

Final Report

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List of Terms and Abbreviations

NIOSH	National Institute for Occupational Safety and Health
RFA	Request for applications
ROSE	Reproductive Outcomes in Salon Employees
OR	Odds ratio
CI	Confidence interval
TTP	Time-to-pregnancy
SD	Standard deviation
BMI	Body mass index
POF	Premature ovarian failure

Abstract

Cosmetologists constitute a major occupational group of female workers who sustain chemical exposures during their reproductive lifespan. In fact, there are between 500,000 and 750,000 cosmetologists in the United States alone, and 80-85% of these workers are women. The National Occupational Exposure Survey indicates that cosmetologists are regularly exposed to many chemicals, including dibutyl phthalate (CAS Number 84-74-2), N-hydroxymethylacrylamide (CAS Number 924-42-5), ethylene glycol (CAS Number 107-21-1), and 2,2 bis(BM)1,3-propanediol (CAS Number 3296-90-0). This poses a serious human health concern because these chemicals have been prioritized for study by the National Institute for Occupational Safety and Health (NIOSH) due to the potential for a large number of workers to be exposed to the chemicals and evidence that the chemicals adversely affect reproduction or development in animal models (please see RFA-OH-05-003).

Despite the large number of cosmetologists exposed to chemicals prioritized for study by NIOSH and the ability of such chemicals to cause reproductive toxicity in animal models, little was known about reproductive function in cosmetologists. Thus, this study tested the hypothesis that exposure to chemicals used in cosmetology businesses is associated with reproductive abnormalities in women through mechanisms involving destruction of ovarian follicles. To test this hypothesis, we determined whether cosmetologists have an increased risk of reproductive abnormalities compared to women who are not cosmetologists (specific aim 1) and investigated whether cosmetologists have reduced ovarian volume and follicle numbers compared to women who are not cosmetologists (specific aim 2).

To complete the specific aims, we designed and conducted a large survey-based study of cosmetologists and non-cosmetologists who were residents of the Baltimore metropolitan region (please note this includes Baltimore city and its surrounding counties). We named this study Reproductive Outcomes in Salon Employees (ROSE). The final study sample consisted of 450 cosmetologists and 512 women employed in other occupations. This study sample was used to examine pregnancy outcomes, infertility, and premature ovarian failure (an indicator of ovarian volume and follicle numbers) in cosmetologists compared to non-cosmetologists.

The data indicate that there are no statistically significant associations between occupation and adverse pregnancy outcomes after adjustment for age, race, education, and smoking and alcohol use at the time of pregnancy. A statistically significant association was found between race and low birth weight such that non-white women were at increased risk of reporting a low birth weight baby compared to white women (OR 3.35; 95% CI 1.53 to 7.26). Similarly, current smoking was found to be positively associated with miscarriage (OR 1.53; 95% CI 1.09 to 2.16) and miscarriage or stillbirth (OR 1.64; 95% CI 1.18 to 2.28).

In additional analyses, infertility was assessed with questions addressing time-to-pregnancy (TTP) length (>12 months), consulting a medical professional about fertility problems, taking medication to become pregnant or to maintain a pregnancy. Occupational exposure was assessed by job tasks and customers served per week. We found no statistically significant associations between working as a cosmetologist and the odds of TTP>_12 months, consulting a medical professional about infertility, or taking medication to either become pregnant or maintain a pregnancy.

Further, the data indicate that 3.2% of hairdressers and 1.4% of women working in other occupations reported premature ovarian failure (POF). Among Caucasian women 40 to 55 years of age, hairdressers were more than five times as likely to report POF compared to non-hairdressers (OR 5.58; 95% CI 1.24, 25.22). Collectively, these data indicate that hairdressers may not be at an increased risk for adverse pregnancy outcomes and infertility, but they may be at increased risk for POF compared to women employed in other occupations.

Section 1

Highlights/Significant Findings

The funded work was designed to test the hypothesis that exposures in cosmetology businesses are associated with reproductive abnormalities in women through mechanisms involving destruction of ovarian follicles. To test this hypothesis, we determined whether cosmetologists have an increased risk of reproductive abnormalities compared to women who are not cosmetologists (specific aim 1) and investigated whether cosmetologists have an increased risk of premature ovarian failure (an indicator of reduced ovarian volume and follicle numbers) compared to women who are not cosmetologists (specific aim 2).

To complete specific aim 1, we: 1) developed a large cross-sectional survey study of Reproductive Outcomes in Salon Employees (ROSE), 2) we used data from the ROSE study to examine reproductive outcomes in salon employees compared to non-cosmetologists, and 3) we determined that cosmetologists do not have increased odds of adverse pregnancy outcomes or infertility compared to non-cosmetologists. Specifically, we found no statistically significant associations between occupation and selected pregnancy outcomes after adjustment for age, race, education, and smoking and alcohol use at the time of pregnancy. A statistically significant association was found between race and low birth weight such that non-white women were at increased risk of reporting a low birth weight baby compared to white women (OR 3.35; 95% CI 1.53 to 7.26). Similarly, current smoking was found to be positively associated with miscarriage (OR 1.53; 95% CI 1.09 to 2.16) and miscarriage or stillbirth (OR 1.64; 95% CI 1.18 to 2.28). Collectively, these data indicate that there is not an increased risk of adverse pregnancy outcomes among cosmetologists compared to women of the same age working in other occupations.

In additional analyses, infertility was assessed with questions addressing time-to-pregnancy (TTP) length (>12 months), consulting a medical professional about fertility problems, taking medication to become pregnant or to maintain a pregnancy. Occupational exposure was assessed by job tasks and customers served per week. We found no statistically significant associations between working as a cosmetologist and the odds of TTP>_12 months, consulting a medical professional about infertility, or taking medication to either become pregnant or maintain a pregnancy. Together, these data suggest that cosmetologists are not at increased risk for infertility compared to women of the same age working in other occupations.

To complete specific aim 2, we: 1) used data from the ROSE study to examine premature ovarian failure (POF) in salon employees compared to non-cosmetologists and 2) we determined that cosmetologists have a significantly increased odds of POF compared to non-cosmetologists. Specifically, we found that among 443 hairdressers and 508 women in other occupations, 14 (3.2%) and 7 (1.4%) developed POF, respectively. A non-significant increase in the odds of POF was observed among hairdressers compared to non-hairdressers (OR 1.90; 95% CI 0.76, 4.72). When limited to Caucasian women only, the association was statistically significant (OR 3.24; 95% CI 1.06, 9.91). Among Caucasian women 40 to 55 years of age, hairdressers were more than five times as likely to report POF compared to non-hairdressers (OR 5.58; 95% CI 1.24, 25.22). Collectively, these data indicate that hairdressers may be at increased risk for POF compared to women employed in other occupations.

Translation of Findings

The results presented in this study suggest that hairdressers may not be at increased risk for adverse pregnancy outcomes and infertility compared to women of the same age employed in other occupations. However, hairdressers may be at an increased risk for POF compared to women of the same age employed in other occupations. The increased risk of POF observed in the ROSE study is of concern because POF is associated with many adverse health outcomes including an early age at infertility, an increased risk of osteoporosis, and an increased risk of cardiovascular disease. Since other studies have not reported on POF in hairdressers yet, it is important that other studies confirm our findings before we

can definitively conclude that working as a hairdresser increases the risk of POF. In addition, future research should be conducted to elucidate the cause of the association between POF and working as a hairdresser, focusing specifically on the chemical exposures that have been shown in animal models to destroy ovarian follicles. If other studies confirm our findings and identify chemicals used in salons that are associated with POF, future efforts should be directed towards reducing exposure of hairdressers to such chemicals.

Outcomes/Relevance/Impact

Despite the large number of cosmetologists exposed to chemicals prioritized for study by NIOSH and the ability of such chemicals to cause reproductive toxicity in animal models, little was known about reproductive function in cosmetologists. The completed work is significant because it determined that hairdressers may not be at increased risk for adverse pregnancy outcomes and infertility, but they may be at increased risk for POF compared to women of the same age employed in other occupations. Such information indicates that businesses may need to adopt preventive measures that protect cosmetologists from reproductive disorders such as POF. Before such preventive measures can be put in place, however, it is important for other investigators to confirm our findings to be sure that POF is associated with working as a hairdresser in multiple populations. If POF is consistently associated with working as a hairdresser, it will be important to determine why this is the case. To do so, future studies should examine whether chemical exposures in hair salons are associated with POF in hairdressers. Once this information is obtained, steps can be taken to reduce or eliminate exposure of hairdressers to chemicals known to be associated with POF.

Section 2

Scientific Resort

Our long-term goal is to understand risks of adverse outcomes in cosmetologists. Thus, the funded work was designed to test the hypothesis that exposures in cosmetology businesses are associated with reproductive abnormalities in women through mechanisms involving destruction of ovarian follicles. The progress that we made in completing these aims is summarized below using the original specific aims as subheadings.

Specific Aim 1 : Determine whether cosmetologists have an increased risk of reproductive abnormalities compared to women who are not cosmetologists. To complete this specific aim as well as the other specific aim proposed during the funding period, we designed and conducted a large survey-based study of cosmetologists and non-cosmetologists who were residents of the Baltimore metropolitan region (please note this includes Baltimore city and its surrounding counties). We named this study Reproductive Outcomes in Salon Employees (ROSE).

Recruitment

To recruit participants for the ROSE study, the names and addresses of all registered female cosmetologists and non-cosmetologists (i.e., realtors, teachers, and retail sales clerks) who were between 21-55 years of age were obtained from a commercial mailing house. The target age range was selected because it represents adults who should be in their reproductive lifespan, and eliminates most women who are well into their menopausal years or retired and who may not accurately remember the exposures or outcomes of interest. The targeted non-cosmetologist groups were selected because they are composed of occupational groups of women with similar educational levels, socioeconomic status, stress, and workplace environments to cosmetologists, but are not exposed to chemicals used in salons on a regular basis.

Each woman in the targeted age range and occupational group was mailed a recruitment packet, which included a letter explaining the study, a validated questionnaire, a \$1.00 incentive, and a stamped, addressed return envelope. The \$1.00 incentive was included because previous studies indicate that it significantly increases the response to mailed surveys. To help avoid selective response and bias, the study was presented to potential participants as a study on women who work.

To be included in the study, all respondents to the cross-sectional survey had to be between 21-55 years of age, not have had a hysterectomy/oophorectomy, and be working or have worked either in a cosmetology business or in selected occupations with similar salary and hours to that in the cosmetology business, but with limited/no chemical exposures (i.e., retail sales, real estate sales, nursing, teaching). Females under 21 years of age were excluded either because most females in this age range are not actively trying to have children or they are not working in the targeted occupations. Women over 55 years of age were excluded because they likely are post-menopausal, infertile or to have other reproductive abnormalities due to their age and not just occupational exposures. In addition, women in older age groups were excluded because they are likely to be retired or unable to accurately recall reproductive abnormalities that occurred during their reproductive years.

Recruitment packets were mailed to 4,228 cosmetologists and, of these, 242 were returned due to bad addresses. Of the remaining 3,986 surveys that were mailed, 846 were mailed back to the study office; 394 of the surveys were mailed back from women who did not meet the inclusion criteria or could not/did not want to participate in the study. Reasons for ineligibility/exclusion were: not currently employed, n = 7; hysterectomy/oophorectomy, n =136; over 55 years of age, n = 56; not interested in participating, n =153; deceased, n = 2; not cosmetologists, n =10; male, n =1; more than 50% of the survey incomplete, n = 9; and other (not specified), n = 20. Therefore, 452 surveys were mailed back from the cosmetologists who

met the eligibility criteria. Based on their job descriptions, four of these surveys were from women who were re-classified as non-cosmetologists. Informed consent was implied by return of the questionnaire.

Similarly, recruitment packets were mailed to 2,118 women in occupations other than cosmetology, as described above. Of these packets, 115 were returned due to bad addresses. Of the remaining 2,003 surveys, 698 were returned, of which 189 were mailed back from women who did not meet the inclusion criteria or could not/did not want to participate in the study. Specific reasons for exclusion were: hysterectomy/looporectomy, n = 94; over 55 years of age, n = 27; not interested, n = 55; deceased, n = 1; not employed, n = 4; more than 50% of the survey incomplete, n = 1; other (not specified), n = 7. Therefore, 509 surveys were mailed back from employed women from the non-cosmetologists group who met the eligibility criteria. Based on their job descriptions, two of the surveys in this group were from women who were reclassified as cosmetologists. Thus, the study sample consisted of 450 cosmetologists and 512 women employed in other occupations. This study sample was used to examine pregnancy outcomes, infertility, and premature ovarian failure in cosmetologists compared to non-cosmetologists as detailed below. Please note that the study sample for each outcome does not always equal 450 cosmetologists and 512 non-cosmetologists due to some missing data on reproductive outcomes.

Data collection

The survey was constructed to collect data on a number of reproductive health topics, including infertility, pregnancy outcomes, and premature ovarian failure. For the purposes of obtaining data on pregnancy outcomes, each woman was asked to report the number of times she had been pregnant (including a current pregnancy, if applicable) and detailed data were collected on the woman's first five pregnancies. These data pertained to: maternal age and weight gain at the time of the pregnancy; cigarette smoking and alcohol drinking habits at the time of the pregnancy; outcome of the pregnancy [termination, miscarriage (defined as spontaneous abortion at less than 20 weeks), stillbirth (defined as spontaneous abortion at 20 weeks or greater) or live birth]; the occurrence of maternal health conditions during pregnancy (preeclampsia, high blood pressure, diabetes); hospitalization or physician-ordered bed rest during pregnancy; pre-term labor or premature delivery (<37 weeks at delivery); and whether the child had any post-delivery health problems, including allergies, asthma, autism, learning disorders, Down syndrome, or birth defects. Of primary importance, the woman's occupation at the time of each pregnancy was queried, with participants asked to select from the following choices: homemaker; student; cosmetologist; technical or scientific; sales or administrative support; managerial or professional specialty; service, operator, fabricator and laborer; or other. Although initial plans entailed the comparison of cosmetologists at the time of each pregnancy to multiple 'other' occupational groups, a cross-check of occupation at the time of survey completion by the selection at the time of each pregnancy showed variability in the choice made by individuals of a single occupation. For example, teachers chose 'service' and 'managerial, professional specialty' with equal frequency. Therefore, occupation at the time of pregnancy was analyzed as a dichotomous variable: 'cosmetologist' and 'other occupation.'

In addition to pregnancy history, the survey collected detailed data pertaining to the woman at the time at enrollment; these data included marital status, education level, weight and height, race, personal and household income, type of health insurance, and time since last doctor visit. In addition, data on history of hormone and oral contraceptive use as well as personal and family medical history were also collected.

The characteristics of the study population are shown in Table 1 below. Compared to women in the non-cosmetologist occupation group, cosmetologists were significantly less likely to have a college degree or some graduate schooling, to have a household income of \$100,000 or greater, to be employed full-time, and to have health insurance. Conversely, the cosmetologists were significantly more likely to report that they were current smokers compared to women in the non-cosmetologist occupation group. There were no statistically significant differences between the two groups in terms of race, marital status, body mass index, alcohol drinking, and time since last visit to a primary care doctor.

Table 1: Characteristics of cosmetologists and non-cosmetologists

	Cosmetologists		Other		p-value
	n	%	n	%	
Sample size*	450		512		
Current occupation					--
Teacher			222	55.9	
Medical (including nurses)			108	27.2	
Manager/professional			67	16.9	
Sales			47	11.8	
Other			68	17.1	
Age, years, mean (SD)	43.7	6.4	42.3	7.9	0.005
Race					0.1
Caucasian	389	86.4	439	85.7	
African-American	44	9.8	51	10.0	
Other	7	1.6	19	3.7	
Education					<0.0001
Some high school	8	1.8	7	1.4	
High school/GED	118	26.2	42	8.2	
Some college/tech	164	36.4	109	21.3	
College/tech degree	122	27.1	130	25.4	
Some graduate school	12	2.7	49	9.6	
Graduate degree	15	3.3	171	33.4	
Marital status					0.4
Single	32	7.1	49	9.6	
Married	331	73.6	373	72.9	
Widowed	10	2.2	6	1.2	
Divorced/separated	48	10.7	63	12.3	
Partners	18	4.0	19	3.7	
Household income					<0.0001
<\$20,000	28	6.2	14	2.7	
\$20,000 to 49,000	75	16.7	63	12.3	
\$50,000 to 99,000	210	46.7	223	43.6	
\$100,000+	107	23.8	194	37.9	
Employment status					<0.0001
Full time	241	53.6	395	77.1	
Part time	193	42.9	101	19.7	
Student	1	0.2	5	1.0	
Medical leave	4	0.9	3	0.6	
Body mass index (kg/m ²)					0.2
<18.5	3	0.7	11	2.1	
18.5-24.9	172	38.2	188	36.7	
25.0-29.9	141	31.3	154	30.1	
>30.0	113	25.1	149	29.1	
Smoking status					<0.0001
Current	97	21.6	83	16.2	
Former	170	37.8	133	26.0	
Never	175	38.9	292	57.0	
Alcohol drinking status					0.1
Current	294	65.3	306	59.8	
Former	125	27.8	172	33.6	
Never	28	6.2	31	6.1	
Health insurance					0.03

None	34	7.6	18	3.5	
Medicare/Medicaid	9	2.0	7	1.4	
Conventional (PPO, POS)	254	56.4	318	62.1	
Managed care (HMO)	121	26.9	127	24.8	
Mixed/Other	26	5.8	39	7.6	
Visit to primary care doctor					0.07
Never	5	1.1	3	0.6	
<1 year ago	317	70.4	325	63.5	
1-2 years ago	84	18.7	122	23.8	
3-5 years ago	20	4.4	35	6.8	
>5 years ago	14	3.1	22	4.3	

*Note: some characteristics may not add up to 100% due to missing data

Cosmetologists and Pregnancy Outcomes

We used data obtained from the ROSE study population to estimate the association between cosmetologists and adverse pregnancy outcomes. These data are presented in detail in the manuscript titled "Cosmetologists and reproductive outcomes." Briefly, in unadjusted analyses, there were no statistically significant differences in terms of pregnancy outcomes (miscarriage, stillbirth, or live birth) for each individual pregnancy between the cosmetologists and non-cosmetologist comparison group. For example, for pregnancy 1, among pregnancies that were not terminated, approximately 17% of the women who reported being a cosmetologist at the time of pregnancy reported either a miscarriage or a stillbirth compared to 15.8% of women who reported not being a cosmetologist ($p = 0.91$).

Among live births, compared to non-cosmetologists, women who reported being cosmetologists at the time of pregnancy were significantly less likely to report a low birth weight child at pregnancy 2 (0.0% for cosmetologists versus 4.6% for non-cosmetologists; $p = 0.02$) and significantly more likely to report having a child with health problems at pregnancy 4 (59.1 % versus 29.4%; $p = 0.01$). Similarly, among live births, cosmetologists were less likely than non-cosmetologists to be diagnosed with high blood pressure or preeclampsia at pregnancy 1 (high blood pressure: 4.5% versus 10.5%; $p = 0.04$; preeclampsia: 1.5% versus 7.18%; $p = 0.02$). In contrast, cosmetologists were more likely to be diagnosed with gestational diabetes at pregnancies 4 and 5 compared to the non-cosmetologists.

There were no statistically significant associations between occupation and the pregnancy outcomes or the child health outcomes after adjustment for age, race, education, and smoking and alcohol use at the time of pregnancy. A statistically significant association was found between race and low birth weight such that non-white women were at increased risk of reporting a low birth weight baby compared to white women (OR 3.35; 95% CI 1.53 to 7.26). Similarly, current smoking was found to be positively associated with miscarriage (OR 1.53; 95% CI 1.09 to 2.16) and miscarriage or stillbirth (OR 1.64; 95% CI 1.18 to 2.28). Age and education were not significantly associated with any of the pregnancy or child health outcomes.

Cosmetologists and Infertility Outcomes

We used data obtained from ROSE to estimate the association between cosmetologists and infertility. These data are presented in detail in the manuscript titled "Infertility among cosmetologists." Among the 448 cosmetologists and 509 non-cosmetologists included in the analysis, 73 (16.3%) and 104 (20.4%) reported a time to pregnancy (TTP) of ≤ 12 months, respectively ($p = 0.1$). A small, non-significant decrease in the odds of a TTP > 12 months was observed among cosmetologists compared to the non-cosmetologists after adjustment for age, body mass index (BMI), marital status, education, smoking habits, and current alcohol use (odds ratio (OR) 0.82; 95% confidence interval (CI) 0.57, 1.18). The fully adjusted OR for TTP > 12 months was close to 1 and not statistically significant when the cosmetologists

were compared to the non-professional non-cosmetologist comparison group only (OR 0.98; 95% CI 0.54, 1.89).

Women were also asked in the survey if they sought and/or acquired a diagnosis of infertility from a doctor or nurse. A total of 57 cosmetologists (12.7%) and 94 non-cosmetologists (18.5%) reported that they had consulted a doctor or nurse about infertility ($p=0.01$). Consistent with the results for TTP > 12 months, a small, non-significant decrease in the odds of obtaining a formal diagnosis of infertility was observed among the cosmetologists compared to the non-cosmetologists after adjustment for age, BMI, marital status, education, smoking habits, and current alcohol use (OR 0.76; 95% CI 0.51, 1.12). A similar OR was observed when comparing the cosmetologists to the non-professional non-cosmetologist group only (OR 0.72; 95% CI 0.39, 1.34).

Few cosmetologists and women in the comparison group reported taking a medication to become pregnant or a medication to maintain pregnancy. Although the odds of taking a medication to become pregnant or taking a medication to maintain pregnancy were lower among cosmetologists compared to the entire non-cosmetologist comparison group, the results were not statistically significant after adjustment for age, BMI, marital status, education, smoking habits, and current alcohol drinking (medication to become pregnant: OR 0.70; 95% CI 0.40, 1.24; medication to maintain pregnancy: OR 0.68; 95% CI 0.37, 1.26). In addition, the strength of the ORs for these outcomes was decreased when the cosmetologists were compared to the non-professional non-cosmetologists only (medication to become pregnant: OR 0.85; 95% CI 0.33, 2.21; medication to maintain pregnancy: OR 0.85; 95% CI 0.30, 1.40).

There were no statistically significant associations between job tasks in a salon and infertility. For example, cosmetologists who reported bleaching hair of customers did not have significantly different odds of TTP > 12 months than cosmetologists who reported not bleaching hair of customers (OR 0.76; 95% CI 0.46, 1.28). Further, there was no evidence of a dose-response relationship between the number of customers served per week on a specific task or the number of hours per week working in a specific task and TTP > 12 months.

In summary of specific aim 1, we: 1) developed a large cross-sectional study of Reproductive Outcomes in Salon Employees (ROSE), 2) we used data from this study to examine reproductive outcomes in salon employees compared to non-cosmetologists, 3) we determined that cosmetologists do not have increased odds of adverse pregnancy outcomes or infertility compared to non-cosmetologists, and 4) we published two manuscripts, and presented one abstract related to his specific aim.

2. Investigate whether cosmetologists have reduced ovarian volume and follicle numbers compared to women who are not cosmetologists. To complete this aim, we originally planned to recruit women from the ROSE study and subject them to transvaginal ultrasounds to determine whether cosmetologists had reduced ovarian size and follicle numbers compared to non-cosmetologists. We proposed to obtain these measures because reduced ovarian size and follicle numbers are indicators of premature ovarian failure. Despite several attempts and incentives to enroll women for the transvaginal ultrasound portion of the study, we only recruited a small number of women to complete the transvaginal ultrasounds ($n=6$). This small number of women was not sufficient to evaluate premature ovarian failure in cosmetologists versus non-cosmetologists. We think that it was difficult to obtain the transvaginal ultrasounds because women had to be scheduled to come to the clinic on day 3 of their menstrual period for an accurate reading. This often did not match well with the women's job and family obligations.

Given that we could not assess premature ovarian failure using transvaginal ultrasound, we decided to obtain information on premature ovarian failure by asking ROSE participants if a physician/clinician diagnosed them with premature ovarian failure (ovarian failure before age 40) or early menopause (ovarian failure before age 45). This approach allowed us to complete this specific aim and to obtain very interesting data related to this outcome in cosmetologists. These data have been presented in the manuscript titled "Premature ovarian failure among hairdressers" and are described briefly below.

Among the 443 hairdressers and 508 women in other occupations included in the analyses, 14 (3.2%) and 7 (1.4%) developed POF, respectively ($p = 0.1$). In the entire sample, a non-significant increase in the odds of POF was observed among the hairdressers compared to the non-hairdressers after adjustment for age, current cigarette smoking, and current alcohol use (Table 2; odds ratio (OR) 2.31; 95% confidence interval (CI) 0.82, 5.83). When limited to Caucasian women only, the strength of the association was greater and statistically significant (OR 3.98; 95% CI 1.28,12.38). In addition, among Caucasian women greater than 40 years of age, hairdressers were six times as likely to report POF compared to non-hairdressers after adjustment for smoking and alcohol use (OR 6.25; 95% CI 1.36, 28.74).

Table 2: The association between hairdresser occupation and premature ovarian failure

		All ages		
	n	% POF	p-value ^s	adjusted OR (95% CI)
All races				
Non-hairdressers	508	1.4	0.1	1.00 (reference)
Hairdressers	443	3.2		2.31 (0.82, 5.83)
Caucasian women				
Non-hairdressers	435	0.9	0.009	1.00 (reference)
Hairdressers	384	3.7		3.98 (1.28,12.38)
		Ages 40 to 55 years		
	n	% POF	p-value ^s	adjusted OR (95% CI)
All races				
Non-hairdressers	317	1.6	0.1	1.00 (reference)
Hairdressers	318	3.8		2.41 (0.83, 7.05)
Caucasian women				
Non-hairdressers	289	0.8	0.01	1.00 (reference)
Hairdressers	268	4.2		6.25 (1.36, 28.74)

95% CI = 95% confidence interval; OR = odds ratio; POF = premature ovarian failure

^acalculated using Fisher's exact test

^badjusted for age, current smoking (yes/no), and current alcohol use (yes/no)

In summary of specific aim 2, we: 1) developed a large cross-sectional study of Reproductive Outcomes in Salon Employees (ROSE), 2) we used data from this study to examine premature ovarian failure in salon employees compared to non-cosmetologists, 3) we determined that cosmetologists have a significantly increased odds of premature ovarian failure compared to non-cosmetologists, and 4) we submitted one manuscript and presented one abstract related to his specific aim.

Additional Data

During the course of the ROSE study, we obtained additional data on menstrual cycle abnormalities that were not part of the original specific aims. We thought these data were important and thus, we prepared and submitted an additional manuscript on menstrual cycle abnormalities among cosmetologists. Analysis of data from the entire study sample showed that cosmetologists were not at increased risk of menstrual cycle abnormalities compared to the non-cosmetologists after adjustment for age and smoking status at the time of the survey. For example, a similar percentage of cosmetologists and non-cosmetologists reported irregular menstrual cycle length (less than or greater than 28 days) [35.6% of cosmetologists versus 37.9% of non-cosmetologists; adjusted OR 0.92; 95% CI 0.70, 1.211 and ever having

excessive/abnormal menstrual bleeding [37.3% of cosmetologists versus 38.5% of non-cosmetologists; adjusted OR 0.95; 95% CI 0.73,1.24]. After excluding women from the analyses of the specific outcome variables based on oral contraceptive use history, none of the resulting estimates showed a statistically significant association between hairdresser occupation and an investigated menstrual cycle abnormality.

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Peer-Reviewed Manuscripts

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Abstracts

1. Gallicchio, L., Miller, S., Greene T., Zacur, H.A., Flaws, J.A. Reproductive outcomes among cosmetologists in Maryland. *Society for Epidemiologic Research* 2007.
2. Gallicchio, L., Miller, S., Greene T., Zacur HA, Flaws, J.A. A survey-based study of reproductive outcomes among cosmetologists. *Society for Epidemiologic Research* 2008.

Letter to the Editor

1. Flaws, J.A., Gallicchio, L. (2009) No interaction between smoking and working as a hairdressers with respect to miscarriage and infertility. Letter to the Editor. *Journal of Occupational and Environmental Medicine* (in press).

Inclusion of gender and minority study subjects

The proposed study only included women because it was designed to examine female reproductive outcomes. The proposed work did not exclude anyone based on race/ethnicity. As shown in table 1, we enrolled approximately 10% African American women and 2-4% other minorities. This minority distribution is consistent with the general population in the recruitment area.

Inclusion of children

Children were excluded from the study because most are not able to reproduce (i.e., those under 13-14 years) or work in the selected businesses (i.e., those under 16-18 years) and the proposed study was designed to test hypotheses related to reproductive function in women who work. We decided to exclude all children under 21 years of age even though children between 16 and 21 can reproduce and work because our past experience and published studies indicate that most women in this age range are not actively trying to have children because they are unmarried, still in school, or unable to handle the emotional and financial responsibilities of a child. Further, published studies indicate that risk factors for reproductive abnormalities differ for people in this young age group compared to the women who are over 21 years. Thus, we elected to exclude people under 21 years to minimize differences in risk factors that are unrelated to occupational setting.

Materials available for other investigators

During the research, we developed questionnaires that assess reproductive outcomes in women who work. We will share these questionnaires with other investigators. To obtain the questionnaires, other investigators just need to email or phone the PI and request electronic or paper copies of the questionnaires.