

# Work-Related Respiratory Symptoms and Airway Disease in Hairdressers

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## Abstract

**Background:** Hairdressers are occupationally exposed to a number of agents in their workplace that result in respiratory symptoms and changes in pulmonary function.

**Objective:** To evaluate associations between occupational exposure and respiratory function and reported symptoms in a group of hairdressers compared to a control group.

**Methods:** A questionnaire on respiratory symptoms and workplace characteristics was completed by 94 hairdressers and 39 age- and sex-matched controls. Spirometry and exhaled nitric oxide (FeNO) measurements were also performed.

**Results:** Hairdressers reported more severe dyspnea ( $p=0.03$ ) and eye ( $p=0.001$ ) and throat ( $p=0.007$ ) irritation, compared to the control group, at the workplace; no differences were noted at home. Lower  $FEV_1/FVC$  ( $p<0.001$ ) and higher FeNO values ( $p=0.012$ ) were observed in hairdressers. A larger working area and presence of window ventilation were associated with better pulmonary function.

**Conclusion:** Worsening of symptoms and pulmonary function at workplace, and alleviating the symptoms at home, indicate that they may be related to occupational exposure.

**Keywords:** Barbering; Occupational exposure; Respiratory tract diseases; Spirometry; Nitric oxide; Environmental exposure; Inhalation exposure

## Introduction

Hairdressers are occupationally exposed to a number of agents in their workplace that would result in respiratory and ocular symptoms and changes in pulmonary function. There is a need to investigate whether potential occupational exposure of hairdressers to aerosol chemicals is associated with airway disease, including asthma.

Previous studies indicate that asthma and respiratory symptoms are common in hairdressers.<sup>1, 2</sup> This has been attribut-

ed to their exposure to a number of toxic elements used in the coiffures, including sprays, hair colors,<sup>3</sup> and, more importantly, bleaching agents, specifically persulfate salts, although the mechanism of inducing occupational asthma has not definitely been demonstrated.<sup>4</sup> In addition, other risk factors such as smoking, may confound the effect of these toxins on the development of respiratory symptoms.<sup>5</sup>

According to the *Observatoire National des Asthmes Professionnels* (ONAP) data, hairdressing represented the fourth



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Received: Jan 20, 2013  
Accepted: Feb 26, 2013

Cite this article as: Skoufi GI, Nena E, Kostikas K, et al. Work-related respiratory symptoms and airway disease in hairdressers. *Int J Occup Environ Med* 2013;4:53-60.

For more information on occupational asthma see [www.theijoem.com/ijoem/index.php/ijoem/article/view/87](http://www.theijoem.com/ijoem/index.php/ijoem/article/view/87)

For more information on respiratory problems among quarry workers in Nigeria see [www.theijoem.com/ijoem/index.php/ijoem/article/view/152](http://www.theijoem.com/ijoem/index.php/ijoem/article/view/152)

most frequent occupation in both sexes, and the second most frequent occupation in women, among people with occupational asthma.<sup>6</sup> The high rates of occupational asthma are present not only in professional hairdressers, but also in their apprentices, who have been demonstrated to have poorer lung function than respective office apprentices, and who develop bronchial hyper-responsiveness and deterioration of lung function over a 3-year follow-up.<sup>7-9</sup>

The primary objective of this study was to determine self-reported ocular and respiratory symptoms as well as pulmonary function and airway inflammation, as measured by exhaled nitric oxide (FeNO) level among hairdressers and to compare it with a group of office workers. The secondary objective of this study was to determine whether these differences in respiratory symptoms and pulmonary function are affected by characteristics of hairdressers' working area, such as availability of natural ventilation (window) in their work environment, work duration and whether respiratory symptoms are

modified at home.

## Materials and Methods

All hairdressers (n=127) from the city of Larissa, central Greece, were invited to participate in this study. Of 127 invitees, 94 hairdressers agreed to participate (response rate of 74%). The hairdressers were matched with office employees for gender, age and smoking habit. Subjects with a previous diagnosis of asthma or other chronic respiratory conditions were excluded from the study. Answers to the distributed questionnaire, spirometry and FeNO measurements were obtained within their workplace during working hours. The study was approved by the Ethics Committee of the University Hospital of Larissa; all participants provided written informed consent.

Participants were interviewed by one of the researchers, using a questionnaire which included demographic data, smoking history, family and past medical history of asthma and atopy, chronic respiratory symptoms (cough, sputum production, dyspnea, wheezing, and eye-nose-throat irritation), and temporal changes in symptoms (worse at work or improved during weekends or holidays).<sup>10</sup> Smoking status was measured in pack-years (PYS). Respiratory and ocular symptoms at work and home were measured using response items containing 10 ordinal responses calibrated from 0 (indicating "the worst outcome," *i.e.*, "frequent or intense symptoms") to 10 ("the best outcome," *i.e.*, "no symptoms"). Separately, these items included cough, sputum production, dyspnea, wheezing, and eye, nose, and throat irritation. Additionally, in order to evaluate modifiable risk factors for occupational asthma, occupational history data, work duration (total years of work, hours per day and hours per week) and intensity, work area size and ventilation

### TAKE-HOME MESSAGE

- Hairdressers are occupationally exposed to a number of agents in their workplace that would result in respiratory symptoms and changes in pulmonary function.
- Hairdressers reported more severe symptoms compared to office workers at the workplace.
- Hairdressers had significantly lower spirometric and higher FeNO values than the controls.
- Worsening of symptoms at workplace and alleviation of the symptoms at home, indicate that they may be related to occupational exposure.
- A larger working area and presence of window were significantly associated with improved pulmonary function in hairdressers.

**Table 1:** Comparison between anthropometric characteristics, spirometric results and FeNO values between two studied groups. Values are mean±SD or frequency (%).

Parameter	Hairdressers (n=94)	Office workers (n=39)	p value
Age (yrs)	34.7±11.4	36.9±9.1	0.298
Female gender	83 (88%)	33 (85%)	0.563
Smokers	56 (60%)	28 (72%)	0.183
Amount of smoking (pack year)	12.4±1.4	16.5±2.4	0.129
FEV <sub>1</sub> (L)	3.18±0.65	3.22±0.62	0.768
FEV <sub>1</sub> (% Pred)	99.3±1.5	98.7±1.8	0.825
FVC (L)	3.73±0.80	3.79±0.72	0.691
FVC (% Pred)	100.7±19.2	100.3±11.2	0.906
FEV <sub>1</sub> /FVC (% Pred)	92.0±10.3	103.5±6.1	<0.001
FeNO (ppb)	13.8±10.2	9.6±3.7	0.012

in the workplace (window, ventilation exhaust hood, fan or other ventilation), were included in the questionnaire. Work intensity was estimated using a validated measure which included the average number of bleaching, dye and permanent wave applications per week.<sup>11</sup> Work area size was calculated as working area per person in square meter. We also assessed the presence of ventilation, its type and frequency of use during the work hours.

Spirometry was performed using a dry spirometer (KoKo Legend, Ferraris, UK), according to the American Thoracic Society recommendations.<sup>12</sup> The spirometric reference values used were those proposed by the European Respiratory Society (ERS).<sup>13</sup> Forced expiratory maneuvers were repeated until three acceptable tests

were obtained and the best forced expiratory volume in the first second (FEV<sub>1</sub>), forced vital capacity (FVC), and FEV<sub>1</sub>/FVC values were recorded. FeNO was measured using a portable nitric oxide analyzer (NIOX MINO airway inflammation monitor, Aerocrine, Solna, Sweden) that provided FeNO measurements at 50 mL/s exhalation flow rate; the values were reported in parts per billion (ppb).<sup>14</sup> Measurements with this device are in clinically acceptable agreement to measurements provided by a stationary analyzer (NIOX; Aerocrine) according to the American Thoracic Society guidelines.<sup>15-17</sup> The accuracy of the NIOX MINO device is ±5 ppb for measured values of <50 ppb and ±10% for values ≥50 ppb. All subjects were asked not to consume food or bever-

**Table 2:** Comparison between self-reported evaluation of symptoms at work between hairdressers and office workers. Data are presented as mean±SD. Lower values indicate a worse outcome, *i.e.*, frequent or severe symptoms.

Symptom	Hairdressers (n=94)	Office workers (n=39)	p value
Cough	8.9±2.0	9.2±1.6	NS*
Sputum production	9.1±2.2	8.9±2.2	NS
Dyspnea	9.0±2.2	9.5±1.9	0.026
Wheezing	9.9±1.1	9.9±0.3	NS
Eye irritation	7.7±3.2	9.4±1.7	0.001
Nose irritation	8.9±2.4	9.3±2.3	NS
Throat irritation	8.9±2.3	9.8±1.1	0.009

\*Not significant

ages or smoke at least for two hours before the measurement of FeNO.

Normality of distribution was assessed for all continuous variables prior to any statistical analyses. For normally distributed measures, *Student's t* test for unpaired data was used. For ordinal measures of respiratory and ocular symptoms, Wilcoxon signed-rank test was used to assess differences between hairdressers and the control group, stratified by smoking history, while current smoking was used to define smokers. Spearman's rho was used to assess the correlation between the hairdresser's work area and measures of pulmonary function and FeNO. All analyses were performed by SPSS® for Windows® ver 19.0. A two-tailed p value <0.05 was considered statistically significant.

## Results

Ninety-four hairdressers and 39 office workers participated in this study. The majority of the participants were female (88% of hairdressers, and 85% of office

workers) and current smokers (60% of hairdressers, and 72% of office workers) (Table 1).

No significant differences were noted in age, gender, and smoking habit between hairdressers and office workers (Table 1). Hairdressers had a significantly lower FEV<sub>1</sub>/FVC (%) (p<0.001) and a higher FeNO values (p=0.012) compared to the office workers. During working hours, hairdressers reported more severe dyspnea (p=0.03), and irritation of eye (p=0.001) and throat (p=0.007) as compared to the controls (Table 2). This effect appeared to be driven by the subgroup of smoking hairdressers who, in comparison to smoking office workers, had significantly more severe self-reported intensity of dyspnea, eye, nose, and throat irritation (Table 3). No significant differences in self-reported symptoms were demonstrated between the two groups when they were away from work; 17 (18%) of hairdressers reported worsening of their respiratory symptoms at work in contrast to no office workers.

Within the hairdressers group, a sig-

**Table 3:** Comparison between self-reported symptoms at work between smokers of the two studied groups. Data are presented as mean±SD. Lower values indicate a worse outcome, *i.e.*, frequent or severe symptoms.

Symptom	Hairdressers (n=94)	Office workers (n=39)	p value
Cough	8.7±2.1	9.0±1.8	NS*
Sputum production	8.8±2.4	8.9±2.1	NS
Dyspnea	8.8±2.4	9.6±1.7	0.027
Wheezing	9.8±1.3	9.9±0.3	NS
Eye irritation	7.6±3.1	9.5±1.7	0.001
Nose irritation	8.9±2.2	9.6±1.5	0.022
Throat irritation	8.9±2.1	9.9±0.3	0.007

\*Not significant

nificant positive correlation was found between spirometric values and the work area size per person (Spearman's  $\rho = 0.54$ ) (Table 4). While the presence of a ventilation system did not affect the reported symptoms and the spirometry and FeNO measures, the presence of window, as a mode of ventilation in the workplace, was associated with better spirometric values (Table 5). However, neither a large working area, nor the type of chemical exposure or ventilation was associated with self-reported respiratory or ocular symptoms. No significant correlation was observed between work duration, work intensity and either spirometric or FeNO results.

## Discussion

In the present study, hairdressers reported worse respiratory symptoms than office workers. This finding was also demonstrated in previous studies that also reported improvement of symptoms away from work.<sup>19</sup> We also found that the working environment plays a key role in

the severity of respiratory symptoms reported by the participants—hairdressers at work, had a significantly higher intensity of dyspnea, eye and throat irritation as compared to a group of office workers. Moreover, the temporal nature of their symptoms, which were not significantly different from those of the office workers when both were not at work, suggest that occupationally-related exposures are responsible for these symptoms. Although the presence of natural ventilation in the form of a window, work duration, and the intensity of exposure—as measured by the number of chemical applications per week—did not appear to be associated with self-reported ocular and respiratory symptoms, a larger working area and the presence of natural ventilation were significantly associated with improved spirometric measures. The outcome of the survey agrees with similar surveys and is further supported by our spirometric and airway inflammation data.<sup>7, 18</sup>

Exposure to pollutants in the air of hairdressing salons can cause irritation and sensitization. Workplace health sur-

For more information on the effect of outdoor air pollution on chronic bronchitis see [www.theijoem.com/ijoem/index.php/ijoem/article/view/168](http://www.theijoem.com/ijoem/index.php/ijoem/article/view/168)

**Table 4:** Correlation between work area (m<sup>2</sup>) and spirometric and FeNO values in 94 hairdressers

Parameter	Spearman's $\rho$	p value
FEV <sub>1</sub> (%)	0.323	0.002
FVC (%)	0.394	<0.001
FEV <sub>1</sub> /FVC (%)	0.539	<0.001
FeNO	-0.107	0.311

veillance aims to identify possible causes of irritation to prevent progression of the condition to a permanent disease.<sup>20</sup> Self-reported symptom questionnaires and spirometry are commonly used in surveillance programs, however, questions have been raised regarding their validity and reliability.<sup>20-23</sup> Therefore, there remains a need for other non-invasive tests that can be used in addition to questionnaires and spirometry.

The mechanism of inducing asthma in hairdressers is still not well-understood. Some studies suggest an immunological mechanism, immunoglobulin (Ig)E dependent<sup>24, 25</sup> or non-IgE dependent<sup>26</sup>, while others report a non-immunological mechanism<sup>27</sup>. An underlying immunological mechanism is strongly suggested but not definitively demonstrated.<sup>24, 28, 29</sup>

The fact that FeNO and spirometric results, as well as the reported symptoms

are not significantly correlated with work duration and severity of symptoms can be attributed to the fact that similar duration of exposure does not necessarily mean similar total dose of exposure.<sup>4</sup> Spirometry is the most common pulmonary function test and is an important means for assessing conditions such as asthma. According to our analysis, hairdressers had lower FEV<sub>1</sub>/FVC values compared to the age- and smoking-matched office workers—a result suggestive of impaired airway function in hairdressers that may be related to occupational exposure. The fact that a larger work area and natural ventilation were associated with better spirometric data in the hairdressers further supports a possible association of pulmonary function with working environment.

Measurement of FeNO is a non-invasive, potentially useful test for respiratory surveillance, which was initially proposed as an index of airway inflammation in asthma.<sup>30</sup> FeNO was found to be useful as a marker of exposure to dusts, gases and organic solvents<sup>31, 32</sup> and as an early marker of asthma in workers exposed to potroom pollutants and concentrations of exhaled NO have been positively associated with the level of exposure to dust, but it was not significantly associated with either duration of employment or routine measurements of dust and fluorides.<sup>33</sup> Measuring FeNO may be a use-

**Table 5:** Comparison of the spirometric values of hairdressers working with vs without window (natural ventilation). Values are mean±SD.

Parameter	Window	No window	p value
FEV <sub>1</sub> (%)	108.3±16.3	97.8±13.4	0.021
FVC (%)	119.9±34.1	97.6±13.3	<0.001
FEV <sub>1</sub> /FVC (%)	97.2±13.5	91.2±9.5	<0.001

ful way to screen airway inflammation in occupational epidemiology.<sup>8</sup> It has been proposed that FeNO is so useful in occupational setting that it must be added to the information obtained by questionnaires and spirometry.<sup>20</sup> In the present study, the mean FeNO for hairdressers was higher than that for the control group; higher variability of FeNO was observed in hairdressers as compared to the office workers. FeNO was however not significantly associated with either duration of employment or ventilation in the workplace. The presence of elevated FeNO levels in the hairdressers provides evidence for the presence of increased eosinophilic airway inflammation in them that may be suggestive for an increased risk of asthma. The latter suggestion however needs to be confirmed in longitudinal studies.

The present study was limited by the validity and reliability of the self-reported questionnaire in accurately reflecting the true symptoms of the study subjects. Equally objective changes in pulmonary function may be variably reported between subjects. Moreover, although the self-reported ocular and respiratory symptom questionnaire does capture some disease specific information, we did not capture global measures of health related quality of life such as the SF-36 or EuroQol questionnaires. Moreover, the actual surface area of natural ventilation and strength of mechanical ventilation systems were not precisely measured. Finally, we could not elucidate which of the multiple chemical exposures most affected respiratory symptoms, as we did not capture each type of chemical and amount or duration of exposure in our study.

In conclusion, we found that the nature of work of hairdressers, which involves use of various chemicals, is associated with more frequent ocular and respiratory symptoms compared to office workers. The symptoms are associated

with spirometric evidence of airflow obstruction and increased levels of airway inflammation, as reflected by increased FeNO level. However, further studies are needed to find out the actual chemicals which produce symptoms and declines in pulmonary function, the long-term consequences of these exposures in terms of symptoms, spirometric function and health-related quality of life.

**Conflicts of interest:** None declared.

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