced 18.7–fold and *P. ovale* 3.5–fold more positive prick test reactions among hairdressers compared with the occupationally non-exposed referents (Table 14).

Table 14. Prick tests with human dandruff & *Pityrosporum ovale*

| **Allergen** | **Hairdressers** | | **Referents*** | |
|---|---|---|---|---|
| | n/N | % | n/N | % |
| Human dandruff | 7/81 | 8.6 | 1/311 | 0.3 |
| *P. ovale* | 12/99 | 12.1 | 26/711 | 3.5 |

* occupationally non-exposed, n = number of positively tested, N = total number of tested

We have studied further the antigenic properties of human dandruff and *P. ovale* in the 16 hairdressers with a positive prick test to one or both of these agents (unpublished results). The human dandruff RASTs were all negative. Four of the *P. ovale* prick-positive subjects had also a positive *P. ovale* RAST, and all of them exhibited IgE-binding bands in immunoblotting. The most commonly encountered IgE-binding bands had molecular weights of 39 kD, 21 kD and 9 kD. The IgE immunoblotting with human dandruff revealed strong IgE binding in only one patient (a barber suffering from atopic dermatitis and hypersensitive rhinitis symptoms in hair cutting) to bands with MW of 43 kD, 13 kD and 9 kD. This patient revealed binding to bands with the same molecular weights as in *P. ovale* blotting. The other five subjects positive to human dandruff in the prick tests were negative in IgE immunoblotting.

## 5.6 Prevalence of occupational respiratory diseases and their causes (*Study III*)

The prevalence was 1.7% (95% CI 0.4–3.0%) for rhinitis and 0.8% (95% CI 0%–1.7%) for asthma. One hairdresser had occupational laryngitis caused by ammonium persulfate. Ammonium persulfate caused 90% (9/10) of the

occupational respiratory diseases (Table 15). One asthma was caused by permanent-wave solution.

Table 15. Diagnosed occupational respiratory and skin diseases and their causes in 17 hairdressers

| Disease | Causative agent | No. of cases* |
|---|---|---|
| Asthma | Ammonium persulfate | 2 |
| | Permanent-wave solution | 1 |
| Allergic rhinitis | Ammonium persulfate | 6 |
| Laryngitis | Ammonium persulfate | 1 |
| Allergic contact dermatitis | Paraphenylenediamine | 2 |
| | Ammonium persulfate | 1 |
| Contact urticaria | Natural rubber latex | 1 |
| | Ammonium persulfate | 1 |
| Irritant contact dermatitis | Wet work | 4 |
| | Ammonium persulfate | 1 |
| Koilonychia | Permanent-wave solution | 1 |

*some of the hairdressers had more than one occupational disease and more than one causative agent

## 5.7 Prevalence of occupational skin diseases and their causes (*Study III*)

The prevalence was 2.8% (95% CI 1.1–4.5%) for dermatitis. 40% (4/10) of them were caused by wet work. Paraphenylendiamine caused two and ammonium persulfate one allergic contact dermatitis. Natural rubber latex

and ammonium persulfate each caused one case of contact urticaria. One case of koilonychia was caused by permanent-wave solutions (Table 15).

## 5.8 Risk of leaving the profession (*Study V*)

When the health, work organization, ergonomic, financial and social reasons for leaving the profession were examined, we found that only the concern for health increased the risk of leaving the profession (RR 1.33, 95% CI 1.16–1.52) among hairdressers, as compared with the referents.

The relative risk of hairdressers leaving their profession for health reasons during the 15–year follow-up time was calculated in two ways: 1) comparing the hairdressers' risk with that of the referents, and 2) comparing the risk between those hairdressers diagnosed as having a disease at the beginning of the follow-up with those not having the disease. The results are shown in the Tables 16 and 17.

The categories of diseases that increased most the risk of leaving the profession were: 1) asthma and hand dermatitis: 3.5 times, 2) strain injury of the wrist or tennis elbow: 2.7 times, and 3) diseases of the neck and shoulders: 1.7 times. When the second most important reasons for leaving the profession were considered, also atopic dermatitis, allergic rhinitis and chronic bronchitis were found to increase the risk.

Having an atopic disease at the beginning of the follow-up increased the risk of leaving the profession, compared to those not having the disease in 1980 among hairdressers but not among the women engaged in commercial work. A diagnosed atopic disease at some point of life also increased the risk of the hairdressers (OR 1.2, 95% CI 1.1–1.3) leaving their profession.

In *Study V*, 73% of the hairdressers answered positively to a question inquiring whether the disease that had caused leaving the profession was work-related, and 53% claimed that their doctors shared their opinion. Among the referents the corresponding figures were 43% and 26%, respectively. In *Study III*, three years after the diagnosis of occupational

disease, one third had changed to another job, were in retraining, or had retired (Table 18).

Table 16. Relative risk (RR) of leaving the profession for health reasons during the 15–year follow-up (1980–1995); comparison: hairdressers (N = 3471) versus women in commercial work (N = 3263)

| **Health reason** | **Main health reason** | | **All health reasons** | |
|---|---|---|---|---|
| | RR | 95% CI | RR | 95% CI |
| Hand dermatitis | 3.5 | 2.1–5.7 | 4.6 | 3.0–6.9 |
| Atopic dermatitis | 0.9 | 0.1–15.0 | 3.8 | 1.7–8.1 |
| Allergic rhinitis | 2.0 | 0.8–5.4 | 2.8 | 1.9–4.1 |
| Chronic bronchitis | 0.6 | 0.1–3.7 | 4.0 | 2.0–8.0 |
| Asthma | 3.5 | 1.8–6.8 | 2.8 | 1.8–4.3 |
| Disease of the neck or shoulder | 1.7 | 1.2–2.5 | 1.6 | 1.4–2.0 |
| Tendinitis of the wrist or tennis elbow | 2.7 | 1.1–6.3 | 1.3 | 0.8–2.3 |
| Disease of the back | 0.8 | 0.5–1.2 | 1.2 | 0.9–1.5 |
| Other musculo-skeletal diseases | 0.7 | 0.4–1.0 | 0.9 | 0.7–1.2 |
| Cardiovascular disease | 0.8 | 0.5–1.3 | 0.9 | 0.7–1.2 |
| Diabetes | 0.3 | 0.1–3.0 | 0.7 | 0.4–1.5 |
| Mental disturbances | 0.3 | 0.2–0.7 | 0.5 | 0.4–0.8 |

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Table 17. Relative risk (OR) of leaving the profession during the 15–year follow-up among hairdressers and women in commercial work; comparision: subjects diagnosed as having a disease of concern in 1980 with those not having the disease in 1980

| **Health reason** | **Hairdressers** | | **Referents** | |
|---|---|---|---|---|
| | OR | 95% CI | OR | 95% CI |
| Hand dermatitis | 2.8 | 2.2–3.7 | 1.6 | 1.1–2.2 |
| Atopic dermatitis | 3.0 | 1.8–4.8 | 1.4 | 0.9–2.3 |
| Allergic rhinitis | 1.4 | 1.1–1.8 | 0.9 | 0.7–1.2 |
| Chronic bronchitis | 2.8 | 1.7–4.5 | 1.1 | 0 .6–2.2 |
| Asthma | 3.4 | 2.2–5.2 | 1.2 | 0.7–2.0 |
| Disease of the neck or shoulder | 1.5 | 1.2–1.8 | 1.4 | 1.1–1.8 |
| Tendinitis of the wrist or tennis elbow | 1.3 | 0.8–2.1 | 1.3 | 0.7–2.6 |
| Disease of the back | 1.9 | 1.4–2.6 | 1.3 | 0.9–1.8 |
| Other musculo-skeletal diseases | 2.8 | 1.9–4.2 | 2.8 | 1.7–4.6 |
| Cardiovascular disease | 1.8 | 1.3–2.6 | 2.4 | 1.6–3.5 |
| Diabetes | 3.0 | 1.4–6.5 | 3.8 | 1.4–9.7 |
| Mental disturbances | 2.8 | 1.5–5.2 | 4.4 | 1.6–12.7 |

Table 18. Change in professional situation 3 years after the diagnosis of occupational disease (11/16 continued in hairdressing)

| **Case number** | **Age** | **Atopy** | **Diagnosis** | **Causative agent** | **Professional situation 3 years after the diagnosis** |
|---|---|---|---|---|---|
| 2 | 28 | + | A, AR | APS | in retraining |
| 4 | 48 | – | A, AR | PS, APS | retired |
| 10 | 34 | + | ACD, ICD | PPDA, WW | in retraining |
| 11 | 24 | + | ACD | APS | changed occupation |
| 12 | 29 | + | CU | APS | in retraining |

A = asthma, AR = allergic rhinitis, ACD = allergic contact dermatitis, ICD = irritant contact dermatitis, CU = contact urticaria, APS = ammonium persulfate, PS = permanent wave solution, PPDA = paraphenylenediamine, WW = wet work.

# 6 Discussion

## 6.1 Validity of the studies

### 6.1.1 Study designs and selection of the study populations

We used both cross-sectional and longitudinal study designs to find out the prevalence and incidence of several diseases, including asthma and chronic bronchitis. The cross-sectional study allowed us to study current symptoms and their relation to work exposure among hairdressers. On the other hand, a longitudinal design was needed to study incidence rates and to overcome some of the known problems of cross-sectional studies (Järvholm 1998, Torén 1999).

*Study I* was designed to obtain descriptive information on the working conditions in hairdressing salons in Finland. The salons were sampled randomly from the Helsinki metropolitan area to represent small and large salons. The locations and conditions of hairdressing salons do not vary greatly in the different parts of the country. Thus the results can be generalized to the conditions in typical Finnish hairdressing salons.

The study population in *Study I* consisted of the personnel in the selected 20 salons in the Helsinki metropolitan area, in *Studies II* & *III* the female hairdressers and supermarket saleswomen aged 15–54 years in the Helsinki metropolitan area, and in *Studies IV* & *V* the female hairdressers and shop personnel employed in 1980 in Finland according to the Longitudinal Census Data File of Statistics Finland.

The trade union membership registers were used to get a random sample of study populations for *Studies II* & *III*. About half of the hairdressers and even a higher proportion of saleswomen were registered members of the unions at the time of the study in 1994. According to membership register

data, the age distribution of the hairdressers was strongly bent towards younger age groups. The sampling was therefore disproportionate. We wanted to have a control group with the same age distribution and sosioeconomic status as hairdressers, but not working in tasks in which the exposure to chemicals or organic materials is known to be substantial. Cashiers and saleswomen in supermarkets were regarded to be the best for this purpose. Men were selected out, because they were clearly outnumbered in hairdressing (about 500 in Finland), and to simplify the statistical calculations. It was also essential to get a population of hairdressers who were currently working (had been working as a full-time hairdresser for at least three months before the study started), and dwelling close to FIOH, in order to maximize hairdressers' participation in the clinical studies for occupational skin and respiratory diseases (*Study III*). Due to economic restrictions the control group did not participate in the clinical studies.

The number of persons who did not meet the selection criteria, did not have a traceable address or telephone number, did not answer the telephone or refused to be interviewed, was substantial in both groups: 145 (29%) of the hairdressers and 417 (42%) of the saleswomen. Several causes were identified, such as change of occupation, place of employment, place of residence, or marital status (change of surname). As a result, the reference group was older, included more persons who were smoking or had smoked, but did not differ from the hairdressers with regard to the frequency of atopic diseases in their medical history. This could have led to underestimation of the true risk odds of particularly chronic bronchitis among the hairdressers, as compared with the saleswomen.

The Longitudinal Census Data File of Statistics Finland offered excellent possibility to form a retrospective cohort of female hairdressers and saleswomen employed in 1980, and to study the changes in employment, as well as, a host of health and other variables during the 15–year follow-up time in *Studies IV* & *V*. The sample of hairdressers was drawn using proportionate sampling. Province, age and status in employment (enterpreneur vs. employee) were determined as the stratification variables. The reference group was matched with the study group for province and

age, and as far as possible also with the status in employment. The missing enterpreneurs (n=218) in nine of the eleven provinces were compensated with the same number of employees from the same province and age group. This represents less than 7% of the referents and is unlikely to bias the results.

### 6.1.2 Validity of the information on outcomes and exposure estimates

In *Study I*, the exposure to hairdressing chemicals, air exchange rate, and physical conditions were based on actual measurements, which are accurate within the detection limit of each method. We asked the workers and owners of the salons about their work tasks and the type of ventilation in the salons. We did not, however, base our analysis solely on this information, because we noted, as did Kersemaekers et al., that hairdressers tend to overestimate their work load, and they do not know accurately about the type of ventilation (Kersemaekers 1998). The experienced health problems associated with working conditions were asked a rather roughly with a self-administered questionnaire. Almost 30% of the workers in the salons did not respond to the questionnaire. All of them were working in the large salons. If the non-respondents would have had health problems associated with their working conditions more frequently than the respondents, this could have led to some underestimation of the true prevalence of discomfort and illhealth among the workers. This is unlikely, however, because usually the compliance to respond is better among persons having health problems, and the study was done in good understanding with the management and employees of the salons. The workers in the small salons were older enterpreneurs and thus likely to be better adjusted to their working conditions than their younger colleagues in the larger salons. This probably diminished the association between air exchange rate (usually poorer in small salons) and experienced work-related discomfort and illhealth. The personnel in the salons were unaware of the study hypothesis.

In *Studies II* & *IV*, occupation (hairdressers vs. saleswomen) was used as a surrogate for exposure. This is, of course, not an accurate way to estimate

exposure, but we considered it sufficient for our purpose. The respiratory disease outcomes in which we were most interested were asthma and chronic bronchitis. In *Study II* we used symptom questions and the BMRC criteria for chronic bronchitis, and in *Study IV* direct questions about physician-diagnosed asthma and chronic bronchitis. This partly explains why in *Study II* we got a slightly higher prevalence (6.8%) of chronic bronchitis than in *Study IV* (5.6%) among hairdressers. In *Study II*, we considered sensitivity, whereas in *Study IV* the specificity to be more important for our purposes. The question concerning physician-diagnosed asthma has been validated (Torén 1993). Its specificity is very good (94–99%), but sensitivity only moderate (68%). No validation of the same question concerning chronic bronchitis has been done (Torén 1993).

The 12–month prevalence of hand dermatitis was based on the subject's own judgement in *Study II,* and reporting of a physician-diagnosed hand dermatitis in *Study IV*. Both ways of inquiry gave the same prevalence of hand dermatitis among hairdressers: 13.8% and 13%, respectively. The question: "According to your own opinion, have you suffered from hand dermatitis in the past 12 months?" has been validated, and its sensitivity is 65% and specificity 93%, respectively (Smit 1992). It is likely that we have lost especially mild cases of hand dermatitis, and that both the prevalence of hand dermatitis in general and occupational hand dermatitis in particular are underestimates. Also in *Studies II and IV*, the study subjects were not aware of the study hypotheses.

The occupational skin and respiratory diseases were the outcomes in *Study III*. Although the methods employed in allergy tests and challenge tests are standardized, we cannot be sure that the results are accurate. Both under- and overestimation of true prevalences is possible. It is also possible that we lost some cases among those not available for the clinical study (59 hairdressers). The selection bias may not be so great, however, because according to the CATI interview data the prevalence of skin and respiratory symptoms among the nonparticipants was quite the same as in the clinical study group. No occupational diseases were found among the nonparticipants in the Finnish Register of Occupational Diseases.

Recall bias and lack of quantitated exposure data are the two main problems in retrospective epidemiologic studies (Hernberg 1992). We cannot exclude the possiblity that in *Study V*, persons who had changed jobs attributed this incorrectlty to a health condition. However, the respondents did not know the associations we were interested in, neither did they have any benefit in incorrectly attributing the job changes to health conditions. Moreover, if a health condition was the main reason for leaving the profession, it is more likely to be remembered than other reasons. Recall problems may have affected the list of health conditions that a person reported having in 1980. This has propable caused some misclassification. If certain diagnoses, such as asthma or hand dermatitis, have been remembered better by hairdressers than by saleswomen, also a systematic error is possible.

### 6.1.3 Control for confounding

Confounding happens if the association between exposure and outcome is affected by a third variable that is independently correlated with the exposure variable and the health endpoint (Hernberg 1992). In *Studies II* & *IV* in which the endpoints were respiratory symptoms and diseases, the known potential confounding factors age, smoking and atopy were considered. The non-professional use of haircare products was a potential confounder, but it was not associated with respiratory symptoms and diseases in *Study II*, in which home use was asked. The age and employment status (employee vs. enterpreneur) was adjusted in *Study V*, when the relative risk of leaving the profession among those having a disease in 1980 was compared with those not having the disease in question. Therefore, confounding has probably not significantly affected the results of these studies.

In most of the analyses we decided to use risk-odds ratios to express the size of an event. It is known that the odds ratio does not approximate well to the risk ratio when the prevalence of outcome is high. This was pointed out by Nurminen (1995), who used data from selected epidemiologic studies, including ours (*Study II*). The risk for rhinitis symptoms among hairdressers compared with the referents was 1.2 (95% CI 1.1–1.4) when he used the

prevalence rate ratio (RR). The odds ratio gave a three times higher excess risk (OR 1.6, 95% CI. 1.2–2.1) of rhinitis among hairdressers. This situation does not apply to rarer events, such as asthma and chronic bronchitis, in which the odds ratio is approximately the same as the risk ratio. To conclude, I quote the words of Davies (1998): "Odds ratios may be non-intuitive in interpretation, but in almost all realistic cases interpreting them as though they were relative risks is unlikely to change any qualitative assessment of the study findings"

## 6.2 Significance of the results and synthesis with previous knowledge

### 6.2.1 Hygienic conditions

The physical conditions and ambient concentration of chemicals in the hairdressing salons were comparable with previous studies (Van Muiswinkel 1997, Van der Wal 1997, Hollund 1998). Although the concentrations of measured chemicals were well under the TLVs, the levels of ammonia and organic solvents in high-exposure work exceeded the odor threshold and could cause mucosal irritation (Van der Wal 1997, Hollund 1998). In this study, one third of the telephone-interviewed hairdressers suffered from odors (*Study II*) and about 15% of the workers in the salons experienced discomfort and ill health caused by chemicals (*Study I*). The concentrations of particles (mostly dust from traffic and other sources) and $CO_2$ did not meet the Finnish standard of good indoor air quality in the small salons with poor ventilation (the Finnish Society of Indoor Air 1995). The situation was the same in the naturally ventilated salons in Holland. The comfort limit of $CO_2$ was exceeded only on busy days and in the winter season (Van der Wal 1997). Tobacco smoke was not a problem in the salons because smoking in working premises is prohibited by law in Finland.

### 6.2.2 Occurrence and risk of asthma and chronic bronchitis

As seen in section 2.3, epidemiological studies on respiratory symptoms and diseases among hairdressers are few. Most of the literature is clinical, and concerns occupational asthma caused by persulfate salts in bleaches (Gaultier 1966, Macchioni 1999). The older studies focused largely on whether hair lacquers cause thesaurosis (Bergman 1958, Ameille 1985). In this study, general respiratory symptoms and symptoms related to work were common among hairdressers. The cross-sectional comparision of hairdressers with saleswomen (*Study II*) revealed an increased risk of chronic bronchitis, asthmatic symptoms, and rhino-conjunctival symptoms. Also the 15–year retrospective follow-up cohort study brought up a two-fold relative risk for asthma and chronic bronchitis among hairdressers (*Study IV*). The prevalence of asthma (10%) in hairdressers in 1995 was twice that in the general population in Finland, and similar to other occupationally exposed high-risk groups, such as bakers and laboratory animal workers (Brisman 1995, Heederik 1999). The incidence of asthma (2.2 cases/1000/year) was increased among hairdressers compared with women in the general population (1.7/1000/year) (Vesterinen 1988). Sensitization to bakery allergens seems to be the main cause of baker's asthma and rhinitis (Baur 1998a), whereas in the case of hairdressers a more likely explanation is the combined non-specific effect of atmospheric pollutants in hairdressing salons (Van der Wal 1997).

It is difficult to compare the prevalence of chronic bronchitis among hairdressers with the earlier studies of COPD in Finland due to differences in the demography of the study populations. In the questionnaire studies, the prevalence of chronic bronchitis among female populations has varied between 5.8–10.2% (Huhti 1965, Huhti 1978, Aromaa 1989, Kotaniemi 1996). Smoking is a strong determinant of COPD. In our study (*Study II*) almost half of the hairdressers and saleswomen were current smokers. As expected, the number of cigarettes smoked per day increased significantly the odds of having chronic bronchitis. Chronic bronchitis was the only respiratory disease outcome in which the risk odds were increased by hairdressing. It is possible that hairdressing is only an effect modifier in the

development of chronic bronchitis in hairdressers. However, in *Study IV* the relative risk for chronic bronchitis was increased also among never-smoked hairdressers in 1995, suggesting an independent role of hairdressing in the development of chronic bronchitis.

The risk of asthma was not increased among hairdressers in the cross-sectional *Study II,* as it was in 1995 among hairdressers in the longitudinal cohort *Study IV*. The small size of the study group in *Study II*, as well as selection can partly explain this result. Although both studies give true risk estimates for the target population, the longitudinal cohort *Study IV* is likely to be more precise as regards rare diseases, such as asthma (Järvholm 1998). Therefore, the increased risk of asthma among hairdressers in *Study I*V is considered relevant. The relative risk for developing asthma is consistent with this result.

The risk for chronic bronchitis among hairdressers was increased in both studies. It is interesting to note that in *Study II* chronic bronchitis was strongly attributed to hairdressing, whereas in *Study IV* the risk for developing chronic bronchitis in hairdressing was only slightly, but not significantly, increased. There may be many reasons behind this seemingly controversial result, including the different definition of chronic bronchitis in *Study II* & *Study IV*. The symptom-based diagnosis of chronic bronchitis used in *Study II* is more sensitive, whereas the self-reported physician-diagnosed chronic bronchitis used in *Study IV* is more specific. In *Study IV*, it is possible that retrospectively a diagnosis of asthma is easier to remember than that of chronic bronchitis. Doctors may make a diagnosis of asthma more easily than one of chronic bronchitis, especially, when we know that the symptoms of asthma and chronic bronchitis overlap, and that asthma medication is compensated by the Social Insurance Institution. Also the diagnostic procedures may have changed during the 15–year observation time. On the other hand, recall bias is unlikely in *Study II.* Hairdressers may be more likely to report their symptoms, than the unexposed referents. Thus the conclusion has to be cautious: there is only limited evidence that the risk for developing chronic bronchitis in hairdressing is increased, although the risk of chronic bronchitis symptoms is increased among hairdressers.

### 6.2.3 Attributable fraction of asthma due to exposure

Several population-based studies on the prevalence of adult-onset asthma have been published in recent years (Reijula 1996, Kogevinas 1999, Torén 1999, Mannino 2000). These studies indicate that a much higher proportion of asthma is attributed to occupational exposure than thought earlier. In this study, the attributable fraction of asthma due to exposure in hairdressing was 0.41 (***Study IV***), i.e. four out of ten asthma cases among hairdressers could have been prevented if exposure in hairdressing had not happened. In absolute numbers: of the 1010 asthma cases among 10 000 female hairdressers in 1995, 414 cases would have been work-related (***Study IV***). How many of these asthma cases are specifically caused by chemicals used in hairdressing remains unknown. However, only 37 occupational asthma cases/100,000 (95% CI 26–51) among female hairdressers were reported to the Finnish Register of Occupational Diseases (Karjalainen 2000). It seems that many of the occupational asthma cases of hairdressers remain undiscovered.

### 6.2.4 Occurrence of dermatitis

As mentioned in section 2.2, most of the current knowledge of contact dermatitis stems from case series and occupational disease register data (see Table 2). Some cross-sectional studies with and without a reference group, and recently also prospective cohort studies have been performed among hairdressers and apprentice hairdressers (Diepgen 1993, Holm 1994a–f, Smit 1994, Majoie 1996b, Uter 1998, Zelger 1999). In the present study (***Study II***), the point prevalence 16.9% and annual prevalence 13.8% of hand dermatitis were similar to those observed in population-based studies on women, e.g. in Sweden (14.6%) and the Netherlands (10.6%) (Meding 1990b, Smit 1993). The observed prevalence of hand dermatitis in ***Study II*** is likely to be higher, since self-reported diagnoses tend to underestimate the true prevalence due to the recurrent nature of dermatitis and recall bias (Smit 1992). This was seen in ***Study III***: 2.5% (9 cases) of the suspected occupational dermatitis cases were identified among hairdressers who came to a medical examination for work-related respiratory symptoms.

The earliest report of the incidence of occupational dermatitis among hairdressers is from Postdam, German Democratic Republic in 1974 (Laubstein 1974). The incidence of occupational dermatoses per year was then 22.8 cases/10 000 among men and 12.3 cases/10 000 among women. In twenty years, the incidence of occupational dermatitis has increased ten-fold (194/10 000/year) in Germany (Diepgen 1994). According to *Study III*, the annual incidence of occupational dermatitis among hairdressers in Finland was 280/10 000, which is in the same range as in Germany. The rate is high compared to that reported to the Finnish Register of Occupational Diseases (20–40 cases/10 000 employed/year). It is evident that both under-diagnosing and under-reporting of occupational skin diseases among hairdressers happens in Finland. If all, instead of only about one out of ten, occupational dermatitis cases would have been recognised among hairdressers, the hairdressing trade would have the highest incidence of occupational dermatitis among all industries in Finland. This is the prevalent situation in other countries, such as Germany, Italy and Australia (Lodi 2000, Diepgen 1994, Rosen 1992, Wall 1991).

One reason for the under-reporting is the reluctance of hairdressers to seek medical care. The CATI (*Study II*) revealed that only half of the interviewed hairdressers had consulted a physician because of their hand dermatitis. Another reason is the Finnish insurance system, which allows a self-employed person or an entrepreneur to take an insurance which does not cover the diagnosis, treatment and compensation for occupational diseases. It is not known how many of the hairdressers are not covered by this insurance. It is likely that the percentage can be considerable, since about half of the hairdressers were self-employed or entrepreneurs in 1998 (Statistics Finland 2000).

### 6.2.5 Exposure-outcome relations

Ammonium persulfate in bleaches was the most often mentioned reason for worsening of the respiratory and skin symptoms (*Studies II* & *III*). Persulfates caused 90% of the asthma, rhinitis and laryngitis cases and 30% of the allergic and irritant contact dermatitis and urticaria cases. The mechanism

and chain of events leading to sensitization to persulfates is largely unknown and may not be IgE-mediated at all (Parsons 1979, Yawalkar 1999). Allergy tests have revealed both immediate and delayed reactions caused by persulfates (Fisher 1976, Parra 1992). However, in the case of persulfates the dose-effect-outcome relation is not linear, as e.g. for platinum salts (Banks 2000). Workers can handle persulfates in much higher concentrations than in hairdressing without problems for years and then suddenly get sensitized to it (Merget 1996). In this study (*Study III*), the exposure time varied from half a year to 15 years. Even if the peak concentrations of ammonium persulfate measured in the salons were only one hundredth of the TLV, they reached the level we have seen in the clinic causing acute asthma reactions in sensitized hairdressers. It seems to be difficult to determine a safe exposure level for persulfates, under which no sensitization would happen. Therefore, the preventive actions should be directed at reducing exposure to a minimum. A closed mechanical mixer, commonly used in industry, is one option. Local exhaust ventilation is another possible solution. It has been shown to reduce markedly chemical concentrations in hairdressing operations (Hollund 1998). Regular follow-up of workers' health and use of personal protection are also important (Quirce 1998, Macchioni 1999).

In *Study III*, about 45% of the hand dermatitis cases were caused by wet work and skin irritation of hairdressing chemicals, which is close to what has been found in other studies (Uter 1995, Majoie 1996b, Zelger 1999). This is not surprising, considering that hairdressers reported washing their hands with shampoos and soaps as many as over 20 times a day (*Study III*). Regular use of hand creams and non-alkaline soaps is recommended. Jarisch et al. have shown that with these simple precautions irritant hand dermatitis can be alleviated in 70% of the cases (Jarisch 1986).

Nickel was the most common cause of allergy in our study (*Study III*). One third of the tested hairdressers presented a positive patch reaction to it. This rate is higher than in the general population in Finland, but does not differ from those found in other countries among hairdressers and younger age groups (Kerosuo 1996, Zelger 1999). Even after careful investigation of the history of exposure to nickel and occurrence of skin symptoms, none of the

nickel allergies were found to be occupationally relevant in this study. In a population-based study of 662 hairdressers in Germany, half of the examined hairdressers were sensitized to nickel, but only 6% had an allergic contact dermatitis for which sensitization to nickel was relevant (Diepgen 1994). This represents one tenth of all the nickel allergic hairdressers in that study. In a survey of 368 nickel-sensitive subjects, nickel was considered an occupational allergen or possible allergen in 22.8% (84) of the cases (Shah 1998). Three occupational groups: retail clerks (20), hairdressers (17) and cleaners (12) represented most of the cases. In these two studies, the criteria for determining the work-relatedness of nickel allergy may not have been as stringent as in our study. Nickel, as a cause of occupational contact dermatitis among hairdressers, remains a controversial issue. Assessment of each case individually is recommended (Estlander 1993, Shah 1998).

Glyceryl monothioglycolate, paraphenylenediamine and its derivates and persulfates are the most common causes of occupational allergic contact dermatitis in hairdressers according to several studies in Europe (Guerra 1992b, Frosch 1990, Frosch 1993, Von Peters 1994, Conde-Salazar 1995, Katsarou 1995, Gall 1997, Özkaya-Bayazit 1997, Leino 1998, Lodi 2000). The same allergens can cause contact dermatitis in hairdressers' clients (Guerra 1992a). In this study only two cases of allegic contact dermatitis were caused by paraphenylenediamine, one by ammonium persulfate and none by thioglycolate salts (***Study III***). One reason for the low prevalence of allergy and contact dermatitis to PPDA in our material can be the fact that the use of both the ortho- and para-forms of PPDA were forbidden in Finland until 1991 (Leino 1998). Another important reason is the common use of protective gloves in hair dyeing and bleacing jobs: over 90% used them regularly, whereas e.g. in Italy only a half of the hairdressers did so (Guerra 1992b). However, the use of protective gloves does not explain the non-existense of allergic contact dermatitis to glyceryl monothioglycolate (GMTG) since only a half of the hairdressers used gloves when setting permanents (***Study III***). A declining trend of GMTG allergy among hairdressers has been noted in Germany (Uter 2000). The use of natural rubber gloves was low (***Study II***); only 6.4% used them daily. We found three positive allergic reactions to NRL in the prick tests, and one contact urticaria

case caused by NRL (Kanerva 1999). This is much less than the rate observed for latex allergy (5/41; 12%) among hairdressers in the Netherlands (Van der Walle 1995). The use of vinyl or polyethene gloves instead of latex gloves is recommended (Van der Walle 1994b, Estlander 1994). Thick rubber gloves or 4H gloves could give even better protection against GMTG. However, gloves made of these materials are not very practical in hairdressing (Fisher 1989b, Fisher 1993a, Fisher 1997).

As an original finding, hairdressers had considerably more immediate allergic reactions to human dandruff and to a saprophyte fungus, *P. ovale* present in dandruffy scalps, than did the non-occupationally exposed controls (*Study III*). It is known that hairdressers can get skin and respiratory symptoms when cutting or brushing someone's hair (Leino 1995). In the nasal provocation tests, dandruff has caused positive reactions in hairdressers, but the results have not been consistent with the allergy tests (Hytönen 1997). The antigen in human dandruff has not yet been determined. In *Study III* we found one patient (an atopic barber who had hypersensitive rhinitis when cutting the hair) who had postive prick tests to both human dandruff and *P. ovale*. The Ig-E immunoblotting with human dandruff revealed the same antigens as to *P. ovale*. This saprophytic yeast, present in human dandruff of the scalp, may thus contribute to the skin and respiratory symptoms in the hairdressers sensitized to it.

### 6.2.6 Effect of atopy

Atopy was a strong independent determinant in all of the studied respiratory diseases. An atopic disease in the medical history increased the risk for diagnosis of an occupational skin or respiratory disease by 3–fold (*Study III*). Coenraads et al. (1998) have reviewed the data of several studies on hand dermatitis. They conclude: "A history of atopic dermatitis without exposure at least doubles the risk for hand eczema, and occupational exposure (skin irritants) at least doubles this risk again." In *Study V* atopy increased the risk of leaving the profession by 20%, and if a hairdresser had a manifested asthma or hand dermatitis, the risk of leaving the profession increased by about 3–3.5 –fold. This is in agreement with other studies (Antti-Poika 1991,

Majoie 1996b, Shah 1996, Ameille 1997, Cavin-Milhaud 1998, Zelger 1999). Although about one third of the hairdressers having an occupational disease had to leave their profession (*Study II*), the majority were able to continue despite their condition or atopy (Uter 1998d). This illustrates the importance of counselling, personal protection, and product selection (Davidson 1994, Van der Walle 1994b, Diepgen 1996, Coenraads 1998, Uter 1998, Banks 2000). Each case should be evaluated individually by a medical specialist. Questionnaires and skin tests can supplement the evaluations, but cannot replace them (Gebhardt 1995). No absolute restrictions for atopic subjects should be given. Younger persons with persulfate-induced asthma and dermatoses were in retraining. This is an indication of a well-functioning vocational rehabilitation system in Finland. Although in Finland the social consequences of an occupational disease may not be so severe as in some other countries (Ameille 1997), in individual cases they can be dire and lead to permanent disability and loss of income (Antti-Poika 1991).

# 7 Conclusions

On average, the physical and chemical working conditions in the hairdressing salons are satisfactory compared with the Finnish indoor climate criteria for offices. Although TLVs were not exceeded, over half of the workers experienced discomfort and illhealth caused by bleaching powders, hair dyes, permanent wave solutions and hair sprays. Local emissions of chemicals are frequent in hairdressing. They can partly explain why increased general ventilation was not sufficient to reduce significantly work-related health complaints among workers. The use of local ventilation is recommended in all high-exposure tasks.

The prevalence of rhino-conjunctivitis and the prevalence and incidence of asthma and chronic bronchitis are increased among hairdressers compared with the occupationally non-exposed women. The 2–fold relative risk of asthma and chronic bronchitis and 1.7–fold relative risk of developing asthma are corresponding to other high risk occupational groups. The attributable fraction of asthma due to exposures in hairdressing was 41%, indicating that a large propotion of hairdressers become asthmatics, or their asthma is exacerbated by their occupation. Exposure to any single hairdressing chemical is unlikely to be the cause of the excess risk of asthma and chronic bronchitis among hairdressers. The effects of exposure to a combination of atmospheric pollutants, frequently of an irritant nature, explain better the increased morbidity.

The study increased the number of new cases of occupational diseases in the Finnish Register of Occupational Diseases by 20%, indicating considerable underreporting. Work-related skin and respiratory symptoms were frequent: of the hairdressers two third related their skin symptoms and over half their respiratory symptoms to work. Occupational dermatitis was diagnosed in about 20% of the symptomatic hairdressers. A specific cause was identified much less often when a hairdresser was suffering from rhinitis or had

asthmatic symptoms at work: 4.4% of those with work-related rhinitis and 3% of those suffering from work-related asthma symptoms. If a non-sensitizing alternative for ammonium persulfate (and other persulfates) were available, 90% of occupational respiratory diseases and 30% of occupational dermatoses could have been avoided. New safer compounds for bleaching the hair should be sought.

As an original finding, hairdressers had 18.7–fold more allergy to human dandruff and 3.5–fold more to *P. ovale* yeast compared with the non-occupationally exposed referents. The clinical relevance of these allergies is still not fully understood. Both seem to be capable of causing skin and respiratory symptoms among hairdressers.

Atopic diseases in the subject's medical history increased the risk of occupational skin or respiratory disease by 3–fold, and leaving of the occupation by 20%. The highest risk for leaving the occupation was among hairdressers suffering from asthma, hand dermatitis, strain injuries of the elbow and wrist, and diseases of the neck or shoulders. Hairdressers having asthma, hand dermatitis or strain injuries early in their career are most probably going to have problems in keeping their job. They need individual councelling, job adjustments and personal protection.

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