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Chemical Hair Treatments and Adverse Pregnancy Outcome among Black Women in Central North Carolina

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Several studies suggest that toxic chemicals in hair products may be absorbed through the scalp in sufficient amounts to increase the risks of adverse health effects in women or their infants. This case-control study of 525 Black women from three counties in North Carolina who had delivered a singleton, liveborn infant examined whether exposure to chemicals used in hair straightening and curling increased the odds that the infant was preterm or low birth weight. Cases consisted of 188 preterm and 156 low birth weight births (for 123 women, their infant was both low birth weight and preterm). Controls were 304 women who delivered term and normal birth weight infants. Women who used a chemical hair straightener at any time during pregnancy or within 3 months prior to conception had an adjusted odds ratios (OR) of 0.7 (95% confidence interval (CI) 0.4–1.1) for preterm birth and 0.6 (95% CI 0.4–1.1) for low birth weight. Exposure to chemical curl products was also not associated with preterm delivery (adjusted OR = 0.9, 95% CI 0.5–1.8) or low birth weight (adjusted OR = 1.0, 95% CI 0.5–1.9). Despite this failure to find an association, continued search for risk factors to which Black women are uniquely exposed is warranted. *Am J Epidemiol* 1999;149:712–16.

Blacks; cosmetics; hair preparations; infant, low birth weight; infant, premature; pregnancy outcome; women

Black women are twice as likely as White women to have a preterm delivery or a low birth weight infant (1, 2). Differential socioeconomic status accounts for part but not all of these disparities (3–5). Environmental factors (e.g., chemical exposures) that are common in Black women but uncommon or absent in White women might account for some of the variation in risk. Potentially toxic exposures that affect Black women at all socioeconomic levels should be particularly appropriate targets of research; one such factor is the use of chemical hair straighteners.

US women (almost all of them Black) who use chemical hair straighteners, also known as "relaxers", generally have a treatment every 4 to 8 weeks. Chemical curling, which is used by both races, is applied less frequently. Lye relaxers containing 2–3.5 percent concentrations of sodium hydroxide or potassium hydroxide are used by professional cosmetologists to straighten hair (6). Non-lye relaxers, used professionally as well as directly by the consumer in the home, contain calcium hydroxide cream and guanidine carbonate, which are mixed to form guanidine hydroxide. These products disrupt the disulfide bonds in the hair shaft. The hair is then combed to straighten out the natural curl in the fiber and a neutralizer is applied which stimulates reformation of the disulfide bonds leaving the hair in its straightened shape. In permanent curl products, sodium or ammonium thioglycolate is the active ingredient. This chemical also breaks the disulfide bonds. The hair is then neutralized with hydrogen peroxide after being set on rollers to establish a curled configuration (6). Both hair damage and skin irritation are commonly reported by women who undergo such treatment (6–10), but we are unaware of any evidence of any reported systemic health effects. These products, along with other cosmetics, are not subjected to an approval process by the Food and Drug Administration (FDA). Instead, the FDA regulations include only voluntary registration of products by the manufacturers (11).

A recent report (12) indicated that cosmetologists may be at increased risk of spontaneous abortions from occupational exposure to a variety of chemicals. Thus, it seems appropriate to investigate whether women who undergo chemical hair straightening or

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Abbreviations: CI, confidence interval; OR, odds ratio.

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curling may themselves be at increased risk for adverse pregnancy outcomes. The finding in the report on cosmetologists that not wearing gloves was associated with increased adverse risk suggests that skin absorption may have played an important role in a cascade of events that ultimately led to spontaneous abortion. Perhaps absorption of certain chemicals triggers hormonal changes that lead to early parturition; possibly the chemicals play a role in other events that affect pregnancy outcome. In this study of Black women residing in central North Carolina, we sought to determine whether exposure to the chemicals used in permanent hair straightening and curling increased their risk of delivering a preterm or low birth weight infant.

MATERIALS AND METHODS

We conducted a population-based, case-control study of low birth weight (<2,500 g) and preterm delivery (<37 weeks) among Black women aged 18 years or older who delivered a singleton, liveborn infant and who resided in North Carolina in either Durham or Orange County (September 1988 to August 1989), or in Alamance County (September 1988 to April 1991). For the present study, we designated as case patients Black women in this group who delivered either a low birth weight or preterm infant; we excluded women who gave up their infant for adoption at delivery. Further details on the methods by which the preterm births were identified have been published elsewhere (13). One control patient was chosen for each case patient enrolled in the original study. The first full-term, normal weight live birth in the index hospital following a case birth that was delivered by a Black woman 18 years of age or older who resided in Alamance, Durham, or Orange County was selected as a control birth. The five hospitals with maternity services in the three counties of interest delivered nearly 97 percent of the women residing in those counties who gave birth during the study period indicated.

Exposure information was acquired during a telephone interview that lasted 45–60 minutes. Both case and control women were asked whether they had ever used chemicals to curl or straighten ("relax") their hair, either at a beauty salon or at home, during the 3 months before becoming pregnant or at any time during the pregnancy. Trimester specific exposure information, including type of chemical and frequency of use, was collected, as was information on the potentially confounding variables of marital status, education, income, and history of smoking during the pregnancy.

Statistical analysis

We first calculated the crude odds ratios for delivering a preterm or low birth weight infant among women with peripregnancy exposure to chemical straighteners or to chemical curl products compared with women with neither exposure ("unexposed"). (We excluded from the analysis all women who were exposed to both chemical straightening and chemical curling.) To assess the independent effects of the exposures on the outcomes, we constructed four separate logistic regression models, each with one of the exposures (chemical hair straighteners or chemical curl products) and one of the nominal response variables of preterm birth (<37 weeks gestation) or low birth weight (<2,500 g). Each model was adjusted for age, education, gravidity, marital status, smoking history, poverty status, and county of residence. We used the same comparison group—full-term (>37 weeks gestation), normal weight (>2,500 g) births—for all the models.

We estimated model coefficients by using unconditional maximum likelihood methods and we estimated relative risks by calculating adjusted odds ratios. All main effects and all two-way interaction terms were evaluated in the models. We evaluated interaction by using a backward elimination algorithm, i.e., entering first-order, cross-product terms of potential confounders with the exposure and evaluating statistical significance by using likelihood ratio tests (14). During model reduction, we monitored the effect on the estimated relative risk of deleting potential confounders from the model; 95 percent confidence intervals for the adjusted odds ratios were calculated. The SAS software package (15) was used for all analyses.

RESULTS

Of the 823 Black women originally selected for inclusion in the larger study, 531 (65 percent) completed the entire one-hour telephone interview; 525 had interviews judged to be satisfactory by the interviewers and were included in the analysis. Among cases, 123 women delivered an infant who was both preterm and low birth weight, 65 women had a preterm birth that was not low birth weight, and 33 women had a low birth weight delivery that was not preterm. Thus, there were 188 women with preterm births and 156 with low birth weight births; these overlapping subpopulations were treated as case groups. Controls consisted of 304 women who had a term, normal birth weight delivery.

Social, demographic, and exposure characteristics of cases and controls are presented in table 1. Using a chemical hair straightener was more than twice as common as using a chemical curl product during the peripregnancy period. Nearly one-fifth of participants

TABLE 1. Characteristics of selected Black women who delivered liveborn, singleton infants: case-control study of chemical hair treatments and adverse pregnancy outcome, central North Carolina, 1988–1991*

Characteristic	Preterm case patients (n = 188)		Low birth weight case patients (n = 156)		Controls (n = 304)	
	No.	%	No.	%	No.	%
Marital status						
Married or cohabiting	60	31.9	44†	28.2	117‡	39.8
Not married or cohabiting	128	68.1	112	71.8	177	60.2
Smoked during pregnancy						
Yes	61‡	32.6	54‡	35.1	97‡	32.2
No	126	67.4	100	64.9	204	67.8
Gravidity						
Primigravida	45	23.9	40	25.6	88	29.0
Multigravida	143	76.1	116	74.4	216	71.1
Education (years)						
<12	48†	25.5	42	26.9	51	16.8
12	82	43.6	63	40.4	127	41.8
≥13	58	30.9	51	32.7	126	41.5
Age (years)						
18–19	39	20.7	30	19.2	44	14.5
20–34	135	71.8	116	74.4	239	78.6
≥35	14	7.5	10	6.4	21	6.9
County of residence						
Alamance	79	42.0	56	35.9	98	32.2
Durham	90	47.9	82	52.6	177	58.2
Orange	19	10.1	18	11.5	29	9.5
Poverty§						
Yes	58‡	35.6	51‡	38.1	81‡	30.9
No	105	64.4	83	61.9	181	69.1
Exposure						
Straightener only	91	48.4	72	46.2	175	57.6
Curl product only	52	27.7	48	30.8	68	22.4
No exposure	40	21.3	33	21.2	57	18.8
Straightener and curl product	5	2.7	3	1.9	4	1.3

* Percents may not add to 100.0 due to rounding.
† $p < 0.05$.
‡ Subjects with missing data were excluded from individual analyses.
§ Subject's household income below the federal poverty level.

reported no exposure to either chemical hair treatment during the same period.

None of the crude odds ratios for preterm or low birth weight birth for women with chemical exposures was statistically significantly different from 1.0 (table 2). We detected no significant interactions between any of the variables (age, education, gravidity, marital status, smoking history, poverty status, and county of residence) we entered in our logistic regression models. Adjusted odds ratios for preterm or low birth weight birth for the two groups of exposed women ranged from 0.6 to 1.0, suggesting no association or a weak inverse association. Neither the number of times the chemical was used in the pregnancy or in the 3 months before pregnancy nor the timing of exposure by trimester yielded evidence of an association with preterm birth or low birth weight (data not shown).

DISCUSSION

The present study is, to our knowledge, the only case-control study conducted to date of possible adverse reproductive outcomes associated with use of chemical hair straighteners or curl products. We did not find that users of either of these products had an increased risk of preterm delivery or low birth weight. We observed, however, that women who used chemical straighteners had adjusted odds ratios for preterm delivery and low birth weight that, while not statistically significant, were somewhat below 1.0. We consider it very unlikely that exposure to a chemical hair straightener during pregnancy could protect against preterm delivery and low birth weight; perhaps exposure is related to a woman's life-style choices that could affect her health during pregnancy.

TABLE 2. Crude and adjusted* odds ratios (OR) for preterm and low birth weight infants born to Black women, by exposure† to chemical hair products, central North Carolina, 1988–1991

	Controls (n = 300)	Preterm birth (n = 183)				Low birth weight birth (n = 153)			
		%	Crude OR	Adjusted OR	95% CI‡	%	Crude OR	Adjusted OR	95% CI
Unexposed	19.0	21.9	1.0	1.0	§	21.6	1.0	1.0	§
Straightener	58.3	49.7	0.7	0.7	0.4–1.1	47.1	0.7	0.6	0.4–1.1
Curl product	22.7	28.4	1.1	0.9	0.5–1.8	31.4	1.2	1.0	0.5–1.9

* Adjusted for age, education, gravidity, marital status, smoking, poverty status, and county of residence.
† Women exposed to both products were excluded from analyses.
‡ CI, confidence interval.
§ Referent group.

Despite failure to find a deleterious effect from chemical hair straightening or curling, several studies (16–24) suggest that toxic chemicals may be absorbed through the scalp in sufficient amounts to increase the risk of various adverse health effects, including various cancers. For example, a case report (16) of a severe congenital defect that occurred after a mother had shampooed with a lotion containing 0.5 percent malathion during her 12th week of pregnancy suggests that teratogenicity could be stimulated by this type of transient dermal exposure. The report speculates that scalp absorption of the neurotoxic agent had no adverse side effect on the mother because it was rapidly metabolized in her system, but placental transfer of the toxic chemical to the developing fetus resulted in amyoplasia congenita, which proved to be a fatal defect. In addition, neuroblastoma, a common pediatric neoplasm, was found in one study (17) to be three times as likely when the infant's mother used hair coloring products during pregnancy (one-sided p = 0.002). Although no other studies of adverse reproductive outcomes have implicated exposure to hair dye, a study of men with leukemia and non-Hodgkin's lymphoma (19) reported a relative risk of ever using hair dyes of 1.8 (95 percent CI 1.1–2.7) and 2.0 (95 percent CI 1.3–3.0), respectively. Hair dye was also identified as the etiologic agent in two case reports of severe aplastic anemia (20), as more statistically prevalent among adults with brain tumors (21), and as associated with chronic renal failure in two case reports (22). This evidence suggests that toxic chemicals can be absorbed through the scalp in sufficient amounts to cause a variety of adverse health effects.

Although no specific evidence that chemical hair straighteners or curl products cause serious health problems has thus far been reported in the medical literature, the hair care industry recognizes that skin and scalp damage are particular problems for Black women who use these products (7–9). Thus, neutralizing shampoos have been developed specifically to restore the pH of the scalp and scalp lipids, and thereby to alleviate the damaging effects of most relaxers (25).

One limitation of our study was that the high prevalence (80 percent) of exposure to chemical hair straighteners or curl products in our study population meant that we had little power to detect a small difference in outcomes between exposed and unexposed women. By performing an additional statistical procedure (26) we were able to judge with precision whether the true odds ratios for preterm birth or low birth weight following exposure was 1.5 or greater. Thus, we can say that, in our population, use of the products of interest was not associated with a substantial increase in risk for preterm delivery or low birth weight.

Another limitation of our study was that 35 percent of the women eligible to participate did not provide consent for either a lengthy interview or for review of their medical record. These non-responders were equally distributed between cases (n = 147) and controls (n = 145). It is possible that these women were different from those who did agree to participate. A significant effect, either positive or negative, to the exposure in question might have been demonstrated had the non-response rate been lower. The final limitation was that other hair chemicals, such as dyes, setting gels, and holding hair sprays were not assessed in this study. These products often are used concurrently with chemical hair straighteners and curl products, and theoretically could have produced an interactive effect.

The chemical reaction during the disulfide bond disruption of the protein molecules in the hair that occurs as part of the straightening process might conceivably facilitate absorption of the toxins contained in the chemicals used. Therefore, research on the health effects of chemical hair straighteners or curl products is justified in light of reports of absorption effects from other hair preparations such as dyes (17–24). Furthermore, women are concerned about the safety of these products (27), but, to our knowledge, the extent

of skin absorption and systemic safety has not been thoroughly assessed. Besides testing one specific hypothesis, our effort illustrates an attempt to broadly explore possible reasons for the greater risk of Black women for delivering preterm and low birth weight infants.

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