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ORIGINAL ARTICLE

Reproductive outcome among female hairdressers

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Background: Working as a hairdresser involves exposure to a variety of chemical agents.

Aims: To estimate the risk of such exposure in relation to reproductive outcome.

Methods: A cohort of hairdressers, certified in Sweden from 1970 onwards, and a referent cohort of women from the general population were established and linked to the Swedish Medical Birth Register for the period 1973 to 1994. In the cohort of hairdressers 3706 women gave birth to 6960 infants. The corresponding numbers among the referents were 3462 and 6629. Questionnaires were sent to all hairdressers to obtain individual exposure data. The response rate was 65%.

Results: Compared with the referents, the hairdressers more often gave birth to infants that were small for gestational age (SGA). In addition, a higher fraction of the infants born to a hairdresser had a major malformation (2.8% v 2.1%). Frequent permanent waving and spraying tended to be associated with increased risk of having an SGA infant, whereas no clear association could be seen between the individual exposure assessments and malformation risk.

Conclusions: Results indicated that hairdressers have a slight increased risk of having intrauterine growth retarded infants and infants with major malformation compared with women from the general population. However, no clear associations were seen between individual exposure assessments and these outcomes.

Today there are about 18 000 working hairdressers in Sweden, of which 85% are women. Hairdressers constitute a major occupational group exposed to a wide range of products with potential reproductive toxicity. Their work involves exposure to a variety of chemical agents as a result of use of several hair products like shampoos, permanent wave solutions, hair dyes, and hair sprays.¹ Reproductive toxic effects have been reported for some of these agents: in animals for selenium,^{2,3} some dye formulations,^{4,5} dibutylphthalate,⁶ ethylene glycol ethers,⁷ and lead acetate⁸; and in humans after exposure to organic solvents,^{9,10} nitrosamines,¹¹ formaldehyde,^{3,12} and hexachlorophene.¹³ A wide range of effects were observed, such as loss of fertility, growth retardation, and congenital defects. Both dermal absorption and inhalation are relevant uptake routes for hairdressers.¹⁴ However, only a few epidemiological studies on reproductive risk among hairdressers have been performed, and the results are inconsistent.¹

The aim of the present study was to estimate the risk of working as a hairdresser in relation to reproductive outcome, such as birth weight, gestational length, stillbirths, malformations, and gender ratio. For comparison, we used a cohort of women from the general population. The associations between individual exposure assessments among hairdressers and reproductive outcome were also estimated.

METHODS

Cohort of hairdressers

A cohort of hairdressers was established from lists of all women that were certified at the major hairdressing schools in Sweden from 1970 to 1995. Only hairdressers born in 1945 or later were included (n = 7202). In Sweden the training for hairdressing lasts three years. During the period between 1970 and 1993, the third year was spent practising in hairdressings salons. In 1993, the education was changed so that less time was spent in salons and the practice work was completed at the school.

Referents

For comparison, a referent cohort of 7353 women was created. They were frequency matched to the hairdressers by calendar

year of birth, but otherwise were randomly selected from the registry of the total population in Sweden.

Register linkage and reproductive outcomes studied

Both cohorts were linked to the Swedish Medical Birth Register (MBR), which includes almost every infant born in Sweden since 1973.¹⁵ The MBR is based on copies of record forms for maternity health care, the delivery, and the paediatric examination of the newborn. Some of the variables in the MBR were not added until 1982, therefore some information, for example, maternal smoking habits in early pregnancy, is missing for infants born before 1982. There is, however, no information about the spouses in the MBR. The MBR contains information (coded as International Classification of Diseases, 8th revision) on all types of birth defects identified in the newborn period, including many minor and insignificant deviations. This information was further supplemented by data from the Swedish Registry of Congenital Malformations, which has a higher diagnostic precision than the MBR with respect to malformations.¹⁶ The study was approved by the Ethics Committee of Lund University.

During the period 1973–94, 3706 women in the cohort of hairdressers gave birth to 6960 infants (1.88 infants per woman). The corresponding numbers among the referents were 3462 and 6629 (1.91 infants per woman). The reproductive outcomes studied were gender ratio, low birth weight (LBW, <2.5 kg), preterm birth (<37 weeks), small for gestational age (SGA),¹⁷ stillbirths, early neonatal deaths (END, <7 days of age), all malformations, and major malformations (excluding minor malformations such as preauricular appendices, undescended testicles, unstable hip, and nevus).

Questionnaires

To obtain individual exposure data, questionnaires were sent to all women in the cohort of hairdressers. The response rate

Abbreviations: END, early neonatal death; LBW, low birth weight; MBR, Medical Birth Register; SGA, small for gestational age

Table 1 Background characteristics of a cohort of Swedish hairdressers (All) and a cohort of women from the general population and their children (Referents); background characteristics are also presented for the subgroup of hairdressers (Questionnaire) that answered a questionnaire regarding occupational exposure

	Hairdressers		
	All n (%)	Questionnaire n (%)	Referents n (%)
Infants born	6960	4465	6629
Women given birth	3706	2410	3462
Calendar year of birth			
1973–77	830 (12)	486 (11)	722 (11)
1978–82	1122 (16)	680 (15)	1041 (16)
1983–88	2019 (29)	1307 (29)	1866 (28)
1989–94	2989 (43)	1992 (45)	3000 (45)
Maternal age (y)			
15–19	135 (2)	63 (1)	238 (4)
20–24	2288 (33)	1415 (32)	1945 (29)
25–29	2957 (42)	1929 (43)	2735 (41)
30–34	1312 (19)	888 (20)	1376 (21)
≥35	268 (4)	170 (4)	335 (5)
Maternal weight (kg)*			
<60	572 (16)	548 (16)	381 (16)
60–69	1166 (33)	1032 (30)	732 (31)
70–79	1101 (31)	1039 (31)	732 (31)
≥80	715 (20)	766 (23)	492 (21)
Unknown	1701	1721	1111
Maternal height (cm)*			
<160	529 (13)	348 (13)	499 (13)
160–164	1223 (30)	787 (29)	1072 (28)
165–169	1236 (30)	814 (30)	1189 (31)
170–174	901 (22)	612 (22)	850 (22)
≥175	247 (6)	167 (6)	280 (7)
Unknown	1119	720	1216
Parity			
1	4061 (58)	2630 (59)	3696 (56)
2	2135 (31)	1374 (31)	1993 (30)
≥3	764 (11)	461 (10)	939 (14)
Smoking habits in early pregnancy (cigarettes per day)*			
0	3529 (73)	2418 (75)	3508 (75)
1–9	876 (18)	532 (17)	761 (16)
≥10	435 (9)	256 (8)	425 (9)
Unknown	415	242	412

*Recorded since 1982.

after two reminders was 65% (2410/3706, table 1). The women were asked to state the calendar years of all work periods as a hairdresser from the time they graduated and the hours of work per week for each work period. They also stated whether they were not actively working during periods of more than one year for any reason. "Working as a hairdresser during pregnancy" was defined in accordance with the following: start of work the calendar year before the birth, or earlier; and leaving work at the calendar year of birth, or later. By this definition the responders worked as a hairdresser during 47% of the studied pregnancies. In addition, questions on exposure during work as a hairdresser were asked for each employment (treatments per week for permanent waving, hair dyeing, bleaching, shampooing, and spraying).

Characteristics of the cohorts

The hairdresser differed only marginally from the referents with regard to calendar year of birth, maternal age, height, weight, parity, and smoking habits in early pregnancy (table 1). Moreover, the characteristics were also very similar for the hairdressers who answered the questionnaire and for those who did not. By definition, the majority of hairdressers have the same educational level in the MBR, whereas the referents

comprised more women with lower educational level as well as more women with higher educational level (data not shown).

Statistics

Logistic regression was used to estimate the odds ratio (OR) with respect to cohort affiliation (hairdressers versus referents) on LBW, preterm birth, SGA, stillbirths, END, and malformations, respectively. Multiple births and infants with major malformations were excluded from the analyses regarding LBW, preterm birth, and SGA; as potential confounders we analysed calendar year of birth (1973–77, 1978–82, 1983–88, and 1989–94), maternal age (≤ 24 , 25–29, and ≥ 30 years), gender, parity (1 and ≥ 2), maternal weight in early pregnancy (<60, 60–69, 70–79, and ≥ 80 kg), maternal height (<160, 160–164, 165–169, 170–174, and ≥ 175 cm), and smoking habits in early pregnancy (non-smokers, 1–9 cigarettes a day, ≥ 10 cigarettes a day, and unknown). In addition, we tested whether these factors modified the effect of exposure. Regarding stillbirths, END and malformations calendar year of birth, maternal age, and parity were analysed as potential confounders. If the adjusted OR differed less than 15% from the crude OR, we present the crude results. Among

Table 2 Delivery outcomes among 6960 infants born to 3706 Swedish hairdressers (All) and 6629 infants born to 3462 women from the general population (Referents); delivery outcomes are also presented for the subgroup of hairdressers (Questionnaire; 2410 women) that answered a questionnaire regarding occupational exposure

	Hairdressers		
	All n (%)	Questionnaire n (%)	Referents n (%)
Gender (boys)	3601 (51.7)	2317 (51.9)	3332 (50.3)
Low birth weight (<2.5 kg)	309 (4.5)	190 (4.3)	274 (4.1)
Preterm birth (<37 weeks)	446 (6.4)	281 (6.3)	410 (6.2)
Small for gestational age	247 (3.6)	162 (3.6)	188 (2.9)
Stillbirths	29 (0.4)	0 (0)	26 (0.4)
Early neonatal deaths (<7 days)	23 (0.3)	13 (0.3)	13 (0.2)
All malformations	327 (4.7)	204 (4.6)	290 (4.4)
Major malformations*	195 (2.8)	124 (2.8)	142 (2.1)

*Excluding minor malformations such as preauricular appendices, undescended testicles, unstable hip, and nevus.

the hairdressers who had answered the questionnaire the associations between specific exposure and reproductive outcome were analysed in the same manner.

RESULTS

Birth weight, preterm birth, and SGA

The median birth weights were 3.48 kg (quartiles 3.15 and 3.81) among infants born to hairdressers and 3.53 kg (quartiles 3.17 and 3.86) among the referent infants. The hairdressers had a higher incidence of infants with LBW compared with the referents (4.5% versus 4.1%; OR 1.2, 95% CI 1.0 to 1.5, tables 2 and 3), whereas no obvious differences were seen regarding preterm birth. There was a higher fraction of intrauterine growth retarded infants (that is, SGA) in the hairdressers' cohort than among the referents (3.6% versus 2.9%; OR 1.4, 95% CI 1.1 to 1.7).

An association was indicated between the number of weekly work hours as a hairdresser and LBW. The hairdressers who worked more than 30 hours per week during pregnancy had an LBW infant more frequently than hairdressers with less working hours per week (OR 1.8, 95% CI 1.0 to 3.3, table 4). Moreover, permanent waving tended to be associated with LBW and SGA, shampooing with LBW, and spraying with SGA (table 4).

Stillbirths and END

The fractions of stillbirths were similar in both cohorts, whereas there was a somewhat increased fraction of END

among the hairdressers (0.3% versus 0.2%; OR 1.7, 95% CI 0.9 to 3.3, tables 2 and 5). There was no obvious difference of the sum of stillbirths and END between the cohorts (OR 1.3, 95% CI 0.8 to 1.9, not in table). Because of the small number of cases, no further analyses were done with regard to specific exposures within the cohort of hairdressers.

Malformations

The fractions among the newborns who had a major malformation were 2.8% in the cohort of hairdressers and 2.1% among the referents corresponding to an OR of 1.3 (95% CI 1.1 to 1.6, tables 2 and 5). None of the individual exposures showed any clear positive associations with the outcome major malformation. However, hairdressers who during pregnancy had performed more than 30 treatments of spraying per week tended to have fewer infants with major malformations compared with hairdressers with less treatments (OR 0.6, 95% CI 0.3 to 1.0, $p = 0.07$, not in table). Table 6 presents the numbers of some specific malformations within the cohort of hairdressers.

Gender ratio

The fraction of boys in the hairdressers' cohort was 51.7% (95% CI 50.6 to 52.9) corresponding to a gender ratio (number of boys/number of girls) of 1.07 (table 2). The corresponding figures among the referents were 50.3% (95% CI 49.0 to 51.5) and 1.01. In the overall Swedish population the gender ratio is 1.06.¹⁸

Table 3 Risk of having an infant with LBW (<2.5 kg), preterm birth (<37 weeks), or SGA among 6960 newborn infants in a cohort of Swedish hairdressers compared with 6629 newborn infants in a cohort of women from the general population (Referents)

Cohort	Outcome								
	1973-82			1983-94			1973-94		
	OR	95% CI	p	OR	95% CI	p	OR	95% CI	p
LBW									
Referents	1.0			1.0			1.0		
Hairdressers	1.4	0.9 to 2.0	0.10	1.2	0.9 to 1.4	0.23	1.2	1.0 to 1.5	0.06
Preterm birth									
Referents	1.0			1.0			1.0		
Hairdressers	1.2	0.9 to 1.7	0.21	1.0	0.9 to 1.2	0.64	1.1	0.9 to 1.3	0.30
SGA									
Referents	1.0			1.0			1.0		
Hairdressers	1.5	1.0 to 2.1	0.03	1.3	1.0 to 1.7	0.06	1.4	1.1 to 1.7	0.004

Multiple births and major malformations were excluded from the analysed data.

Table 4 Risk of having an infant with LBW (<2.5 kg), preterm births (<37 weeks), or SGA in relation to different exposures among 4465 newborn infants in a cohort of Swedish hairdressers

Exposure	%	LBW			Preterm			SGA		
		OR	95% CI	p	OR	95% CI	p	OR	95% CI	p
Working as a hairdresser during pregnancy										
No	53	1.0			1.0			1.0		
Yes	47	1.2	0.9 to 1.7	0.22	1.1	0.8 to 1.4	0.47	0.8	0.6 to 1.2	0.34
Hours of work per week										
≤30	30	1.0			1.0			1.0		
>30	70	1.8	1.0 to 3.3	0.06	1.3	0.8 to 2.0	0.30	1.8†	0.7 to 4.8	0.23
Permanent waving*										
0-1	62	1.0			1.0			1.0		
≥2	38	1.9†	0.9 to 4.0	0.09	1.1	0.7 to 1.6	0.77	1.9†	0.9 to 4.2	0.11
Hair dyeing*										
0-1	42	1.0			1.0			1.0		
≥2	58	0.7	0.5 to 1.2	0.25	1.1	0.6 to 1.6	0.71	0.8	0.4 to 1.4	0.41
Hair bleaching*										
0-1	34	1.0			1.0			1.0		
≥2	66	0.9	0.5 to 1.4	0.57	0.9	0.6 to 1.3	0.45	1.6†	0.6 to 4.1	0.32
Shampooing*										
≤30	43	1.0			1.0			1.0		
>30	57	1.5	0.9 to 2.6	0.11	1.5	1.0 to 2.3	0.05	1.1	0.7 to 2.0	0.63
Spraying*										
≤30	33	1.0			1.0			1.0		
>30	67	1.3	0.8 to 2.4	0.31	1.3	0.8 to 2.0	0.30	2.3‡	0.9 to 6.1	0.09

Multiple births and major malformations were excluded from the analyses.

*Treatments per week.

†Adjusted for maternal weight in early pregnancy.

‡Adjusted for maternal height.

DISCUSSION

The main finding of the present study was an increased risk among Swedish hairdressers of having infants being small for gestational age compared with women from the general Swedish population. In addition, the hairdressers' infants had a higher incidence of major malformations.

Information on the outcome variables are based on data from the MBR. The quality of birth weight data has been judged as good, whereas it is more difficult to get a good estimation of gestational length.¹⁵ It is, however, reasonable to

believe that the estimations of gestational length were most likely affected by non-differential errors. Such misclassification tends to produce an underestimation of the actual risk.¹⁹

The MBR includes most infants born in Sweden since 1973.¹⁵ Thus, it is not reasonable to believe that selection bias was present when comparisons were performed between the cohorts of hairdressers and the referents. The fraction of hairdressers who answered the questionnaire was only 65%, which in principle might lead to selection bias affecting the exposure effects. However, the distributions of the background

Table 5 Delivery outcome among 6960 newborn infants in a cohort of Swedish hairdressers and 6629 newborn infants in a cohort of women from the general population (Referents)

Cohort	Outcome		
	OR	95% CI	p
Stillbirths			
Referents	1.0	–	
Hairdressers	1.1	0.6 to 1.8	0.82
Early neonatal death (<7 days)*			
Referents	1.0	–	
Hairdressers	1.7	0.9 to 3.3	0.13
All malformations			
Referents	1.0	–	
Hairdressers	1.1	0.9 to 1.3	0.37
Major malformation†			
Referents	1.0	–	
Hairdressers	1.3	1.1 to 1.6	0.01

*Stillbirth excluded from the analysis.

†Excluding minor malformations such as preauricular appendices, undescended testicles, unstable hip, and nevus.

Table 6 Some specific major malformation diagnoses among 6960 newborn infants in a cohort of Swedish hairdressers

Malformation	n
Spina bifida	5
Hydrocephalus	6
Cleft palate	2
Cleft lip/palate	12
Heart defects	46
Ventricle septal defect (VSD)	15
Patent ductus arteriosus	2
Hypoplastic left heart syndrome (HLHS)	2
Atrial septum defect	1
Aortic valve stenosis	1
Transposition of great vessels	1
Common truncus	1
Coarctation aorta + VSD	1
Unspecified	22
Oesophagus/anal atresia	3
Omphalocele	1
Bladder extrophy	1
Hypospadias	11
Polydactyly	5
Syndactyly	9
Limb reduction	4
Talipes	24
Down's syndrome	7
Other chromosomal abnormalities	3
Multiple malformation	
Microcephaly + cystic kidney	1
Cleft lip/palate + heart defect (HLHS/Falot/ unspecified)	3
Heart defect (single ventricle + coarctation aorta) + spine malformation + micrognathia	1
Cleft palate + severe ear malformation	1
Anal atresia + choanal atresia	1
Anal atresia + hypospadias	1
Anal atresia + kidney dysgenesis + cloacal malformation + absent genital organ + sacral agenesis	1
Anal atresia + oesophagus atresia + kidney agenesis	1
Severe kidney malformation + syndactyly	1

characteristics were very similar among the hairdressers who had answered the questionnaire and the other hairdressers. Moreover, with the exception of stillbirths, the distributions of the outcome variables were also very similar for the responders and non-responders. We do not therefore believe that selection bias is an issue of major concern.

Maternal age, parity, gender of the infant, maternal weight and height, and smoking habits are all known factors affecting the birth weight of an infant.¹⁸ When these factors were considered as potential confounders in the comparisons performed between the cohort of hairdressers and the referents, the effect estimates regarding LBW and SGA only changed marginally. In addition, these factors did not modify the effect of exposure. Consideration of these potential confounders did not change the effect estimates for major malformations. Thus, the findings in the present study cannot be disregarded as a result of confounding from these factors. Information about other potential confounders, such as the women's alcohol consumption and the spouse's age and height, were not obtained. Therefore, whether the distributions for these factors differed between the cohorts remains unknown.

For LBW, similar results were seen in a cohort study performed in the Netherlands by Kersemeakers *et al*, where reproductive disorders were compared between hairdressers and clothing sale clerks.²⁰ Their study indicated an increased risk of having an infant with LBW among hairdressers' infants conceived between 1986 and 1988. This negative effect seemed, however, to disappear during a later period (1991–93). In the present study, calendar year did not modify the observed effect on LBW.

Main messages

- Compared with women from the general population, hairdressers more often gave birth to growth retarded infants.
- A slightly higher fraction of infants born to hairdressers had a major malformation.
- Frequent permanent waving and spraying tended to be associated with increased risk of having a growth retarded infant.
- No increased risk was found for individual exposure assessments and major malformations.

Policy implications

- Regular use of protective gloves, especially during pregnancy.
- Installation of exhaust ventilation in the mixing areas, and improvement of the general ventilation in the salons.

In the Netherlands study major malformations had occurred more frequently among infants of hairdressers, but the numbers were small.²⁰ In a recent multicentre study investigating the association between maternal exposure at work and cleft lip/palate, hairdressers had an increased risk for cleft palate.²¹ This result was also based on small numbers. In another recent study, Martínez-Frías *et al* found an increased risk for choanal atresia among children born to hairdressers.²² Although the present study comprised a relatively large number of infants with malformations, the figures were still insufficient to allow comparisons with regard to specific malformations. Moreover, cleft lip and cleft lip/palate as isolated diagnoses are relatively rare events. Based on statistics for Sweden during the period 1983–92, the frequencies were 5.8 and 10.5 per 10 000 newborns, respectively. The figures among infants born to hairdressers in the present study were 2.9 and 17.2 per 10 000, respectively. For choanal atresia we observed one infant born to a hairdresser with a multiple malformation including this diagnosis. Thus, the associations observed in the other studies were not clearly supported by our results. In general, regarding specific malformations, when small or moderate risk increases are suspected, multicentre studies are required.

Infants born to hairdressers who reported frequent spraying and permanent waving, respectively, were more likely to be intrauterine growth retarded. Hairspray contains a mixture of components. Among these, ethanol and acetone have occasionally been associated with reduced birth weight,^{6, 18} but data from a Dutch study indicated that considered separately, the concentrations of these agents in hair salons are too low to explain adverse effects on reproduction.^{1, 23} However, possible interactions in the complex exposure situation among hairdressers should also be considered. Furthermore, prolonged bending, standing positions, and work related stress, which we did not consider in this study, may affect intrauterine growth.^{24, 25}

Within the cohort of hairdressers, none of the individual exposure estimates indicated an association with major malformations. The reliability of self reported exposures for bleaching and spraying among the hairdressers was examined by comparing answers in the present study to those given three years later in a subsample of the cohort. The answers were given in predefined categories in the present study and in absolute numbers in the second questionnaire. The reliability (agreement of response for the same retrospective period between the two questionnaires) was fair for bleaching (kappa value 0.24) and poor for spraying (kappa value 0.17), and thus misclassification of exposure may have introduced a bias which is most likely negative.²⁶

To summarise, the present study indicates that working as a hairdresser is associated with a moderately increased risk for retarded intrauterine growth and major malformations, although no consistent patterns were seen with regard to specific agents. Studies of other reproductive outcomes, such as decreased fertility and miscarriages, are in progress.

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