

BMJ Open Lung function and respiratory symptoms among female hairdressers in Palestine: a 5-year prospective study

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ABSTRACT

Objectives: Hairdressers are exposed to chemicals at the workplace which are known to cause respiratory symptoms and asthma. This study aimed to examine changes in self-reported respiratory symptoms over 5 years, as well as to examine the lung function decline and determine whether it is within the expected range, to assess the dropout rate and reasons for leaving the profession, and to examine the associations between occupational factors and lung function changes at follow-up.

Design: Prospective study.

Setting: Female hairdressing salons in Hebron city, Palestine.

Participants: 170 female hairdressers who participated in a baseline survey in 2008 were followed up in 2013. A total of 161 participants participated in 2013.

Outcome measures: Change in reported respiratory symptoms and change in lung function over follow-up. Dropout from the profession and reasons for it. Differences between current and former hairdressers in respiratory symptoms and lung function at follow-up. Ambient air ammonia levels in 13 salons.

Results: Current hairdressers reported more respiratory symptoms in 2013 compared with baseline. Former hairdressers reported fewer symptoms at follow-up. At follow-up, current hairdressers showed a significant decrease in forced vital capacity of 35 mL/year (95% CI 26 to 44 mL/year) and of 31 mL/year (95% CI 25 to 36 mL/year) for forced expiratory volume in 1 s (FEV₁). 28 (16%) of the hairdressers quit the job during the 5-year follow-up, 8 (28%) because of health problems. Hairdressers who had been working for 4 years or more at baseline showed a stronger decline in FEV₁ compared with those who worked less than 4 years (difference 13, 95% CI 1 to 25).

Conclusions: Current hairdressers developed more respiratory symptoms and larger lung function decline than former hairdressers during follow-up. Few hairdressers left their profession because of respiratory health problems. Working for more years is associated with lung function decline among current hairdressers.

INTRODUCTION

Hairdressers are exposed to several chemicals from applied hairstyling to care products

Strengths and limitations of this study

- This is a 5-year prospective study with a high participation rate (94%), and few were lost to follow-up.
- The ability to follow-up the hairdressers who quit the job was useful for comparison with the ones who kept their job.
- Exposure and outcome were measured.
- Lack of an external control group and dependence on internal controls.
- Ammonia measurement was carried out at the follow-up time, which makes it difficult to conclude on the associations with the health outcomes.

at work. These chemicals are known to have irritant and sensitising effects on the airways and can induce respiratory symptoms and affect lung function. Thus, increased prevalences of chronic bronchitis, rhinitis and different respiratory symptoms have been reported among hairdressers,^{1–4} and occupational asthma has been reported with prevalence among hairdressers even reaching 14%.^{2 5 6}

The ability of hairdressers to work and the length of time they stay in the profession could potentially be affected by several factors such as work-related stress, poor work postures, repetitive work tasks, and exposure to sensitising and irritating agents to the respiratory tract mucous membranes.^{7–9} A Finnish study found that hairdressers who suffered from asthma and hand eczema composed a high-risk group for leaving the profession.⁹ As for hairdressers in Palestine, most work in small salons where the harmful exposure could be substantial.¹⁰

In a cross-sectional study among female hairdressers in Palestine, we found that hairdressers had more adverse respiratory symptoms than the controls, and that the prevalence of doctor-diagnosed asthma

among the hairdressers was 5.9%, while that of controls was 0.6%.¹⁰ Additionally, lung function measurements including flow rates were consistently lower for the hairdressers compared with the control group.¹⁰ In subgroups, hairdressers showed a higher prevalence of neutrophilic airway inflammation compared with the controls, and the measured levels of ammonia in the workplaces were higher than the threshold limit values.¹¹

Most studies concerning lung effects among hairdressers have been cross-sectional or clinical studies from western or developed countries. In addition, few prospective (follow-up) studies among hairdressers have been published.^{7–9 12}

We have performed a follow-up study in a fixed cohort where hairdressers were examined in 2008 and 2013. This allowed us to pursue the following objectives: to examine changes in the self-reported respiratory symptoms over 5 years, to examine the lung function decline and determine whether it was within the expected range, to assess the dropout rate and reasons for leaving the profession, and to examine the associations between occupational factors and lung function changes at follow-up.

METHODS

Study design and participants

The baseline study was conducted in 2008. In that study, according to the local Hairdressers' Association in Hebron, the total number of female hairdressing workers was 406 and they were working in 82 salons. A sample of 200 hairdressers was systematically selected.¹⁰ Twenty hairdressers refused to participate, while seven were excluded because they did not fulfil the inclusion criteria (aged between 18–50 years, and working in the salon for more than 1 month). Only three hairdressers were smokers and were excluded. Thus, the total group consisted of 170 non-smoking hairdressers, with a mean age of 28 years (SD=8), coming from 56 salons, yielding an initial participation rate of 85%. Participants answered a questionnaire and performed a lung function test in 2008.

The current study is a prospective study in which the same cohort of hairdressers was followed up 5 years after

the baseline study, in 2013. A total of 161 participants participated and 9 were lost to follow-up, giving a participation rate of 94%.

The characteristics of the participants are summarised in [table 1](#).

Questionnaire

The same questionnaire was used on both occasions, including a modified version of a standardised questionnaire on respiratory symptoms from the American Thoracic Society.¹³ This questionnaire includes items on respiratory symptoms such as chest tightness, shortness of breath, wheezing, cough and phlegm during the past 12 months. Furthermore, we assessed questions on doctor-diagnosed asthma. Descriptive data were also included in the questionnaire such as age, years of education, number of years of working in hairdressing, intensity of work and the most frequent tasks performed. The follow-up questionnaire included some questions investigating the dropout from the profession. These included the time of quitting, reasons of quitting (family reasons, economic reasons, health reasons), and to specify the health reason and if it was related to their previous work.

Lung function test

The lung function test was performed by all participants using a PC spirometer (ML2525, Micro Medical Limited, UK) and a disposable mouthpiece filter and nose clip during the test. Date of birth, height and weight for each participant were recorded before starting the test. American Thoracic Society/European Respiratory Standards guidelines¹⁴ were followed. Participants were given instructions on the forced maximal expiratory manoeuvres. The lung function test included forced vital capacity (FVC) and forced expiratory volume in 1 s (FEV₁). The same researcher performed the lung function test, using the same apparatus that was used in 2008, around the same time of the year (late Autumn 2013) and mostly at the similar time of the day.

Ammonia measurement at the salons

Ammonia measurements at the salons were conducted during the airway inflammation study which was carried

Table 1 Characteristics of the hairdressers at baseline (2008) and at follow-up (2013), Hebron, Palestine

	2008	2013	
	Hairdressers (n=170)	Current hairdressers (n=133)	Former hairdressers (n=28)
Age (years)	28 (8)	33 (8)	31 (7)
Years of education (years)	11 (2)	11 (2)	11 (2)
Years of employment (years)	6 (6)	11 (5)	7 (4)
Height (cm)	160 (6)	160 (6)	157 (7)
Weight (kg)	62 (11)	65 (9)	62 (8)
Body mass index (kg/m ²)	24 (4)	25 (4)	25 (2)

Data are presented as means (SDs).

out on a subgroup of the hairdressers' cohort in 2012–2013. The selection of salons for ammonia measurements is described elsewhere.¹¹ In a previous cross-sectional study on a subsample (n=33) of the same cohort of hairdressers that we followed up, the concentration levels of atmospheric ammonia were measured in the salons where those 33 hairdressers were working, which are 13 salons selected out of the 56 total salons of the cohort, using an electrochemical sensor instrument (pac7000 Dräger Aktiengesellschaft, Lübeck, Germany), which was affixed to 1 hairdresser in each of the salons. The sampling duration ranged from 45 to 305 min (mean=191, SD=89). The instrument gives a new reading every 30 s and yields concentration in part per million (ppm).

Statistical methods

Statistical analyses were conducted using Stata SE V.13.1 (StataCorp, Texas, USA). Standard descriptive statistics (arithmetic means and SDs) were computed for age, years of education, years of employment, height, weight and body mass index (BMI).

Changes in reported respiratory symptoms and doctor-diagnosed asthma for current and former hairdressers were calculated using generalised estimating equations (xtgee command in Stata with identity link), giving the prevalence difference (PD) between baseline and follow-up with 95% CI. Differences in baseline-reported symptoms between current and former hairdressers were measured using the generalised linear model for binomial data (glm command in Stata with identity link) (giving PD and 95% CI). Crude differences are presented for respiratory symptoms comparisons.

A linear mixed model (mixed command in Stata) was used to find the annual age decline in lung function parameters (mL/year) for current and former hairdressers. It was also used to measure differences (mL/year change with a 95% CI) in lung function change between current and former hairdressers, in a model including age, height and BMI, as they are known to affect lung function.

Current hairdressers were also analysed according to different occupational factors: intensity of work, working tasks and level of ammonia measured in selected salons. Each factor was divided into two or three categories with a nearly similar number in each category, with the exception of ammonia where the threshold limit value of 25 ppm¹⁵ split the hairdressers into two categories of unequal size. Exposure groups were based on baseline (2008) assessment, except for ammonia measurements which were carried out in 2012–2013. Separate mixed models compared the categories of each exposure type with respect to age decline in FEV₁.

Ethical considerations

Written informed consent was obtained from all participants and they were informed about the right to withdraw from the study at any time.

RESULTS

Self-reported respiratory symptoms and asthma

Table 2 shows the change in reported respiratory symptoms and doctor-diagnosed asthma between baseline and follow-up for current and former hairdressers. Current hairdressers reported a significant increase in chest tightness (PD=+0.037, 95% CI +0.005 to +0.069), shortness of breath (PD=+0.038, 95% CI +0.001 to +0.076) and morning phlegm (PD=+0.068, 95% CI +0.020 to +0.115) in 2013 compared with baseline reports, while former hairdressers reported a non-significant decrease in symptoms at follow-up.

On the other hand, former hairdressers reported cough and phlegm at baseline more frequently than did the current hairdressers (PD=+0.171, 95% CI +0.016 to +0.326) and (PD=+0.241, 95% CI +0.072 to +0.409) (table 2).

Lung function

Table 3 shows the annual decline in mean FVC and FEV₁ among current and former hairdressers, adjusted for age, height and BMI. Current hairdressers showed a significant annual decline in FVC and FEV₁ at follow-up of 35 mL (95% CI 26 to 44 mL) and 31 mL (95% CI 25 to 36 mL), respectively. This was not the case for former hairdressers who disclosed a non-significant annual decline of 6 mL for FVC and 11 mL for FEV₁.

When comparing lung function decline during follow-up between current and former hairdressers, we found that current hairdressers had a stronger reduction in FVC (29 mL with 95% CI 6 to 52 mL) and FEV₁ (19 mL with 95% CI 4 to 35 mL), which was significant even after adjusting for age, height and BMI (table 3).

Reasons for leaving the profession

Among the 170 hairdressers, 28 quit the job during the 5-year period of follow-up. We found that eight hairdressers left the job because of health problems that they associated with hairdressing. Three of them stopped because of hand dermatitis and five developed respiratory health problems which forced them to stop working. Twenty hairdressers left because of other reasons (marriage, care of children, no financial need or being fired).

Relation between exposure and lung function change among current hairdressers

Selected variables describing the intensity of work, work tasks and chemical exposure were used to compare changes in FEV₁ among hairdressers who remained at work at the time of follow-up (table 4).

Hairdressers who had been working for four or more years at baseline showed a significantly stronger decline in FEV₁ compared with those who worked for less than 4 years (13 mL with 95% CI 1 to 25 mL). In addition, hairdressers who applied bleaching more than five times per week showed a non-significant stronger decline of

Table 2 Changes in self-reported respiratory symptoms and doctor-diagnosed asthma between baseline (2008) and follow-up (2013) for current and former hairdressers, Hebron, Palestine

Symptoms	Current hairdressers n=133				Former hairdressers n=28				Difference in baseline between current and former hairdressers					
	Baseline		Follow-up		Baseline		Follow-up		95% CI		Difference†		95% CI	
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	Lower	Upper	Lower	Upper	Lower	Upper
Wheezing	26 (19)	27 (20)	+0.008	+0.040	6 (21)	4 (14)	-0.071	+0.024	-0.167	+0.024	-0.144	+0.187	-0.144	+0.182
Chest tightness	40 (30)	45 (34)	+0.037	+0.069	13 (46)	11 (39)	-0.071	+0.024	-0.167	+0.024	-0.027	+0.163	-0.027	+0.354
Shortness of breath	33 (25)	38 (29)	+0.038	+0.076	8 (29)	6 (21)	-0.071	+0.023	-0.167	+0.023	-0.140	+0.037	-0.140	+0.216
Morning cough	20 (15)	23 (17)	+0.023	+0.055	9 (32)	8 (29)	-0.036	+0.033	-0.104	+0.033	+0.016	+0.171	+0.016	+0.326
Morning phlegm	25 (19)	34 (26)	+0.068	+0.115	12 (43)	7 (25)	-0.178	+0.037	-0.320	+0.037	+0.072	+0.241	+0.072	+0.409
Asthma	7 (5)	9 (7)	+0.015	+0.044	3 (11)	3 (11)	0	+0.162	-0.162	+0.162	-0.044	+0.054	-0.044	+0.153

*Prevalence difference between baseline and follow-up reported symptoms, using generalised estimating equations.

†Prevalence difference in baseline reported symptoms between current and former hairdressers (former-current), using the generalised linear model.

10 mL in FEV₁ compared with those who applied it less than five times per week.

An apparent U-shaped pattern of FEV₁ decline in association with working hours and number of customers could be a chance finding, as the differences between the middle and the highest exposure categories were non-significant.

The group of hairdressers who worked at the salons with ammonia levels exceeding 25 ppm disclosed a significantly stronger decline in FEV₁ (57 mL with 95% CI 23 to 92 mL) compared with those who worked in salons with levels less than 25 ppm (table 4).

DISCUSSION

In this follow-up study of 5 years with a high participation rate, we found that female Palestinian hairdressers reported more respiratory symptoms after the 5-year follow-up, and had a more pronounced decline in lung function than a group of internal controls who had left the profession. In total, 16% (28) of the hairdressers in 2008 had left their profession by 2013, of which 28% (8) left because of health problems that they associated with their previous work. Current hairdressers who had been working for more than 4 years and who were working in salons with ammonia levels higher than 25 ppm showed a greater decline in FEV₁ at follow-up.

We have conducted a 5-year follow-up on 170 female hairdressers with a high participation rate (94%). Few were lost to follow-up and both exposure and health outcomes were measured. Our ability to follow-up the hairdressers who quit the job made it possible to compare their respiratory health condition with the ones who remained at work. Previous prospective studies on hairdressers included smaller sample sizes or lower participation rates compared with our study.^{7 8 16} Furthermore, some follow-up studies on hairdressers have been retrospective.^{1 12 17}

A strength of this study, which helped in reducing bias related to data collection, is that lung function was performed by the same researcher, using the same apparatus, around the same time of the year, at a similar time of the day, and following standard instructions. Additionally, possible confounders for lung function test were adjusted for in all analyses, namely age, height and BMI.

A limitation of this study was the use of questionnaires to assess respiratory symptoms and asthma, which could have caused recall or information bias.¹⁸ Thus, the hairdressers who stayed at work might deny having health problems because they liked their job, and the ones who left might try to complain less because they think they became better after quitting. Additionally, the difficult economic situation and the high unemployment rates in Palestine might force the sick workers to complain less in order to keep their jobs. These potential sources of bias could have affected our results which were taken from the questionnaire by underestimating or overestimating the true symptoms that the current hairdressers might have.

Table 3 Mean baseline (2008) and change (2008–2013) in lung function parameters among current and former hairdressers, and differences between current and former hairdressers in change of lung function parameters, Hebron, Palestine

	Current hairdressers (n=133)				Former hairdressers (n=28)				Difference in change*		
	Mean†	Change‡	95% CI		Mean†	Change‡	95% CI		Difference*	95% CI	
			Lower	Upper			Lower	Upper		Lower	Upper
FVC (L)	3.29	-35	-44	-26	3.35	-6	-27	+16	+29	+6	+52
FEV ₁ (L)	2.74	-31	-36	-25	2.75	-11	-26	+3	+19	+4	+35

*Difference in annual decline (mL/year) between former and current hairdressers (former–current), adjusted for age, height and BMI.

†Mean value (L) at baseline (2008).

‡Estimated annual decline (mL/year) in lung function, adjusted for age, height and BMI.

BMI, body mass index; FEV₁, forced expiratory volume in 1 s; FVC, forced vital capacity.

Since we did not have an external control group in this study, we divided our group of hairdressers into different groups according to their exposure level. The low-exposed workers acted then as an internal control group, which could be a good choice because they had the same socioeconomic status and lifestyle. Likewise, those who quit the hairdressing profession could act as an internal control group when compared with the current hairdressers. However, former hairdressers could have chronic health effects because of their previous work, which could affect the comparisons.

The occupational proxies that we used for grouping the hairdressers (number of working years, working hours, number of customers per week, bleaching times per week, and dyeing times per week) were all carried

out at baseline (2008), except for ammonia which was measured close to the follow-up time (2012–2013). Thus, owing to the lack of temporality in the exposure–outcome relationship, it is hard to conclude that high chemical exposure caused the strong decline in lung function. However, the working conditions which were assessed in the salons at baseline,¹⁰ including the size of the salon, presence and types of ventilation and use of personal protective equipment, did not change at follow-up.¹¹ This could indicate that the current levels of ammonia measured in the salons were not much different compared with the earlier years.

Current hairdressers reported generally more respiratory symptoms in 2013 than in 2008, significantly so for chest tightness, shortness of breath and phlegm. Former

Table 4 Relation between intensity of work, work tasks and chemical exposure in 2008, and changes in FEV₁ among current hairdressers between 2008 and 2013, Hebron, Palestine

Occupational factors (n)	Δ FEV ₁ (mL/year)			
	Mean*	Coefficient†	95% CI	
			Lower	Upper
Working years				
<4 (n=68)	-22	0 (reference)		
≥4 (n=65)	-35	-13	-25	-1
Working hours				
<5 (n=22)	-21	0 (reference)		
5–7 (n=76)	-34	-13	-30	+3
8–10 (n=35)	-28	-6	-25	+12
Customers (per week)				
<15 (n=28)	-23	0 (reference)		
15–35 (n=77)	-37	-13	-28	+1
>35 (n=28)	-22	+1	-16	+18
Bleaching (per week)				
<5 (n=83)	-25	0 (reference)		
≥5 (n=50)	-36	-10	-22	+1
Dyeing (per week)				
<7 (n=64)	-32	0 (reference)		
≥7 (n=69)	-30	+2	-9	+13
Mean NH ₃ (ppm)				
<25 (n=24)	-35	0 (reference)		
≥25 (n=5)	-93	-57	-92	-23

All occupational factors were measured in 2008 except NH₃ which was measured in 2012–2013.

*Estimated annual decline of FEV₁ (mL/year), adjusted for age, height and BMI.

†Difference in annual decline of FEV₁ (mL/year) compared with the reference, adjusted for age, height and BMI.

BMI, body mass index; FEV₁, forced expiratory volume in 1 s; ppm, part per million.

hairdressers, on the other hand, reported generally less symptoms in 2013 as compared with baseline (not significant). This could indicate that remaining in the hairdressing profession caused more respiratory problems, while quitting the job made these symptoms less apparent at follow-up since they no longer had chemical exposure from the hairdressing profession. However, since the respiratory symptoms are self-reported, current hairdressers could have over-reported symptoms and former hairdressers could have under-reported symptoms.

On the other hand, former hairdressers reported generally more respiratory symptoms at baseline than did the current hairdressers, significantly so for cough and phlegm. This suggests that this group developed symptoms which might have forced them to quit the job.

Other longitudinal studies focusing on respiratory health among hairdressers have found results that differ from our study. A 4-year follow-up study among Norwegian hairdressers found improvement in reported respiratory symptoms among current and former hairdressers at follow-up, possibly due to improvement in local ventilation,⁷ while in a 2-year follow-up among hairdressers and office apprentices in France, within each group of workers similar respiratory symptoms were found at the follow-up as at baseline.⁸ On the other hand, a 15-year retrospective study in Finland showed that hairdressers had an increased prevalence of asthma and chronic bronchitis which was larger than that for shopworkers.¹⁷

Current hairdressers had a significant decline in FVC and FEV₁ at follow-up, while former hairdressers had a smaller and non-significant decline in both parameters. Although both groups had similar lung function at baseline, this was not the case for respiratory symptoms as former hairdressers reported more symptoms at baseline than current hairdressers did. This could indicate that not all the hairdressers who left the profession had bad health at baseline since measurements of lung function are more reliable than a questionnaire for detecting chronic obstructive pulmonary disease and asthma.^{19 20}

Our results on lung function are similar to what was found in the French study.⁸ Here, hairdressers had more deterioration of lung function at follow-up than did the office workers. However, hairdressers who quit the job had lower lung function values at baseline than the ones who stayed at work, which was not the case in our study.

Among the current hairdressers, we found an adjusted decline in FEV₁ of 31 mL/year. Our estimate of decline combines cross-sectional (baseline) and longitudinal information. Investigators tend to assess the effects on lung function in a study cohort by comparing an observed average annual lung function change with the age regression coefficient established in cross-sectional surveys of samples, assuming that they provide valid estimates of expected longitudinal decline.²¹ However, previous studies indicate that prospectively measured lung function has a higher accelerated rate of decline compared with what is predicted from cross-sectional

data.^{21–23} Age is considered the most important factor in decline, and the decrease in lung function measured longitudinally is higher among older individuals.^{24 25} Given that we have conducted a 5-year longitudinal study, and our group's mean age was 28 years, one could expect a loss in FEV₁ of less than 20 mL/year in this longitudinal model.²³ The decline that we found among our group of current hairdressers is therefore more than would be expected in a group of young non-smoking females examined prospectively.^{23 26 27} Furthermore, compared with the former hairdressers as an internal control group, the current hairdressers showed a significantly stronger decline in FEV₁ of 19 mL/year.

In this study, the dropout from the profession is low compared with the Norwegian study where 40% left their job within a 4-year follow-up time⁷ for different reasons including allergy and musculoskeletal disorders. The yearly dropout rate of 3.2% in our study was, however, close to that found in the Finnish study. Here, the dropout, as a result of health reasons such as asthma, chronic bronchitis, hand eczema and musculoskeletal disorders, was 41.2% during a 15-year follow-up period.⁹

Working for more years and performing tasks which include intensive exposure to chemicals such as bleaching and dyeing were found to increase the decline in lung function in our study. Ammonia levels in the salons also affected the deterioration in lung function among the workers. These findings support what we have found in our previous airway inflammation study.¹¹ Here, the hairdressers had signs of neutrophilic airway inflammation possibly due to the high exposure to chemicals at the workplace and poor working conditions such as lack of ventilation and small sizes of salons.

CONCLUSIONS

The present study highlights the respiratory health effects of the hairdressing profession, and gives information on the extent and the reasons for leaving this job. It suggests that hairdressing is associated with both self-reported respiratory symptoms and objective measured respiratory effects, possibly due to the long working years, intensive exposure to chemicals through bleaching and dyeing, and high concentrations of ammonia in the working environment. During follow-up, only a few hairdressers left their profession because of respiratory health problems and the ones who did had a more advantageous development in lung function. The results suggest that improvements in the chemical work environment are recommended.

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Patient consent Obtained.

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