Scand J Work Environ Health 2006;32(1):61-66
https://doi.org/10.5271/sjweh.977
Issue date: 31 Feb 2006

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by Zhu JL, Vestergaard M, Hjollund NH, Olsen J

Affiliation: The Danish Epidemiology Science Centre, University of Aarhus, Vennelyst Boulevard 6, DK 8000 Aarhus C, Denmark. zjl@soci.au.dk

The following articles refer to this text: 2013;39(3):302-309; 2020;46(4):417-428

Key terms: congenital malformations; Danish National Birth Cohort; developmental milestones; female; fetal loss; hairdresser; pregnancy outcome

This article in PubMed: www.ncbi.nlm.nih.gov/pubmed/16539173

Print ISSN: 0355-3140 Electronic ISSN: 1795-990X

Original article

Scand J Work Environ Health 2006;32(1):61–66

Pregnancy outcomes among female hairdressers who participated in the Danish National Birth Cohort

by Jin Liang Zhu, PhD,[1] Mogens Vestergaard, PhD,[2] Niels Henrik Hjollund, PhD,[3] Jørn Olsen, PhD [1, 4]

Zhu JL, Vestergaard M, Hjollund NH, Olsen J. Pregnancy outcomes among female hairdressers who participated in the Danish National Birth Cohort. *Scand J Work Environ Health* 2006;32(1):61–66.

Objectives The Danish National Birth Cohort (DNBC) was used to examine pregnancy outcomes among female hairdressers and neurodevelopment in their offspring.

Methods A population-based cohort study was conducted of 550 hairdressers and 3216 shop assistants (reference group) by using data from the Danish National Birth Cohort between 1997 and 2003. Information on job characteristics was reported by the women in the first interview (around 17 weeks of gestation). Pregnancy outcomes were obtained by linkage to the national registers. Developmental milestones were reported by the mother at the fourth interview, when the child was approximately 19 months old. Cox regression was applied to analyze fetal loss and congenital malformation. Logistic regression was used to analyze other pregnancy outcomes and developmental milestones.

Results We found no significant differences in fetal loss, multiple births, gender ratio, preterm birth, small-for-gestational age, congenital malformations, or achievement of developmental milestones among the children of hairdressers and shop assistants.

Conclusions The results do not indicate that children of hairdressers in Denmark currently have a high risk of fetal impairment or delayed psychomotor development.

Key terms congenital malformations; developmental milestones; fetal loss.

Hairdressers can be exposed to several chemicals, such as solvents and dyes (1, 2). On the basis of limited evidence of an excess risk of bladder cancer among male hairdressers, the International Agency for Research on Cancer (IARC) concluded that occupation as a hairdresser entails exposures that are probably carcinogenic (group 2A) (3). Some chemicals used by hairdressers, such as dibutyl phthalates (4), 2-nitro-p-phenylenediamine (5), and 4-nitro-o-phenyenediamine (5), have shown adverse reproductive effects in animal studies, but evidence from human studies is very limited (1, 6). Some studies suggest that exposures in hairdressing salons may be related to menstrual disorders (7), spontaneous abortion (8–10), congenital malformations (9, 11, 12), small-for-gestational age (11, 13), or delayed neurodevelopment in offspring (14), but others have not found any association (15–17).

In recent years, some dye formulations, dichloromethane, nitrosamines, and lead acetate have been banned, or exposure limits have been lowered in the United States and some European countries to prevent reproductive disorders (3). In Denmark, work with hair-care products should follow the regulations of the European Union and Denmark with respect to safety and health (Homepage of Union of Danish Hairdressers and Cosmetologists, http://www.dfkf.dk/). Work-related risks should be reduced by using low-risk products and by changing work methods to minimize the contact with hazardous substances. The use of local exhaust ventilation, individual protective measures, and safe storage of hair-care products has also been implemented. In this study, we evaluated pregnancy outcomes among Danish hairdressers and developmental milestones among their children.

1 The Danish Epidemiology Science Centre, University of Aarhus, Aarhus, Denmark.
2 Institute of Public Health, Department of Epidemiology, University of Aarhus, Aarhus, Denmark.
3 Department of Occupational Medicine, Aarhus University Hospital, Aarhus, Denmark.
4 Department of Epidemiology, School of Public Health, University of California at Los Angeles, Los Angeles, California, United States.

Reprint requests to: Dr JL Zhu, The Danish Epidemiology Science Centre, University of Aarhus, Vennelyst Boulevard 6, DK 8000 Aarhus C, Denmark. [E-mail: zjl@soci.au.dk]

Study population and methods

Study population

This study was conducted within the Danish National Birth Cohort, which has been described elsewhere (Homepage of the Cohort, http://www.bsmb.dk/) (18, 19). In brief, the cohort recruited pregnant women who wanted to carry their pregnancy to term at their first contact with the antenatal care system in Denmark. About 60% of all of the general practitioners in Denmark participated in the recruitment, and about 60% of all of the invited women accepted to join the cohort. The cohort was constructed to examine whether potentially hazardous occupational exposures during pregnancy have effects on the health of the children. The exposure information was collected by computer-assisted telephone interviews twice during pregnancy and twice after the delivery of the child.

Among the 88 915 pregnancies enrolled in the first interview between June 1997 and February 2003, we identified 571 pregnancies of hairdressers and 3317 pregnancies of shop assistants or sales assistants. We used shop assistants as the "unexposed" reference group because their educational and socioeconomic background was similar to those of hairdressers. We selected those who had only one job and worked more than 15 hours per week at the time of the first interview. If a woman participated in the cohort with more than one pregnancy, we included only the first (and excluded all subsequent pregnancies for each woman (21 for hairdressers and 93 for shop assistants). We excluded pregnancies terminated by an induced abortion (0 for hairdressers and 5 for shop assistants) and pregnancies with no information on outcomes (0 for hairdressers and 3 for shop assistants). Finally, 550 hairdressers and 3216 shop assistants were available for the analysis. Compared with the shop assistants, the hairdressers were more often multiparous, smokers, and less obese, and they more often worked in a standing position and less than 35 hours per week (table 1). The hairdressers and shop assistants took part in the four interviews at similar weeks of gestation or months of age of the children [eg, 17.3 (SD 4.4) weeks for the hairdressers and 17.7 (SD 4.4) weeks for the shop assistants for the first interview and 18.9 (SD 1.2) months for both the hairdressers and the shop assistants for the fourth interview].

Table 1. Characteristics of the hairdressers and shop assistants (referents). [a]

Characteristic	Hairdressers		Shop assistants	
	N	%	N	%
Maternal age				
<30 years	385	70.0	2334	72.6
≥30 years	165	30.0	882	27.4
Gravidity				
0	217	39.5	1521	47.3
≥1	332	60.4	1693	52.6
Prepregnancy body mass index				
<18.5 kg/m^2	23	4.2	173	5.4
18.5–30 kg/m^2	486	88.4	2714	84.4
>30 kg/m^2	29	5.3	287	8.9
Smoking				
Yes	178	32.4	912	28.4
No	372	67.6	2302	71.6
Alcohol consumption, unit per week [b]				
0	313	56.9	1842	57.3
0.5–1	164	29.8	966	30.0
>1	71	12.9	406	12.6
History of spontaneous abortion [c]				
Yes	96	28.9	508	30.0
No	236	71.1	1184	69.9
Weekly workhours				
<35	140	25.5	693	21.5
≥35	410	74.5	2523	78.5
Work posture				
Standing	260	47.3	425	13.2
Walking and standing	93	16.9	1428	44.4
Changeable	194	35.3	864	26.9
Sitting or other	3	0.5	499	15.5
Total	550	100.0	3216	100.0

[a] The numbers do not always add up due to missing values.
[b] One unit of alcohol equals one glass of wine or one bottle of beer.
[c] Women who were pregnant for the first time not included.

Measurement of exposure and outcomes

In the first interview, the women provided information on job title, number of jobs, weekly workhours, and work postures. In the second interview, they were asked whether their work condition had changed and whether they were on sick leave during pregnancy.

Data on pregnancy outcomes were obtained by linking the cohort to the National Hospital Register and the Medical Birth Register by means of the unique personal identification number (civil registration number) assigned to all citizens in Denmark at the time of birth. The National Hospital Register entails data on all hospital admissions, outpatients, and emergency ward contacts (20). All pregnancy outcomes, including fetal loss and gestational age, are reported to this register. Diagnoses on malformations (DQ00–DQ99) are also registered on the basis of the International Classification of Diseases, version 10. We defined "major" malformations by excluding accessory auricle (DQ170), undescended testes (DQ53), hip dislocation (DQ650–DQ656), and pigmented nevus (DQ825) (21). The Medical Birth Register comprises data, including birthweight, on all live births and stillbirths of women with permanent residence in Denmark (22). If the registers contained no information on the pregnancy, we used information obtained in interviews or on the telephone with the mothers (<1%).

We studied fetal loss (spontaneous abortion and stillbirth), multiple births, gender ratio (being a male infant), preterm (<37 weeks of gestation), and very preterm birth (<34 weeks of gestation), small-for-gestational age (less than the 10th percentile of the gender- and gestation-specific birthweight of the cohort), and congenital malformations. Gestational age at birth was determined from three sources: the last menstrual period, provided in the consent form (94.1%), the expected date of delivery, given in the second interview (4.7%), or the registered gestational age in the National Hospital Register (1.2%) (19). The registered gestational age was reported by midwives and most often was based on the ultrasound measure. Since each source has errors, we used the last menstrual period if this measure agreed within 2 weeks with either the expected date of delivery or the registered gestational age. If the difference was more than 2 weeks, we used the measure that best fit the observed birthweight (19).

In the fourth interview, the mother was asked questions about the developmental milestones of her child. The mother was, for example, asked at what age the child could sit alone and walk alone. We used a cut-off of 8 months of age for sitting and that of 14 months of age for walking, based on the motor and cognitive development of normal children as reported in the literature (23).

Statistical analysis

Hazard ratios of fetal loss and the diagnosis of congenital malformations for the hairdressers compared with the shop assistants were calculated using the Cox regression. For fetal loss, follow-up started from the date of the first interview and ended at the date of fetal loss or delivery (Cox regression with left truncation). For diagnosing malformations, follow-up started from the date of birth and ended at the date of diagnosis or at the end of the follow-up (9 November 2004). Although congenital malformations per definition are present at birth, their diagnosis is often delayed. The median follow-up time for the analysis of malformations was 3.8 years for the children of both the hairdressers and the shop assistants. The odds ratios for other pregnancy outcomes and the achievement of developmental milestones were calculated with a logistic regression. Chi-square tests were used to examine the differences in the pregnancy outcomes and the developmental milestones among hairdressers with different weekly workhours or work postures.

Potential confounders included maternal age, gravidity, history of spontaneous abortion, prepregnancy body mass index, smoking, and alcohol consumption. When evaluating the developmental milestones, we further adjusted for parental difficulties (requiring support) in speech, reading, arithmetic, or behavior (such as restlessness) (yes or no), breastfeeding at 6 months of age (yes or no), and gestational age at birth, as well as age of the child at the fourth interview for items assessed only in the fourth interview. Only nine male partners (3 for the hairdressers and 6 for the shop assistants) were working at a hairdressing salon at the time of the first interview. Cox regressions were performed with STATA 8.0 (College Station, TX, USA) and the other analyses with SPSS 10.0 (Chicago, IL, USA).

Results

We found no statistically significant differences for any of the examined pregnancy outcomes between the hairdressers and the shop assistants (table 2). Singleton

Table 2. Pregnancy outcomes for the hairdressers and shop assistants (referents). (HR = hazard ratio, OR = odds ratio, 95% CI = 95% confidence interval)

Outcome	Shop assistants (N=3216)		Hairdressers (N=550)				
	N	%	N	%	Crude HR or OR[a]	Adjusted OR or HR[a]	95% CI
Fetal loss	36	1.1	5	0.9	0.7	0.7	0.3–1.8
Multiple births [b]	54	1.7	11	2.0	1.2	1.3	0.7–2.5
Male infant [c]	1607	51.4	281	52.6	1.1	1.0	0.9–1.2
Preterm birth [c]	168	5.4	29	5.4	1.0	1.0	0.7–1.6
Very preterm birth [c]	44	1.4	8	1.5	1.1	0.9	0.4–2.1
Small-for-gestational age [c, d]	348	11.2	57	10.7	0.9	1.0	0.7–1.3
All malformations [c]	197	6.3	29	5.4	0.9	0.8	0.6–1.2
"Major" malformations [c, e]	158	5.1	24	4.5	0.9	0.9	0.6–1.4

[a] The hazard ratio for fetal loss or malformations was calculated using a Cox regression; the odds ratio for other outcomes was calculated using a logistic regression, adjusted for maternal age, gravidity, history of spontaneous abortion, prepregnancy body mass index, smoking, and alcohol consumption.
[b] Among the live births.
[c] Among the singletons.
[d] Excluding births with no information on birthweight for the hairdressers (N=1) and shop assistants (N=29).
[e] Excluding accessory auricle, undescended testes, hip dislocation, and pigmented nevus.

births had a mean gestational age of 280 (SD15) days and a mean birthweight of 3551 (SD 598) grams for the hairdressers; the corresponding values for the shop assistants were 280 (SD13) days and 3544 (SD 574) grams. No difference was found for the achievement of developmental milestones except for slightly earlier language skills for the children of the hairdressers (table 3). The results were almost the same with or without adjustment for potential confounders (tables 2 and 3).

When we restricted our analyses to women who were pregnant for the first time, we obtained similar results (data not shown). No differences were found for the pregnancy outcomes and milestone achievements among the hairdressers with different weekly workhours or work postures (data not shown).

Discussion

We found no differences in fetal loss, multiple births, gender ratio, preterm birth, very preterm birth, small-for-gestational age, congenital malformations, and developmental milestones for children between the hairdressers and shop assistants. Furthermore, no significant differences in fetal loss, preterm birth, very preterm birth, or small-for-gestational age were found for the hairdressers when they were compared with all the daytime workers in the Danish National Birth Cohort (the corresponding incidence being 1.2%, 4.2%, 1.1%, and 9.6%, respectively) (19, 24).

The findings are in line with those of recent studies from the Netherlands indicating that the increased risk of adverse pregnancy outcomes for hairdressers decades ago may have disappeared (9, 14). However, one study showed a higher prevalence of major malformations among children of hairdressers than among children of clothing salesclerks, although the numbers were very small (9). Another study from Sweden found a higher prevalence of major malformations among the infants born to hairdressers in a comparison with a randomly selected population sample (2.8% versus 2.1%) (11). But in a later study this increased prevalence had disappeared (13). Both studies from Sweden found an increased risk of small-for-gestational age for hairdressers (11, 13), but the odds ratio was reduced from 1.2 (95% CI 1.1–1.4) for 1983–1992 to 1.1 (95% CI 0.9–1.3) for 1993–2001 (13).

The Danish National Birth Cohort recruited about 30–40% of all pregnant women in Denmark during the study period, with about 60% of the invited women eventually participating in the cohort (18). A selection bias may have been operating if the hairdressers and shop assistants had different participation rates for the outcomes under study, which is unlikely. We collected exposure information before the outcome was known. We had almost complete follow-up on pregnancy outcomes, and these results were not biased by differential losses to follow-up.

Although the Danish National Birth Cohort is a large cohort, the exposed population (hairdressers) is rather small, and we lacked the power to detect small or moderate increases in the risks of rare adverse pregnancy outcomes. The information on developmental milestones was not complete (65%) since some of the children in the cohort had not reached the target age at the

Table 3. Developmental milestones of the children of the hairdressers and shop assistants (referents). (OR = odds ratio, 95% CI = 95% confidence interval)

Developmental milestones	Shop assistants (N=2029)		Hairdressers (N=350)				
	N[a]	%	N[a]	%	Crude OR[b]	Adjusted OR[b]	95% CI
Sitting without support at 8 months of age	1553	81.1	278	84.2	1.2	1.3	1.0–1.9
Walking without support at 14 months of age	1480	73.0	257	73.4	1.0	1.0	0.8–1.3
Items assessed in the fourth interview (approximately 19 months of age)							
Going upstairs with support	1912	95.1	334	95.4	1.1	1.1	0.7–2.0
Taking off socks and shoes when asked	1651	82.3	284	82.1	1.0	1.0	0.7–1.3
Drinking from an ordinary cup without help	1998	98.5	341	97.4	0.6	0.6	0.3–1.3
Being occupied alone with the same thing for at least 15 minutes	1603	79.5	269	78.0	0.9	0.9	0.7–1.2
Bringing things when told	1948	96.2	342	97.7	1.7	1.7	0.8–3.6
Making marks on table or paper	1864	92.5	328	94.0	1.3	1.3	0.8–2.1
Turning pictures right side up when looking in a book	993	51.6	166	49.1	0.9	0.9	0.7–1.2
Using word-like sounds to tell what he or she wants	1959	96.6	340	97.1	1.2	1.2	0.6–2.3
Mentioning more than 25 names of various things	221	10.9	47	13.4	1.3	1.4	1.0–2.0
Using two-word sentences	816	40.3	162	46.4	1.3	1.4	1.1–1.7

[a] The percentage in parentheses for each item was calculated on the basis of those providing the corresponding information.
[b] The odds ratio and 95% confidence interval were calculated using logistic regression, adjusted for maternal age, gravidity, history of spontaneous abortion, prepregnancy body mass index, smoking, alcohol consumption, parental difficulties, breastfeeding, and gestational age at birth, as well as for age of the child in the fourth interview for the last 10 items, assessed only for the fourth interview.

time of the analysis, and thus the sample size was further reduced. However, the effect measures were unlikely to have been biased, because we found similar participation rates between the hairdressers and shop assistants in the fourth interview and similar maternal and infantile characteristics between participants and nonparticipants. The interviews were made by phone, and the attempt to make the interview was abandoned if no contact was made after four attempts at different times of the day. Since women with previous pregnancy complications may try to avoid occupational hazards in a new pregnancy, women probably remember developmental milestones in more detail for their first child and women with previous pregnancies are probably a selected group regarding fecundity, we restricted our analyses to women who were pregnant for the first time and obtained similar results.

It must be born in mind that we investigated fetal loss only after the first interview, which was around 17 (range 8–38) weeks of gestation. If an exposure led to early abortion, we were not able to detect this effect.

In Denmark, doctors and midwives recommend paid pregnancy leave if they suspect any potential harmful exposures in the workplace. However, compared with shop assistants, fewer hairdressers changed their work (eg, new task, new job) (1.4% versus 5.5%) or took leave more than 3 days during pregnancy (42.5% versus 47.5%). Restricting the analyses to women who did not change their work or who did not take leave did not change the results.

The questions on developmental milestones were constructed by an experienced neuropsychologist, and studies have shown that parents and pediatricians agree well on the assessment of the neurodevelopment of children (25, 26). Genetic, environmental, and social factors are important determinants of neurodevelopment (23, 27). The slightly earlier language development among the children of the hairdressers may have been due to better environmental stimulation in early childhood, since the hairdressers had shorter workhours than the shop assistants.

Our data do not suggest that the children of hairdressers in Denmark have a high risk of perinatal problems or any delay in developmental milestones in early childhood. The results need not apply to other countries or other periods with different work conditions.

Acknowledgments

The activities of the Danish Epidemiology Science Centre are financed by grants from the Danish National Research Foundation, and the study was also supported by a grant from the Danish Medical Research Council (grant 22–02–0363). The establishment of the Danish National Birth Cohort has been financed by the Danish National Research Foundation, the Danish Pharmaceutical Association, the Ministry of Health, the National Board of Health, the Statens Serum Institut, BIOMED, the March of Dimes Birth Defects Foundation, the Danish Heart Association, the Danish Medical Research Council, and Sygekassernes Helsefond.

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Received for 24 February 2005