Reproductive Disorders among Hairdressers

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To evaluate whether hairdressers have an increased risk of reproductive disorders, we conducted a historical cohort study in the Netherlands. Because exposure to reproduction toxic agents in hair salons may have changed over time, we studied two specific periods: conceptions in 1986–1988 and in 1991–1993. We ascertained 9,000 hairdressers and, as a comparison group, 9,000 clothing salesclerks from their respective trade associations. All were of reproductive age in the defined study periods. Frequency matching on 5-year age groups ensured comparability with regard to age. All women were approached by mail to complete a short, self-administered questionnaire on reproductive history, including questions on time-to-pregnancy, spontaneous abortion, livebirths, and congenital malformations. In the analyses, we used random effect models to account for correlated outcomes (multiple pregnancies per woman). The results show that hairdressers who conceived in 1986–1988 had an increased risk of prolonged time-to-pregnancy of more than 12 months [odds ratio (OR) = 1.5; 95% confidence interval (CI) = 0.8–1.6], spontaneous abortion (OR = 1.6; 95% CI = 1.0–2.4), and a low-birthweight infant (OR = 1.5; 95% CI = 0.7–3.1). In both periods, more major malformations occurred among children of hairdressers, but numbers were small. These results indicate an increase in reproductive risks for hairdressers in earlier years that now seems to be disappearing. (Epidemiology 1997;8:396–401)

Keywords: occupation, hairdressers, reproduction.

Hairdressers constitute a major occupational group of female workers who sustain chemical exposures at childbearing age. Although hairdressers are exposed to several agents potentially toxic to reproduction, such as solvents and dye formulations, few human data are available regarding their reproductive risks.[1]

Two epidemiologic studies that focused on hairdressers have shown increased risks of menstrual disorders[2] and spontaneous abortion.[3] In a case-control study on mental retardation and parental occupation, an increased risk was found for mental retardation among the offspring of hairdressers.[4] Other studies reporting on reproductive risks among hairdressers did not find increased risks.[5–7] The main methodologic shortcomings in these studies are small numbers of hairdressers and misclassification of exposure. Work conditions may vary over time and from place to place. Therefore, apparently identical job characteristics may, in fact, entail different reproductive risks. For example, the use of some potentially toxic agents, such as dye formulations and dichloromethane, has recently (1990) been banned or limited in some countries (including the United States and several European countries).[8] Furthermore, in recent years, increasing attention has been paid to working conditions such as ventilation and the use of gloves. For these reasons, reproductive risks that were present in earlier years might have diminished or disappeared.[1] Furthermore, many studies focused on one specific reproductive outcome, thereby potentially missing other effects, because some agents might have affected more than one reproductive process, physiologic processes do not always correspond directly to outcome variables as measured, and a reverse dose-response relation might be apparent.[9,10]

This paper describes a large retrospective cohort study on a wide range of reproductive disorders among hairdressers in the Netherlands. In this study, we have taken into account potential changes of exposure over time by evaluating two separate time periods, 1986–1988 and 1991–1993.

Methods

Population

We identified hairdressers and clothing salesclerks through the database of the trade association for service jobs (DETAM: Detailhandel, Ambachten en Huisvrouwen), which keeps information about Dutch workers for a period of 5 years. From this database, we selected 9,000 women who were registered as a hairdresser and 9,000 women who were registered as a salesclerk in a clothing store in 1989 and/or in 1991 and who were of reproduc-

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tive age (22–35 years) in one or both of the two study periods (1986–1988 and 1991–1993). Frequency matching in 5-year age groups ensured comparability on age. We chose salesclerks as referents because of comparability with respect to educational and socioeconomic level and working conditions (for instance, standing and stress), apart from chemical exposures.

Data Collection

All 18,000 women were sent a mailing that consisted of an introductory letter and a short, self-administered questionnaire. To increase response rates, two reminders were sent, after 2 and 6 weeks. To avoid selective nonresponse and information bias, the study was presented to the participants as a study on pregnancy and working conditions in general. In the questionnaire, women were asked whether they had ever been pregnant. If so, they were asked questions about time-to-pregnancy and outcomes for each pregnancy. In addition, information was gathered on the month and year of conception, the gestational week in which the pregnancy was confirmed, and the gestational age of the outcome. The first day of the last menstrual period was considered the start of each pregnancy. Women who had never been pregnant were asked whether they had tried to become pregnant and for how many months they had been trying. To check the registered occupation, we gathered information on the actual occupation during pregnancy and the number of hours worked during the first 2 months of pregnancy. With regard to potential confounding factors, a few questions were asked on age at conception and educational level.

Study Periods

Based on the date of conception, we assigned pregnancies to the first study period when conceived between January 1, 1986, and October 31, 1988, and to the second study period when conceived between January 1, 1991, and October 31, 1993.

Outcome Definitions

We defined prolonged time-to-pregnancy as a time-to-pregnancy of more than 12 months. To present consistent data with regard to job information and period definition, we included only a time-to-pregnancy that actually led to a pregnancy in one of the defined study periods in the analyses. We defined spontaneous abortions as miscarriages that occurred before the 20th week of pregnancy. We excluded reported spontaneous abortions resulting from ectopic pregnancies and molar pregnancies from the spontaneous abortion effect parameter. We included only pregnancies confirmed by a pregnancy test or a doctor before the pregnancy failure or, for livebirths, before the 20th week of pregnancy (99% of all pregnancies).

We defined low birthweight as a birthweight less than or equal to 2,500 gm. As birthweight largely depends on gestational age and we are interested in determinants of fetal growth, we adjusted for gestational age in the analyses of birthweight. We defined a preterm birth as a livebirth before 37 weeks of gestation (counted from the first day of the last menstrual period).

We classified major structural congenital malformations among livebirths using the *International Classification of Diseases*, 9th revision-British Pædiatric Association System.[11] Many reported malformations could not be classified into major or minor malformations owing to insufficient information. Therefore, we restricted the analyses to major structural malformations that could be classified definitely. Moreover, we excluded major malformations with a known genetic or chromosomal cause (Down syndrome, von Willebrand's disease, Werdnig-Hoffmann disease, and Turner syndrome).

Analyses

We analyzed the data separately for each study period. We included only pregnancies in which a woman reportedly had worked at least 10 hours per week as a hairdresser or a salesclerk during the first 2 months of pregnancy. We calculated crude relative risks for each specific outcome using all pregnancies of a woman in the study period. To address the problem of correlated outcomes through multiple pregnancies per woman, we used the logistic binomial model for distinguishable data, one of the random effect models available in the statistical program EGRET.[12] We compared the distribution of educational level, age at conception, and gravidity between hairdressers and referents. Although only slight differences were found, we included these covariates in the random effect model for each outcome. If the adjusted odds ratio differed less than 10% from the crude odds ratio, we present the crude results.[13]

Results

Response rates were 72% and 66% for hairdressers and salesclerks, respectively (Table 1). Approximately 4% of the questionnaires were returned because of incorrect addresses. Of the women who returned the questionnaire, 3,358 (54%) hairdressers and 2,796 (49%) salesclerks had been pregnant at least once, leading to 6,012 and 5,024 pregnancies, respectively. Most of the women registered as a hairdresser actually worked as a hairdresser during pregnancy (70%). Only 58% of women registered as salesclerks, however, actually worked in this occupation while pregnant. The percentage of women who did not work during pregnancy was 22% among hairdressers and 26% among salesclerks. The remaining women worked in another occupation during pregnancy. The proportion of conceptions in the first and second study periods was comparable between hairdressers and salesclerks.

In the first study period, hairdressers worked at least 10 hours per week in 460 pregnancies and salesclerks in 277 pregnancies. We included these pregnancies in the subsequent analyses. In the second study period, 1,394 pregnancies of hairdressers and 1,055 pregnancies of

TABLE 1. Response Rates and Number of Pregnancies per Occupational Group and Study Period

	Hairdressers		Salesclerks	
	Number	%	Number	%
Originally selected	9,000		9,000	
Persons who received questionnaire	8,668	96	8,629	96
Respondents	6,270	72	5,688	66
Women with pregnancies	3,358	54	2,796	49
Pregnancies	6,012		5,024	
Pregnancies worked as hairdresser or salesclerk*	4,236	70	2,932	58
Pregnancies worked as hairdresser or salesclerk, conceived in 1986–1988	490	12	304	10
Pregnancies worked as hairdresser or salesclerk, conceived in 1991–1993	1,606	38	1,181	40

* In 89 pregnancies of registered hairdressers, the woman worked as a salesclerk and in 12 pregnancies of registered salesclerks, the woman worked as a hairdresser.

salesclerks were included. Among these women, the median number of hours worked per week was 32 in both periods and occupational groups.

In the first study period, 569 (88%) women had experienced one pregnancy, 75 (12%) women had two pregnancies, and 6 (1%) women had three pregnancies. The second study period included 1,897 (88%) women with one pregnancy, 224 (10%) women with two pregnancies, and 33 (2%) women with three or more pregnancies.

The distributions of covariates over occupational groups and study periods are presented in Table 2. Based on the Dutch school system, women were divided into low and high educational levels, corresponding to 10 or fewer years or more than 10 years of education, respectively. In both study periods, the distributions of educational level were nearly equally balanced among hairdressers and salesclerks. Maternal age at conception and gravidity were comparable between hairdressers and salesclerks within each study period. In the first period, however, women were younger at conception and had more first pregnancies compared with the second period. For each outcome, we included these three covariates in the random effect model, but we found no difference of more than 10% between crude and adjusted odds ratios. Therefore, we present crude effect measures. As the relative risks calculated from the random effect models did not differ much from the odds ratios, we present only the odds ratios.

Time-to-pregnancy data were available for 663 (90%) and 2,298 (95%) pregnancies conceived in the first and the second study period, respectively. In both study periods, 50% of the women conceived within 3 months, and 95% conceived within 24 months. Table 3 shows that in the first study period, hairdressers had an increased risk of time-to-pregnancy of more than 12 months ($OR_{1986–1988}$ = 1.5; 95% CI = 0.8–2.8). The corresponding odds ratio was lower in the second study period ($OR_{1991–1993}$ = 1.2; 95% CI = 0.8–1.6). We found an increased odds ratio for spontaneous abortion among hairdressers who conceived in the first study period (OR = 1.6; 95% CI = 1.0–2.4), but not for hairdressers who conceived in the second study period (OR = 0.9; 95% CI = 0.7–1.1).

We restricted analyses of low birthweight, prematurity, and congenital malformations to livebirths ($N_{1986–1988}$ = 575 and $N_{1991–1993}$ = 2,056). In both study periods, gender of the child was almost equally distributed among hairdressers and salesclerks. As shown in Table 4, we found an increased odds ratio for low birthweight adjusted for gestational age in the first study period (OR = 1.5; 95% CI = 0.7–3.1), which was less pronounced in the second study period ($OR_{1991–1993}$ = 1.2; 95% CI = 0.8–1.9). We saw no increased odds ratios for prematurity. In the analyses of congenital malformations, we excluded three chromosomal defects and two genetic defects, all of which occurred in the second study period (Table 4). Because the number of any specific major malformation was small (less than 10), we analyzed major malformations as one group. In both study periods, more major malformations occurred among children of hairdressers, but confidence intervals were wide ($OR_{1986–1988}$ = 1.6; 95% CI = 0.3–8.4; $OR_{1991–1993}$ = 1.9; 95% CI = 0.5–6.9). The major malformations in the second study period were mainly limb malformations (15 among hairdressers *vs* 6 among salesclerks).

TABLE 2. Characteristics of the Study Population

	1986–1988				1991–1993			
	Hairdressers		Salesclerks		Hairdressers		Salesclerks	
	Number	%	Number	%	Number	%	Number	%
Number of pregnancies*	460		277		1,394		1,055	
Educational level								
Low	283	63	179	65	823	60	593	57
High	168	37	95	35	557	40	456	43
Age at conception (years)								
≤25	229	50	147	53	266	19	192	18
26–30	211	46	118	43	910	65	687	65
>30	20	4	12	4	218	16	176	17
Gravidity								
First	359	78	213	77	956	69	710	67
Second	81	18	52	19	323	23	252	24
≥Third	20	4	12	4	115	8	93	9

* Pregnancies in which the woman worked more than 10 hours per week.

Discussion

Based on literature and personal communication from manufacturers, we hypothesized that effects on reproduc-

TABLE 3. Results of Random Effect Models Concerning Prolonged Time-to-Pregnancy (TTP >12 Months) and Spontaneous Abortion per Study Period

	1986–1988						1991–1993					
	Hairdressers		Salesclerks*				Hairdressers		Salesclerks*			
	Number	%	Number	%	OR	95% CI	Number	%	Number	%	OR	95% CI
Number of pregnancies	460		277				1,394		1,055			
TTP >12 months	52	12	22	9	1.5	0.8–2.8	149	11	99	10	1.2	0.8–1.6
Spontaneous abortion†	84	19	34	13	1.6	1.0–2.4	161	12	137	13	0.9	0.7–1.1

* Reference group.
† Only pregnancies confirmed before the 20th week were included: $N_{1986-1988} = 696$, $N_{1991-1993} = 2,372$.

tive disorders among hairdressers were greater in the earlier years. For pregnancies conceived in 1986–1988, we indeed found increased risks of spontaneous abortion, prolonged time-to-pregnancy, and low-birthweight infants among hairdressers. Among hairdressers who worked in 1991–1993, we did not find comparably increased risks of these adverse outcomes. The risks found for major congenital malformations were increased but compatible with chance in both periods.

Concern among hairdressers about their occupational risks could lead to reports of more adverse outcomes among hairdressers or higher response rates. This possibility would artificially inflate the effect estimates of a study. To prevent this problem, our study was presented as a study on pregnancy and working conditions in general, including physical workload and stress at the work place. Date of response might be an indicator for the level of concern among responders. If this were the case, the highest relative risks would be expected among early responders. As studies on spontaneous abortions are known to be vulnerable to selection bias, we calculated the odds ratios for this outcome stratified by date of response. The odds ratios for the first study period were 1.3 (95% CI = 0.7–2.3) and 2.0 (95% CI = 1.0–4.0) for hairdressers who responded before and after the first reminder, respectively. In the second study period, we found little difference in odds ratios ($RR_{\text{before 1st reminder}} = 0.9$; 95% CI = 0.7–1.3; $RR_{\text{after 1st reminder}} = 0.8$; 95% CI = 0.5–1.2). These results do not indicate selective awareness among hairdressers who experienced a spontaneous abortion.

As the trade association DETAM preserves their data for 5 years, for the earlier study period only women who were registered at the end of the study period (1989) could be selected. It appeared that fewer women of reproductive age were registered in this period compared with the second study period. Through selection at the end of the period, we might have missed women who had stopped working, possibly because of having liveborn children. As the procedure was similar for hairdressers and salesclerks, and we only used working women in the analyses, selection bias through the infertile worker effect[14,15] cannot have accounted for the increased risks found for spontaneous abortion and prolonged time-to-pregnancy in the first study period.

We used self-reported job title as a proxy for exposure. No information was available on specific tasks performed or on actual exposure. In the analyses, we included only women who reported having worked more than 10 hours per week as a hairdresser or a salesclerk during pregnancy. The number of hours worked was comparable for both occupational groups and both study

TABLE 4. Results of Random Effect Models Concerning Low Birthweight (Adjusted for Gestational Age), Prematurity, and Congenital Malformations per Study Period

	1986–1988						1991–1993					
	Hairdressers		Salesclerks*				Hairdressers		Salesclerks*			
	Number	%	Number	%	OR	95% CI	Number	%	Number	%	OR	95% CI
Number of livebirths	350		225				1,175		881			
Low birthweight (≤2,500 gm)†	59	14	22	9	1.5	0.7–3.1	176	13	114	12	1.2	0.8–1.9
Prematurity (<37 weeks)	28	10	23	8	0.5	0.1–2.2	135	12	99	11	1.0	0.8–1.4
Major structural malformation	5	1‡	2	1§	1.6	0.3–8.4	23	2‖	10	1¶	1.9	0.5–6.9

* Reference group.
† Adjusted for gestational age.
‡ Talipes, cleft lip or palate (N = 2), ureteral stenosis, pyloric stenosis.
§ Unilateral renal agenesis, cleft palate.
‖ Talipes (N = 2), polydactyly (N = 2), limb reduction, hypoplasia of toe, hypoplasia of hand, congenital dislocation of hip (N = 8), congenital anomaly of heart (N = 3), pyloric stenosis, gastroesophageal stenosis, ureteral stenosis, Potter's syndrome, congenital cataract. Excluded from analyses: Down syndrome, von Willebrand's disease, Werdnig-Hoffmann disease.
¶ Polydactyly, congenital dislocation of hip (N = 4), syndactyly of toes, congenital anomaly of heart (N = 2), spina bifida, pyloric stenosis. Excluded from analyses: Turner syndrome (N = 2).

periods (average = approximately 30 hours per week). We did not restrict the analyses to full-time workers, as a recent work place exposure assessment study has shown higher exposure levels on weekends and on shopping nights, which are the hours that most part-timers work.[16] Additional analyses among women who had worked more than 25 hours per week showed somewhat lower odds ratios for prolonged time-to-pregnancy (OR = 1.1; 95% CI = 0.6–2.1) and spontaneous abortion (OR = 1.3; 95% CI = 0.8–2.3) in the first study period and higher odds ratios for time-to-pregnancy (OR = 1.5; 95% CI = 1.0–2.3), low birthweight (OR = 1.5; 95% CI = 0.9–2.6), and prematurity (OR = 1.6; 95% CI = 0.6–4.2) in the second study period. For the other outcomes, results hardly changed when the analyses were restricted to women who worked more than 25 hours per week. These findings do not strengthen our hypothesis of chemical agents causing adverse reproductive outcomes among hairdressers, but they are still compatible with this hypothesis, because part-time workers do not necessarily have lower exposure than full-time workers, as was shown by the above-mentioned exposure assessment study.

With respect to the quality of retrospective self-reported data on reproductive outcomes that occurred 2–9 years previously, it has been reported that time-to-pregnancy, birthweight, and gestational age are reported quite accurately.[17] Underreporting of spontaneous abortions is a well known problem. Therefore, we restricted analyses to those pregnancies that had been confirmed.[9,18] With regard to malformations, we used only major malformations in the analyses, because these are believed to be reported more accurately than minor malformations.[19]

The time-to-pregnancy data in our study are comparable with those found in other studies. In our analyses, 11% tried to conceive for at least 12 months, compared with 10–20% in other studies.[17,20] Unfortunately, we had to exclude women without pregnancies from the analyses, because self-reported job title was only available for women with pregnancies. Among the women registered as hairdressers and salesclerks without pregnancies, 239 (9%) and 263 (10%), respectively, were trying to conceive without having achieved pregnancy when they completed the questionnaire. These comparable percentages indicate that little or no bias was introduced by excluding the women without pregnancies. The results with regard to time-to-pregnancy may not be comparable with other outcomes regarding exposure period definition. Part of the time-to-pregnancy may fall before the defined study period, which could lead to overlap. Nevertheless, because 95% of the pregnancies occurred within 24 months, and there was a contrast of 2 years between the defined study periods, overlap is minimal.

Although we restricted the analyses of spontaneous abortions to confirmed pregnancies, the gestational age at which a pregnancy was recognized might have affected the reporting of a spontaneous abortion. The gestational week of pregnancy when tests were performed, however, was comparable for hairdressers and salesclerks in both periods: 75% of the pregnancies were confirmed before the 7th week, and 90% before the 10th week.

Limited information was available on potential confounders. We chose salesclerks as the reference group because of presumed comparability concerning educational level, socioeconomic status, and physical and psychological workload. Although educational level and age were comparable, we cannot rule out possible confounding from other factors such as physical workload, life-style factors such as alcohol consumption, smoking habits, use of medication, and paternal exposure. We did not control for reproductive history, such as previous spontaneous abortion, because this history may be related to the exposure under study, and controlling for such a variable can bias the results.[21] The presented covariates did not differ much between the occupational groups within a study period, but some differences existed between the study periods, especially with regard to age at conception. In the first study period, 51% of women were younger than 25 years at conception, compared with 19% in the second study period. Stratification by age (≤25 years/>25 years) indicated, however, that these age differences could not account for the differences in odds ratios found between the two study periods.

With regard to most outcomes studied, the results of the random effect models (OR_{rem}) hardly differed from the results when correlated outcomes were not accounted for (OR_{crude}). Largest differences were found for prematurity in the first study period (OR_{crude} = 0.8; 95% CI = 0.4–1.4 *vs* OR_{rem} = 0.5; 95% CI = 0.7–3.1) and major malformations in the second study period (OR_{crude} = 1.7; 95% CI = 0.8–3.9 *vs* OR_{rem} = 1.9; 95% CI = 0.5–6.9).

Our results are in accordance with findings in other studies. John *et al*[3] also found an increased risk of spontaneous abortions among cosmetologists, using pregnancies from the period 1983–1988. They found increased risks, however, only among cosmetologists who worked more than 35 hours per week. Blatter and Zielhuis[2] described an increased risk of menstrual disorders. Furthermore, some components of hairdressers' products have been associated with reproductive disorders. For example, the use of solvents has been associated with reduced fertility,[20,22] spontaneous abortions,[22,23] and congenital malformations.[24,25]

We chose the study periods based on restrictions on the use of dichloromethane and some dye formulations in 1990, as well as potential changes in working conditions such as ventilation and the use of gloves. With regard to spontaneous abortions, time-to-pregnancy, and low birthweight, the results support the hypothesis of decreasing risks in recent years.

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