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Risk factors for alcohol use among pregnant women, ages 15–44, in the United States, 2002 to 2017

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ABSTRACT

Fetal alcohol exposure can lead to severe birth and developmental defects. Determining which pregnant women are most likely to drink is essential for targeting interventions. In National Survey on Drug Use and Health data on pregnant women from 2002 to 2017 (N = 13,488), logistic regression was used to produce adjusted odds ratios (aOR) indicating characteristics associated with two past-month outcomes: any alcohol use and binge drinking. Risk factors were sociodemographic (age, race/ethnicity, marital status, education level, income) and clinical (trimester, substance use, alcohol use disorder, major depression). Where associations differed by pregnancy stage (trimester 1 vs. trimesters 2 and 3), association was evaluated by stage. Overall, higher risk for any and binge drinking was observed among those with other substance use (aORs 2.9–25.9), alcohol use disorder (aORs 4.5–7.5), depression (aORs = 1.6), and unmarried women (aORs 1.6–3.2). For any drinking, overall, higher risk was observed in adolescents (aOR = 1.5) and those with higher education (aOR = 1.4), while lower risk was observed in those with lower income (aORs = 0.7). For binge drinking, associations differed by pregnancy stage. In trimester 1, lower risk was observed in middle ages (aOR = 0.4). In trimesters 2/3, higher risk was observed in Blacks (aOR = 3.3) and those with lower income (aORs 3.5–3.9), while lower risk was observed in those with higher education (aOR = 0.3). To prevent severe prenatal harm, health care providers should focus on women at higher risk for binge drinking during pregnancy: women with tobacco or drug use, alcohol use disorder, or depression, and women who are unmarried, Black, or of lower socioeconomic status.

1. Introduction

Alcohol is the leading preventable cause of birth and developmental defects in the U.S. (Behnke and Smith, 2013; Williams and Smith, 2015). Prenatal exposure can lead to adverse consequences including fetal alcohol spectrum disorders, characterized by cardiovascular and skeletal defects, growth deficiencies, developmental delays, learning disabilities and behavioral problems (Centers for Disease Control and Prevention, 2018; Jones et al., 1973), and less severe neurodevelopmental problems, preterm birth, low birth weight, spontaneous abortions, and criminal behavior (Behnke and Smith, 2013; Patra et al., 2011; Blume, 1985; Sood et al., 2001; Streissguth et al., 1989; O'Callaghan et al., 2007). While greater prenatal alcohol exposure, e.g., binge drinking, leads to more severe outcomes, even moderate or light drinking may produce negative outcomes (Behnke and Smith, 2013; Blume, 1985; Sood et al., 2001; Streissguth et al., 1989; O'Callaghan et al., 2007; Flak et al., 2014; Sayal et al., 2007; May and Gossage, 2011; Maier and West, 2001). Since fetal exposure in early pregnancy, even before pregnancy awareness, can cause significant damage (Floyd et al., 2008), public health campaigns aim to reduce drinking among women who are or might become pregnant (Williams and Smith, 2015; Centers for Disease Control and Prevention, 2018; Floyd et al., 2008; Centers for Disease Control and Prevention, n.d.; National Institute on Alcohol Abuse and Alcoholism, 2012). Such campaigns in the U.S. general population have shown some success (Seiler, 2016; Warren, 2015), with lower prevalence of drinking in pregnant women than in non-pregnant women (Centers for Disease Control and Prevention, 2009; Zhao et al., 2012; Centers for Disease Control and Prevention, 2012; Tan et al., 2015; Slater et al., 2015; Oh et al., 2017; Havens et al., 2009; Alshaarawy et al., 2016; Muhuri and Gfroerer, 2009; Brown et al., 2016). Since 2002, drinking decreased in general population pregnant women (Slater et al., 2015; Agrawal et al., 2019), and the prevalence of newborns affected by prenatal alcohol use decreased significantly (Pan and Yi, 2013; Robbins et al., 2006). Yet, the U.S.

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national goals of reducing any drinking to 1.7% and binge drinking to 0% in pregnant women by 2020 (Office of Disease Prevention and Health Promotion, 2019) have not been met.

To design appropriately focused interventions to meet those goals, determining which subgroups of general population pregnant women are most likely to drink during pregnancy is an important public health issue. Further, drinking is associated with pregnancy stage, with higher prevalence of any use and binge drinking in the first trimester (early pregnancy) than the second and third trimesters (middle/late pregnancy), when the prevalence of drinking is similar (Oh et al., 2017; Havens et al., 2009; Muhuri and Gfroerer, 2009; Brown et al., 2016). Because many women quit or reduce drinking after pregnancy recognition (Ethen et al., 2009; Harrison and Sidebottom, 2009), risk factors for drinking could also differ by pregnancy stage, with risk factors in early pregnancy similar to those for non-pregnant women, and different risk factors for drinking in middle/late pregnancy. No previous study has investigated whether risk factors for drinking differ by pregnancy stage.

Potential risk factors include sociodemographic variables associated with alcohol use among all adults: age, race/ethnicity, marital status, education level, and income (Grant et al., 2017; Keyes et al., 2009; Hasin et al., 2007). In U.S. general population pregnant women from the Behavioral Risk Factor Surveillance System surveys, studies spanning brief periods (1995–1999; 2001–2005; 2006–2010; 2011–2013) showed higher risk for any drinking in ages 35–44, single women, and college graduates (Centers for Disease Control and Prevention, 2009; Centers for Disease Control and Prevention, 2012; Tan et al., 2015; Centers for Disease Control and Prevention, 2002), and for binge drinking in single women (Centers for Disease Control and Prevention, 2009; Centers for Disease Control and Prevention, 2012; Centers for Disease Control and Prevention, 2002), with no significant effect of race/ethnicity. However, the association of drinking and income was not tested, the data are over 5 years old, and the association of risk factors with specific pregnancy stages (trimester) was not addressed. Clinical factors associated with drinking during pregnancy in specific populations (mostly prenatal clinics) include alcohol dependence, depression and other substance use (Ethen et al., 2009; Harrison and Sidebottom, 2009; Meschke et al., 2008; Leonardson et al., 2007; Flynn et al., 2003), but little is known about these factors among U.S. general population pregnant women. Using National Survey on Drug Use and Health (NSDUH) 2002–2011 data, alcohol dependence was associated with drinking and binge drinking during pregnancy (Alshaarawy et al., 2016), suggesting that these women have a harder time stopping during pregnancy. In another study using 2005–2014 NSDUH data, depression was not associated with drinking in pregnant adolescent or adult women, but risk for drinking was increased among pregnant tobacco users (Oh et al., 2017). This study did not include binge drinking or evaluate the association of drinking or binge drinking with use of marijuana, cocaine, or other drugs. Assessing these substances separately is important, as the contexts of tobacco, marijuana, and cocaine vary substantially, with tobacco remaining prevalent and legal, the legality of marijuana changing rapidly, and cocaine showing lower prevalence but increasing (John and Wu, 2017; Kerridge et al., 2019) and remaining strongly associated with alcohol use (Goldstein et al., 2012). Since prenatal exposure to these substances also leads to adverse consequences, associations would identify particularly high-risk pregnancies (Behnke and Smith, 2013; Floyd et al., 2008). Therefore, determining the sociodemographic and clinical risk factors for drinking during pregnancy, overall and by pregnancy stage, in up-to-date general population data is needed to provide a better understanding of which pregnant women are at increased risk for any drinking, and especially for binge drinking, which can cause the most prenatal damage.

Accordingly, in data on general population pregnant women from the NSDUH (2002–2017), we investigated risk factors for past-month alcohol use and binge drinking. First, we evaluated the association of drinking with sociodemographic (age; race/ethnicity; marital status; education level; and income) and clinical factors (trimester; use of tobacco, marijuana, cocaine, any drug; alcohol use disorder; and depression). We then determined if associations differed by pregnancy stage (early versus middle/late). For each risk factor that showed a differential association with the alcohol outcomes by pregnancy stage, we evaluated the associations within each pregnancy stage.

2. Methods

2.1. Sample and procedures

The sample came from NSDUH surveys for years 2002–2017. NSDUH surveys, sponsored by the Substance Abuse and Mental Health Services Administration, provide annual cross-sectional nationally representative data on substance use in the U.S. population (National Survey on Drug Use and Health, n.d.). The survey uses a multistage probability sampling scheme to select households or non-institutional group homes from the 50 states and the District of Columbia, followed by selection of individuals aged ≥12 years. Sampling weights were used to adjust for non-response and oversampling of young adults, Blacks, and Hispanics to correspond with population estimates from the U.S. Census Bureau. Response rates ranged from 72 to 77% over the years studied (Grucza et al., 2018).

The survey was administered by trained interviewers using computer-assisted personal interviewing and audio computer-assisted self-interviewing for sensitive topics (e.g., substance use) to maintain privacy and confidentiality and encourage honest responses. Informed consent was obtained from participants before the interview. Since de-identified publicly available data were used, this study was exempt from Institutional Review Board approval.

For each year, data were downloaded from the NSDUH public data portal (Substance Abuse and Mental Health Data Archive, n.d.). Then, datasets were concatenated, adding a variable indicating survey year. Since the goal was to investigate alcohol use among pregnant women, the sample was limited to those aged 15–44, following the World Health Organization definition of reproductive age, as in another study (Slater et al., 2015). Pregnant women were those who responded "yes" to "are you currently pregnant." Women aged 15–44 who were missing information on pregnancy or trimester status were excluded (n = 1880), leaving a sample of 13,488 pregnant women. < 1% of all women aged 15–44 were missing pregnancy status, and the prevalence of missing pregnancy information did not change over time ($\beta = -0.01$; 95% confidence interval = −0.02, 0.01; $p = 0.48$).

2.2. Measures

2.2.1. Outcomes: past month alcohol use

To assess alcohol use, respondents were asked how long it was since their last alcoholic drink; those who responded "within the past 30 days" were considered positive for any past-month use. Such respondents were then asked how many days (in the past 30 days) they had five or more (≥5) drinks on the same occasion; those who responded "at least one day" were considered positive for binge drinking in data through 2014. In 2015, binge drinking was re-defined as four or more (≥4) drinks per occasion, consistent with the National Institute on Alcohol Abuse and Alcoholism (National Institutes of Health, 2004). Therefore, for binge drinking, data were analyzed separately from 2002 to 2014 and 2015 to 2017.

2.2.2. Sociodemographic predictors

Sociodemographic risk factors included age (15–17; 18–20; 21–25; 26–34; 35–44), race/ethnicity (non-Hispanic White; non-Hispanic Black; Hispanic; Other), education level (less than high school; high school; at least some college), family income ($0–19,999; $20,000-49,999; $50,000-74,999; ≥$75,000), and marital status (married;

previously married; never married). While many NSDUH studies use an age category of 18–25, we differentiated young adults at the legal drinking age (21 years) and defined categories of 18–20 and 21–25, because drinking patterns differ in those aged above and below 21 years (Slater et al., 2015; White et al., 2015).

2.2.3. Clinical predictors

Trimester. The response to "How many months pregnant are you" was used to create a variable indicating trimester (first, second, or third 3 months of pregnancy). < 1% of pregnant women were missing trimester information (n = 125). For analysis of differential association by pregnancy stage, we created a two-level variable, indicating early (trimester 1) and middle/late (trimesters 2 and 3). Trimesters 2 and 3 were combined because outcome prevalence was similar, and to increase power, particularly for binge drinking.

Past-year DSM-IV alcohol use disorders (dependence or abuse; AUD) were diagnosed using DSM-IV definitions: dependence was positive if 3 or more dependence criteria were endorsed, and abuse was positive if 1 or more abuse criteria were endorsed in the absence of dependence. As in previous studies (Grant et al., 2017; Dawson et al., 2015), respondents positive for dependence or abuse were considered positive for AUD, since AUD criteria reflect one underlying disorder (Hasin et al., 2013; Shmulewitz et al., 2015).

Past-month substance use was queried for tobacco, marijuana, cocaine, heroin, hallucinogens, methamphetamine, inhalants, and non-medical use of prescription psychotherapeutics (opioid pain relievers, stimulants, sedatives, and tranquilizers). We used 4 variables, indicating past month use of tobacco, marijuana, cocaine, and any drug (except alcohol or tobacco). Due to methodological changes in 2015, the any drug use variable was pooled and analyzed from 2002 to 2014 and 2015 to 2017.

Past-year major depressive disorder (depression) was diagnosed based on the DSM-IV criteria for a major depressive episode, requiring 5 or more of 9 symptoms to occur within a 2-week period, with at least 1 symptom being depressed mood or loss of interest or pleasure. The depression variable was available since 2005.

2.3. Statistical analysis

All analyses were conducted using SUDAAN 11.0.1, using sample weights to adjust for the complex survey design. Following procedures used previously (Pacek et al., 2015; Carliner et al., 2017), sample weights were divided by the number of concatenated datasets.

Prevalence of past-month drinking outcomes and sociodemographic and clinical risk factors were calculated. Among all pregnant women, for each outcome (alcohol use, binge drinking), one logistic regression model was used to evaluate the association with the sociodemographic risk factors (age, race/ethnicity, education level, income, and marital status), also correcting for trimester and year. Similarly, for each outcome, logistic regression was used to evaluate the association with each of the clinical risk factors (trimester, past-month use of tobacco; marijuana; cocaine; any drug; past-year AUD; past-year depression), correcting for the sociodemographic factors, trimester, and year. Results are reported as adjusted odds ratios (aOR). To determine if association differed by pregnancy stage, for each risk factor, the logistic regression model was rerun with a term indicating interaction between the risk factor and pregnancy stage. Where the interaction term was significant (p-value < 0.05), association analyses were conducted by pregnancy stage (early and middle/late). Analysis was carried out in data pooled from 2002 to 2017 for any drinking and 2002 to 2014 for binge drinking. For any drug use, data were pooled from 2002 to 2014; for depression, data were pooled from 2005.

2.3.1. Exploratory analysis

We evaluated association of risk factors with the new definition of binge drinking (≥4 drinks per occasion), pooling data from 2015 to 2017.

Table 1
Sample characteristics, pregnant women, ages 15–44, 2002–2017, NSDUH (N = 13,488).

Characteristic	n	Prevalence of sample in each subgroup % (SE)[a]
Sociodemographic variables		
Age		
15–17	823	2.8 (0.12)
18–20	2527	11.1 (0.34)
21–25	5922	25.2 (0.49)
26–34	3420	47.4 (0.73)
35–44	796	13.6 (0.55)
Race		
White	7421	58.1 (0.72)
Black	2157	14.1 (0.47)
Hispanic	2725	19.7 (0.58)
Other	1185	8.1 (0.43)
Education		
< High school	3484	18.5 (0.40)
High school	4158	25.2 (0.52)
> High school	5846	56.3 (0.60)
Income		
$0–$19,999	4210	23.3 (0.54)
$20,000–$49,999	5131	32.4 (0.65)
$50,000–$74,999	1972	17.4 (0.46)
≥$75,000	2175	26.9 (0.65)
Marital status		
Married	6378	60.5 (0.68)
Previously married	745	6.3 (0.34)
Never married	6365	33.2 (0.65)
Clinical variables		
Trimester		
First	4104	31.1 (0.69)
Second	4925	36.0 (0.67)
Third	4459	33.9 (0.69)
Past month substance use		
Alcohol	1319	9.9 (0.41)
Binge drinking[b]	482	3.4 (0.21)
Tobacco	2871	16.0 (0.45)
Marijuana	810	4.2 (0.21)
Cocaine	45	0.3 (0.06)
Any drug[b,c]	795	5.0 (0.26)
Past year disorder		
Alcohol use disorder	969	5.8 (0.28)
Depression[d]	829	6.6 (0.31)

[a] Adjusted for complex survey design and weighted to represent prevalence in the general population of pregnant women.
[b] Available through 2014 (n = 11,262).
[c] Use of marijuana, cocaine, heroin, hallucinogens, methamphetamine, inhalants, or non-medical use of prescription psychotherapeutics (opioid pain relievers, stimulants, sedatives, tranquilizers).
[d] Available from 2005 (n = 10,787).

3. Results

3.1. Sample characteristics

Among pregnant women, over all years, the average prevalence of past-month alcohol use was 9.9%, and 3.4% for past-month binge drinking (Table 1). Among pregnant women, about three-quarters were aged 21–34; about 60% were married and non-Hispanic White; about half had income levels below $50,000 and greater than high school education; about one-third were in each trimester; 16% used tobacco; 4% used marijuana; 0.3% used cocaine; 5% used any drug; 6% had an AUD; and 7% had depression.

3.2. Any past-month drinking

3.2.1. Association with risk factors

Among all pregnant women, drinking risk was significantly

Table 2
Association of sociodemographic characteristics with any past-month drinking, NSDUH 2002–2017.

	All pregnant women (n = 13,488)		Does association differ by pregnancy stage?[a]
	Prevalence of drinking among the subgroup % (SE)[b]	Odds ratio (95% CI)[b]	Wald $F_{(df)}$, p-value
Age			$0.82_{(4)}$, $p = 0.52$
15–17	13.0 (1.90)	1.53 (1.07, 2.19)	
18–20	8.4 (0.89)	0.91 (0.76, 1.17)	
21–25	9.1 (0.57)	Reference	
26–34	9.8 (0.63)	1.09 (0.88, 1.35)	
35–44	11.9 (1.44)	1.37 (0.99, 1.90)	
Race			$0.14_{(3)}$, $p = 0.93$
White	10.8 (0.50)	Reference	
Black	11.4 (0.97)	1.07 (0.85, 1.34)	
Hispanic	7.0 (0.91)	0.61 (0.45, 0.82)	
Other	6.6 (1.26)	0.56 (0.36, 0.87)	
Education			$0.56_{(2)}$, $p = 0.57$
< High school	8.0 (0.75)	Reference	
High school	8.8 (0.73)	1.13 (0.86, 1.48)	
> High school	10.9 (0.62)	1.44 (1.11, 1.88)	
Income			$0.09_{(3)}$, $p = 0.97$
$0–$19,999	8.8 (0.67)	0.69 (0.52, 0.91)	
$20,000–$49,999	8.8 (0.64)	0.70 (0.52, 0.93)	
$50,000–$74,999	9.9 (0.96)	0.80 (0.60, 1.06)	
≥$75,000	12.0 (1.02)	Reference	
Marital status			$2.96_{(2)}$, $p = 0.06$
Married	8.2 (0.49)	Reference	
Previously married	15.1 (1.74)	2.09 (1.52, 2.85)	
Never married	12.3 (0.82)	1.62 (1.30, 2.01)	

[a] Differential association was indicated by significant interaction between the risk factor and pregnancy stage (early [trimester 1] vs. middle/late [trimesters 2 and 3]) in logistic regression. Since no interaction was significant (all p-values > 0.05), results are not shown stratified by pregnancy stage.
[b] Adjusted for trimester, age, race/ethnicity, education, income, marital status, and year.

associated with age, race/ethnicity, education, income, marital status (Table 2), and the clinical factors (Table 3). Lower risk was observed in Hispanics (aOR = 0.6) and Other race/ethnicity (aOR = 0.6) as compared to Whites, the lowest two income groups as compared to the highest (aORs = 0.7), and among those in trimester 2 (aOR = 0.3) and trimester 3 (aOR = 0.2) as compared to trimester 1. Higher risk was observed in ages 15–17 as compared to ages 21–25 (aOR = 1.5), those with greater than high school education as compared to less than high school (aOR = 1.4), those previously (aOR = 2.1) and never (aOR = 1.6) married as compared to currently married, and among those with AUD (aOR = 4.5), depression (aOR = 1.6), and substance use: tobacco (aOR = 2.9), marijuana (aOR = 7.1), cocaine (aOR = 13.4), and any drug (aOR = 6.6).

3.2.2. Differences by pregnancy stage

Differences in association by pregnancy stage were observed for marijuana use (interaction p-value = 0.035), with stronger association in middle/late pregnancy (aOR = 11.5) than early pregnancy (aOR = 5.3) (Table 3).

3.3. Past-month binge drinking

3.3.1. Association with risk factors

Among all pregnant women, risk for binge drinking was significantly associated with race/ethnicity, marital status (Table 4), and the clinical factors (Table 5). Lower risk was observed in Hispanics as compared to Whites (aOR = 0.6), and in trimester 2 (aOR = 0.2) and trimester 3 (aOR = 0.1) as compared to trimester 1. Higher risk was observed in previously (aOR = 3.2) or never (aOR = 2.3) married as compared to currently married, and among those with AUD (aOR = 7.5), depression (aOR = 1.6), and substance use: tobacco (aOR = 5.1), marijuana (aOR = 6.5), cocaine (aOR = 25.9), and any drug (aOR = 7.5).

3.3.2. Differences by pregnancy stage

Differences in association by pregnancy stage were observed for age (interaction p-value = 0.014), race/ethnicity (interaction $p = 0.001$), education (interaction $p = 0.014$), and income (interaction $p = 0.013$), with significant association observed in one stage but not the other (Table 4). In early pregnancy, lower risk was observed in ages 35–44 (aOR = 0.4) as compared to ages 21–25. In middle/late pregnancy, lower risk was observed in Other race/ethnicity (aOR = 0.3) as compared to Whites, and in those with greater than high school education (aOR = 0.3) as compared to less than high school. Higher risk was observed in Blacks (aOR = 3.3) as compared to Whites, and in the lower two income groups (aORs 3.9, 3.5) as compared to the highest group.

3.3.3. Exploratory association

Using the ≥4 threshold for binge drinking, pooling data from 2015 to 2017 showed results that were similar to the main results: higher risk was associated with not being married, AUD, depression, and past-month tobacco, marijuana, or any drug use; lower risk was associated with trimester; and risk was not associated with age or education (Supplemental Table 1). Differences were that lower risk was associated with lower income, and the association with Hispanics was not significant. Further, while the prevalence of binge drinking was expected to increase with a lower threshold, ages 21–25 and the highest income group show a relatively greater increase than other groups.

4. Discussion

This is the first study to evaluate sociodemographic and clinical risk factors for drinking during pregnancy, overall and by pregnancy stage, using 16 years of general U.S. population data. Findings provide important information to health practitioners and policy makers. Factors associated with higher risk of any use or binge drinking were early pregnancy, other substance use, AUD, depression, and being unmarried. For any drinking, higher risk was associated with higher socioeconomic status and adolescence. For binge drinking, in early pregnancy, lower risk was associated with ages 35–44, while in middle/late pregnancy, higher risk was associated with lower socioeconomic status and Black

Table 3
Association of clinical variables with past-month drinking, NSDUH, 2002–2017.

	Pregnant women n = 13,488		Does association differ by pregnancy stage?[a]	Early pregnancy n = 4104		Middle/late pregnancy n = 9384	
	Prevalence of drinking among the subgroup % (SE)[b]	Odds ratio (95% CI)[b]	Wald $F_{(df)}$, p-value	Prevalence of drinking among the subgroup % (SE)[c]	Odds ratio (95% CI)[c]	Prevalence of drinking among the subgroup % (SE)[c]	Odds ratio (95% CI)[c]
Trimester							
First	19.1 (0.92)	Reference					
Second	6.5 (0.55)	0.29 (0.23, 0.36)					
Third	4.6 (0.56)	0.20 (0.15, 0.27)					
Past year disorder							
Alcohol use disorder			$0.88_{(1)}$, $p = 0.35$				
Yes	27.0 (2.05)	4.46 (3.43, 5.81)					
No	8.6 (0.42)	Reference					
Depression[d]			$0.04_{(1)}$, $p = 0.84$				
Yes	13.6 (1.79)	1.58 (1.12, 2.24)					
No	9.4 (0.79)	Reference					
Past month substance use							
Tobacco			$0.37_{(1)}$, $p = 0.54$				
Yes	18.8 (1.29)	2.85 (2.33, 3.49)					
No	8.1 (0.43)	Reference					
Marijuana			$4.50_{(1)}$, $p = 0.035$				
Yes	35.7 (2.64)	7.13 (5.42, 9.39)		50.3 (4.28)	5.29 (3.70, 7.57)	34.8 (4.47)	11.45 (7.37, 17.78)
No	8.5 (0.42)	Reference		17.0 (0.88)	Reference	4.8 (0.40)	Reference
Cocaine			$0.45_{(1)}$, $p = 0.50$				
Yes	51.9 (11.12)	13.41 (4.91, 36.63)					
No	9.7 (0.41)	Reference					
Any drug[e]			$3.27_{(1)}$, $p = 0.07$				
Yes	34.3 (2.87)	6.63 (4.85, 9.06)					
No	8.6 (0.49)	Reference					

[a] Differential association was indicated by significant interaction between the risk factor and pregnancy stage in logistic regression. Where interaction was significant ($p < 0.05$), results are shown stratified by pregnancy stage.

[b] Adjusted for age, race/ethnicity, education, income, marital status, trimester, and year.

[c] Adjusted for all except trimester.

[d] For depression, n = 10,787, because this variable was not available for 2002–2004.

[e] Use of marijuana, cocaine, heroin, hallucinogens, methamphetamine, inhalants, or non-medical use of prescription psychotherapeutics (opioid pain relievers, stimulants, sedatives, or tranquilizers); n = 11,262, available 2002–2014.

Table 4
Association of sociodemographic characteristics with past-month binge drinking, NSDUH, 2002–2014.

	Pregnant women n = 11,262		Does association differ by pregnancy stage?[a]	Early pregnancy n = 3393		Middle/late pregnancy n = 7869	
	Prevalence of binge drinking among the subgroup %[b] (SE)	Odds ratio[b] (95% CI)	Wald $F_{(df)}$, p-value	Prevalence of binge drinking among the subgroup %[c] (SE)	Odds ratio[c] (95% CI)	Prevalence of binge drinking among the subgroup %[c] (SE)	Odds ratio[c] (95% CI)
Age			$3.22_{(4)}$, p = 0.014				
15–17	4.2 (0.85)	1.17 (0.71, 1.90)		8.8 (2.12)	0.98 (0.54, 1.78)	2.4 (0.84)	2.03 (0.92, 4.49)
18–20	3.3 (0.47)	0.89 (0.63, 1.25)		7.9 (1.31)	0.87 (0.57, 1.31)	1.1 (0.29)	0.90 (0.48, 1.69)
21–25	3.6 (0.36)	Reference		9.0 (0.91)	Reference	1.2 (0.24)	Reference
26–34	3.2 (0.41)	0.88 (0.61, 1.26)		8.2 (1.19)	0.90 (0.60, 1.36)	1.0 (0.26)	0.80 (0.39, 1.64)
35–44	2.9 (0.91)	0.77 (0.36, 1.64)		4.0 (1.05)	0.41 (0.22, 0.74)	2.9 (1.45)	2.49 (0.78, 7.97)
Race			$5.61_{(3)}$, p = 0.001				
White	3.5 (0.31)	Reference		8.7 (0.89)	Reference	1.2 (0.23)	Reference
Black	4.2 (0.63)	1.21 (0.81, 1.81)		6.6 (1.19)	0.73 (0.45, 1.16)	3.6 (1.08)	3.27 (1.50, 7.14)
Hispanic	2.3 (0.39)	0.63 (0.41, 0.95)		6.0 (1.25)	0.66 (0.38, 1.14)	0.6 (0.19)	0.53 (0.26, 1.07)
Other	3.5 (0.92)	1.00 (0.55, 1.81)		10.8 (2.84)	1.28 (0.66, 2.50)	0.4 (0.19)	0.33 (0.12, 0.88)
Education			$4.41_{(2)}$, p = 0.014				
< High school	4.1 (0.59)	Reference		8.2 (1.44)	Reference	2.3 (0.50)	Reference
High school	2.8 (0.43)	0.66 (0.41, 1.08)		6.3 (0.97)	0.75 (0.42, 1.32)	1.3 (0.43)	0.54 (0.26, 1.13)
> High school	3.3 (0.41)	0.78 (0.48, 1.25)		8.8 (1.14)	1.09 (0.61, 1.92)	0.8 (0.23)	0.34 (0.16, 0.75)
Income			$3.70_{(3)}$, p = 0.013				
$0–$19,999	4.0 (0.48)	1.43 (0.85, 2.39)		9.1 (1.22)	1.13 (0.64, 2.02)	1.8 (0.43)	3.94 (1.35, 11.54)
$20,000–$49,999	3.1 (0.37)	1.07 (0.63, 1.79)		6.2 (0.71)	0.74 (0.45, 1.21)	1.6 (0.42)	3.47 (1.16, 10.41)
$50,000–$74,999	3.4 (0.62)	1.19 (0.71, 2.01)		9.3 (1.77)	1.17 (0.64, 2.14)	0.8 (0.35)	1.66 (0.53, 5.25)
≥ $75,000	2.9 (0.53)	Reference		8.1 (1.55)	Reference	0.5 (0.20)	Reference
Marital status			$0.89_{(2)}$, p = 0.41				
Married	2.1 (0.27)	Reference					
Previously married	6.3 (1.22)	3.20 (1.87, 5.48)					
Never married	4.6 (0.53)	2.27 (1.53, 3.38)					

[a] Differential association was indicated by significant interaction between the risk factor and pregnancy stage in logistic regression. Where interaction was significant ($p < 0.05$), results are shown stratified by pregnancy stage.
[b] Adjusted for trimester, age, race/ethnicity, education, income, marital status, and year.
[c] Adjusted for all except trimester.

Table 5
Association of clinical variables with past-month binge drinking, NSDUH, 2002–2014.

	Pregnant women n = 11,262		Does association differ by pregnancy stage?[a]
	Prevalence of binge drinking among the subgroup %[b] (SE)	Odds ratio[b] (95% CI)	Wald $F_{(df)}$, p-value
Trimester			
First	7.7 (0.56)	Reference	
Second	1.8 (0.24)	0.21 (0.16, 0.28)	
Third	0.9 (0.28)	0.10 (0.05, 0.21)	
Past year disorder			
Alcohol use disorder			$0.06_{(1)}$, $p = 0.81$
Yes	13.8 (1.66)	7.50 (5.39, 10.43)	
No	2.4 (0.19)	Reference	
Depression[c]			$0.30_{(1)}$, $p = 0.59$
Yes	4.6 (0.87)	1.60 (1.04, 2.48)	
No	3.0 (0.24)	Reference	
Past month substance use			
Tobacco			$1.15_{(1)}$, $p = 0.29$
Yes	8.6 (0.89)	5.11 (3.71, 7.05)	
No	1.9 (0.20)	Reference	
Marijuana			$1.06_{(1)}$, $p = 0.31$
Yes	13.4 (1.50)	6.53 (4.78, 8.91)	
No	2.6 (0.21)	Reference	
Cocaine[d]			Not available
Yes	42.8 (11.07)	25.85 (9.67, 66.12)	
No	3.4 (0.22)	Reference	
Any drug[e]			$0.60_{(1)}$, $p = 0.44$
Yes	14.1 (1.49)	7.54 (5.52, 10.29)	
No	2.4 (0.21)	Reference	

[a] Differential association was indicated by significant interaction between the risk factor and pregnancy stage in logistic regression. Since no interaction was significant ($p > 0.05$), results are not shown stratified by pregnancy stage.
[b] Adjusted for age, race/ethnicity, education, income, marital status, trimester, and year.
[c] For depression, $n = 8561$ because this variable was not available for 2002–2004.
[d] Not adjusted for trimester due to lack of convergence.
[e] Use of marijuana, cocaine, heroin, hallucinogens, methamphetamine, inhalants, or non-medical use of prescription psychotherapeutics (opioid pain relievers, stimulants, sedatives, or tranquilizers).

race/ethnicity.

Similar to previous studies (Oh et al., 2017; Havens et al., 2009; Muhuri and Gfroerer, 2009; Brown et al., 2016), the highest risk was observed in trimester 1, when alcohol use, especially binge drinking, can cause significant damage (Floyd et al., 2008; Centers for Disease Control and Prevention, n.d.). Women may drink before pregnancy recognition, since most women are not aware of pregnancy before 4–6 weeks (Floyd et al., 2008; Centers for Disease Control and Prevention, n.d.). Even after realizing they are pregnant, some women may need time to reduce or quit drinking, while others may not get early prenatal care or be fully aware of the dangers of prenatal alcohol exposure. Reducing drinking in all women of reproductive age could limit alcohol exposure in early pregnancy, but increases in drinking have been observed in these women (Slater et al., 2015; White et al., 2015). Although abstinence is recommended for women who may become pregnant, these recommendations are often viewed as patronizing and paternalistic (Seiler, 2016; Warren, 2015), and expecting young adult women to never drink may be unrealistic. Rather, the standard of care for reproductive age women should include pre-pregnancy health counseling to discuss the harms of alcohol exposure and how to realistically prevent or reduce such exposure (Moyer et al., 2013). Additionally, for women who want to avoid pregnancy, having reliable, accessible, and affordable contraception could prevent alcohol exposure early in unintended pregnancies.

Clinical factors were consistently associated with any use and binge drinking during pregnancy, suggesting that health care professionals should focus on the issue of drinking during pregnancy with these at-risk women and motivate change as needed. Women with alcohol use disorders showed higher risk, similar to previous studies (Alshaarawy et al., 2016; Ethen et al., 2009; Harrison and Sidebottom, 2009; Meschke et al., 2008; Leonardson et al., 2007); these women may expose their fetuses to higher doses of alcohol, and might have difficulty cutting down or quitting drinking, warranting specialized treatment. Increased risk was observed in women using other substances (e.g., tobacco, marijuana, cocaine), consistent with evidence of poly-substance use among pregnant women in treatment for alcohol use (Washio et al., 2017). These pregnancies may pose particularly high prenatal risk, since other substances can also cause significant fetal damage (Behnke and Smith, 2013). Yet, pregnant women may refrain from discussing alcohol and drug use with their health providers, due to stigma related to use or fear of punitive measures, such as mandatory reporting of use to law enforcement agencies (Seiler, 2016; Drabble et al., 2014). Health care providers should conduct these discussions in a respectful manner. Further, policy makers should construct laws regarding substance use during pregnancy that protect both the mother and baby, such as priority access to treatment, rather than punish the mother (Seiler, 2016).

Analysis of sociodemographic risk factors identified effects common for any use and binge drinking among all pregnant women, and showed unique effects for binge drinking by pregnancy stage. Marital status showed robust effects, with higher risk of any use and binge drinking among unmarried pregnant women, as in previous studies (Centers for Disease Control and Prevention, 2009; Zhao et al., 2012; Centers for Disease Control and Prevention, 2012; Tan et al., 2015; Centers for Disease Control and Prevention, 2002; Meschke et al., 2008; Leonardson et al., 2007). This could be due to the lack of social support engendered by marriage, suggesting that health care providers seeing unmarried pregnant women should discuss the challenges of coping with pregnancy and help them build support networks. For binge drinking, in early pregnancy, women ages 35–44 showed lower risk, similar to effects observed in non-pregnant (Centers for Disease Control and Prevention, 2009; Centers for Disease Control and Prevention, 2012; Tan et al., 2015) and all women (White et al., 2015), suggesting that risk in early pregnancy is somewhat similar to non-pregnancy. In

middle/late pregnancy, higher risk was found in Black women and women with lower socioeconomic status. These women may be less likely to get adequate prenatal care (Melnikow and Alemagno, 1993; Gadson et al., 2017), perhaps due to perceived discrimination, inability to access providers who take public insurance, and difficulties with transportation (Gadson et al., 2017; Roman et al., 2017; De Marco et al., 2008; Slaughter-Acey et al., 2013). Home-visiting programs may partially solve those problems and improve prenatal care among vulnerable sub-populations (Gadson et al., 2017; Adler et al., 2017). Additionally, low-income women may be less aware of the risks of drinking during pregnancy (Dufour et al., 1994) and have insufficient resources to cope with pregnancy. Health care providers should inform pregnant women about assistance programs, e.g., the Women, Infants, and Children (WIC) nutrition program, which provides supplemental food and counseling to low-income pregnant women, potentially reducing stress and drinking to cope with stress (Adler et al., 2017). Conversely, risk for any drinking was increased in all pregnant women with higher socioeconomic status, similar to previous studies (Centers for Disease Control and Prevention, 2009; Zhao et al., 2012; Centers for Disease Control and Prevention, 2012; Tan et al., 2015; Centers for Disease Control and Prevention, 2002), consistent with effects among all women (Centers for Disease Control and Prevention, 2009; Centers for Disease Control and Prevention, 2012; Tan et al., 2015; White et al., 2015). This may be due to changing social norms, leading to more permissive attitudes towards drinking among such women (Keyes et al., 2011). Additional studies should identify mechanisms driving the associations and the different effects for any drinking and binge drinking, and replicate differential effects by pregnancy stage.

5. Limitations

Study limitations are noted. First, pregnancy status was based on self-report, so women who were unaware of their pregnancy were designated as non-pregnant. Information on alcohol and drug use was self-reported, so there could be under-reporting of less socially-acceptable behaviors. To mitigate this possibility, NSDUH uses self-administered interviewing, which increases perception of confidentiality and encourages honest answers, and the substance use modules precede the pregnancy questions. Second, drinking was assessed over the past 30 days, which does not capture drinking across the entire pregnancy or the frequency of drinking. Third, while it may be informative to assess pregnancy stage continuously (by month), those data were not available in the publicly downloadable NSDUH datasets. Fourth, in these cross-sectional data, the direction of effect cannot be determined. Fifth, data was pooled across years to increase power for outcomes with low prevalence, which may mask relationships that change over time. Studies using datasets enriched for coverage of drinking during pregnancy should assess whether the predictors of drinking remain consistent over time. Sixth, until 2015, binge drinking was defined as ≥ 5 drinks per occasion, higher than the recommended threshold of ≥ 4 drinks (National Institutes of Health, 2004), and the data were not available to apply the ≥ 4 threshold. Exploratory analysis from 2015 to 2017, when the ≥ 4 definition was used, suggested that most results were robust to the threshold change (i.e., association was observed for clinical risk factors and marital status), but ages 21–25 and higher income showed relatively greater increased prevalence than other groups. Further studies should determine if those differences are due to the threshold change or to changes over time (before and after 2015).

6. Conclusion

Alcohol exposure during pregnancy, particularly binge drinking, can cause a wide range of negative consequences in many areas: physical, psychological, neurodevelopmental, intellectual, and behavioral (Behnke and Smith, 2013). While fetal alcohol exposure and correlated negative outcomes are preventable, some pregnant women do drink; interventions are therefore needed to reduce drinking (Waterman et al., 2013). Health care providers should screen all women of reproductive age for alcohol use, inform them of the potential harms due to prenatal alcohol use, and discuss ways to limit fetal exposure (Moyer et al., 2013), either by limiting drinking (for women who could become pregnant) or with contraception (for women who want to avoid pregnancy). For women with problematic alcohol or other substance use, or other psychiatric disorders, health care providers should specifically address the possibility of pregnancy and the dangers of prenatal substance exposure. During pregnancy, health care providers should address alcohol use in a respectful, non-punitive manner, and encourage women to get appropriate treatment. Specific attention should be paid to women who may lack resources or social support to cope with pregnancy, such as adolescents, unmarried women, or those with lower socioeconomic status. Together these interventions may accomplish the important public health goals of ensuring healthy mothers and children.

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Conflicts of interest

No conflicts of interest are declared.

References

Adler NE, Cutler DM, Fielding JE, et al. Addressing social determinants of health and health disparities. In: Dzau VJ, McClellan M, McGinnis JM, Finkelman EM, eds. Vital Directions for Health & Health Care: An Initiative of the National Academy of Medicine. Washington, DC: National Academy of Medicine; 2017. https://nam.edu/wp-content/uploads/2018/02/Vital-Directions-for-Health-and-Health-Care-Final-Publication-022718.pdf. Accessed March 25, 2019.

Agrawal, A., Rogers, C.E., Lessov-Schlaggar, C.N., Carter, E.B., Lenze, S.N., Grucza, R.A., 2019. Alcohol, cigarette, and cannabis use between 2002 and 2016 in pregnant women from a nationally representative sample. JAMA Pediatr. 173 (1), 95–96.

Alshaarawy, O., Breslau, N., Anthony, J.C., 2016. Monthly estimates of alcohol drinking during pregnancy: United States, 2002–2011. J. Stud. Alcohol Drugs 77 (2), 272–276.

Behnke, M., Smith, V.C., 2013. Committee on substance abuse, committee on fetus and newborn. Prenatal substance abuse: short- and long-term effects on the exposed fetus. Pediatrics 131 (3), e1009–e1024.

Blume, S.B., 1985. Is social drinking during pregnancy harmless? There is reason to think not. Adv. Alcohol Subst. Abuse 5 (1-2), 209–219.

Brown, Q.L., Hasin, D.S., Keyes, K.M., Fink, D.S., Ravenell, O., Martins, S.S., 2016. Health insurance, alcohol and tobacco use among pregnant and non-pregnant women of reproductive age. Drug Alcohol Depend. 166, 116–124.

Carliner, H., Mauro, P.M., Brown, Q.L., et al., 2017. The widening gender gap in marijuana use prevalence in the U.S. during a period of economic change, 2002–2014. Drug Alcohol Depend. 170, 51–58.

Centers for Disease Control and Prevention, 2002. Alcohol use among women of childbearing age: United States, 1991–1999. MMWR Morb. Mortal. Wkly Rep. 51 (13), 273–276.

Centers for Disease Control and Prevention, 2009. Alcohol use among pregnant and nonpregnant women of childbearing age: United States, 1991–2005. MMWR Morb. Mortal. Wkly Rep. 58 (19), 529–532.

Centers for Disease Control and Prevention, 2012. Alcohol use and binge drinking among women of childbearing age: United States, 2006–2010. MMWR Morb. Mortal. Wkly Rep. 61 (28), 534–538.

Centers for Disease Control and Prevention An Alcohol-free Pregnancy is the Best Choice for Your Baby. https://www.cdc.gov/ncbddd/fasd/documents/fasdbrochure_final.

pdf, Accessed date: 18 October 2018.
Centers for Disease Control and Prevention. Fetal Alcohol Spectrum Disorders (FASDs). U. S. Department of Health & Human Services. 2018. https://www.cdc.gov/ncbddd/fasd/index.html. Accessed August 9, 2018.
Dawson, D.A., Goldstein, R.B., Saha, T.D., Grant, B.F., 2015. Changes in alcohol consumption: United States, 2001–2002 to 2012–2013. Drug Alcohol Depend. 148, 56–61.
De Marco, M., Thorburn, S., Zhao, W., 2008. Perceived discrimination during prenatal care, labor, and delivery: An examination of data from the Oregon Pregnancy Risk Assessment Monitoring System, 1998–1999, 2000, and 2001. Am. J. Public Health 98 (10), 1818–1822.
Drabble, L., Thomas, S., O'Connor, L., Roberts, S.C., 2014. State responses to alcohol use and pregnancy: findings from the Alcohol Policy Information System (APIS). J. Soc. Work. Pract. Addict. 14 (2), 191–206.
Dufour, M.C., Williams, G.D., Campbell, K.E., Aitken, S.S., 1994. Knowledge of FAS and the risks of heavy drinking during pregnancy. 1985 and 1990. Alcohol Health Res World. 18 (1), 86–92.
Ethen, M.K., Ramadhani, T.A., Scheuerle, A.E., et al., 2009. Alcohol consumption by women before and during pregnancy. Matern. Child Health J. 13 (2), 274–285.
Flak, A.L., Su, S., Bertrand, J., Denny, C.H., Kesmodel, U.S., Cogswell, M.E., 2014. The association of mild, moderate, and binge prenatal alcohol exposure and child neuropsychological outcomes: a meta-analysis. Alcohol. Clin. Exp. Res. 38 (1), 214–226.
Floyd, R.L., Jack, B.W., Cefalo, R., et al., 2008. The clinical content of preconception care: alcohol, tobacco, and illicit drug exposures. Am. J. Obstet. Gynecol. 199 (6 Suppl 2), S333–S339.
Flynn, H.A., Marcus, S.M., Barry, K.L., Blow, F.C., 2003. Rates and correlates of alcohol use among pregnant women in obstetrics clinics. Alcohol. Clin. Exp. Res. 27 (1), 81–87.
Gadson, A., Akpovi, E., Mehta, P.K., 2017. Exploring the social determinants of racial/ethnic disparities in prenatal care utilization and maternal outcome. Semin. Perinatol. 41 (5), 308–317.
Goldstein, R.B., Dawson, D.A., Chou, S.P., Grant, B.F., 2012. Sex differences in prevalence and comorbidity of alcohol and drug use disorders: results from Wave 2 of the National Epidemiologic Survey on Alcohol and Related Conditions. J Stud Alcohol Drugs. 73 (6), 938–950.
Grant, B.F., Chou, S.P., Saha, T.D., et al., 2017. Prevalence of 12-month alcohol use, high-risk drinking, and DSM-IV alcohol use disorder in the United States, 2001–2002 to 2012–2013: results from the National Epidemiologic Survey on Alcohol and Related Conditions. JAMA Psychiatry. 74 (9), 911–923.
Grucza, R.A., Sher, K.J., Kerr, W.C., et al., 2018. Trends in adult alcohol use and binge drinking in the early 21st-century United States: a meta-analysis of 6 national survey series. Alcohol. Clin. Exp. Res. 42 (10), 1939–1950.
Harrison, P.A., Sidebottom, A.C., 2009. Alcohol and drug use before and during pregnancy: an examination of use patterns and predictors of cessation. Matern. Child Health J. 13 (3), 386–394.
Hasin, D.S., Stinson, F.S., Ogburn, E., Grant, B.F., 2007. Prevalence, correlates, disability, and comorbidity of DSM-IV alcohol abuse and dependence in the United States: results from the National Epidemiologic Survey on Alcohol and Related Conditions. Arch. Gen. Psychiatry 64 (7), 830–842.
Hasin, D.S., O'Brien, C.P., Auriacombe, M., et al., 2013. DSM-5 criteria for substance use disorders: recommendations and rationale. Am. J. Psychiatry 170 (8), 834–851.
Havens, J.R., Simmons, L.A., Shannon, L.M., Hansen, W.F., 2009. Factors associated with substance use during pregnancy: results from a national sample. Drug Alcohol Depend. 99 (1-3), 89–95.
John, W.S., Wu, L.T., 2017. Trends and correlates of cocaine use and cocaine use disorder in the United States from 2011 to 2015. Drug Alcohol Depend. 180, 376–384.
Jones, K.L., Smith, D.W., Ulleland, C.N., Streissguth, P., 1973. Pattern of malformation in offspring of chronic alcoholic mothers. Lancet 1 (7815), 1267–1271.
Kerridge, B.T., Chou, S.P., Pickering, R.P., et al., 2019. Changes in the prevalence and correlates of cocaine use and cocaine use disorder in the United States, 2001–2002 and 2012–2013. Addict. Behav. 90, 250–257.
Keyes, K.M., Geier, T., Grant, B.F., Hasin, D.S., 2009. Influence of a drinking quantity and frequency measure on the prevalence and demographic correlates of DSM-IV alcohol dependence. Alcohol. Clin. Exp. Res. 33 (5), 761–771.
Keyes, K.M., Li, G., Hasin, D.S., 2011. Birth cohort effects and gender differences in alcohol epidemiology: a review and synthesis. Alcohol. Clin. Exp. Res. 35 (12), 2101–2112.
Leonardson, G.R., Loudenburg, R., Struck, J., 2007. Factors predictive of alcohol use during pregnancy in three rural states. Behav. Brain Funct. 3, 8.
Maier, S.E., West, J.R., 2001. Drinking patterns and alcohol-related birth defects. Alcohol Res. Health 25 (3), 168–174.
May, P.A., Gossage, J.P., 2011. Maternal risk factors for fetal alcohol spectrum disorders: not as simple as it might seem. Alcohol Res. Health 34 (1), 15–26.
Melnikow, J., Alemagno, S., 1993. Adequacy of prenatal care among inner-city women. J. Fam. Pract. 37 (6), 575–582.
Meschke, L.L., Hellerstedt, W., Holl, J.A., Messelt, S., 2008. Correlates of prenatal alcohol use. Matern. Child Health J. 12 (4), 442–451.
Moyer, V.A., Preventive Services, U.S., Force, Task, 2013. Screening and behavioral counseling interventions in primary care to reduce alcohol misuse: U.S. Preventive Services Task Force recommendation statement. Ann. Intern. Med. 159 (3), 210–218.
Muhuri, P.K., Gfroerer, J.C., 2009. Substance use among women: associations with pregnancy, parenting, and race/ethnicity. Matern. Child Health J. 13 (3), 376–385.
National Institute on Alcohol Abuse and Alcoholism. Drinking and Your Pregnancy. NIH Publication No. 96-4101. National Institutes of Health. 2012. https://pubs.niaaa.nih.gov/publications/DrinkingPregnancy_HTML/pregnancy.pdf. Accessed August 9, 2018.
National Institutes of Health. NIAAA Newsletter, Winter 2004, Number 3. Department of Health and Human Services. 2004. https://pubs.niaaa.nih.gov/publications/Newsletter/winter2004/Newsletter_Number3.pdf. Accessed October 18, 2018.
National Survey on Drug Use and Health. NSDUH. Substance Abuse and Mental Health Services Administration; RTI International. https://nsduhweb.rti.org/respweb/homepage.cfm. Accessed July 25, 2018.
O'Callaghan, F.V., O'Callaghan, M., Najman, J.M., Williams, G.M., Bor, W., 2007. Prenatal alcohol exposure and attention, learning and intellectual ability at 14 years: a prospective longitudinal study. Early Hum. Dev. 83 (2), 115–123.
Office of Disease Prevention and Health Promotion, 2019. Maternal, Infant, and Child Health. U.S. Department of Health and Human Services Accessed October 18, 2018. https://www.healthypeople.gov/2020/topics-objectives/topic/maternal-infant-and-child-health/objectives.
Oh, S., Reingle Gonzalez, J.M., Salas-Wright, C.P., Vaughn, M.G., DiNitto, D.M., 2017. Prevalence and correlates of alcohol and tobacco use among pregnant women in the United States: evidence from the NSDUH 2005–2014. Prev. Med. 97, 93–99.
Pacek, L.R., Mauro, P.M., Martins, S.S., 2015. Perceived risk of regular cannabis use in the United States from 2002 to 2012: differences by sex, age, and race/ethnicity. Drug Alcohol Depend. 149, 232–244.
Pan, I.J., Yi, H.Y., 2013. Prevalence of hospitalized live births affected by alcohol and drugs and parturient women diagnosed with substance abuse at liveborn delivery: United States, 1999–2008. Matern. Child Health J. 17 (4), 667–676.
Patra, J., Bakker, R., Irving, H., Jaddoe, V.W., Malini, S., Rehm, J., 2011. Dose-response relationship between alcohol consumption before and during pregnancy and the risks of low birthweight, preterm birth and small for gestational age (SGA): a systematic review and meta-analyses. BJOG 118 (12), 1411–1421.
Robbins, J.M., Bird, T.M., Tilford, J.M., et al., 2006. Reduction in newborns with discharge coding of in utero alcohol effects in the United States, 1993 to 2002. Arch. Pediatr. Adolesc. Med. 160 (12), 1224–1231.
Roman, L.A., Raffo, J.E., Dertz, K., et al., 2017. Understanding perspectives of African American Medicaid-insured women on the process of perinatal care: an opportunity for systems improvement. Matern. Child Health J. 21 (Suppl. 1), 81–92.
Sayal, K., Heron, J., Golding, J., Emond, A., 2007. Prenatal alcohol exposure and gender differences in childhood mental health problems: a longitudinal population-based study. Pediatrics. 119 (2), e426–e434.
Seiler, N.K., 2016. Alcohol and pregnancy: CDC's health advice and the legal rights of pregnant women. Public Health Rep. 131 (4), 623–627.
Shmulewitz, D., Greene, E.R., Hasin, D., 2015. Commonalities and differences across substance use disorders: phenomenological and epidemiological aspects. Alcohol. Clin. Exp. Res. 39 (10), 1878–1900.
Slater ME, Haughwout SP, Castle IP. Trends in Substance Use Among Reproductive-age Females in the United States, 2002–2013. Surveillance Report #103. Arlington, VA: National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health; 2015. https://pubs.niaaa.nih.gov/publications/surveillance103/SUBST01.pdf. Accessed August 13, 2018.
Slaughter-Acey, J.C., Caldwell, C.H., Misra, D.P., 2013. The influence of personal and group racism on entry into prenatal care among African American women. Womens Health Issues 23 (6), e381–e387.
Sood, B., Delaney-Black, V., Covington, C., et al., 2001. Prenatal alcohol exposure and childhood behavior at age 6 to 7 years: I. Dose-response effect. Pediatrics 108 (2), E34.
Streissguth, A.P., Sampson, P.D., Barr, H.M., 1989. Neurobehavioral dose-response effects of prenatal alcohol exposure in humans from infancy to adulthood. Ann. N. Y. Acad. Sci. 562, 145–158.
Substance Abuse and Mental Health Data Archive. Substance Abuse and Mental Health Services Administration. https://datafiles.samhsa.gov/info/browse-studies-nid3454. Accessed December 31, 2018.
Tan, C.H., Denny, C.H., Cheal, N.E., Sniezek, J.E., Kanny, D., 2015. Alcohol use and binge drinking among women of childbearing age: United States, 2011–2013. MMWR Morb. Mortal. Wkly Rep. 64 (37), 1042–1046.
Warren, K.R., 2015. A review of the history of attitudes toward drinking in pregnancy. Alcohol. Clin. Exp. Res. 39 (7), 1110–1117.
Washio, Y., C, E.M., Goldstein, N.D., Terplan, M., 2017. Characteristics of pregnant women who reported alcohol use at admission to substance use treatment. J. Subst. Abus. Treat. 82, 82–86.
Waterman, E.H., Pruett, D., Caughey, A.B., 2013. Reducing fetal alcohol exposure in the United States. Obstet. Gynecol. Surv. 68 (5), 367–378.
White, A., Castle, I.J., Chen, C.M., Shirley, M., Roach, D., Hingson, R., 2015. Converging patterns of alcohol use and related outcomes among females and males in the United States, 2002 to 2012. Alcohol. Clin. Exp. Res. 39 (9), 1712–1726.
Williams, J.F., Smith, V.C., 2015. Committee on substance abuse. Fetal alcohol spectrum disorders. Pediatrics 136 (5), e1395–e1406.
Zhao, G., Ford, E.S., Tsai, J., et al., 2012. Trends in health-related behavioral risk factors among pregnant women in the United States: 2001–2009. J. Women's Health (Larchmt) 21 (3), 255–263.