Occupational Exposures and Obstructive Lung Disease: A Case-Control Study in Hairdressers

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BACKGROUND: Hairdressers are exposed to various irritating chemicals during work. OBJECTIVE: This study was designed as a case-control study to evaluate the risk of developing obstructive lung disease in relation to occupational exposures in hairdressers. METHODS: We interviewed a cohort of 50 female hairdressers and 50 matched controls recruited from a random sample of the general population, using a validated questionnaire for occupational respiratory disease, to compare the prevalence of work-initiated and work-related respiratory symptoms in both groups. We also performed pulmonary function tests (PFTs) in all participants. RESULTS: Almost half of the hairdressers reported work-initiated respiratory symptoms. Cough (33%) and breathlessness (29%) were the most common self-reported symptoms after chemical exposures. All respiratory symptoms (cough, breathless, wheezing, and phlegm) were significantly higher in the hairdressers than in the control group ($P < .001$). The hairdressers reported that bleaching powder and hair spray were the most irritant chemicals that provoke their respiratory symptoms. The impaired PFT values (forced vital capacity, FEV_1, maximum mid-expiratory flow, peak expiratory flow) in the hairdressers, compared to the matched controls, were in line with the questionnaire data. CONCLUSIONS: Hairdressing work is associated with a high frequency of work-initiated respiratory symptoms and, to a lesser extent, with allergic symptoms, particularly after exposure to bleaching powder and hair spray. PFT values were significantly lower among the hairdressers, which might be a predictor for developing obstructive lung disease. *Key words: occupational exposure; chronic obstructive pulmonary disease; COPD; occupational asthma; occupational lung disease; pulmonary function test; PFT.* [Respir Care 2010;55(7):895–900. © 2010 Daedalus Enterprises]

Introduction

Occupational and environmental exposures increase the risk of asthma, COPD, and other respiratory diseases. These respiratory diseases are predicted to become the third leading cause of death by 2020, according to the World Health Organization.[1] Epidemiological studies have identified high-risk occupations and harmful exposures,[2-4] but there are still many unknown workplace exposures causing respiratory problems.[5,6] Hairdressers are extensively exposed to low air concentrations of numerous chemicals in cosmetic products that may cause bronchoconstriction and airway obstruction.[7] Increased prevalence of upper and lower respiratory symptoms,[8-10] occupational asthma,[11] and hand dermatitis has been reported in hairdressers,[12] but no studies have mentioned the possibility of developing chronic bronchitis.

Workplace exposure to various chemicals, which may be absorbed or inhaled, can affect airways directly or cause bronchial mucosal inflammation in hairdressers.[13] For example, persulfate salts cause occupational asthma and airway hyper-responsiveness via an immunologic mechanism.[14-19] Bleach and ammonia can cause mucosal membrane irritation and are associated with occupational

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asthma and chronic bronchitis.[20,21] "Hair-spray lung" (thesaurosis) has also been reported due to hair spray exposure.[22,23] Nasal airway obstruction may occur as a result of exposure to permanent waving solution.[24] Increased prevalence of asthma, airway symptoms, and total serum immunoglobulin was also reported in hairdressers exposed to bleaching powder, hair spray, permanent wave solution, and hair dye.[25,26] Hairdressers' exposure to noxious chemicals can also lead to occupational rhinitis, with nasal hyper-responsiveness to dandruff, ammonium persulphate, and ammonium thioglycolate.[27] Exposure to hair dye before or during pregnancy can induce brain tumor in the child.[28] Installation of local exhaust ventilation may reduce or avoid exposure and improve respiratory symptoms to some extent, but evidence in this regard is still limited.[25]

The aims of this study were to assess self-reported work-related respiratory and air-flow obstruction among hairdressers, compared to unexposed matched controls.

Methods

Population

A case-control study was designed in the city of Mashhad, northeast Iran, to assess work-related respiratory/allergic symptoms and pulmonary function tests (PFTs) in a cohort of 50 female hairdressers, and 50 matched controls. For the purpose of this study, about 30 hair salons were selected across the city of Mashhad. The hair salons differed in size and ventilation conditions. The selection of studied hairdressers was based on the following criteria: minimum of 2 consecutive years of full-time hairdressing experience, no history of respiratory disease, not taking medication for allergy or respiratory disease, and no history of cardiovascular disease. The studied hairdressers were chosen randomly from among 1,000 female hairdressers in Mashhad. The studied hairdressers and control subjects were not aware of the purpose of the study. All the studied hairdressers, regardless of their response were included in the study. In addition, all the hairdressers who met the inclusion criteria in the studied salons were included in the study.

The hairdressers were exposed to various hair products on the job, and the intensity of exposure was affected by type of job, duration of exposure, protection methods, and ventilation settings in the work place. The hairdressers worked a mean ± SD 7.6 ± 1.9 h/d for the past mean ± SD 6.3 ± 7.5 y (Table 1). Some of the hairdressers tended to do less of the work that causes chemical exposures, such as bleaching, dying, or waving hair. Two percent used masks, 37% used gloves, and 61% used both mask and gloves while working with those chemicals. A few of them quit their jobs because of their respiratory conditions, and resumed their jobs after their respiratory symptoms improved.

Table 1. Demographic and Respiratory Health Characteristics*

	Hairdressers	Controls
Subjects (all female)	50	50
Age (mean ± SD y)	32.5 ± 11.2	30.6 ± 10.6
Smoker (*n*)	4	0
Atopy (*n*)	0	4
Family history of atopy (*n*)	3	25

* The subjects and controls were matched based on demographic values.

The controls were volunteers who had office jobs and had never been exposed to hair products. The controls were recruited via flyers that we distributed in public areas. To eliminate demographic factors, the controls were matched to the hairdressers for age, sex, socioeconomic status, ethnicity, residential area, and smoking habits. The participants were compensated for their participation, and they all provided informed written consent. The ethics committee of Mashhad University of Medical Sciences approved the study.

Protocol

Subjects were interviewed by the study coordinator, using a questionnaire derived from previous studies.[29-31] The questionnaire sought information on respiratory symptoms, history of atopy, medications, smoking habits, and characteristics of the participant's current job. Asthma status was determined via history of physician-diagnosed asthma and a follow-up question on whether working provoked an asthma attack or provoked the symptoms.

The hairdressers were asked to state their respiratory symptoms; the relationship of the symptoms to the hairdressing chemicals (bleaching powder, permanent waving solution, hair dye, and hair conditioner spray); how often they were exposed to those chemicals; and their hairdressing employment history and whether they had quit hairdressing for a period of more than a year.

We also asked about common risk factors, such as smoking habit, atopy, family history of atopy, and their use of gloves and/or mask, and about the air ventilation during work and whether it reduces the intensity of work-related symptoms.

Exposure Assessment

The frequency and duration of exposure were estimated based on the detailed job-history information. One section of the questionnaire included specific questions on characteristics of exposure as hours per day, hours per week, or

Table 2. Respiratory and Allergic Symptoms in Hairdressers and Controls

Symptom	Hairdressers Before Exposure (%)*	Hairdressers After Exposure (%)	*P* for Before vs After Exposure	Controls (%)	*P* for Subjects vs Controls
Cough	6	33	< .001	10	< .001
Phlegm	4	16	< .001	4	< .001
Breathlessness	20	29	.19	10	< .001
Wheezing	2	8	.10	2	< .001
Sneezing	12	29	.005	16	.04
Runny nose	6	26	< .001	16	.12
Itchy eye	8	26	.002	12	.02
Urticaria	2	16	< .001	2	< .001

* Percent with this symptom before work-related exposure to hairdressing products.

hours per year, and years in the hairdressing job. All frequencies were converted into hours per year and hours per lifetime (which was defined as number of years multiplied by hours per year). Then the subjects were categorized into an intermediate-exposure group (≤ 500-h work as a hairdresser) and a high-exposure group (> 500-h work as a hairdresser).

All the hairdressers worked directly, but intermittently, with hairdressing chemicals. We asked detailed questions regarding the types of chemicals and exposures per day.

Pulmonary Function Testing

The PFTs (ST90 spirometer, Fukuda, Sangyo, Japan) for the hairdressers were performed on a regular day at their workplaces. Prior to the spirometry, the required maneuver was demonstrated by the operator, and the subject was encouraged and supervised throughout the PFT. PFT was performed in a standing position, with nose-clips, per the American Thoracic Society guidelines.[32] All the PFTs were carried out by one operator, between 10:00 AM and 5:00 PM. The spirometer was calibrated each day prior to PFTs. With each subject the PFT was performed 3 times with acceptable technique. All the PFTs were without bronchodilator. The highest forced vital capacity (FVC), FEV_1, peak expiratory flow, maximum mid-expiratory flow, and maximum expiratory flow at 25%, 50%, and 75% of the FVC were taken independently from the 3 curves.

Data Analysis

The PFT values are expressed as mean ± SD, and differences between the mean and median of the hairdressers and control groups were tested with the unpaired *t* test and the Mann-Whitney test. A 2-sided *P* value of .05, with a confidence interval of 95%, was the criterion for statistical significance. In addition, we subcategorized our subjects into a high-exposure group and an intermediate-exposure group to evaluate the impact of exposure intensity, A subgroup analysis was performed to compare the high-exposure, intermediate-exposure, and control (un-exposed) groups. All analyses were performed with statistics software (Prism 5, GraphPad Software, San Diego, California).

Results

Work-Exposure-Related Respiratory Symptoms

The hairdressers had spent a mean ± SD 7.6 ± 1.9 h/d on the job for the past mean ± SD 6.3 ± 7.5 y (see Table 1). All the hairdressers were both directly exposed (ie, worked with) and less directly exposed (ie, worked near ["passively" exposed]) to hairdressing chemicals. The prevalence of respiratory symptoms was: cough 33%, breathlessness 29%, and self-reported wheezing 8%, all of which were significantly higher among the hairdressers than the controls (Table 2). The respiratory symptoms occurred usually right after exposure or during the work hours. Some subjects said that they did not experience any of these symptoms when they stopped working. Two subjects said that they left hairdressing for a couple of years and resumed hairdressing when their symptoms had improved; however, they were still complaining of respiratory symptoms during work with hairdressing chemicals.

The frequency and severity of respiratory symptoms was also affected by the type of chemicals that the hairdressers had been exposed to. The most common products in the majority of the hair salons were hair dye, hair sprays, permanent wave solution, and bleaching powder. Exposure to these chemicals during work induced cough, breathlessness, and sneezing in the hairdressers. The bleaching powder and hair spray were reported as the most irritating chemicals for respiratory symptoms. Gloves and/or mask were the only protection methods used by our subjects.

Table 3. Exposures and Symptoms

Chemical	Exposure (%)	Provoked Symptoms (%)
Bleaching powder	96	24
Hair spray	100	8
Permanent wave solution	78	6
Hair dye	96	2

Table 4. Pulmonary Function Test Results in Hairdressers and Controls

	Mean ± SD Percent of Predicted		
	Hairdressers	Controls	*P**
FVC	83 ± 22	103 ± 32	< .001
FEV_1	88 ± 17	104 ± 28	< .001
MMEF	88 ± 24	120 ± 28	< .001
PEF	81 ± 18	101 ± 27	< .001
MEF_{25}	116 ± 32	112 ± 28	.14
MEF_{50}	95 ± 29	102 ± 32	.26
MEF_{75}	84 ± 25	104 ± 49	< .001

* Via Mann-Whitney test.
FVC = forced vital capacity
MMEF = maximum mid-expiratory flow
PEF = peak expiratory flow
MEF_{25} = maximum expiratory flow at 25% of the FVC

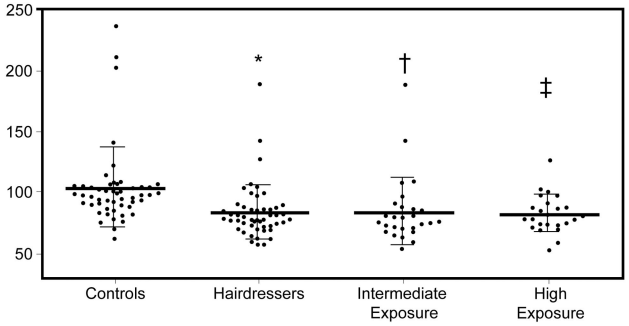

Fig. 1. Forced vital capacity (FVC) in hairdressers was significantly lower than in controls. In subgroup analysis, the hairdressers with intermediate exposure or high exposure to hairdressing chemicals had significantly lower FVC than the controls. * $P = .04$. † $P = .009$. ‡ $P < .001$.

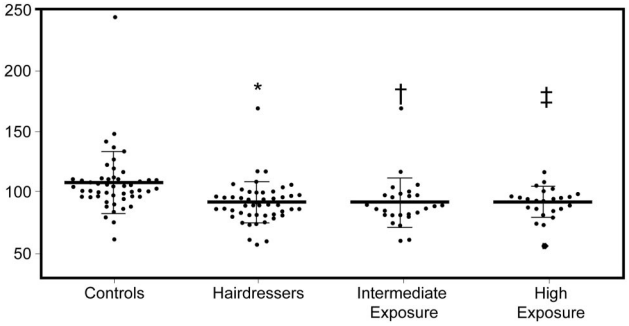

Fig. 2. FEV_1 in hairdressers was significantly lower than in controls. In subgroup analysis, the hairdressers with intermediate exposure or high exposure to hairdressing chemicals had significantly lower FEV_1 than controls. * $P = .02$. † $P = .006$. ‡ $P < .001$.

Only one of our hairdresser subjects reported wearing a mask, but 38% of the hairdressers wore gloves before chemical contact. Five of the hairdressers refused to work with bleaching powder because of its irritating effect on the respiratory tract, including cough and breathlessness. The majority of the hair salons did not have an adequate ventilation system, even though workers were exposed to airborne bleaching powder.

Pulmonary Function Test Values

PFT values were measured in subjects and controls by the same technician. The values were compared in each case with the normal curve, and results are reported in percent of predicted. FVC and FEV_1 were significantly lower in the hairdressers than in the controls, and almost 30% of the hairdressers had an $FEV_1 < 80\%$ of predicted (Table 4). Subgroup analysis showed significantly lower FVC and FEV_1 in both the high-exposure group and the intermediate-exposure groups, compared to the control group (Figs. 1 and 2). The maximum mid-expiratory flow and peak expiratory flow were significantly lower in the hairdressers than in the controls (see Table 4).

Discussion

Inhalation of chemical agents in the workplace can cause acute and chronic respiratory conditions. Occupational asthma and COPD are strongly associated with occupational and environmental chemical exposures. Several national epidemiologic studies have reported the association between occupational exposure to inorganic and organic dusts and chemical agents and increased risk of COPD; however, those studies mainly focused on employment in industrial jobs.[5,6,33-35]

In the current study we identified the impact of hairdressers' jobs on their respiratory health, and found significantly higher work-exposure-induced respiratory symptoms in hairdressers than in the general population. The respiratory symptoms mostly occurred after work exposure. All of the hairdressers in our study reported that they did not have any respiratory symptoms before starting work as hairdressers. They also emphasized that their symptoms improved when they stopped hairdressing. Hair bleaching powder was reported as the most irritating chemical for the respiratory tract; some of our subjects refused to work

with it, and one wore a mask while working with it. Hairdressing products emit chemicals in both gaseous and aerosol form, which remain in the work environment and are inhaled by hairdressers. Our findings indicate impaired PFT values in hairdressers, compared to the general population. The hairdressers also reported a large increase in allergic reactions after exposure to hairdressing chemicals at work.

We performed all the hairdressers' PFTs at their work environments, after a couple of hours of starting their daily work, so the PFT values might indicate post-exposure values; however, there is no evidence regarding their pulmonary function prior to exposure. In addition, self-reported work-exposure-induced symptoms were significantly higher after work exposure than before work exposure.

The French Observatoire National des Asthmes Professionnels (ONAP) study stated that hairdressing has a higher risk of occupational asthma.[11] Leino et al found a considerable difference in the prevalence of chronic bronchitis in hairdressers, compared to a control group in Finland.[10]

The exact mechanism of respiratory reaction to chemicals is still unclear, although a few studies have reported the roles of various factors. The methacholine-inhalation test showed airway hyper-responsiveness in hairdressers.[16] The clinical and immunological studies carried out with hairdressers reported that they developed respiratory symptoms about one year after being employed in a hairdressing salon, after exposure to persulphate salts, which are common constituents of hair bleach.[17] Skin-prick tests with 1:5 weight/volume potassium and sodium persulphate extracts were positive in hairdressers at 15 min and negative in controls. Bronchial provocation test with a 1:5 weight/volume potassium persulphate extract elicited a non-immediate asthmatic reaction, followed by decreased FEV_1 that lasted up to 3 days after the test. Plethysmography revealed air-trapping caused by a marked increase of airway resistance 3 hours after the specific bronchial challenge.[17]

Parra et al clearly showed that exposure to hair bleach containing potassium persulphate is mainly responsible for the development of respiratory disorders in hairdressers. Our study also shows increased respiratory and allergic symptoms after exposure to hair bleach. Hair bleaching products containing persulphates dissolved in H_2O_2 cause airway hyper-responsiveness to acetylcholine in rabbits.[36] That study indicated that a 4-hour exposure to a hair bleach induced airway hyper-responsiveness to acetylcholine, but aerosolized H_2O_2 did not influence airway responsiveness to acetylcholine.[36]

The limitations of the present study are the small study size, self-reported health data, no review of medical records of participants to confirm respiratory conditions, lack of environmental air data confirming exposures, and potential for selection or non-response bias, all of which require further study.

Conclusions

Hairdressing work is associated with a high frequency of work-exposure-related respiratory symptoms, and, to a lesser extent, allergic symptoms. The respiratory and allergic symptoms were particularly aggravated after work-exposure to bleaching powder and hair spray. PFT values were also significantly reduced among hairdressers, compared to the general population, which may suggest early development of COPD.

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