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Lung cancer risk among hairdressers — a pooled analysis of case-control studies conducted between 1985 and 2010

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Abstract

Large registry-based cohort studies from Scandinavia observed increased lung cancer risks among hairdressers, but could not adjust for smoking; our objective was to evaluate the effect of adjusting for smoking and other confounders in a pooled database of 16 case-control studies conducted in Europe, Canada, China and New Zealand between 1985 and 2010 (SYNERGY project). Lifetime occupational and smoking information was collected through interviews from 19,369 cases of lung cancer and 23,674 matched populations or hospital controls. Overall, 170 cases and 167 controls ever worked as hairdresser or barber. The odds ratios (ORs) for lung cancer in women were 1.65 (95% CI: 1.16, 2.35) without adjustment for smoking and 1.12 (95% CI: 0.75, 1.68) with adjustment; however, women employed before 1954 experienced an increased lung cancer risk also after adjustment for smoking (OR 2.66, 95% CI: 1.09, 6.47). The ORs in male hairdressers/barbers were generally not elevated, except for an increased OR for adenocarcinoma in long-term barbers (OR 2.20, 95% CI: 1.02-4.77). Our results suggest that the increased lung cancer risks among hairdressers and barbers are due to their smoking behavior; single elevated risk estimates should be interpreted with caution when not replicated in other studies.

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WHO's International Agency for Research on Cancer classified "occupational exposures of hairdressers and barbers" as probably carcinogenic to humans (Group 2A) in 1993 and 2010 based on limited evidence for an association with bladder cancer, mainly in men [1, 2]. Increases in lung cancer risk (20–40%) have been observed in several cohort studies and a few case-control studies [3].Yet the evidence for an association between occupation as hairdresser or barber and lung cancer is not conclusive because most of the data from cohort studies come from linkage between census data and cancer registry data, primarily in the Scandinavian countries, which provide excellent opportunities to monitor cancer risks by occupation but have limited ability to control for tobacco smoking and other confounders [4]. The case-control studies have not been convincing due to lack of power and details about type, calendar period and duration of employment as hairdresser [5, 6].

Hairdressers and barbers can be exposed to a wide range of chemicals, for example volatile organic chemicals (toluene, ethanol, isopropanol, ether, diaminotoluene, phenylenediamine) via hair sprays and setting lotions and ammonia, ammonium persulfates, hydrogen peroxide and organic pigments as ingredients of permanent waves, hair dyes and hair bleaching applications [7, 8]. Important changes in the composition and use of hair products have taken place over the years; many hazardous dyes have been phased out and chlorinated solvents used as propellants in hair sprays (e.g. methylene chloride) have been replaced by less harmful organic solvents [9]. Work-related skin and respiratory symptoms remain frequent and contribute together with musculoskeletal complaints to many hairdressers leaving their jobs few years after they started working as hairdressers [10].

Our objective was to study the potential association between employment as hairdresser and increased lung cancer risk in a large pooled case-control dataset, while adjusting for tobacco smoking. We stratified analyses by sex, type of hairdresser, calendar period of employment, and lung cancer histology. We also compared smoking habits between hairdressers and non-hairdressers.

MATERIALS AND METHODS

Study population and data collection

The SYNERGY project includes data from 16 case-control studies on lung cancer conducted in 13 European countries, Canada, New Zealand and China between 1985 and 2010. The LUCAS, LUCA and HONG KONG studies were restricted to men and the PARIS study included only former and current smokers. INCO is a multi-center study in Central and Eastern Europe and the United Kingdom (UK) [11]. MORGEN is a case-control study nested in the prospective EPIC cohort in the Netherlands and the study participants filled in a questionnaire at recruitment [12]. Besides MORGEN, all studies have provided data on life time smoking habits and complete occupational history. Cases were recruited from hospitals or cancer registries in respective studies and the case definition varied slightly across the original studies. In most studies cases were eligible if: 1) younger than 75 years; 2) had been a resident of the study area for at least one year and 3) final diagnosis of lung cancer was confirmed by histology or cytology. Controls were recruited from the general population (81%) or hospitals (19%), and were individually or frequency matched to cases by sex and age (±3 years). Information was predominantly collected by interviews with the subjects themselves, though next-of-kin respondents were accepted in LUCAS (Sweden), ICARE (France), MONTREAL (Canada), HONG KONG (China), and OCANZ (New Zealand) if subjects were unavailable (9.1% of cases, 6.6 % of controls). In most studies face-to-face interviews (87% of study population) were conducted; however LUCAS and MORGEN sent out questionnaires via mail and part of the study populations in HONG KONG, MONTREAL, TORONTO and OCANZ were interviewed via telephone. More information about the SYNERGY project is available on http://synergy.iarc.fr/ and in previously published papers [13-15]. The subtype of lung cancer was classified according to WHO guidelines by pathologists associated with the participating hospitals. Reference pathology was performed for the German cases [16]. Study participants gave their informed consent prior to their inclusion in the original studies. Ethical approvals for the original studies were obtained in accordance with legislation in each country and in addition for the pooling project by the IARC Ethics Committee, and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Identification of hairdressers and barbers

The occupational data was coded or re-coded to the International Standard Classification of Occupations (ISCO) issued by International Labor Office (ILO) in 1968 [17]. We studied all hairdressers (ISCO: 5-70.20 and 5-70.30), and women's hairdressers (ISCO: 5-70.20) and barbers (ISCO: 5-70.30) separately. Women's hairdressers represented those who cut and dress primarily women's hair. Barbers cut and dress the hair of men, and shave or trim their beard. Thirteen participants had worked as both women's hairdressers and barbers and therefore contribute to both sub-analyses.

Statistical analysis

Differences in mean lifetime smoking consumption (log pack-years) between hairdressers and non-hairdressers among ever smoking control subjects were evaluated using the *t*-test. The Pearson's chi-squared test was used to compare the distributions in hairdressers vs. non-hairdressers regarding smoking status and ever employment in a job with known lung cancer risk. Odds ratios (ORs) and 95% confidence intervals (95% CI) of lung cancer risk were estimated using unconditional logistic regression. We stratified analyses by gender, types of hairdressers (all hairdressers, women's hairdressers, barbers), lung cancer cell type, and calendar period of employment. We chose the cut-off before and after the median start of first employment as hairdresser/barber in our study population (1954) to ensure a sufficient number of persons in each category. Duration of employment was studied in categories using tertiles based on the distribution of employment duration of all hairdressers in the control population (1-7 years; 8-26 years; 27+ years). Subjects who had never worked as hairdresser or barber comprised the reference group. The maximum likelihood estimates were used for the *P* for trend. ORs were adjusted for potential confounders in a stepwise manner: OR1 was adjusted for log(age) and study (22 study centers), and OR2 was in addition adjusted for smoking using pack-years (log(cigarette pack-years+1)) as a continuous variable and time-since-quitting smoking all types of tobacco as a categorical variable (current smokers, stopped smoking 2-7 years, 8-15 years, 16-25 years, 26+ years before interview or diagnosis, never smokers). OR3 was in addition adjusted for ever employment in a job with known lung cancer risk (List A), as a proxy for exposure to occupational lung carcinogens [18, 19]. Stability of the results was assessed by restricting the analyses to never smokers, and by exploring potential heterogeneity using I-squared (I^2) measuring the percentage variation in risk estimates attributable to heterogeneity between studies, countries, size of the study (±1500 participants), year of the study (end of data collection ±1995) and type of controls (population, hospital, mixed). Statistical analyses were conducted using SAS, version 9.2 (SAS Institute Inc., Cary, North Carolina) and STATA, version 12.1 (StataCorp LP, College Station, Texas). A *P*-value of 0.05 or less was considered statistically significant.

RESULTS

Table 1 describes the studies included in the SYNERGY project. Study participants not providing complete data (519 cases and 398 controls) were excluded, thus, 18850 cases and 23276 controls were included in these analyses.

Table 2 shows the characteristics of hairdressers/barbers and non-hairdressers/barbers by sex. Smoking pack years was slightly different between hairdressers and non-hairdressers including the never smokers. However, the mean cumulative smoking consumption (log pack-years) in ever smoking hairdressers vs. non-hairdressers was not statistically different among male (P=0.14) or female (P=0.40) control subjects. The frequency distribution across never, former and current smoking was significantly different between female hairdressers and non-hairdressers ($P<0.001$ in controls), but not between male hairdressers/barbers and non-hairdressers/barbers ($P=0.70$ in controls). The percentage of participants having worked in a job with known lung cancer risk (List A) was <5% among women overall, and there was no significant difference between hairdressers and non-hairdressers ($P=0.72$ in controls). In men, hairdressers/barbers had less often been employed in a List A job compared to non-hairdressers/barbers (*P=0.05* in controls). Adjusting for List A in the analyses (OR3) did not influence the results, therefore only OR1 and OR2 are displayed in Table 3.

Lung cancer risk among hairdressers

The percentage of men having worked as women's hairdresser was 0.20% in cases (n=30) and 0.22% in controls (n=40), and as barbers 0.51% in cases (n=77) and 0.40% in controls (n=73) (Table 3). We observed no significant increased risk of lung cancer among male hairdressers, neither before nor after adjusting for smoking. Among barbers we observed a trend of increasing ORs for lung cancer with longer duration of employment, with ORs ranging from 0.83 (95% CI: 0.43, 1.61) to 1.62 (95% CI: 0.88, 2.98), *P= 0.32*.

Employment as hairdresser/barber with regard to time of first employment did not reveal a different risk pattern, the OR2 was 0.92 (95% CI: 0.52, 1.63) before 1954 and 0.95 (95% CI: 0.65, 1.38) in or later than 1954. Regarding histology, long-term barbers (>26 years) had an increased OR for adenocarcinoma, based on 12 cases (OR2 2.20; 95% CI: 1.02, 4.77). In never smokers, the OR1 for male hairdressers/barbers was 1.60 (95% CI: 0.53, 4.82), based on 4 cases. Further sensitivity analyses among men revealed no significant heterogeneity in risk estimates with regard to study, country, calendar period of data collection, size of study, or type of control group; and all overall odds ratios remained below 1 (data not shown).

The percentage of women ever employed as hairdresser among cases and controls was 1.89% (N=69) and 1.17% (N=59), respectively. Only one female case and one female control had worked as barber so women's hairdressers and barbers were not analysed separately. A significant increased lung cancer risk among hairdressers was observed OR1 1.65 (95% CI: 1.16, 2.35), which was reduced and no longer statistically significant when adjusting for smoking (OR2 1.12, 95% CI: 0.75, 1.68). The highest OR was observed among those who worked less than eight years as a hairdresser. No trend in relation to duration was observed, *P=0.71*.

The risk changed with time period of employment; women employed as hairdressers before 1954 experienced an increased lung cancer risk before and after adjustment for smoking (OR1 3.01, 95% CI: 1.38, 5.59; OR2 2.66, 95% CI: 1.09, 6.47); while women employed in or later than 1954 did not (OR1 1.41, 95% CI: 0.94, 2.12; OR2 0.89, 95% CI: 0.56, 1.40). Table 4 shows lung cancer risk by calendar period, duration of employment and lung cancer histology. Female hairdressers first employed before 1954 experienced increased risk of all major lung cancer types, and the strongest association was observed for adenocarcinoma (OR2 3.10; 95% CI: 1.14-8.43). Across all lung cancer types the elevated risks were restricted to the short-term hairdressers (<8 years).

In never smokers female hairdressers experienced an OR1 of 1.33 (95% CI: 0.57, 3.08) based on 8 cases. A meta-analysis by study resulted in an overall OR2 of 1.13 (95% CI: 0.74, 1.73), with an I^2 of 0% and *P=0.84*. The OR2 for the AUT-Munich study alone was 3.25 (95% CI: 1.03, 10.23); when excluding AUT-Munich the overall OR2 decreased to 1.07 (95% CI: 0.80, 1.43). Excluding AUT-Munich from the analysis of female hairdressers employed before 1954 resulted in an OR2 of 2.72 (95% CI: 0.93, 8.02), and for adenocarcinoma alone in an OR2 of 3.91 (95% CI: 1.22, 12.50). With regard to the calendar period of data collection in the different studies (taking 1995 as cut-off) we observed an OR2 of 1.84 (95% CI: 0.85, 3.98) for women enrolled in the earlier studies and an OR2 1.00 (95% CI: 0.63, 1.59) for the more recent studies, the I^2 was 42% (*P= 0.19*). When comparing the risk estimates for the different sources of control subjects we observed an OR2 of 1.26 (95% CI: 0.82, 1.95) for population based case-control studies and ORs below 1 for hospital based and mixed case-control studies, I^2 0% (*P= 0.64*). No heterogeneity was observed with regard to country or study size (data not shown).

DISCUSSION

We investigated hairdressers' and barbers' lung cancer risk compared to non-hairdressers/barbers in the SYNERGY population, which is a large pooled dataset allowing rigorous adjustment for smoking habits. The OR for women overall (including both time periods) was significantly elevated before adjustment for smoking but not afterwards. Female hairdressers were more often smokers compared to non-hairdressers, while there was no significant difference in smoking habits between male hairdressers/barbers and non-hairdressers/barbers in this study. In sub-group analyses, our results revealed an increased risk among women with first employment before 1954 and when working shorter than eight years as hairdresser but not after 1954 or when working long-term as hairdresser; and no increased risk among men, except for an increased OR for adenocarcinoma in long-term barbers (>26 years).

Strengths of this study include 1) the large study size, which is necessary to study a relatively rare occupation in the general population and to stratify the results by gender and type of hairdresser; 2) most of the original studies were initiated to study occupational risk factors and therefore collected detailed lifetime work histories; 3) most interviews were made face-to-face with the study participants; and 4) we could adjust for smoking, the most important risk factor for lung cancer. Smoking was a confounder, particularly in women. Our adjustment for List A jobs did not reveal a confounding effect, probably because so few hairdressers/barbers worked in List A jobs that overall are more common in men.

A limitation of this study is the lack of information on determinants of exposure, for example to which specific agents this group of hairdressers were exposed and whether protective devices had been used**.** All case-control studies may be affected by some degree of recall bias. However, we did not solicit direct information on the use of specific chemicals and no emphasis had been put on employment as barber or hairdresser. Further, no special alert was present in the general population on a possible cancer risk linked to these occupations, which could have induced cancer patients to report them more frequently than controls. Next-of-kin were interviewed instead of the index subject in a few studies, but represented a small proportion (<10%) of the cases. Recall bias in the smoking history may have resulted in residual confounding when adjusting for smoking; however, the smoking adjusted increased risks in women are unlikely due to residual confounding by smoking. Low response rates among control subjects in some studies may have resulted in selection bias if hairdressers were more likely than other control subjects to be non-respondents. AUT-Munich with a response rate of 41% in controls was the only single study with a significantly elevated OR in female hairdressers. In the pooled dataset and in HdA, another German study, the lung cancer risk was not increased.

The SYNERGY data was collected between 1985 and 2010, and the time of working as a hairdresser covered the period from around the 1930s onwards. Both types and quantities of products used by hairdressers have changed substantially during this time span and it cannot be excluded that some exposures might have increased in the late 1940s (e.g. use of propellant and colouring agents etc.) before they were reduced or changed again in the mid-1980s. We observed an increased risk of lung cancer among female hairdressers first employed before 1954, but restricted to women working less than eight years in this job, and a somewhat higher OR for the earlier studies compared to the more recent studies, which could indicate that hairdressers previously experienced an increased risk of lung cancer. This result should, however, be interpreted with caution because the number of hairdressers employed before 1954 was low (22 cases, 9 controls), resulting in wide confidence intervals and risks were only increased in women with the shortest duration of employment. Besides, this hypothesis does not get support from cohort studies. A Finnish study linked census data with cancer registry data 1970-1987 and found 13 lung cancer cases among female hairdressers, resulting in a standardized incidence ratio (SIR) of 1.72 (95% CI: 0.92, 2.94). The SIR for lung cancer was below unity from 1970-1981 and significantly elevated in the last period 1982-1987 (SIR 2.92, 95% CI: 1.46, 5.22) [20]. A similar study in Sweden investigated hairdressers 1960-1990 and found an increased risk of lung cancer in both male and female hairdressers, with SIRs of 1.38 (95% CI: 1.16, 1.68) and 1.35 (95% CI: 1.15, 1.58), respectively. When they analyzed the earlier period (before 1960) separately the risk was similar for men (SIR 1.41, 95% CI: 1.18, 1.68) and somewhat lower (SIR 1.22, 95% CI: 1.00, 1.47) for female hairdressers [21]. As employment as barbers/hairdressers often is abandoned early and census information refers to the current job, it is not likely that the employment periods in these cohorts correspond to the employment period in our study, therefore these results are not directly comparable.

We observed a stronger association for adenocarcinoma when compared to squamous cell carcinoma and small cell carcinoma. Interestingly, the NOCCA project made a similar observation in the combined Nordic population followed-up 1961-2005. Among male hairdressers the SIR for all lung cancer types combined was 1.22 (95% CI: 1.12, 1.33), while 1.33 for adenocarcinoma alone (95% CI: 1.10, 1.60). The SIR for all lung cancer types combined in women hairdressers was 1.30 (95% CI: 1.19-1.42), and 1.38 for adenocarcinoma (95% CI: 1.19, 1.61) [4].

Schoenberg et al. studied occupation and lung cancer risk in New Jersey white men and observed a non-significant association between employment as barber/hairdresser and lung cancer risk after smoking adjustment, OR 2.0 (95% CI: 0.72, 5.60) [6]. We observed a non-significant increased risk for long-term barbers, which may partly be explained by past exposures to cosmetic talc and passive smoking in barber shops. Consumer talc products prior 1973 could have been contaminated to varying degrees by asbestos [22].

Our results in never smokers (slightly elevated non-significant ORs) were limited by their small numbers.

In summary our observed association with adenocarcinoma in both men and women is supported by results from the NOCCA study, while our other findings are not directly comparable with results in the previous literature. Although the statistical power to detect an increased risk was limited in the sub-analyses and our extensive stratification may have resulted in high variation of the risk estimates by chance, it was important to conduct these analyses as it is a rare opportunity to study hairdressers in a population based study with detailed smoking information covering such a long calendar period.

Our results suggest that the increased lung cancer risk among female hairdressers is due to smoking behavior among this occupational group and not directly related to occupational exposure. Single elevated risks among the many sub-group analyses should be interpreted with caution unless replicated in other studies.

Table 1. Description of the studies included in the SYNERGY project 1985-2010

Study	Country	Data collection	Cases N	Cases Response rate (%)	Controls N	Controls Response rate (%)	Source of controls P=Population H=Hospital
AUT-MUNICH	Germany	1990–1995	3180	77	3249	41	P
HdA	Germany	1988–1993	1004	69	1004	68	P
EAGLE	Italy	2002–2005	1943	87	2116	72	P
TURIN/VENETO	Italy	1990–1994	1132	79	1553	80	P
ROME	Italy	1993–1996	347	74	365	63	H
LUCA	France	1989–1992	309	98	302	98	H
PARIS	France	1988–1992	173	95	234	95	H
ICARE	France	2001–2007	2926	80	3555	76	P
CAPUA	Spain	2000–2010	875	91	838	96	H
MORGEN*	Netherlands	1993–1997	71	N/A	202	N/A	P
INCO	Czech Republic	1999–2002	304	94	453	80	H
INCO	Hungary	1998–2001	402	90	315	100	H
INCO	Poland	1998–2002	800	88	841	88	P & H
INCO	Slovakia	1998–2002	346	90	285	84	H
INCO	Romania	1998–2002	181	90	228	99	H
INCO	Russia	1998–2001	600	96	580	90	H
INCO-LLP	United Kingdom	1998–2005	442	78	918	84	P
LUCAS	Sweden	1985–1990	1042	87	2356	85	P
OCANZ	New Zealand	2003–2009	457	53	792	48	P
MONTREAL	Canada	1996–2002	1203	85	1509	69	P
TORONTO	Canada	1997–2002	425	62	910	71	P & H
HONG KONG	China	2003–2007	1208	96	1069	48	P
Overall		1985–2010	19370	81%	23674	67%	

*Nested case-control study

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Table 2. General characteristics of hairdressers/barbers and non-hairdressers/barbers in the SYNERGY project

Characteristics		Hairdressers				Non hairdressers			
		Cases		Controls		Cases		Controls	
		No.	%	N	%	No.	%	N	%
Men		100		107		15095		18109	
Age	Mean (SD)	64.7 (8.3)		64.0 (8.9)		62.7 (9.0)		62.2 (9.5)	
	≤40	1	1.0	1	0.9	200	1.3	398	2.2
	40-50	4	4.0	7	6.5	1362	9.0	1857	10.2
	50-60	19	19.0	26	24.3	4106	27.2	4698	25.9
	60-70	52	52.0	46	43.0	6206	41.1	7373	40.7
	70-80	23	23.0	25	23.4	3165	21.0	3736	20.6
	>80	1	1.0	2	1.9	56	0.4	47	0.3
Smoking status	Never	4	4.0	24	22.4	464	3.1	4707	26.0
	Former	28	28.0	49	45.8	4887	32.4	7925	43.8
	Current	68	68.0	34	31.8	9742	64.5	5473	30.2
Pack -years	Mean (SD)	46.8 (31.9)		24.8 (26.9)		42.4 (28.8)		20.3 (24.1)	
Time-since quitting smoking	Mean (SD)	5.0 (9.5)		11.1 (12.9)		5.2 (9.1)		11.7 (13.6)	
	Current	68	68.0	34	31.8	9742	64.5	5473	30.2
	2-7	10	10.0	10	9.4	1641	10.9	1170	6.5
	8-15	7	7.0	9	8.4	1470	9.7	1809	10.0
	16-25	6	6.0	17	15.9	1091	7.2	2220	12.3
	>26	5	5.0	12	11.2	609	4.0	2441	13.5
	Never	4	4.0	24	22.4	464	3.1	4707	26.0
List A	Ever	9	9.0	4	3.7	2130	14.1	1663	9.2
Women		70		60		3585		5000	
Age	Mean (SD)	56.7 (11.2)		55.1 (10.5)		60.6 (10.1)		60.3 (11.2)	
	≤40	7	10.0	3	5.0	99	2.8	266	5.3
	40-50	15	21.4	19	31.7	543	15.2	699	14.0
	50-60	19	27.1	20	33.3	1043	29.1	1319	26.4
	60-70	24	34.3	15	25.0	1227	34.2	1733	34.7
	70-80	5	7.1	2	3.3	653	18.2	969	19.4
	>80	-	-	1	1.7	20	0.6	14	0.3
Smoking status	Never	8	11.4	21	35.0	961	26.8	2997	59.9
	Former	14	20.0	18	30.0	680	19.0	1019	20.4
	Current	48	68.6	21	35.0	1944	54.2	979	19.6
Pack -years	Mean (SD)	30.1 (23.7)		14.3 (20.9)		25.2 (24.9)		7.7 (15.0)	
Time-since quitting smoking	Mean (SD)	2.3 (4.8)		7.2 (10.9)		3.4 (7.7)		6.9 (11.7)	
	Current	48	68.6	21	35.0	1944	54.2	979	19.6
	2-7	6	8.6	3	5.0	246	6.9	194	3.9
	8-15	5	7.1	5	8.3	202	5.6	231	4.6
	16-25	3	4.3	5	8.3	143	4.0	281	5.6
	>26	-	-	3	5.0	80	2.2	277	5.5
	Never	8	11.4	21	35.0	961	26.8	2997	59.9
List A	Ever	3	4.3	1	1.7	86	2.4	58	1.2

Table 3. Lung cancer risk associated with hairdressing and duration of employment

Employment	Cases		Controls		OR1	95% CI	OR2	95% CI
	N	%	N	%				
Men								
All hairdressers (ISCO: 5-70.20 & 5-70.30)								
Never	15095	99.3	18019	99.4	1.00		1.00	
Ever	100	0.7	107	0.6	1.04	0.79, 1.37	0.91	0.66, 1.25
<8yrs	34	0.2	33	0.2	1.14	0.70, 1.85	0.82	0.48, 1.41
8-26yrs	26	0.2	34	0.2	0.83	0.50, 1.39	0.68	0.38, 1.22
>26yrs	40	0.3	40	0.2	1.14	0.73, 1.78	1.26	0.74, 2.12
Women's hairdressers (ISCO: 5-70.20)								
Never	15095	99.8	18109	99.8	1.00		1.00	
Ever	30	0.2	40	0.2	0.84	0.52, 1.35	0.69	0.40, 1.19
<8yrs	18	0.1	14	0.1	1.37	0.68, 2.78	1.12	0.50, 2.52
8-26yrs	19	0.1	13	0.1	0.77	0.33, 1.81	0.61	0.24, 1.60
>26yrs	3	0.0	13	0.1	0.29	0.08, 1.01	0.25	0.06, 0.98
Barber hairdressers (ISCO: 5-70.30)								
Never	15095	99.5	18109	99.6	1.00		1.00	
Ever	77	0.5	73	0.4	1.17	0.84, 1.61	1.09	0.76, 1.59
<8yrs	21	0.1	22	0.1	1.06	0.58, 1.94	0.83	0.43, 1.61
8-26yrs	23	0.2	24	0.1	1.05	0.59, 1.87	0.91	0.47, 1.74
>26yrs	33	0.2	27	0.2	1.35	0.81, 2.27	1.62	0.88, 2.98
Women								
All hairdressers (ISCO: 5-70.20 & 5-70.30)								
Never	3585	98.1	5000	98.8	1.00		1.00	
Ever	70	1.9	60	1.2	1.65	1.16, 2.35	1.12	0.75, 1.68
<8yrs	37	1.0	26	0.5	2.07	1.25, 3.46	1.28	0.72, 2.29
8-26yrs	15	0.4	20	0.4	1.00	0.51, 1.97	0.93	0.42, 2.02
>26yrs	18	0.5	13	0.3	1.96	0.95, 4.03	1.10	0.48, 2.51

OR1 is adjusted for age, and study
OR2 is additionally adjusted for cigarette pack years and time-since-quitting smoking

Table 4. Lung cancer risk associated with hairdressing and duration of employment in women by histology type and start of first employment

Hairdressers	Controls	All lung cancer			Adenocarcinoma			Squamous cell carcinoma			Small cell carcinoma		
ISCO 5-70.20 & 5-70.30	N	N	OR2	95% CI	N	OR2	95% CI	N	OR2	95% CI	N	OR2	95% CI
Never	5000	3585	1.00		1547	1.00		736	1.00		573	1.00	
Ever(<=1953)	9	22	2.66	1.09-6.47	10	3.10	1.14-8.43	7	1.80	0.48-6.73	3	2.51	0.44-14.33
<8yrs	2	15	12.9	2.67-62.44	6	14.66	2.75-78.02	5	14.09	1.63-121.62	2	50.99	4.63-561.67
8-26yrs	5	4	0.67	0.13-3.37	1	0.50	0.05-5.45	2	0.56	0.07-4.85	1	0.78	0.03-21.38
>26yrs	2	3	0.56	0.09-3.48	3	1.46	0.24-9.07	0	-		0	-	
Ever (>1953)	50	48	0.89	0.56-1.40	16	0.73	0.39-1.35	9	1.08	0.47-2.45	13	1.26	0.60-2.65
<8yrs	24	22	0.67	0.35-1.30	8	0.65	0.28-1.54	3	0.49	0.13-1.91	6	1.12	0.40-3.17
8-26yrs	15	11	1.02	0.42-2.50	6	1.48	0.53-4.12	1	0.91	0.11-7.85	3	1.82	0.35-9.37
>26yrs	11	15	1.28	0.51-3.17	2	0.30	0.06-1.46	5	2.92	0.80-10.65	4	1.23	0.32-4.77

OR2 is adjusted for age, study, cigarette pack years, and time-since-quitting smoking

Reference List

1 The IARC Monograph working group. Some Aromatic Amines, Organic Dyes, and Related Exposures. IARC Working Group on the Evaluation of Carcinogenic Risks to Humans 99. Lyon: IARCPress; 2010.

2 The IARC Monograph working group. Occupational Exposures of Hairdressers and Barbers and Personal Use of Hair Colourants; Some Hair Dyes, Cosmetic Colourants, Industrial Dyestuffs and Aromatic Amines. IARC Working Group on the Evaluation of Carcinogenic Risks to Humans 57. Lyon: IARCPress; 1993.

3 Takkouche B, Regueira-Mendez C, Montes-Martinez A. Risk of cancer among hairdressers and related workers: a meta-analysis. *Int J Epidemiol* 2009;38 (6):1512-31.

4 Pukkala E, Martinsen JI, Lynge E, *et al.* Occupation and cancer - follow-up of 15 million people in five Nordic countries. *Acta Oncol* 2009;48 (5):646-790.

5 Jahn I, Ahrens W, Bruske-Hohlfeld I, *et al.* Occupational risk factors for lung cancer in women: results of a case-control study in Germany. *Am J Ind Med* 1999;36 (1):90-100.

6 Schoenberg JB, Stemhagen A, Mason TJ, *et al.* Occupation and lung cancer risk among New Jersey white males. *J Natl Cancer Inst* 1987;79 (1):13-21.

7 Hollund BE, Moen BE. Chemical exposure in hairdresser salons: effect of local exhaust ventilation. *Ann Occup Hyg* 1998;42 (4):277-82.

8 Mounier-Geyssant E, Oury V, Mouchot L, *et al.* Exposure of hairdressing apprentices to airborne hazardous substances. *Environ Health* 2006;5:23.

9 Brown N. J. (1987). *Health hazard manual for cosmetologists, hairdressers, beauticians and barbers.* Ithaca, NY: Cornell University, Chemical Hazard Information Program. (http://digitalcommons.ilr.cornell.edu/manuals/6). (Accessed October 1, 2012).

10 Leino T, Tammilehto L, Hytonen M, *et al.* Occupational skin and respiratory diseases among hairdressers. *Scand J Work Environ Health* 1998;24 (5):398-406.

11 Olsson AC, Fevotte J, Fletcher T, *et al.* Occupational exposure to polycyclic aromatic hydrocarbons and lung cancer risk: a multicenter study in Europe. *Occup Environ Med* 2010;67 (2):98-103.

12 Riboli E, Kaaks R. The EPIC Project: rationale and study design. European Prospective Investigation into Cancer and Nutrition. *Int J Epidemiol* 1997;26 Suppl 1:S6-14.

13 Olsson AC, Gustavsson P, Kromhout H, *et al.* Exposure to diesel motor exhaust and lung cancer risk in a pooled analysis from case-control studies in Europe and Canada. *Am J Respir Crit Care Med* 2011;183 (7):941-8.

14 Pesch B, Kendzia B, Gustavsson P, *et al.* Cigarette smoking and lung cancer-relative risk estimates for the major histological types from a pooled analysis of case-control studies. *Int J Cancer* 2011;131(5):1210-9.

15 Peters S, Kromhout H, Olsson AC, *et al.* Occupational exposure to organic dust increases lung cancer risk in the general population. *Thorax* 2012;67 (2):111-6.

16 Stang A, Pohlabeln H, Muller KM, *et al.* Diagnostic agreement in the histopathological evaluation of lung cancer tissue in a population-based case-control study. *Lung Cancer* 2006;52 (1):29-36.

17 International Labour Office. International standard classification of occupations. 2nd ed. Geneva, Switzerland: International Labour Organization; 1968.

18 Ahrens W, Merletti F. A standard tool for the analysis of occupational lung cancer in epidemiologic studies. *Int J Occup Environ Health* 1998;4 (4):236-40.

19 Mirabelli D, Chiusolo M, Calisti R, *et al.* [Database of occupations and industrial activities that involve the risk of pulmonary tumors]. *Epidemiol Prev* 2001;25 (4-5):215-21.

20 Pukkala E, Nokso-Koivisto P, Roponen P. Changing cancer risk pattern among Finnish hairdressers. *Int Arch Occup Environ Health* 1992;64 (1):39-42.

21 Czene K, Tiikkaja S, Hemminki K. Cancer risks in hairdressers: assessment of carcinogenicity of hair dyes and gels. *Int J Cancer* 2003;105 (1):108-12.

22 Siemiatycki J. Risk factors for cancer in the workplace. Boca Raton, Florida: CRC Press 1991.