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Correlates of Prenatal Alcohol Use

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Abstract *Objectives*: To identify correlates of prenatal alcohol use in a statewide population-based sample. *Methods*: A self-reported survey was conducted in 67 prenatal clinics in Minnesota with 4,272 women at their first prenatal visit. Chi-squared and multivariate logistic regression analyses were conducted to identify risk markers associated with any prenatal alcohol use. *Results*: Nearly 27% of the respondents were calculated as having used alcohol during pregnancy. In multivariable analyses, the following were risk markers for prenatal alcohol use: older age, being unmarried, lower gravidity, greater depressed mood, currently smoking, exposure to intrapersonal violence, a history of not remembering things because of alcohol use, and feelings that the respondent should reduce her drinking. Subsequent analyses revealed that the association of intrapersonal violence with prenatal drinking was mediated by whether the woman reported that she did not remember things while drinking or that the woman felt she should reduce her drinking. *Conclusions*: The demographic and behavioral correlates reported here are consistent with previous research. The significance of two alcohol behavioral factors (i.e., not remembering things and feeling that she should reduce her drinking) suggest that the women who drank during pregnancy would likely have substance abuse issues.

Keywords Prenatal alcohol use · Pregnancy · Substance use

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Introduction

Prenatal alcohol use is one of the major known causes of birth defects and developmental disorders in the United States. Fetal alcohol exposure can result in a variety of neuropsychological, behavioral, and physical disorders commonly referred to as Fetal Alcohol Spectrum Disorders (FASD). Depending on case ascertainment methods, the prevalence of FASD is estimated to be as high as 1% of all livebirths [1]. Because no safe amount of alcohol use during pregnancy has been established, abstinence is recommended during pregnancy [2]. A Healthy People 2010 goal is to increase prenatal alcohol abstinence to 94% and decrease prenatal binge drinking to 0% [3]. Recent self-reported data from the Behavioral Risk Factor Surveillance System (BRFSS) and the National Household Survey on Drug

Abuse, as well as data from smaller studies, consistently show that 13–15% of pregnant women have used alcohol at some time during pregnancy [4–6]. BRFSS data also showed that 3% of pregnant women reported binge drinking [4].

To meet primary prevention goals, it is necessary to understand the characteristics of women who drink alcohol during pregnancy and their reasons for drinking. Prenatal alcohol use occurs for various reasons, including lack of knowledge about pregnancy. It is estimated that 49% of pregnancies—and 31% of births—in the U.S. are unintended [7], thus many women may use alcohol without knowing they are pregnant. Data from the 1988 National Maternal and Infant Health Survey showed that 45% of the women surveyed reported drinking alcohol during the three months prior to learning they were pregnant. Sixty percent of these women did not know about their pregnancy until the fourth week of gestation [8]. Data from the 1996–1998 National Household Survey on Drug Abuse showed that 30% of women reported alcohol use in the first trimester, with a reduction in use reported for the entire pregnancy period. Frequent or binge alcohol use may even increase the risk for unintended pregnancy [9, 10].

Demographic factors, psychosocial well-being, and previous drinking patterns are associated with prenatal alcohol use [1]. Prenatal alcohol use appears to be highest among women who are older than 30 years [1, 4, 6, 11–13], have less than a high school education [4, 13, 14], or are not married [4, 8, 13] White race and unemployment have each been inconsistently associated with prenatal alcohol use [1, 4, 6, 12, 13] For example, a white and non-white comparison of women who reported prenatal substance use between 1995 and 1999 resulted in no significant differences [4]. A comparison of women by prenatal drinking status using 1988 data revealed that white, non-Hispanic women were at greater risk of prenatal alcohol use than their counterparts [8]. Prenatal alcohol use has been consistently associated with other substance use, especially tobacco [5, 6, 10–12, 15, 16].

Factors of psychosocial well-being have also been related to prenatal alcohol use. Higher levels of depression have been associated with greater alcohol use, [6, 17] which may reflect self-medication. Depression has also been correlated to earlier age of pregnancy [18]. Pregnant teens have reported a delay in pregnancy recognition compared to older women, which may increase the likelihood of prenatal alcohol use [19]. The association of alcohol use with physical and sexual abuse may also exist for pregnant women [12, 15, 20, 21]. Women who have experienced abuse may use alcohol to cope with their shame and suffering [22]. Finally, prenatal alcohol use may be associated with preconception behavior patterns that indicate problem drinking [1] Such factors include having a partner or other household members who use substances, experiencing blackouts related to alcohol use, and being asked by others to cut down on one's drinking [23].

Very few data exist that describe the relative contributions of various risk markers for prenatal alcohol use. The larger data sets that are available have been primarily collected nearly a decade ago and rarely include psychosocial factors. The smaller data sets typically have a richer set of variables available but do not have the sample size to support a multivariate analyses of the many risk factors related to prenatal alcohol use. The purpose of this study was to examine a population-based survey to determine the correlates of alcohol use among pregnant women in Minnesota. The survey data were part of a study coordinated by the Minnesota Organization on Fetal Alcohol Syndrome through the 4-State FAS Consortium funded by the Center for Substance Abuse Prevention. Specifically, bivariate and multivariate approaches have been used to examine the factors associated with prenatal alcohol use.

Methods

Design

A Statewide Sample of Prenatal Clinics was Used to Achieve a Representative Sample of Pregnant Women in Minnesota (Table 1)

A purposeful sampling strategy was used to collect the data. The state of Minnesota has a total of 87 counties. These counties have been aggregated into 12 regions by the Minnesota Department of Health. These regions are based on proximity of the counties and population density. In developing the sampling strategy, the 2000 Minnesota Birth Record data by county were aggregated to the regional level to determine estimates for a probability sample by region. The initial plan was to collect a 10% sample (n = 6,755) that proportionately reflected the distribution of births by region. Given challenges of clinic recruitment, limited clinics in some of the sparsely populated regions, and clinic difficulties in implementing the data collection protocol, the sample fell short of the desired goal and the distribution of the sample was not proportionate by region, as desired. Hence the desired probability sample emerged as a purposeful sample (n = 5,186).

Of the approximately 290 clinics who were invited to participate, 67 (23.1%) agreed to do so. The primary reasons for clinic non-participation included: (1) the clinic requested financial incentives that were not affordable to the study; (2) clinic staff chose not to participate because they believed prenatal alcohol use was not an issue in their community; and (3) reasons unknown, as clinic staff did not respond to written and phone requests for participation.

Table 1 Minnesota prenatal assessment study (2001–2003) compared with characteristics of women who gave birth in Minnesota, 2001

	Minnesota Births, 2001		MN prenatal assessment sample	
Characteristics	Number	Percent	Number	Percent
Number of 2001 births/Questionnaires	66,617	–	4,272	6.4
Maternal race[a]				
Native American	1,260	1.9	93	2.2
Asian/Pacific Islander	3,599	5.4	122	2.8
Black or African American	4,555	6.8	127	3.0
White	56,656	85.0	3,697	86.5
Unknown/Other	577	0.9	233	5.5
Hispanic or Latino[b]	4,482	6.7	173	4.0
Maternal age				
Under 15	69	0.1	2	0
15–17	1,529	2.3	102	2.1
18–19	3,527	5.3	216	5.1
20–24	13,822	20.7	993	23.2
25–29	18,711	28.1	1,292	30.2
30–34	18,694	28.1	1,102	25.8
35–39	8,445	12.7	480	11.2
40–44	1,680	2.5	83	1.9
45 and older	135	0.2	2	0
Unknown	5	0.0	0	0
Maternal education				
Less than high school (0–11)	7,043	10.6	387	9.1
High school diploma (12)	17,245	25.9	1,483	34.7
Some college (13–15)	17,472	26.2	874	20.5
College degree (16)	15,379	23.1	919	21.5
More than college (16+)	7,860	11.8	609	14.3
Not stated	1,618	2.4	0	0
Maternal marital status				
Married	49,418	74.2	3,058	71.6
Not married	17,182	25.8	1,214	28.4
Unknown	17	0.0	0	0

[a] Chi-squared revealed that distribution of race differs significantly ($P < .01$) between the state and the sample

[b] Hispanic ethnicity is reported separately from race. Persons of Hispanic origin may be from any racial group

As an incentive, the 67 participating clinic staff received training about fetal alcohol syndrome in the form of computer learning modules and informational brochures, as well as onsite training from staff of the Minnesota Organization on Fetal Alcohol Syndrome. Approval to conduct the study was granted by the University of Minnesota's Research Subjects' Protection Programs (Human Subjects Code Number 0110S08884). The number of participants by clinic ranged from 3 to 261.

Sample

Data were collected from November 2001 to June 2003. Designated clinic staff members were trained to collect data, which included asking the screening questions, administering the self report survey, incentive distribution, assuring confidentiality, and submitting the data. The clinic receptionist or nurse responsible for intake procedures approached potential survey respondents about the study. Eligible women were those who were having their first prenatal visit, self-identified as a Minnesota resident, and were willing to give written consent to participate in the study. The one-time self-administered survey required 5–10 min to complete and was filled out at the clinic. Surveys were available in both English and Spanish. Upon completion, the respondent gave the survey to the receptionist or nurse in a sealed addressed envelope that was sent immediately to the study coordinator. Each respondent received a five-dollar gift certificate for a local store as

compensation. A total of 5,186 women participated in the study, however only 4,272 (82.4%) provided complete data required for this analysis. Participating clinics did not track participant refusal rates.

Measures

The study survey was the Prenatal Questionnaire (PQN) that included measures related to prenatal alcohol use and its associated risk factors, as well as demographic information [24] The PQN's core questions were taken from the Self-Administered Questionnaire (SAQ) [23].

Prenatal Alcohol Use

This outcome measure was based on the number of months pregnant (calculated from date of last normal menstrual cycle and date of survey completion) and the woman's response to the question, "When was your last drink of alcohol?" The response options were: within the last week, within the last month, within the last year (the number of months ago), more than a year ago, and I have never drank. For analysis, the outcome was a dichotomous variable that identified women who reported they drank during pregnancy (i.e., pregnancy date was earlier than date of last drink) and those who reported they stopped drinking prior to pregnancy or never drank.

Binge drinking was also a dichotomous measure based on two questions, "During this pregnancy when you drink, how much do you usually drink?" and "When you drink more than your usual amount, how many drinks do you have?" If the number of drinks reported for either of these questions exceeded four, the respondent received a value of *1* for binge drinking. If both responses were less than a value of five, then the respondent received a *0* for this measure.

Demographic Variables

Race was based on self-report and was dichotomized as white or other (i.e., different race, more than one race, or not identified). Age was a categorical variable, based on self-reported age in years (<20 years, 20–29 years and 30 years or older). For the purpose of the logistic regression models, the 20–29 age group served as the referent group after the measure was dummy coded. Gravidity is a continuous variable represents the woman's self-reported number of pregnancies. Gestation at the first prenatal visit was estimated from the date of last menstruation and the date of the survey.

Education was a categorical variable based on self-reported number of school years completed and age of respondent (i.e., <19 years old and less than high school education, 19 and 20 years old with high school education or less; some college; and college graduate or more). In the dummy coding of this measure, the referent value was college graduate. Unemployed status was reflected in a dichotomous variable that identified women who were currently employed or full-time housewives and not looking for employment and those who self-identified as currently unemployed. A dichotomous variable for marital status identified respondents who were married, cohabitating, or separated and those who were not married (i.e., divorced, never married, single, or widowed).

Depressed Mood

This status was identified from the following item: "In the last month, have you felt so sad, discouraged, hopeless, or had so many problems that you have wondered if everything was worthwhile?" This continuous variable had numerical response options that ranged from one to six (*1* = not at all; *2* = a little bit; *3* = some—enough to bother me; *4* = quite a bit; *5* = very much so; and *6* = extremely so—to the point that I have just about given up).

Prenatal Smoking

Current smoking status was assessed from a single question: "Do you smoke?" The response options were *yes* and *no*.

Violence Exposure

Several dichotomous measures reflecting recent exposure to physical violence and lifetime exposure to sexual violence were asked. These were: (1) "Has anyone physically abused (hit, kicked, slapped, etc.) you during the last year?"; (2) "Has anyone physically abused (hit, kicked, slapped, etc.) you during this pregnancy?"; and (3) "Have you ever had sex without giving your consent?" In addition to examining these questions separately in analyses, a violence exposure summary score was created, with values ranging from *0* (no exposure) to *3* (all three exposures). Both the individual items and the summary score were used in the analyses.

Alcohol risk total was based on the women's responses to the following five yes/no questions about her drinking patterns and history: (1) "Do you ever feel that you have an alcohol problem?"; (2) "Do you ever feel that you should

cut down on your drinking?"; (3) "Has a friend or family member ever told you about things you said or did while you were drinking that you could not remember?"; (4) "Has a friend or family member ever asked you to drink less?"; and (5) "Do you feel you could use treatment at the present time?" The alcohol risk total is the sum of these measures, with a range from *0* (no problems) to *5* (all problems reported). As with violence exposure, the analyses considered both the individual measures and the summary score.

Analysis

Chi-squared and t-test analyses were conducted to compare the study sample with women who were excluded due to missing data, and to compare the prenatal alcohol users with abstainers. Statistical significance was defined as $P < .05$ in two-tailed tests. Hierarchical logistic regression analyses were conducted to identify risk markers of prenatal alcohol use. Five models were examined. Model I included only the demographic variables. Models II, III, IV, and V included the demographic variables and either (1) variables reflecting psychological well-being, the alcohol risk total, the violence exposure summary total, and prenatal smoking (Model II); (2) the five questions about alcohol use patterns (Model III); (3) the three questions about physical and sexual abuse (Model IV); and (4) all the variables except the total scores for alcohol and violence exposure (Model V). Odds ratios and 95% confidence intervals were derived from these models. The birth certificate analyses (Table 1) were conducted per request by the Minnesota Department of Health.

Results

Sample Characteristics

Comparison of Women Included and Excluded From Analysis

In chi-squared and t-test analyses, the respondents with complete data (n = 4,272) differed from those with incomplete data (n = 914; data not shown). Compared with respondents who were excluded from analyses because of incomplete data, the analytic sample was more likely to report they used alcohol during pregnancy (26.6% vs. 10.1%, $P < .001$), were white (86.5% vs. 67.6%; $P < .001$), and were married (81.7% vs. 73.5%; $P < .001$). The analytic sample was less likely than those with incomplete data to report they were unemployed (8.0% vs. 13.1%; $P < .001$), had experienced physical abuse in the past year (3.5% vs. 5.2%; $P < .05$), and had experienced physical abuse during the study pregnancy (1.1% vs. 2.0%; $P < .05$). The analytic sample also had experienced fewer pregnancies (2.6 vs. 2.8; $P < .01$), earlier prenatal care for the study pregnancy (11.6 weeks vs. 12.5 weeks; $P < .01$), were slightly older (27.8 years vs. 26.5 years; $P < .001$), had higher mean levels of education (14.0 years vs. 12.5 years; $P < .001$), lower mean levels of depressed mood (1.6 vs. 1.8; $P < .001$), and higher levels of alcohol risk total (0.25 vs. 0.20; $P < .05$). There were no differences between respondents with complete and incomplete data on smoking status, feeling they had an alcohol problem, being asked to cut down their drinking, not remembering things due to alcohol use, being asked to drink less, thinking they could use alcohol treatment now, physical abuse in the past year, having sex without consent, or mean score on the violence exposure scale.

Sample Characteristics

The respondents used in the analyses ranged in age from 14 to 48 years ($M = 27.8$ years; $SD = 5.7$). Eighty-six percent of the women were white. Nearly 3% of the sample did not report their racial identity. Over one-quarter of the respondents (26.6%) reported they drank alcohol during their pregnancy, with <1% reporting binge drinking during pregnancy. Just over 15% of the women reported they currently smoked cigarettes. Eight percent of the respondents reported they were unemployed and 82% reported that they were married or cohabitating. Eleven percent of the women reported being sexually abused at some time in their lives or recently physically abused. The mean number of years of education completed was 14.0 ($SD = 2.7$). The mean score on the depressed mood scale was 1.6 ($SD = 0.99$), reflecting, on average, no or "a little bit" of sadness or hopelessness.

Study Sample Compared with the Pregnant Women in Minnesota

Chi-squared analysis was used to compare the study sample characteristics to those of the 2001 Minnesota birth record data. There were no statistically significant differences in maternal race, age, education, or marital status (see Table 1).

Comparison of Prenatal Alcohol Users and Abstainers

In this comparison, significant differences for most variables emerged between prenatal alcohol users and

abstainers (Table 2). No significant differences between the two groups were found for unemployment, physical abuse during pregnancy, weeks of gestation, or education.

Five logistic regression models were examined to identify factors related to prenatal alcohol use (Table 3). In Model I, which included only demographic variables, pregnant teens had a 44% lower odds ratio associated with prenatal alcohol use than their older counterparts. Women 30 years and older had a 26% odds ratio related to prenatal alcohol use compared to 20–29 year-olds. Each previous pregnancy was related to a 10% decrease in the odds ratio related to prenatal drinking. Finally, women who were married, cohabitating, or separated were less likely to report alcohol use during pregnancy than their single counterparts.

Model II examined the variables in the first model and depressed mood, smoking, violence exposure and the alcohol risk total. Each increased level of depressed mood increased the odds ratio related to prenatal alcohol use by 12% ($P < .01$). Women who smoked were more likely to drink alcohol during pregnancy than women who did not smoke. Each alcohol-related risk reported by the woman increased the associated odds ratio related to alcohol use by 77%.

The individual items that comprise the alcohol risk total were added as unique factors with the demographic variables in Model III. Of the five alcohol risk factors, two were significant. Women who thought they should cut down on their drinking had almost twice the odds ratio associated with drinking compared to women who did not report this belief ($P < .001$). Women who had been told by a friend or family member about things they said or did while drinking that they could not remember had 243% greater odds ratio related to prenatal drinking than women who did not report this event ($P < .001$).

Model IV included the demographic variables and the individual violence exposure measures. If a woman reported physical abuse in the past year she had a 61% greater odds ratio related to alcohol use during pregnancy than her counterpart without such an experience. Having had sex without consent increased the odds ratio associated with prenatal alcohol use by 38%.

Model V included all of the variables from the previous models, except the violence and alcohol total risk scores. For the most part, factors that were significant in reduced models retained their statistical significance in this full model, except for ever having had sex without consent and reported physical abuse in the past year. This reduction in

Table 2 Prenatal drinkers compared to prenatal abstainers Minnesota prenatal assessment study, 2001–2003; n = 4272

Chi-squared analysis			
	Prenatal drinkers number (percent) 1137 (26.6)	Prenatal abstainers number (percent) 3135 (73.4)	Chi-squared
White	1005 (88.4)	2692 (85.9)	4.55*
Married	884 (77.7)	2608 (83.2)	16.55***
Unemployed	95 (8.4)	245 (7.8)	.33
Smoking now	232 (20.4)	436 (13.9)	26.7***
Alcohol problem	46 (4.0)	35 (1.1)	38.49***
Cut down drinking	136 (12.0)	117 (3.7)	101.42***
Can't remember	267 (23.5)	272 (8.7)	163.97***
Asked to drink less	89 (7.8)	75 (2.4)	66.77***
Could use treatment	9 (.8)	6 (.2)	8.59**
Physical abuse in past year	53 (4.7)	96 (3.1)	6.34*
Physical abuse during pregnancy	16 (1.4)	34 (1.1)	.75
Ever sex without consent	117 (10.3)	242 (7.7)	7.2**
T-test analysis			
	Prenatal drinkers mean (Std Dev)	Prenatal abstainers mean (Std Dev)	*t*-value
Gravidity	2.41 (1.58)	2.61 (1.59)	-3.5***
Weeks of gestation	11.49 (6.73)	11.58 (6.68)	-.39
Depressed mood	1.74 (1.10)	1.58 (.94)	4.70***
Education	14.1 (2.71)	13.9 (2.72)	1.61
Alcohol risk total	.48 (.91)	.16 (.55)	11.10***
Abuse total	.16 (.44)	.12 (.39)	3.04**
Age	28.09 (5.70)	27.67 (5.76)	2.11*

[a] $P < .10$; *$P < .05$; **$P < .01$; ***$P < .001$

Table 3 Model of general risk factors related to prenatal alcohol use, 2001–2003

Factor	Model I	Model II	Model III	Model IV	Model V
White (1) vs. Other (0)	1.25 (1.00, 1.55)[a]	1.27 (1.00, 1.59)*	1.25 (.99, 1.57)[a]	1.25 (1.00, 1.56)*	1.24 (.98, 1.56)[a]
Teens (1) vs. 20–29 year olds (0)	.56 (.41, .77)***	.52 (.38, .73)***	.56 (.41, .78)**	.55 (.40, .76)***	.53 (.38, .74)***
30 and older (1) vs. 20–29 year olds (0)	1.26 (1.08, 1.47)**	1.32 (1.12, 1.54)**	1.30 (1.10, 1.52)**	1.28 (1.09, 1.49)**	1.33 (1.13, 1.56)**
Gravidity	.90 (.86, .95)***	.89 (.84, .93)***	.91 (.86, .95)***	.90 (.85, .94)***	.89 (.85, .94)***
Weeks of gestation	1.00 (.99, 1.01)	1.00 (.99, 1.01)	1.00 (.99, 1.01)	1.00 (.99, 1.01)	1.00 (.99, 1.01)
Less than HS vs. College graduates	1.01 (.71, 1.43)	.84 (.58, 1.22)	1.02 (.71, 1.47)	1.00 (.70, 1.43)	.86 (.59, 1.24)
HS vs. College graduates	.91 (.76, 1.09)	.84 (.70, 1.02)[a]	.93 (.78, 1.12)	.90 (.75, 1.08)	.86 (.71, 1.03)
Some college vs. College graduates	.95 (.78, 1.15)	.90 (.74, 1.10)	.94 (.77, 1.15)	.95 (.78, 1.15)	.91 (.75, 1.11)
Married	.57 (.47, .69)***	.71 (.57, .87)**	.64 (.53, .79)***	.58 (.48, .71)***	.72 (.58, .88)**
Unemployed	1.12 (.86, 1.48)	.89 (.67, 1.19)	1.01 (.76, 1.33)	1.05 (.80, 1.39)	.91 (.68, 1.21)
Depressed mood		1.12 (1.04, 1.21)**			1.12 (1.04, 1.21)**
Smoking now		1.50 (1.22, 1.84)***			1.50 (1.22, 1.84)***
Violence exposure		1.02 (.85, 1.23)			
Alcohol risk total		1.77 (1.60, 1.96)***			
Feel you have an alcohol problem			1.05 (.59, 1.84)		1.00 (.57, 1.78)
Been asked to cut down drinking			1.98 (1.43, 2.75)***		1.93 (1.39, 2.68)***
Can't remember things said or done because of drinking			2.43 (1.75, 2.99)***		2.35 (1.91, 2.90)***
Asked to drink less			1.37 (.92, 2.03)		1.27 (.85, 1.89)
Could use treatment			2.15 (.69, 6.71)		1.78 (.56, 5.61)
Physical abuse in past year				1.53 (1.02, 2.29)*	1.13 (.73, 1.74)
Physical abuse during pregnancy				.90 (.45, 1.779)	.82 (.40, 1.72)
Ever sex without consent				1.36 (1.07, 1.73)*	1.05 (.81, 1.35)
Model Chi-squared	65.51***	182.530***	234.83***	77.90***	261.85***
Model R^2	.02	.06	.05	.02	.06
Nagelkerke R^2	.02	.08	.08	.03	.09

Logistic Regression. Standardized Logistic Regression Coefficients, and 95% Confidence Intervals for Exp(B) n = 4272

[a] $P < .10$; *$P < .05$; **$P < .01$; ***$P < .001$

significance was a preliminary indication that the two significant alcohol risk measures could mediate the relation between the abuse factors and prenatal alcohol use. Mediation is the process by which the effect of the independent variable on the dependent variable is affected by a mediator. In other words, the independent variable causes the mediator which in turn influences the dependent variable [25]. It was of interest to determine whether the effects of abuse on prenatal drinking were affected by the two alcohol risk factors. This effect was tested with a series of regression models as directed by Baron and Kenny [25]. Indeed, the associations of sex without consent and of physical abuse in the past year with drinking while pregnant, were mediated by (1) not remembering things the woman may have said or done while drinking and (2) the woman feeling that she should cut down on her drinking.

Discussion

The results of this study are consistent with other reports about the associations of several demographic and psychosocial risk markers to prenatal alcohol use. The findings also suggest that prenatal alcohol use, even early in pregnancy, may be associated with a history of problem drinking. Age appeared to have a positive linear relation to risk of prenatal alcohol use. Pregnant adolescents had a reduced risk of prenatal drinking compared to their 20–29 year old counterparts. Given that alcohol use for people younger than the age of 21 is illegal in Minnesota, adolescents may have more difficulty obtaining alcohol than their older counterparts, they may be less habitual users, or they may be more reluctant to report its use. Pregnant women who were 30 years or older had a greater risk of prenatal drinking than pregnant women, ages 20–29. This finding is consistent with previous research [26, 27].

Being married or cohabitating was associated with less risk of prenatal drinking, which is also consistent with previous research [7]. Because women who are unmarried are more likely to report an unintended pregnancy than married women [28], it is possible that the association we found could be related to lack of detection of pregnancy or pregnancy ambivalence. Tough, et al. [29] recently reported that alcohol use decreases after pregnancy recognition and that alcohol use prior to pregnancy recognition is higher among those not planning a pregnancy. Because we did not ask about the relationship of pregnancy awareness to alcohol use or about their pregnancy feelings, we could not examine whether the association of marital status was mediated by these variables.

Higher levels of depressed mood, smoking, and alcohol risk increased the risk of prenatal alcohol use, after adjustment for demographic factors. It is not clear what the temporal relationship was between depressed mood and alcohol use. We do not know if the women reporting a depressed mood had clinical diagnoses of depression or if they were being treated for depression. The measure of depressed mood is problematic given that it is limited to one item.

The co-occurrence of alcohol use and smoking has been previously reported [23, 30]. High comorbidity between the use of tobacco and alcohol is well established. Persons who are dependent on alcohol are three times more likely to be heavy smokers [31]. The influence of these addictions on behavior appear to remain challenging during pregnancy.

Also consistent with previous research findings [21], exposure to physical abuse in the past year and ever having sex without consent were both risk factors for prenatal alcohol use. However, after the alcohol risk measures were incorporated in the final model, the reports of abuse experiences were no longer significant. Subsequent analysis confirmed that the alcohol risk measures mediated the relation between abuse history and prenatal alcohol use, suggesting that the abuse history affected the likelihood of alcohol risk, which in turn enhanced the risk of prenatal drinking. Research indicates that alcohol use can serve as a coping mechanism in relation to abuse [22]. This mediation effect may indicate that violence exposure has an effect on prenatal alcohol use only if the survivor uses alcohol as a coping method or is self-medicating the effects of trauma associated with the violence.

Two of the alcohol risk measures on the PQN were strongly related to self-reported prenatal alcohol use: a statement that the respondent had done or said things she could not remember as a result of alcohol use and a statement that friends or family had asked the respondent to drink less. Both of these statements were strongly associated with prenatal alcohol use and suggest that women who report drinking during pregnancy, even in early pregnancy, may do so because of problem drinking behaviors. This would be consistent with the findings of Naimi, et al. that women who binge drink pre-conceptionally also drink prenatally. The findings suggest that addressing prenatal alcohol use may involve more than informing women of fetal risks.

Study Limitations

The sample was limited to clients of participating clinics and the analyses were further limited to data from respondents who had complete data for all measures (82.4% of the original sample). It is noted, however, that the sample was comparable in terms of race, age, education, and marital status to all women who gave birth in Minnesota during the time period. In general, compared

with the excluded cases, the study sample displayed a lower level of risk markers associated with prenatal alcohol use.

Despite the differences in risk markers, the proportion of women who drank during pregnancy was significantly higher for the study sample compared to those who were not included. The rate of prenatal alcohol use for the women included in this study was comparable to that of an earlier study [9]. Consistent with BRFSS data, there were no differences in reported prenatal alcohol use between whites and non-whites [4–6]. The population of Minnesota does not allow for more in-depth examination of prenatal drinking by race or ethnicity. This is unfortunate given the diverse communities represented in the non-white portion of the sample.

The measures available in the study are limited. One measure related to depressed mood is extremely limited. This measure should not be confused with depression, which is more accurately measured by standardized, multi-item instruments. The summary scales created in the areas of violence exposure and alcohol risk are also problematic. Although these two measures were used as continuous variables in the analysis, they are not true continuous measures. A woman who has experienced two risk factors is not necessarily experiencing a 200% greater risk of mental health or alcohol use issues. Factors such as individual differences or the time of occurrence or severity of the incident can not be explored given the data available.

There are limitations to the data collection that could affect the interpretation of the findings. First, to encourage completion of the survey and respect the women's time, the survey was relatively short, requiring 5–10 min to complete. This necessitated limiting questions and including questions with few categorical response options. Thus, potentially important questions, such as those concerned with feelings about the pregnancy, pregnancy timing, household income, history of other drug use, etc., were not asked.

Second, the questionnaire was administered at the prenatal care clinic. It is possible that some women may have been reluctant to truthfully respond to sensitive questions, including the report of prenatal alcohol use. The effects of such biased reporting could have influenced the results of the study in either direction. For example, three of the individual alcohol problem questions were not statistically significantly associated with prenatal alcohol. It is possible that they truly were not associated, but it is also possible that they were so underreported that the analysis of their association emerged as not statistically significant.

Finally, generalizability of the findings is limited. Although the number of participants in the study is great, a purposive sampling strategy was used. Given that the data are not based on probabilistic sampling, the results are not generalizable to the state of Minnesota. The participating clinics did not represent each county in Minnesota nor was the number of participants by clinic necessarily proportionate by the number of women served by the clinic. The refusal rate of women is not known, therefore, the ability of the data to represent women by clinic site is also not certain. Thus, although the findings contribute to our understanding of prenatal alcohol use, these findings should not be generalized to any greater population.

Conclusions

Given the range and strength of the significant indicators, we believe these analyses have the potential to help guide primary and secondary prevention efforts for women regarding prenatal alcohol use. This study helps pinpoint the most relevant risk factors for prenatal alcohol use and may guide the creation of an efficient, effective tool for measuring alcohol use risk factors in pregnant women. Since the screening time available in a prenatal visit is brief, a short survey works best. A streamlined, accurate survey would help women with substance abuse problems get the support and services they need to promote their personal health and the health of their fetuses.

Specifically the significant relation between the two alcohol risk factors and prenatal alcohol use seems to indicate that interventions with women who drink during pregnancy may be more effective if they are more therapeutic as opposed to educational. In other words, the risk of prenatal drinking is much higher for women who reported experiences that warn of potential alcoholism. Given the high rates of unintended pregnancy and binge drinking in the U.S., prenatal alcohol use is a significant and costly problem—socially, economically, and emotionally. Communities, medical providers, and public health and human development researchers can collaborate to develop programs that more effectively promote healthy mother and child outcomes. We are optimistic about these next steps.

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