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Alcohol Use Prior to and During Pregnancy in Western Washington, 1989–2004: Implications for Preventing Fetal Alcohol Spectrum Disorders

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Abstract

OBJECTIVES—We examined trends in rates of self-reported pregnancy alcohol use among women in Western Washington.

STUDY DESIGN—Between 1989 and 2004 we conducted three studies in Western Washington State on problems associated with maternal prenatal alcohol or drug abuse (N = 12,526). To determine study eligibility, we screened hospitalized postpartum women for alcohol and drug use in the month prior to and during pregnancy. We examined trends in alcohol use rates and identified characteristics associated with any drinking and binge drinking (≥ 5 drinks on any occasion).

RESULTS—We found a substantial decrease in pregnancy alcohol use between 1989 and 2004 (from 30% to 12%) across almost all demographic categories. Binge drinking in the month prior to pregnancy increased significantly among all race categories except Native American.

CONCLUSIONS—Increased pre-pregnancy binge drinking rates may estimate alcohol use during very early gestation, and warrant clinical attention because of the potential for fetal alcohol spectrum disorders.

Keywords

alcohol; fetal alcohol spectrum disorders; pregnancy

INTRODUCTION

Public health messages discouraging alcohol use during pregnancy have evolved since alcohol was first identified as a teratogen in 1973 and the fetal alcohol syndrome was named.[1, 2] On a federal policy level, in 1981 the Surgeon General issued an advisory recommending that women not drink alcoholic beverages during pregnancy or while considering pregnancy.[3] In

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late 1990 the "Alcohol Beverage Labeling Act of 1988" went into effect, requiring that all alcoholic beverage containers in the U.S. be labeled with a specific health warning.[4] The Surgeon General's advisory was reissued in 2005, urging women who are pregnant or who are considering becoming pregnant to abstain from alcohol consumption in order to eliminate the risk of alcohol-related birth defects.[5]

The Behavioral Risk Factor Surveillance System (BRFSS) population-based surveys conducted by the Centers for Disease Control and Prevention indicate that between 1991 and 1995 drinking rates during pregnancy increased nationally: use of any alcohol rose from 12.4% to 16.3%, and binge alcohol increased from 0.7% to 2.9%.[6] But beginning in 1997 these national rates began to decrease and stabilize: any alcohol drinking during pregnancy was estimated at 11.4% in 1997, 12.8% in 1999,[7] and 10.1% in 2002.[8] Binge drinking among pregnant women has fluctuated slightly, from 2.9% in 1995, to 1.8% in 1997, 2.7% in 1999, [6,7] and 1.9% in 2002.[8]

Fetal alcohol spectrum disorders (FASD) is the term used to describe the range of physical and neurodevelopmental problems that may be associated with frequent or heavy maternal drinking during pregnancy. FASD prevention efforts are informed by understanding the prevalence of such alcohol use, and the characteristics of those who drink. Between 1989 and 2004 we conducted three federally-funded research studies in Western Washington State on problems associated with maternal prenatal alcohol or drug abuse. The purpose of this paper is two-fold: to examine trends in rates of self-reported pregnancy-related alcohol use by demographic category among women screened for participation in the three studies (N = 12,526); and to examine maternal characteristics associated with pre-pregnancy alcohol use in the most recent study (2002–2004). We discuss implications for the role of clinicians in preventing FASD.

MATERIALS AND METHODS

The three studies and the five hospitals from which our data are derived are described below. In each study, research methodology involved screening hospitalized postpartum women for prenatal alcohol and drug use. The primary purpose of the screening protocol was to identify mothers eligible for our studies (not to ascertain prevalence as in the national studies cited above). We screened women using the Hospital Screening Questionnaire (HSQ), a confidential, one-page self-administered questionnaire developed and piloted by our research unit in 1987.[9] Procedures for administering the HSQ have been described elsewhere.[9] The HSQ asks about demographic characteristics and use of any alcohol, binge alcohol (5 or more drinks on an occasion), illicit drugs, and cigarettes during two time periods: the "month or so before pregnancy," and "during this pregnancy." In all three studies the HSQ screened women for alcohol use by asking the same two questions: "Any alcohol (wine, beer, liquor)?" and "Five or more drinks at a time?" Questions asked in the national prevalence studies differed by asking pregnant women about any alcohol use and binge alcohol use in the previous 30 days.

The screening studies were conducted in King (Studies 1, 2, and 3) and Pierce Counties (Study 3), which are the most populous counties in Western Washington and in the state. According to U.S. Census figures, in 1990 the population of King County was 31% of the entire state population; in 2000 the combined King and Pierce County population was 41.4% of the state.

Study #1: Prenatal Cocaine Exposure: Maternal Assessment and Effects on Children,[10] March 1989 through April 1991 (N = 7,178)

In this study we used the HSQ to screen 7,178 women at four King County area hospitals, including a university-affiliated teaching hospital (Hospital A), a private urban hospital (Hospital B), a private urban hospital serving high-risk patients (Hospital C), and a suburban

hospital (Hospital D). Of the 12,867 total deliveries at these hospitals during the study period, we have data from 7,178 HSQs (56% of the total deliveries). HSQs were not collected from 44% of women delivering for the following reasons (specific percentages not available): not approached due to our weekday screening schedule, refusal, unavailable due to medical reasons or early discharge, and non-English speaking.

Study #2: Home Visitation Intervention for High-Risk Substance-Abusing Mothers,[11] July 1991 through December 1992 (N = 2,230)

We screened women using the HSQ at Hospitals A and C. Of the 4,342 total deliveries at the two hospitals during the study period, we have HSQ data on 2,230 (51%); 44 (1.0%) refused; 231 (5.3%) were unavailable for medical reasons or early discharge; and 323 (7.4%) were non-English speaking. A total of 1,514 women (34.9%) were not approached due to our limited screening schedule (4.5 days per week).

Study #3: Alcohol Abuse During Pregnancy: Twelve-Month Intervention,[12] June 2002 through March 2004 (N = 3,118)

In Study #3 we screened postpartum women at Hospital A and at a large general delivery hospital in Pierce County, Western Washington. Of 5,694 total combined deliveries at the two hospitals during the study period, we have HSQ data on 3,124 (54.9%), 638 (11.2%) refused; 672 (11.8%) were non-English speaking; 536 (9.4%) were not approached primarily due to our weekday screening schedule; 194 (3.4%) were not approached for medical reasons; 336 (5.9%) did not return HSQ for unknown reasons; and 188 (3.3%) lived out of area and were not eligible to participate in the larger study. Data from 6 women were not used in the analysis because alcohol information was incomplete.

Protocols for the three studies were approved by Institutional Review Boards at the University of Washington and participating hospitals. Confidentiality certificates were obtained from the U.S. Department of Health and Human Services.

Data Analysis—Descriptive statistics (means and standard deviations, or percentages depending on the form of the variables) were calculated on demographic characteristics for each of the three studies. Percentages are reported for any alcohol and binge alcohol drinking for two time periods: in the month prior to pregnancy and during pregnancy. We used multiple logistic regression to examine factors associated with drinking rates and changes in drinking rates across the three studies. Analyses were carried out separately by racial group. We also carried out logistic regressions to examine more closely the factors associated with any drinking and binge drinking in the month prior to pregnancy among participants in Study 3 (the most recent study). The multiple logistic regressions reported here, and the associated odds ratios (OR) and 95% confidence intervals, assume independent (additive) effects of each of the covariate factors (age, race, education, marital status, parity, and smoking) on the logit (log odds) of the probability of drinking.

We assessed the adequacy of the assumptions for this model by testing the inclusion of pairwise interaction terms, by comparing models in terms of the Akaike information criterion, and by running “quasibinomial” models permitting the dispersion parameter to deviate from the value 1 assumed by a binomial model.[13] All analyses were done using S-PLUS v.6.1 for Windows.

RESULTS

Demographic Characteristics (Table 1)

Most of the women in the three studies were between 21 and 30 years of age; Study 3 participants were slightly older and had completed about one more year of education (13.8

years) compared to women in Studies 1 and 2. Racial composition was similar among women in all three studies: White (60% to 70%), Black (11% to 18%), Asian (8% to 10%), Native American and Hispanic (each at about 3% to 5%). Women in Studies 1 and 3 were more likely to be married (about 60%) than those in Study 2 (50%). In all studies, the average number of children was nearly two, and for nearly half the women this was their first child. Most study participants were nonsmokers, with a higher proportion in Study 3 (72%).

Time Trends (Table 2)

Any alcohol drinking in the month prior to pregnancy—Over the 15-year span of the three studies, among White women we observed little change in self-report of alcohol use in the month prior to pregnancy (Study 1: 49%, Study 2: 48%, Study 3: 47%). We observed a decrease in rates among Native American women (57%, 49%, 43%, not statistically significant) and a significant increase in rates among Asian women (14%, 17%, 26%; $p = 0.003$, in a logistic regression including effects of education, smoking, and parity). Black women also showed a nominally significant increase in drinking, although mainly among married women. The increase among Hispanic women was nonsignificant.

Binge alcohol drinking in the month prior to pregnancy—Women under 25 years of age had higher rates of binge drinking than older women. Unmarried women had higher rates of binge drinking (16%, 15%, 22%) compared to married women (5%, 6%, 9%). Separate logistic regression analyses by race showed statistically significant increases in rates of binge drinking for all but the Native American women. Native Americans reported the highest rates, but these did not change significantly over time (28%, 32%, 26%). The small overall increase in rates for Whites was due mainly to a significant increase among the 21 to 25-year olds (12%, 13%, 23%, $p = .005$ for interaction of time with age group). Because of smaller sample sizes for Asian and Hispanic women, significance of the increase over time was based on an analysis combining studies #1 and #2 for a 2-level study (time) factor rather than the 3-level study factor used in the analyses for Whites and Blacks. In these analyses, age, education, marital status, smoking and parity were adjusted for and considered as possible interaction effects with time as appropriate (significant).

Any alcohol drinking during pregnancy—We observed a substantial decrease in self-report of any alcohol use during pregnancy (Study 1: 30%; Study 2: 23%; Study 3: 12%) among almost all categories of age, race, education, marital, parity, and smoking status. The decrease was significant for all racial categories except for Asians (who had the lowest drinking rates; details available upon request).

Binge alcohol drinking during pregnancy—Overall, these rates decreased across studies (3%; 4%; 1%). Among specific demographic categories, only Native Americans showed a substantial and significant decrease (16%, 17%, 3%, $p < .005$ in logistic regression analysis adjusting for marital status, smoking and parity).

Smoking effect—Compared to nonsmokers, smokers had higher rates of any alcohol and binge alcohol drinking, both in the month prior to and during pregnancy (Table 2). Over the span of the studies, women smokers age 25 years and under had the highest rates of binge drinking prior to pregnancy, compared to other age groups. However binge drinking during pregnancy in this age group dropped substantially. Among nonsmokers, any alcohol drinking (both prior to and during pregnancy) was highest among women over 31 years. Nonsmoker low binge drinking rates varied little by age. (Age breakdown not shown on table.)

Illicit drug use—In all three studies women were more likely to report any alcohol use than to report illicit drug use, both in the month prior to and during pregnancy. With regard to binge

alcohol use in the month prior to pregnancy, Study 1 and 2 report of binge alcohol use was lower than report of marijuana use (9% and 10% vs. 14% and 14%). During pregnancy, in all three studies women were more likely to report marijuana use (10%; 10%; 6%) than binge alcohol use (3%; 4%; 1%) and Study 1 and 2 women were more likely to report cocaine use (6% and 6%) than binge alcohol use. (Illicit drug use not shown on tables.)

Factors Associated with Drinking Prior to Pregnancy

Analysis of maternal characteristics associated with drinking in the month prior to pregnancy is restricted to Study 3 (2002–2004) in order to identify factors most current and relevant. We focused on report of drinking in the month before pregnancy given the importance of this time when women may actually be drinking prior to pregnancy recognition.

Any alcohol—Women who were more likely to drink any alcohol in the month prior to pregnancy were age 31 to 35 years (*OR* = 1.5, CI 1.2, 1.9), had at least 16 years of education (*OR* = 2.0, CI 1.6, 2.5); and smoked (*OR* = 4.3, CI 3.5, 5.4). Those less likely to drink any alcohol in the month prior to pregnancy were under 21 years of age (*OR* = 0.57, CI 0.41, 0.79), had less than 12 years of education (*OR* = 0.70, CI 0.53, 0.93), were Asian (*OR* = 0.41, CI 0.30, 0.55), and were multiparous (Table 3).

Binge alcohol drinking—Factors significantly associated with maternal binge drinking in the month prior to pregnancy were age 21 to 25 years (*OR* = 1.6, CI 1.2, 2.3); Native American (*OR* = 1.9, CI 1.2, 3.1) or Black race (*OR* = 1.5, CI 1.1, 2.2); unmarried status (*OR* = 1.4, CI 1.1, 1.9), and being a smoker. The odds of binge drinking in the month before pregnancy were 6 times higher for smokers compared to nonsmokers (*OR* = 6.4, CI 4.9, 8.3). Women less likely to binge drink were age 36 years and above (*OR* = 0.50, CI 0.29, 0.85), and multiparous.

We found no effect when we adjusted for hospital in the regression analyses.

COMMENT

Over the study years, while Western Washington rates of any alcohol use prior to pregnancy have remained stable (slightly over 40%), any alcohol use during pregnancy has decreased from 30% (1989–1991) to 12% in 2002–2004. National rates have similarly decreased (to 10.2% in 2002).[8] (National rates are likely lower because the BRFSS studies asked pregnant women only about alcohol use in the previous 30 days, while our study questions asked about use throughout the pregnancy.) These findings suggest that public health messages about the potential risks to the fetus of maternal drinking during pregnancy have been effective. Most women who drink alcohol quit when they recognize they are pregnant. Astley's report (2004) on the prevalence of one form of FASD, fetal alcohol syndrome (FAS), among 264 foster children born in King County between 1993 and 1998, indicates a drop in FAS concomitant to our finding of reduced alcohol use during pregnancy. Five offspring were diagnosed with FAS, representing a significant decline in FAS prevalence across each birth cohort from 1993 to 1998 (1993: 6.67%; 1994: 4.76%; 1995: 0.00%; 1996: 0.00%; 1997: 2.17%; 1998: 0.00% ($p = 0.03$).[14]

Another major study finding is the statistically significant increase in the 'month or so before pregnancy' binge drinking rates in our region: 14% in 2002–2004, a somewhat higher rate than national binge drinking rates in the preceding month among non-pregnant women (12% in 2002).[8] These high 'month or so before pregnancy' drinking rates may actually estimate alcohol use during early gestation before pregnancy recognition.[15] Women who are heavy drinkers and who are not pregnant may have unexpected, unwanted, and unprotected sexual encounters that result in unintended pregnancy. Women who are not planning a pregnancy or who do not know they've conceived, have no pregnancy-related reason to limit their alcohol intake.

Our study is subject to several limitations. This regional study was not designed to be a prevalence study; results are not generalizable to the larger population. However, region-specific studies are important to alert practitioners to the extent of the problem in their communities, and to identify categories of women most likely to be problem drinkers in order to plan more efficiently for local allocation of scarce intervention resources.[16,17] Data were obtained via self-report, and some women may have underreported alcohol use in spite of measures to protect confidentiality. Researchers had no knowledge of the subjects' pregnancy outcomes and therefore cannot determine whether patients who had normal pregnancies and delivered healthy babies were less likely to report alcohol use than those with preterm, IUGR or abnormal infants. We obtained HSQs from 54.7% of all women delivering at the hospitals during the study time frame. The primary reason HSQs were not obtained is that the researchers did not work on weekends. If Study 3, which produced the main finding, was more likely to include 'any alcohol during pregnancy' drinkers who were nonresponders (perhaps because public health caveats about pregnancy drinking had become increasingly common by this time), then our finding of a significant decrease in 'any drinking' during pregnancy would be exaggerated. Results, even by demographic characteristics, could be due to changes in the hospital sampling frame over time rather than true changes in drinking trends. However, we found no substantive differences in drinking rates when we compared frequencies from all study hospitals combined versus Hospital A outcomes, the hospital for which we have data across all three studies (Total sample for Hospital A = 6,000: Study 1 = 3,472; Study 2 = 1,516; Study 3 = 1,012).

We observed a pre-pregnancy binge drinking increase among all racial categories except Native American (whose rates did not increase, but were substantially higher than rates among other groups). In the most recent study years (2002–2004), characteristics that predicted pre-pregnancy binge drinking were age 21 to 25 years, unmarried, or smokers. These are the same characteristics reported by Caetano's research group and Ebrahim and colleagues, who studied risky drinking patterns among pregnant women. Other factors they found to be associated with heavy pregnancy drinking (but that we did not assess) were annual income higher than $40,000 [18] and being employed.[19]

What are the implications of these data for FASD prevention? Regardless of demographic characteristics, physicians should routinely screen every woman of childbearing age about her alcohol use and her risk for becoming pregnant. If warranted, brief alcohol screening instruments are available to help health care providers identify problem drinkers (e.g., the CAGE, TWEAK, Audit, and T-ACE instruments).[20–23] New codes established by the American Medical Association now allow physicians to screen patients for alcohol problems, deliver behavioral interventions, and report these activities to health insurance programs.

Noting that approximately half of all pregnancies in the U.S. and in Washington State are unintended,[24,25] we recommend that women who are not pregnant should be questioned about their use of contraception, and educated about the potential risks of frequent or binge drinking at conception and throughout pregnancy. Screening for binge alcohol use in the non-pregnant population may also identify women who are under-using contraception and who may benefit from more aggressive counseling regarding risks for pregnancy and methods which do not require daily use. They may also benefit from having Plan B (emergency contraceptive backup method) supplies available. Women who are pregnant and who drink should be advised to stop drinking because research has not identified a universally safe level of pregnancy alcohol use.

Physicians are in an ideal position to convey a critical message: although a woman may not know that she is pregnant, heavy drinking very early in pregnancy (during the period of organogenesis) can cause injury to the particular fetal cells, organs, and limbs that are developing at the time of her alcohol use.[26] For example, in the human embryo, the cranial

neural crest cells are particularly vulnerable to alcohol-induced injury. These cells are predetermined to develop into specific body structures and tissue types, therefore early embryonic exposure to alcohol can have teratogenic effects on their later development.[27] Fetuses are susceptible to alcohol damage throughout pregnancy, and effects vary depending on timing, amount, and pattern of exposure, as well as maternal, fetal, and genetic characteristics.[28]

Our finding of an increase in pre-pregnancy binge drinking serves as a reminder that every new generation of women of childbearing age should be screened for drinking, and educated about the potential risks to the fetus of alcohol use during pregnancy.

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Table 1

Demographic Characteristics of Women in the Three Studies

	Study #1 1989 to 1991 (N = 7,178) N (%)	Study #2 1991 to 1992 (N = 2,230) N (%)	Study #3 2002 to 2004 (N = 3,118) N (%)
Age (yrs) (mean, sd)	(26.3, 5.8)	(26.2, 6.4)	(27.9, 6.2)
< 21	1317 (18)	512 (23)	446 (14)
21–25	1982 (28)	574 (26)	714 (23)
26–30	2170 (30)	513 (23)	821 (26)
31–35	1235 (17)	431 (19)	751 (24)
36 +	462 (6)	192 (9)	374 (12)
Missing	12 (0)	8 (0)	12 (0)
Race			
Native Am	185 (3)	101 (5)	132 (4)
Asian	575 (8)	223 (10)	294 (9)
Black	891 (12)	409 (18)	358 (11)
Hispanic	241 (3)	112 (5)	171 (5)
White	5126 (71)	1306 (59)	1994 (64)
Other	154 (2)	71 (3)	59 (2)
Missing	6 (0)	8 (0)	110 (4)
Education (yrs) (mean, sd)	(12.7, 2.3)	(12.8, 2.5)	(13.8, 2.7)
< 12	1595 (22)	510 (23)	428 (14)
12–15	4384 (62)	1301 (59)	1719 (56)
16 +	1145 (16)	394 (18)	935 (30)
Missing	54 (1)	25 (1)	36 (1)
Marital			
Unmarried	2868 (40)	1125 (50)	1152 (37)
Married	4293 (60)	1097 (49)	1948 (62)
Missing	17 (0)	8 (0)	18 (1)
Parity (mean, sd)	(1.9, 1.2)	(1.9, 1.2)	(2.0, 1.2)
1	3244 (46)	1042 (47)	1357 (44)
2	2122 (30)	641 (29)	973 (32)
3	1081 (15)	305 (14)	436 (14)
4 +	634 (9)	223 (10)	298 (10)
Missing	97 (1)	19 (1)	54(2)
Smoking			
Nonsmoker	4435 (62)	1392 (62)	2258 (72)
Smoker	2564 (36)	767 (34)	777 (25)
Missing	179 (2)	71 (3)	83 (3)

Table 2

Any Alcohol and Binge Alcohol Drinking for Two Time Periods: Month or so Prior to Pregnancy and During Pregnancy, for Study 1 (1989–1991), Study 2 (1991–1992) and Study 3 (2002–2004)

	Any Alcohol Prior (%)			Binge Alcohol Prior (%)			Any Alcohol During (%)			Binge Alcohol During (%)		
	Study 1	Study 2	Study 3	Study 1	Study 2	Study 3	Study 1	Study 2	Study 3	Study 1	Study 2	Study 3
Age (yrs)												
< 21	40	38	33	13	11	18	24	19	9	4	4	3
21–25	47	39	47	12	13	23	30	21	10	4	4	2
26–30	47	40	38	9	9	12	33	25	11	3	4	1
31–35	45	46	49	5	8	9	32	28	16	3	4	1
36 +	41	44	46	4	9	6	27	32	16	3	4	0
Race												
Native Am	57	49	43	28	32	26	38	37	15	16	17	3
Asian	14	17	26	2	3	8	9	8	7	1	1	2
Black	39	37	42	8	7	18	28	22	7	4	4	2
Hispanic	29	25	34	6	14	14	22	17	9	3	4	2
White	49	48	47	10	11	13	33	27	15	3	3	1
Other	44	34	31	17	10	12	30	15	5	10	6	0
Education(yrs)												
< 12	43	35	36	15	13	19	31	21	11	6	6	4
12–15	45	40	40	9	11	16	30	23	10	3	4	1
16 +	47	52	53	4	5	8	30	28	18	1	1	1
Marital												
Unmarried	48	42	43	16	15	22	34	26	12	6	7	3
Married	42	40	43	5	6	9	28	21	13	2	1	1
Parity												
1	48	43	50	12	10	18	29	20	15	3	3	2
2	43	41	42	6	8	11	30	24	11	3	3	1
3	42	36	34	8	11	10	32	25	10	5	5	1
4+	38	39	32	10	16	11	31	36	9	5	12	1
Smoking												
Nonsmoker	35	33	37	3	4	7	23	17	11	1	1	1

	Any Alcohol Prior (%)			Binge Alcohol Prior (%)			Any Alcohol During (%)			Binge Alcohol During (%)		
	Study 1	**Study 2**	**Study 3**	**Study 1**	**Study 2**	**Study 3**	**Study 1**	**Study 2**	**Study 3**	**Study 1**	**Study 2**	**Study 3**
Smoker	60	56	60	20	22	33	41	34	17	7	9	3
Total	3180	911	1331	671	229	423	2125	524	372	248	88	44
%	44	41	43	9	10	14	30	23	12	3	4	1

Table 3

Study 3 (2002–2004) odds ratios (OR) and 95% Confidence Intervals (CI) from logistic regression predicting any drinking and binge drinking in the month prior to pregnancy [1]

	Any Drinking in Month Prior to Pregnancy		Binge Drinking in Month Prior to Pregnancy	
Factor	**N (%)**	**OR (95% CI)**	**N (%)**	**OR (95% CI)**
Age (yrs)	(p < .001)		(p < .001)	
< 21	407 (34)	0.57 (.41, .79)	408 (18)	0.71 (.46, 1.09)
21–25	652 (47)	1.30 (1.02, 1.65)	648 (24)	1.63 (1.18, 2.26)
26–30	754 (39)	1.00 reference	740 (12)	1.00 reference
31–35	688 (49)	1.53 (1.22, 1.92)	680 (9)	0.82 (.57, 1.19)
36 +	348 (46)	1.31 (.99, 1.73)	343 (6)	0.50 (.29, .85)
Race	(p < .001)		(p = .021)	
Native Am	119 (43)	1.01 (.67, 1.52)	119 (27)	1.89 (1.16, 3.08)
Asian	276 (26)	0.41 (.30, .55)	273 (9)	0.73 (.46, 1.17)
Black	329 (43)	1.27 (.97, 1.66)	326 (19)	1.52 (1.07, 2.17)
Hispanic	161 (34)	0.75 (.52, 1.08)	161 (14)	1.10 (.66, 1.82)
Other	56 (32)	0.56 (.30, 1.01)	54 (13)	1.07 (.45, 2.56)
White	1908 (47)	1.00 reference	1886 (14)	1.00 reference
Educ (yrs)	(p < .001)		(p = .125)	
< 12	378 (37)	0.70 (.53, .93)	378 (20)	0.73 (.53, 1.03)
12–15	1576 (40)	1.00 reference	1560 (16)	1.00 reference
16 +	895 (52)	2.00 (1.61, 2.49)	881 (8)	1.18 (.82, 1.71)
Marital	(p = .378)		(p = .013)	
Unmarried	1031 (44)	1.10 (.89, 1.36)	1024 (22)	1.43 (1.08, 1.89)
Married	1818 (43)	1.00 reference	1795 (10)	1.00 reference
Parity	(p < .001)		(p < .001)	
1	1268 (50)	1.00 reference	1255 (18)	1.00 reference
2	907 (42)	0.67 (.55, .81)	897 (11)	0.51 (.39, .68)
3	403 (35)	0.48 (.37, .62)	399 (10)	0.39 (.26, .58)
4 +	271 (31)	0.33 (.24, .46)	268 (12)	0.41 (.26, .65)
Smoking	(p < .001)		(p < .001)	
Nonsmoker	2119 (37)	1.00 reference	2093 (7)	1.00 reference
Smoker	730 (61)	4.34 (3.51, 5.35)	726 (34)	6.38 (4.90, 8.30)

[1] In the analysis of any alcohol drinking in the month prior to pregnancy, the model with both age and education, and age and smoking interaction effects was nominally significant (p = .05) compared with the additive model. In the analyses of binge alcohol drinking in the month prior to pregnancy, the interaction effects were not statistically significant. Analyses with a "quasibinomial" model left results virtually unchanged. For simplicity we therefore report only the additive model.