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EPIDEMIOLOGY OF SUBSTANCE-EXPOSED PREGNANCIES AT ONE GREAT LAKES HOSPITAL THAT SERVES A LARGE NUMBER OF AMERICAN INDIANS

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Abstract

Objective—The purpose of this research was to determine the prevalence of substance-exposed pregnancies at a hospital in the Great Lakes region of the U.S.

Method—Data were collected via retrospective chart abstractions of patients who were seen for delivery at one Great Lakes region hospital during a 1-year period who were given at least one of the International Classification of Diseases codes related to substance use.

Results—A total of 342 medical records were included in the analysis, and, while much race/ethnicity data were missing, a large percentage of those in our analysis identified as American Indian. The prevalence of substance-exposed pregnancies at this hospital during a 1-year period was 34.5%. The majority (84.8%) were tobacco users, and many were found to have multiple substance exposures. Also, 48.5% were found to have a mental health diagnosis in addition to substance use.

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Conclusions—Data from this project can be used in prevention efforts, including preconception care for women at risk for substance use and mental health issues.

INTRODUCTION

Alcohol, tobacco, and illicit drugs (i.e., marijuana, cocaine, methamphetamines, and opiates) have the potential to cause extensive harm to a developing fetus when a woman uses these substances during pregnancy. Sithisarn, Granger, and Bada (2012) conclude that the use of these types of substances by pregnant women represents a "public health problem and social morbidity with consequences on both the users and their children" (p. 105). Demographic covariates, including socioeconomic status, parity, prenatal care, race, and nutrition, often affect the varying degrees of impact that these substances can have on the short- and long-term health of the infant (Minnes, Lang, & Singer, 2011). In addition, outcomes are impacted by the combination of drugs used during pregnancy. Many women who use substances are likely to be "polydrug users" (i.e., to use a combination of various substances; Sithisarn et al., 2012).

It is well known that alcohol consumption during pregnancy, especially binge drinking, has the potential to cause lifelong physical and cognitive effects (Floyd & Sidhu, 2004). Fetal alcohol spectrum disorder (FASD) is the continuum of outcomes in children prenatally exposed to alcohol and includes a diagnosis of fetal alcohol syndrome (FAS; Floyd, O'Connor, Sokol, Bertrand, & Cordero, 2005). Prenatal alcohol exposure may result in facial abnormalities, growth retardation, and delayed brain growth, including small head circumference (Centers for Disease Control and Prevention, 2004; Hoyme et al., 2005). In addition to physical features, prenatal exposure to alcohol is linked to conduct disorder, mental illness (i.e., depression, anxiety disorders) and psychosocial functioning (Disney, Iacono, McGue, Tully, & Legrand, 2008; Hellemans, Sliwowska, Verma, & Weinberg, 2009; Roebuck, Mattson, & Riley, 1999). Despite this knowledge, 5-9% of women report binge drinking during pregnancy and 10-30% of pregnant women consume moderate amounts of alcohol (Ethen et al., 2009; Floyd & Sidhu, 2004; Tsai & Floyd, 2004).

Smoking during pregnancy can impact pregnancy outcomes as well, increasing a woman's risk of ectopic pregnancy (Horne et al., 2014; Minnes et al., 2011). In addition, tobacco use during pregnancy has been linked to low birth weight, premature delivery, placental abruption, and intrauterine death, with some evidence linking smoking during pregnancy with Sudden Infant Death Syndrome (Horta, Victora, Menezes, Halpern, & Barros, 1997; Minnes et al., 2011; Spiegler et al., 2013; Warland & Mitchell, 2014). With these outcomes in mind and while the risks of tobacco smoking overall are clearly established, in 2007 an estimated 15.9% of pregnant women were current tobacco smokers (Substance Abuse and Mental Health Services Administration [SAMHSA] & Office of Applied Studies, 2013).

Finally, drug use during pregnancy has the potential to cause harm to the developing fetus, depending on the type and amount of substance used. Table 1 represents a few of the potential outcomes of illicit drug use during pregnancy on the infant (Minnes et al., 2011; Sithisarn et al., 2012). The average rate of use of these substances is approximately 5% in pregnant women, with a range from 0.4% (cocaine) to 3.8% (marijuana; Patrick et al., 2012;

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Sithisarn et al., 2012), although these statistics might be underestimated, as the data were self-reported. However, as physiological tests improve and become routinely used, estimates of substance use during pregnancy likely will increase.

As highlighted, there are ample national data on substance use during pregnancy. However, research focused on smaller pockets of high-risk women is harder to come by. For example, anecdotal information from staff at a hospital in the Great Lakes region of the U.S. indicated concern about frequent substance use during pregnancy. Staff felt that this was a substantial issue within the hospital, yet there were no clear epidemiological data that supported these claims, although descriptions of the community and geographic area point to possible substance use disparities when compared to national data. This hospital serves a small urban center of approximately 15,000 citizens, 26% of whom live below the poverty line. As outlined by SAMHSA (2015), neighborhood poverty is a community risk factor that contributes to substance use disorders. In addition, the area surrounding this small urban center is extremely rural in nature; national data show that alcohol use is higher in rural areas (Chan et al., 2015; Shaw et al., 2014), and, while drug use is generally lower in rural areas, methamphetamine use is on the rise in rural communities (Chen et al., 2014).

In addition to socioeconomic factors and geographic location, the community that the hospital (a non-tribal and non-Indian Health Services medical center) serves is surrounded by three AI reservation communities, and 12% of those living within the small urban community identify as AI. While AIs in general are more likely than non-Natives to abstain from alcohol and other substances, AIs who *do* drink and use illicit drugs tend to do so at heavier levels (SAMHSA, 2010; May & Gossage, 2001; Spicer et al., 2003). While substance use rates vary greatly among tribes, AIs are especially at risk for alcohol- and drug-related consequences when compared to the U.S. population in general (Beauvais, 1998). Within AI communities, alcohol and drug use disproportionately contributes to and is, in turn, influenced by mental health problems, early trauma and childhood abuse, cultural displacement, unemployment, and poverty (Rieckmann et al., 2012). Historical trauma significantly increases the odds of developing substance use disorders among AIs (Whitesell, Beals, Big Crow, Mitchell, & Novins, 2012), as does the trauma associated with domestic violence, loss, and racism (Rieckmann et al., 2012).

Because of the anecdotal information from hospital staff, in conjunction with the potential for substance use because of socioeconomic and geographic risk factors, this research was conducted to determine the prevalence of substance-exposed pregnancies at this hospital, including types of substances most commonly used during pregnancy and the prevalence of multiple substances. The goal also was to highlight pregnancy-related behaviors, such as prenatal health care utilization, among those using substances during pregnancy, and to evaluate the impact of substance-exposed pregnancies on birth outcomes.

METHODS

Institutional review board approval was gained from the hospital before data collection began. Individual participant consent was waived. Data were collected via retrospective chart abstractions of patients who were seen on the obstetrics floor at one hospital in the

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Great Lakes region during a 1-year period and who were given at least one of the International Classification of Diseases, version 9, (ICD-9) codes in Table 2 during their time on the obstetrics floor to deliver their baby. Besides a record of substance use, mental health disorders were included to more fully capture possible prenatal patients who use substances, as mental and substance use conditions often co-occur (SAMHSA, 2013). Codes related to mental health disorders were utilized to help identify those using substances only. Patients who *only* had a mental health disorder code were not included in the analysis. To avoid replications, staff used medical chart numbers to identify individual participants.

Once eligible medical records were identified, the medical charts were pulled and relevant data were abstracted by two trained chart abstractors and entered into a database. Provider/physician notes within the medical record were reviewed as part of this process. Quality assurance for the data entry was ensured by re-abstracting the first 100 charts to identify and resolve data entry errors. Key variables abstracted included the age and race/ethnicity of the mother, as well as any history of smoking, illicit drug use, alcohol use, and/or alcohol treatment at any time before, during, or after the index pregnancy. Other variables collected included prenatal care history, such as the number of total prenatal visits and when prenatal care started (by trimester of pregnancy); any mental health diagnoses; and infant outcomes —specifically, birth weight and estimated gestational age at birth. It is important to note that any data on the infant were abstracted from the mother's medical record, as a review of the infant's medical record was not conducted.

Data from the retrospective chart abstractions were analyzed using descriptive statistics and logistic regression before and after imputation of missing data. Prevalence was calculated as the number of deliveries with the ICD-9 codes in Table 2 (exclusive of those with only a code for a mental health condition) divided by the total number of deliveries at the hospital for the same time period. For continuous variables, means were calculated as appropriate. Categorical variables were described using frequencies and percentages.

There were some data missing from the dataset, which is typical in epidemiological studies, especially those including data on substance use (Burgette & Reiter, 2010). Because analysis with missing data may cause biased parameter estimates, several methods have been proposed to impute missing values. We used multivariate imputations by chained equations "mice" package in R (3.2.2) to impute the missing values (van Buuren & Groothuis-Oudshoorn, 2011). This approach performs the imputation algorithm a number of times, resulting in several data sets each with different imputed values. The imputation model includes the six substance use variables: smoking prior to pregnancy, smoking during the index pregnancy, alcohol use at any time, alcohol use during the index pregnancy, drug use at any time, and drug use during the current pregnancy, as well as six additional variables to provide further information: number of prenatal visits, trimester of first prenatal visit, race, marital status, education level, and employment status. The analysis of the data was repeated for each imputed data set and estimates were combined to account for the uncertainty surrounding the missing data. We used five imputation sets for this study.

The imputed complete datasets were used for logistic regression to identify effect of risk factors (smoking prior to pregnancy, smoking during the index pregnancy, alcohol use at any

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time, alcohol use during the index pregnancy, drug use at any time, drug use during the current pregnancy) on gestational age at birth. Gestational age was categorized into two groups: < 37 weeks (preterm) and ≥ 37 weeks (term and post term). Age at delivery also was included in all the models as a possible confounder. Analysis was performed using PROC LOGISTIC in SAS software, version 9.4.

RESULTS

Out of 991 total deliveries at the hospital in 2012, 402 were identified as having one of the ICD-9 codes in Table 2 and were thus abstracted for additional information. Of these, 7 were subsequently found to not have a code listed in Table 2 and 53 that were abstracted had a mental disorder code only (thus no substance exposure), leaving a final sample size of 342 for analysis. Therefore, the estimated rate of substance-exposed pregnancies (alcohol, tobacco, or other drugs) at this particular hospital during a 1-year time period was 34.5% based on the ICD-9 codes. See Table 3 for demographic features of this sample. While much data on race/ethnicity were missing (44.4% of the total sample), 148 (43.3%) of those included in the analysis were AI or Alaska Native. The average age of the sample was 25.4 years ($SD = 5.5$), with a range of 14 to 44 years. The majority ($n = 220$; 64.3%) had previous deliveries, indicating that this was not their first pregnancy.

Of the 342, the majority were tobacco users ($n = 290$; 84.8% of the sample), with 159 (54.8% out of the total tobacco users and 46.5% of the total sample) using tobacco *only*. Most women were found to have multiple substance exposures. Specifically, a total of 180 (52.6%) had two or more codes (i.e., were both using drugs/alcohol and smoking or were using multiple drugs). See Figure 1 for the numbers who were using specific substances, including a list of types of drugs used. As well, many chart abstractions revealed comorbidity of substance use and identified mental health issues such as depressive disorders, anxiety, bipolar disorder, or post-traumatic stress disorder. Specifically, 166 (48.5%) women in this sample were found to have a mental health diagnosis in addition to a code for substance use. Regarding prenatal health care, nearly all women (95.9%) had at least one prenatal care visit prior to delivery. However, only 61.4% had their first prenatal care visit in the first trimester (as recommended); 23.4% had their first visit in the second trimester, and 9.4% in the third trimester. A total of 9 (2.6%) had no prenatal care. Also, when analyzing health care provider notes, many indicated “insufficient prenatal care.”

As well, substance use impacted birth outcomes. Of the 331 charts for which birth outcome data were available, 27 (8.2%) were low birth weight (i.e., < 5 pounds, 8 ounces) and 42 (12.5%) were preterm (i.e., gestational age < 37 weeks). In addition, the preterm birth of the index pregnancy was associated with drug use during the current pregnancy after adjusting for maternal age, as highlighted in Table 4. Odds ratios for drug use at any time were similar, but only just reached statistical significance in the imputed data. Model estimates were consistent with or without multiple imputations for missing variables. Drug use during the current pregnancy also was significantly associated with preterm birth ($p < 0.05$) when controlling for maternal age, smoking, and alcohol consumption during pregnancy. Maternal age was significantly associated with preterm birth; as age increased preterm birth also increased (Table 4).

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DISCUSSION

As noted, a large percentage (more than 30%) of women delivering a baby at a hospital in the Great Lakes region of the U.S. were given ICD-9 codes related to some type of substance use during pregnancy. While these data are limited to a very small geographic location in the Great Lakes region of the U.S., the implications may be far reaching. A community this small (approximately 15,000 people) with high poverty rates, surrounded by rural, remote areas, and with a relatively large number of racial minorities could represent many similar locations that may have prenatal substance use problems but little data to highlight the need for prevention funding. National published data on substance use during pregnancy may not adequately reveal the full public health epidemic that is occurring in very high-risk communities, such as those in rural or impoverished areas.

Of additional note, many of the participants were identified as AI or Alaska Native. This finding was not necessarily surprising, as large numbers of AI communities surround this particular hospital, and many residents deliver their babies there. More on differences by race/ethnicity cannot be highlighted, however, because much relevant data were missing from the charts. The race/ethnicity item on the hospital's form is optional, and participants often are not asked by staff. Therefore, we do not know if the high rates of substance use during pregnancy truly come from the subpopulation of AIs that are seen within this hospital. Additional studies are needed within this community, especially in partnership with local tribal and Indian Health Service health facilities, to better understand the issue of substance use during pregnancy in AI women and to develop community-based prevention efforts.

In terms of specific behaviors, when compared to national data, the rates of smoking during pregnancy at this Great Lakes hospital were much higher. National prenatal smoking rates range from 12.3% to 15.9% (SAMHSA, 2013; Tong et al., 2013), while 290 (approximately 29.3% of annual deliveries) of women at this hospital were given a prenatal tobacco ICD-9 code. Alcohol rates in this sample were found to be lower than in other studies, with approximately 2% in this sample who drank at least some amount of alcohol during pregnancy (the amount of alcohol was not specified in medical records), compared to national rates of 5-9% of pregnant women with reported binge drinking and 10-30% with moderate consumption of alcohol (Ethen et al., 2009; Floyd & Sidhu, 2004; Tsai & Floyd, 2004). The reasons for only a small number of ICD-9 codes for prenatal alcohol consumption are unclear, although they may relate to a reluctance among providers to screen for prenatal alcohol exposure due to social stigma behind it (Davis, Thake, & Vilhena, 2010; Lange, Shield, Koren, Rehm, & Popova, 2014; Northcote & Livingston, 2011), or because other substance use might be easier to extrapolate (i.e., smoking) or might be of greater concern (i.e., drugs). Our results did not provide important data regarding prenatal alcohol exposure, such as drink size and low/moderate drinking versus binge drinking (Dawson, 2011; Witbrodt et al., 2007).

Of additional concern was that illicit drug use in this sample was high when compared to national rates, although many times the specific type of drug used was not indicated in the medical records. In this sample, 146 patients (14.7%) were found to be using some type of

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drug, compared to approximately 5% of women nationally who have reported substance use during pregnancy (Patrick et al., 2012; Sithisarn et al., 2012). In addition, some women were "polydrug users" (i.e., they used a combination of various substances during pregnancy). The use of multiple substances indicates that prevention and intervention efforts need to be multifaceted, addressing the full picture of substance use that is occurring. For example, some communities in the area feel there is a serious opioid problem among pregnant women, but the results from this study highlight that women's prenatal substance use is more complex and in need of multilevel intervention efforts (Drake, Mueser, Brunette, & McHugo, 2004).

Of additional importance are the variations in effect on preterm birth by *type* of substance used. For example, there was an elevated risk of preterm birth for women with an indication of drug use during the current pregnancy, and drug use continued to be a significant factor after controlling for smoking and alcohol consumption. There were no significant associations for either smoking during pregnancy or alcohol use during pregnancy when controlling for the other behaviors. This result indicates that, even within this very select population in which negative birth outcomes are expected, there were variations on the impact of substances based on the type (drugs vs. alcohol vs. tobacco).

Another significant finding was that maternal age was significantly associated with preterm birth (as age increased, so did preterm birth). Keeping that finding in mind, the women in this study with substance-exposed pregnancies were particularly young mothers, as the average age of the sample was 25.4 years. In addition, 23.1% were under the age of 21 years, indicating a cohort of young women with substance-exposed pregnancies who were teenage mothers. A previous national study found that, although age was significantly associated with higher risk for a substance-exposed pregnancy, there was no clear pattern (Cannon et al., 2014). This same study also found that risk for a substance-exposed pregnancy was significantly associated with younger age at first intercourse, indicating that women who have sex (and are thus at risk for pregnancy) at earlier ages are also at risk of drinking, using drugs, or smoking during these pregnancies (Cannon et al., 2014). As well, a review of tobacco and alcohol use within the context of adolescent pregnancy concluded that "adolescent girls are more likely than women of other ages to smoke tobacco or drink alcohol during pregnancy," highlighting both the "interconnections between [substance] use with adolescent pregnancy" and also the need to focus prevention efforts on young women (Bottorff et al., 2014, p. 561).

Finally, the results of this study point to the large issue of comorbidity among women with a mental health disorder who also use substances. As previous research has found, substance use disorders and mental disorders—such as depression, bipolar disorder, post-traumatic stress disorder, conduct disorders, anxiety, and other personality disorders—commonly co-occur and are mutually detrimental (Farren, Murphy, & McElroy, 2014; Grant, Hasin, Chou, Stinson, & Dawson, 2004; Jacobsen, Southwick, & Kosten, 2001). Of great concern, pregnant women often face this comorbidity, with previous research finding that pregnant women with mood or anxiety disorders are more likely to have a substance use disorder as well (Gyllstrom, Hellerstedt, & McGovern, 2011; Le Strat, Dubertret, & Le Foll, 2011). For example, a previous study found that, among pregnant women who smoke, 45.1% met

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criteria for at least one mental disorder (Goodwin, Keyes, & Simuro, 2007). Unfortunately, preconception and prenatal health appointments, which are key in preventing and/or addressing possible substance use during pregnancy, are lower for women reporting frequent mental distress (Farr & Bish, 2013; Pagnini & Reichman, 2000).

Limitations

This study was confined to one hospital in a specific geographic region; thus, the results are not generalizable. However, they point to the large issue of substance-exposed pregnancies at this particular hospital and possibly to the general region, indicating that larger systems-based studies are necessary for comparison data. Also, this is a retrospective as opposed to a prospective study, and much of the data were labeled in medical records as self-reported, rather than obtained via physiological testing or biomarkers. Therefore, there is potential for reporting bias, and it is possible that substance use was overestimated in some populations and underestimated in others. Likewise, there were much missing data within the medical records, including data on race/ethnicity, education, and employment. Demographic questions such as race/ethnicity do not require a response on the hospital's intake form, thus limiting analyses based on these features. Substance use also was missing frequently in the medical records, especially for alcohol, limiting our ability to make firm conclusions based on this data. However, a preliminary study such as this can be utilized to develop larger studies that involve multiple data sources.

Implications for Practice

Data from this project can be used to develop intervention and prevention efforts, including promoting preconception care for women at risk for substance use and for those with mental health issues. There is a national push to focus on preconception care as a way to prevent prenatal alcohol exposure (Floyd et al., 2014; Temel, van Voorst, Jack, Denktas, & Steegers, 2014). In addition, this type of surveillance data can be used to raise awareness among health care professionals and the patient population about the issue of substance use during pregnancy, especially use of multiple substances during pregnancy and the need for education about comorbid treatment. The data also can be used as a legitimate means of identifying appropriate referral resources for women in rural and tribal communities, recognizing gaps in treatment and referrals for services, and providing support for affected individuals and families. Finally, the data from this project can be utilized to shape public policy locally and federally, as well as to determine future funding allocations.

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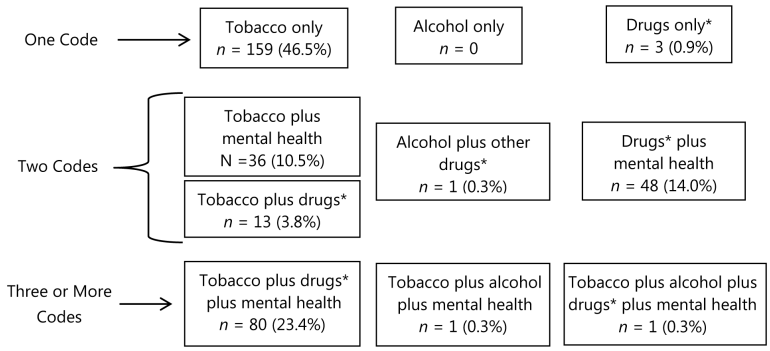

Figure 1. Type of substance used by sample (total sample n = 342)

* Drug Type: Opioid (*n* = 30); marijuana (*n* = 12); cocaine (*n* = 2); methamphetamine (*n* = 5); other/not specified (*n* = 119). Note this number is greater than the total number of individuals using drugs because some individuals were polydrug users.

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Table 1

Potential Outcomes of Drug Use During Pregnancy[a]

Marijuana	Stimulants (including cocaine and methamphetamines)	Opiates
Vasoconstriction of fetal oxygen supply to fetus	Vasoconstriction of fetal oxygen supply to fetus (cocaine)	Increased risk of premature delivery, gastrointestinal dysfunction, stillbirth, and SIDS
1-week shorter gestational period	Reduced weight, head circumference, and/or length at birth (cocaine)	Seizures (2-11% of neonates)
Neurobehavioral outcomes, including poor autonomic control	Increased or impaired behavioral and physiological reactivity to stress (cocaine)	Decreased birth weight, birth length, and head circumference
Learning deficit and impaired emotional reactivity	Small for gestational age and have lower average birth weight (meth)	Impact on infant CNS and autonomic nervous system
Abnormalities associated with visual system	Alters memory or signal processing (meth)	Poorer mental development or functioning

[a]Sources: Minnes et al., 2011; Sithisarn et al., 2012

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Table 2

ICD-9 Codes Used in the Present Study

648.32	Drug dependence of mother, delivered, with mention of postpartum complication
648.41	Mental disorders of mother, delivered, with or without mention of antepartum condition
648.42	Mental disorders of mother, delivered, with mention of postpartum complication
305.20	Specific types of drug abuse (such as cannabis), unspecified, continuous, episodic, or in remission
649.01	Tobacco use disorder complicating pregnancy, childbirth, or the puerperium, delivered, with or without mention of antepartum condition
649.02	Tobacco use disorder complicating pregnancy, childbirth, or the puerperium, delivered, with mention of postpartum complication
305.00	Alcohol abuse, unspecified
303.90	Other and unspecified alcohol dependence, unspecified
303.91	Other and unspecified alcohol dependence, continuous
303.92	Other and unspecified alcohol dependence, episodic
303.93	Other and unspecified alcohol dependence, in remission

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Table 3

Demographics of Abstracted Charts ($N = 342$)

	n	%
Race		
American Indian or Alaska Native	148	43.3
Caucasian	40	11.7
Hispanic	1	0.3
Native Hawaiian or Pacific Islander	1	0.3
Not given or missing data	152	44.4
Marital Status		
Single	231	67.5
Married	42	12.3
Partner/significant other	30	8.8
Other	23	6.7
Separated/divorced	15	4.4
Not given or missing data	1	0.3
Education Level		
Did/has not finish high school	54	15.7
High school diploma	41	12.0
Some college	32	9.4
Not given or missing data	215	62.9
Employment		
Unemployed	127	37.1
Homemaker	59	17.3
Student	56	16.4
Work full-time	49	14.3
Other	49	14.3
Not given or missing data	2	0.6
Age at delivery (mean, *SD*)	25.4	5.5

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Table 4

Regression Results of Prenatal Substance Use on Preterm Gestational Age

		Observed Data				With Multiple Imputation			
Risk Factor	***n* Missing**	**OR[a]**	**Lower CI**	**Upper CI**	***p* Value**	**OR[a]**	**Lower CI**	**Upper CI**	***p* Value**
Smoking									
Prior to pregnancy	153	0.78	0.16	3.81	0.76	1.04	0.24	4.63	0.95
During current pregnancy	18	1.93	0.44	8.51	0.38	2.06	0.46	9.11	0.34
Alcohol Use									
At any time	151	0.90	0.37	2.18	0.81	0.91	0.40	2.05	0.82
During current pregnancy	101	1.17	0.24	5.58	0.85	1.14	0.20	6.47	0.87
Drug Use									
At any time	64	2.30	0.95	5.57	0.07	2.45	1.00	5.98	0.05
During current pregnancy	51	2.46	1.15	5.26	0.02	2.35	1.09	5.05	0.03
Multivariate model	138								
Smoking current pregnancy		1.91	0.41	8.86	0.41	2.02	0.45	9.13	0.36
Alcohol use current pregnancy		0.61	0.07	5.28	0.66	0.92	0.16	5.20	0.92
Drug use current pregnancy		3.42	1.44	8.14	0.01	2.34	1.10	4.98	0.03
Maternal age at delivery		1.08	1.00	1.17	0.04	1.08	1.01	1.14	0.01

[a] All models included maternal age at delivery