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Alcohol use and binge drinking among U.S. men, pregnant and non-pregnant women ages 18–44: 2002–2017

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ABSTRACT

Background: Drinking during pregnancy dropped sharply in the U.S. in the 1980s. More recent time trends in adult drinking and binge drinking in men, non-pregnant and pregnant women have not been directly compared.
Methods: Using logistic regression and National Surveys on Drug Use and Health (NSDUH) 2002–2017 data on any drinking and 2002–2014 data on binge drinking, trends in men, non-pregnant and pregnant women were compared. Analyses of any drinking included 470,309 participants (221,344 men; 236,197 non-pregnant women; 12,768 pregnant women); of binge drinking, 379,379 participants (178,869 men; 189,923 non-pregnant women; 10,587 pregnant women).
Results: In all participants, drinking decreased (62.2%–60.3%). Among adults ages 18–20, drinking decreased in men, non-pregnant women, and pregnant women (−18.4%; −11.1%; −5.3%), as did binge drinking (−11.8%; −5.6%; −3.7%). Among adults ages 21–44, drinking increased in non-pregnant women (+2.3%), and decreased in men and pregnant women (−2.6% and -3.3%), while binge drinking increased in non-pregnant women (+2.7%), but not in pregnant women (−1.8%) or men (0.0%).
Conclusions: Drinking increased in U.S. women ages 21–44, but not those who were pregnant. Increases in women and continuing high rates in men indicate the need for better public health efforts. Divergent trends in men, non-pregnant, and pregnant women ages 21–44 suggest differential influences on drinking. Continued low rates in pregnant women are encouraging, but maintaining public health messages about drinking during pregnancy and innovative efforts to prevent such drinking are needed. Different results in ages 18–20 and 21–44 highlight the importance of developmental stages in drinking.

1. Introduction

Alcohol use and binge use contribute to the global burden of disease (GDB 2016 Alcohol and Drug Use Collaborators, 2018), raising the risk for mortality (Stockwell et al., 2016), cancer (Rehm et al., 2019), liver and cardiovascular disease (Hydes et al., 2019; Rehm et al., 2017; Thursz et al., 2019), and alcohol use disorders/addiction (Cil, 2017). Women are at greater risk of adverse effects than men (Agabio et al., 2016; Nolen-Hoeksema and Hilt, 2006; Rehm et al., 2010; Shield et al., 2016), and drinking during pregnancy can lead to fetal alcohol spectrum disorder (FASD) and fetal alcohol syndrome (FAS) (Centers for Disease Control and Prevention, 2019a, 2019b; May et al., 2005; Popova et al., 2017), characterized by deficits in cognition, behavior, emotions, and congenital anomalies (May et al., 2018; Popova et al., 2016). Thus, understanding differential time trends in drinking and binge drinking in men and women is important, including whether trends differ between pregnant women and other adults.

Until the late 1970s, little attention focused on drinking during pregnancy. Then, as findings on FAS emerged, abstinence during pregnancy was increasingly recommended, e.g., in 1981 and 2005 U.S. Surgeon General advisories (U.S. Office of the Surgeon General, 1981, 2005) and a 1989 law requiring alcoholic beverage warning labels about birth defects due to drinking during pregnancy (27 U.S.C. II, 2019). Medical societies issued warnings (Council on Scientific Affairs, 1983), a national education campaign was launched (Warren, 2015), and television programs featured fetal alcohol syndrome (Warren, 2015).

From 1985 to 1990, American women became increasingly aware of FAS (Dufour et al., 1994). Between 1982 (National Center for Health Statistics et al., 1988) and 1988 (Centers for Disease Control and

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Prevention, 1995), the prevalence of U.S. women who drank during pregnancy decreased (45% to 20.7%). In 21 states (Serdula et al., 1991) from 1985 to 1988, drinking prevalence decreased markedly in pregnant women (32% to 20%) but not in non-pregnant women (57% to 53%). From 1998 to 2008, the proportion of pregnant women with alcohol abuse in substance abuse treatment declined (McCabe and Arndt, 2012), and the prevalence of alcohol disorders decreased among women giving birth from 1999 to 2008 (Pan and Yi, 2013). Thus, drinking in pregnant women changed markedly, coinciding with growing awareness of the risks of drinking during pregnancy (Dufour et al., 1994). The question now is whether the increasingly distinctive patterns in pregnant women have continued, whether this applies to binge drinking as well as any drinking, and how these changes compare to adult men and non-pregnant women.

A meta-analysis of past-month adult drinking and binge drinking in U.S. national survey data up to 2016 (Grucza et al., 2018) provides an overall context for understanding trends in pregnant women. Rates of drinking and binge drinking in men changed little, while rates increased in women. However, this study did not examine pregnant women, was not limited to those of reproductive age, and did not differentiate between those above and below age 21 (legal drinking age), an important distinction for drinking patterns (Keyes et al., 2015; White et al., 2015). Two studies addressed drinking trends in pregnant women using data from National Surveys Drug Use and Health (NSDUH). From 2002–2016, past-month drinking changed little in pregnant women ages 18–44 (9.6% vs. 8.4%) (Agrawal et al., 2018). However, this study did not control for changes in age among pregnant women (i.e., older average age over time) (National Center for Health Statistics and Centers for Disease Control and Prevention, 2019), separate pregnant women above and below age 21, report binge drinking, or directly compare trends to men or non-pregnant women. From 2002–2012 (White et al., 2015), little change occurred in drinking (48.1% to 45.0%) or binge drinking (29.9% to 27.1%) in females ages 18–20, while in males ages 18–20, drinking decreased (54.6% to 46.7%), as did binge drinking (43.2% to 34.1%). Among those ≥21 years, results were presented in small age groups without an explicit rationale, with mixed results. Supplementary tables suggested that among women ages 21–34, drinking and binge drinking changed little in those who were pregnant, but increased significantly in the non-pregnant women.

Thus, since 2000, drinking and binge drinking appeared to change little in men, but increased in women, while rates of drinking and binge drinking were much lower in pregnant women. What remains unknown is whether trends in any drinking and binge drinking differ among three adult groups ages 18–44: pregnant women, non-pregnant women, and men, and whether trends differ in these groups when separated into ages 18–20 and 21–44, the minimum legal drinking age. Further, apparent trends arising out of descriptive results could be due to the increasingly older age when U.S. women become pregnant (National Center for Health Statistics and Centers for Disease Control and Prevention, 2019). To determine robustness of apparent differences in group trends, analyses should control for changing age distributions within groups. Gaps in knowledge about women's drinking remain a public health issue (McCaul et al., 2019). We addressed whether time trends in drinking and binge drinking differed among adult men, non-pregnant and pregnant women ages 18–44, and whether these patterns differed between ages 18–20 and 21–44.

2. Methods

2.1. Sample and procedures

Data were drawn from the National Surveys on Drug Use and Health (NSDUH), sponsored by the Substance Abuse and Mental Health Services Administration (SAMHSA). These provide annual, cross-sectional, nationally representative U.S. data on substance use (National Survey on Drug Use and Health, 2019). Multistage probability sampling was used to select participants ages 12 or older residing in households or non-institutional group homes from the 50 states and the District of Columbia. The survey was administered by trained interviewers, using computer-assisted self-interviewing to encourage honest responses. Informed consent was obtained. Sampling weights adjusted for non-response and oversampling of young adults, Blacks, and Hispanics to represent the underlying population. Response rates were 72–77% (Grucza et al., 2018). Datasets for each year were downloaded from the NSDUH public data portal and concatenated, adding a variable indicating survey year. De-identified publicly available data were used, exempting this study from Institutional Review Board approval.

Participants ages 18–44 were analyzed, thus including most adult women of reproductive age (Furstenberg, 2000). For analyses of any drinking, 470,309 participants were included for 2002–2017: 221,344 men, 236,197 non-pregnant women, and 12,768 pregnant women. Women missing information on pregnancy status (< 1%; n = 1335) were excluded; the prevalence of missing was unchanged over time ($\beta = -0.004$ [se = .01], p = .65). For analyses of binge drinking, participants were included for 2002–2014 because the NSDUH binge drinking measure for women changed after that. A total of 379,379 respondents were included: 178,869 men, 189,923 non-pregnant women, and 10,587 pregnant women. Women missing information on pregnancy status (< 1%; n = 1096) were excluded; the prevalence of missing was unchanged over time ($\beta = 0.013$ [se = .01], p = .33).

2.2. Measures

2.2.1. Outcomes: past month alcohol use and binge drinking

Alcohol use was assessed by asking when respondents had their last alcoholic drink; those responding "within the past 30 days" were considered positive for any past-month use. For binge drinking, respondents were considered positive if they had ≥5 drinks on the same occasion in the prior 30 days; (≥4 drinks for women was not asked until 2015, thus not providing sufficient years for analysis).

2.2.2. Main predictor: gender/pregnancy status

We created a 3-level gender/pregnancy variable: male; non-pregnant female; and pregnant female (determined by "yes" responses to the question, "are you currently pregnant?").

2.2.3. Sociodemographic covariates

These included: age (18–20; 21–25; 26–34; 35–44); race/ethnicity (non-Hispanic White; non-Hispanic Black; Hispanic; Other); education (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).

2.2.4. Parenting status

As an exploratory analysis, we created a variable indicating parenting status. The parenting group was defined as respondents with one or more of their own children below age 18 in the household; all others were classified in the non-parenting group.

2.3. Statistical analysis

Logistic regression was used to model past-month alcohol use or binge drinking as a function of interview year (continuous predictor, 2002–2014 or 2002–2017), adjusted for sociodemographic covariates. To derive prevalences, model-predicted marginal log-odds of outcome were back-transformed. Change over time (trend) was calculated as the difference between model-predicted prevalence at the end-points, which incorporate prevalence over all the years. The difference for 2017 and 2002 indicated the trend for any drinking, and the difference for 2014 and 2002 indicated the trend for binge drinking. To determine if trends differed in men, non-pregnant, and pregnant women, interaction of year and the three-level gender/pregnancy variable was

Table 1
Change in prevalence of any past month drinking in men, non-pregnant and pregnant women, NSDUH 2002–2017.

	Prevalence[a] % (SE)		Change over time[d] % (SE)	Difference in change over time between subgroups[e] % (SE)
	2002	2017		
Ages 18-44[b]				
Whole set (n = 470,309)[c]	62.2 (.23)	60.3 (.19)	−1.9 (.34)[i]	
Non-pregnant women (n = 236,197)	57.4 (.34)	58.2 (.28)	+0.8 (.52)	Reference
Pregnant women (n = 12,768)	13.4 (1.16)	9.9 (.87)	−3.5 (1.56)[f]	−4.3 (1.67)[g]
Men (n = 221,344)	69.1 (.30)	64.6 (.29)	−4.4 (.48)[i]	−5.3 (.73)[i]
Ages 18-20				
Whole set (n = 106,215)[c]	54.8 (.46)	40.0 (.50)	−14.8 (.78)[i]	
Non-pregnant women (n = 51,212)	51.4 (.64)	40.3 (.69)	−11.1 (1.08)[i]	Reference
Pregnant women (n = 2556)	13.3 (2.71)	8.0 (1.99)	−5.3 (3.95)	+5.8 (3.95)
Men (n = 52,447)	59.1 (.61)	40.8 (.56)	−18.4 (.99)[i]	−7.3 (1.35)[i]
Ages 21-44[b]				
Whole set (n = 364,094)[c]	63.0 (.21)	63.2 (.25)	−0.2 (.38)	
Non-pregnant women (n = 184,985)	58.2 (.36)	60.5 (.30)	+2.3 (.56)[i]	Reference
Pregnant women (n = 10,212)	13.4 (1.24)	10.1 (.95)	−3.3 (1.66)[f]	−5.6 (1.75)[g]
Men (n = 168,897)	70.4 (.33)	67.8 (.32)	−2.6 (.55)[i]	−4.9 (.79)[i]

[a]Adjusted for race/ethnicity, education, income, and marital status.
[b]Also adjusted for age.
[c]Also adjusted for gender/pregnancy status.
[d]Change over time is calculated as prevalence in 2017 minus prevalence in 2002; prevalences were back-transformed from predicted marginal log-odds. A significant difference shows that prevalence changed over time, with a positive value indicating increase over time and a negative value indicating decrease over time.
[e]To determine if rates of change over time differed between gender/pregnancy subgroups, the change over time (prevalence in 2017 minus prevalence in 2002) in the non-pregnant women (reference group) was subtracted from the change over time in each other group. A value significantly different from zero indicates differences in rates of change.
p-values: [f] < .05; [g] ≤ .01; [h] ≤ .001; [i] ≤ .0001.

included in the regression model, as well as covariate*gender/pregnancy interaction terms to allow covariate effects to differ among men, non-pregnant women, and pregnant women. For each group (men, non-pregnant women, and pregnant women), prevalence differences (trends) were estimated. Then, interaction contrasts estimated the difference in trends between non-pregnant women and men, and between non-pregnant and pregnant women (Rothman et al., 2008). An interaction contrast significantly different from zero indicates that the trends differ significantly. Wald t-tests assessed the statistical significance of each of the prevalence differences and interaction contrasts. Regression models were also used to generate year-to-year adjusted prevalence for figures by treating year as a categorical predictor.

Previous studies in NSDUH data suggested that those below and above age 21 (legal drinking age) had opposite time trends in drinking, with decreases in those under 21 and increases in those 21 and older (Slater et al., 2015; White et al., 2015). Therefore, to extend this to our three-level gender/pregnancy variable, we used the logistic regression models as above, with two additional interaction terms: interaction of year and age (18–20; 21–44), and the three-way interaction of year, age, and gender/pregnancy. Overall, we estimated the prevalence differences (time trend) in each age group, and differences in the trends between ages 18–20 and 21–44. Then, for each gender/pregnancy group, we estimated the trend in each age group and the differences in the trends between age groups. Due to significant differences in trends between ages 18–20 and 21–44, analyses of trend differences by gender/pregnancy (described above) were also carried out separately in those age groups.

All analyses were conducted using SUDAAN 11.0.1, using sample weights and adjusting for the NSDUH complex survey design. New sample weights were created by dividing the original weight by the number of datasets combined, per SAMHSA recommendations and procedures used previously (Carliner et al., 2017).

2.4. Sensitivity analysis

The average age of pregnant women has increased over time (National Center for Health Statistics and Centers for Disease Control and Prevention, 2019), and in adults, age is inversely related to alcohol consumption. Therefore, sensitivity analyses determined if these age shifts could partially explain the trends in drinking over time in pregnant women ages 21–44. For any drinking and binge drinking, two additional terms were added to the logistic regression model described above: interaction of year and age (21–25; 26–34; 35–44), and three-way interaction of year, age, and gender/pregnancy. Results from these models indicated whether differential trends by gender/pregnancy remained after adjusting for these changes in age distribution.

2.5. Exploratory analysis

Besides the potential damage due to binge drinking during pregnancy (Centers for Disease Control and Prevention, 2019a, b), binge drinking by any parent may cause harm to their children (Donaldson et al., 2016; Lund et al., 2015), warranting exploration of binge drinking among parents. In those ages 21–44, logistic regression was carried out to determine if binge drinking (outcome) was associated with parenting status (predictor), adjusting for gender/pregnancy and sociodemographic covariates. Association was assessed by evaluating the prevalence difference between parenting and non-parenting adults, after back-transformation of the marginal log-odds. Then, a term indicating interaction between parenting status and gender/pregnancy was included in the regression model, to determine if the association of parenting and binge drinking differed by gender/pregnancy, by evaluating if the prevalence differences (between parenting and non-parenting adults) differed between men, pregnant women, and non-pregnant women (reference group).

3. Results

3.1. Sample characteristics

Across all years, 50.4% were women (2.1% pregnant; 48.3% non-pregnant), and 49.6% were men (Supplementary Table 1). Of the pregnant women, ~75% were ages 21–34, while ~50% of the non-pregnant women and men were in that age range. More pregnant

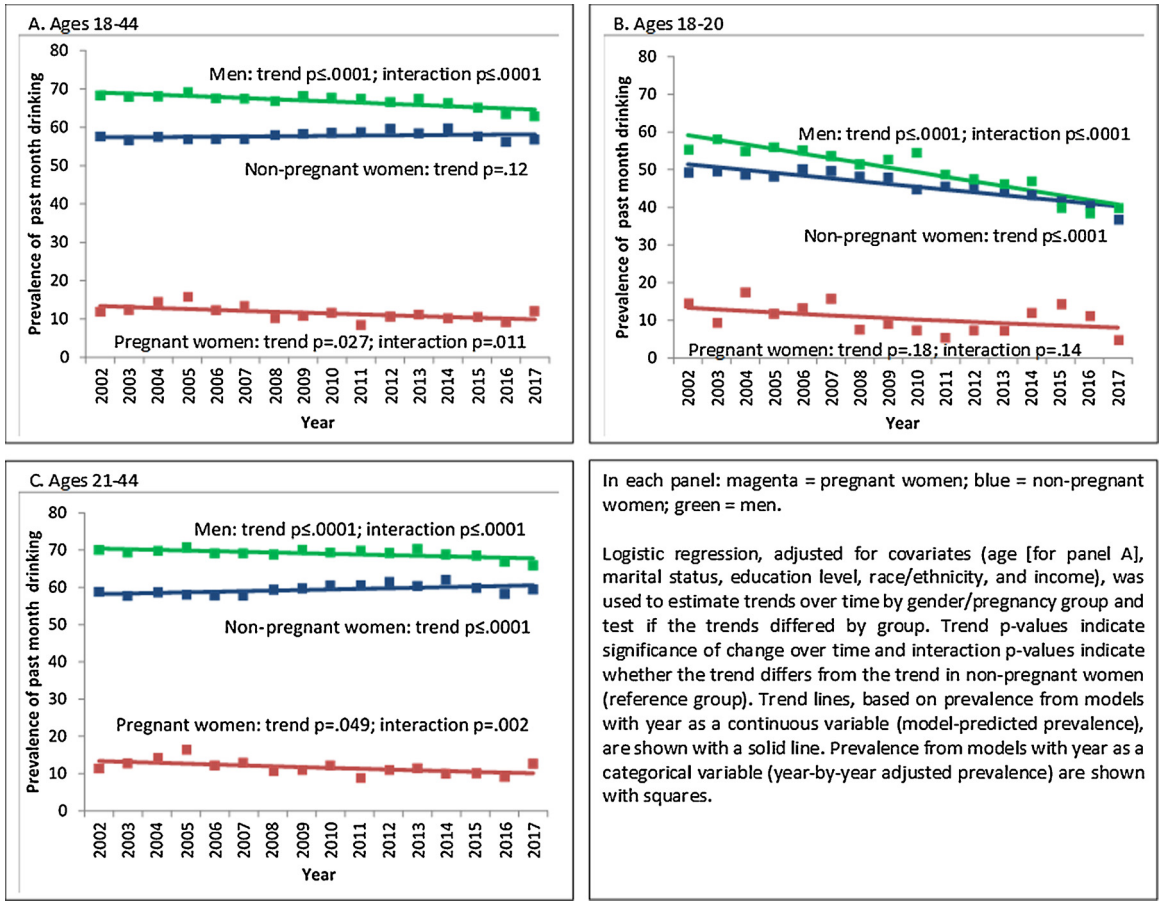

Fig. 1. Change in prevalence of any past-month alcohol use among men, pregnant and non-pregnant women, NSDUH 2002–2017.

women were married (~60%) then non-pregnant women (46% married) and men (42% married). In all three groups, about 60% were non-Hispanic White, about half had income levels ≥$50,000, and ~85% had high school education or more.

3.2. Trends in past-month alcohol use, 2002–2017

Combining all participants ages 18–44, alcohol use decreased from 62.2% to 60.3% (p ≤ .0001), a prevalence change of −1.9% (Table 1). The prevalence change was −3.5% (p = .027) in pregnant women and −4.4% (p ≤ .0001) in men, while in non-pregnant women, the prevalence of drinking was essentially unchanged (+0.8%; p = .12). Fig. 1A displays the results across time (years). Interaction tests showed that trends in non-pregnant women differed from pregnant women (p = .011) and men (p ≤ .0001). Between ages 18–20 and 21–44, trends differed significantly in the whole sample (interaction p ≤ .0001), as well as within men (interaction p ≤ .0001) and non-pregnant women (interaction p ≤ .0001), but not within pregnant women (interaction p = .79).

Within ages 18–20, alcohol use decreased substantially over time (prevalence change, −14.8%; p ≤ .0001). The prevalence change was −11.1% (p ≤ .0001) in non-pregnant women, −18.4% (p ≤ .0001) in men and −5.3% (p = .18) in pregnant women (Fig. 1B). Interaction tests showed that over time, men had a significantly greater decrease than non-pregnant women (interaction p ≤ .0001), resulting in near-convergence by 2017, but the rate of change did not differ between pregnant and non-pregnant women (interaction p = .14).

Within ages 21–44, the overall prevalence of alcohol use changed little (−0.2%). However, this apparent lack of change obscured an increase in non-pregnant women (prevalence change +2.3%; p ≤ .0001) and decreases in men (−2.6%; p ≤ .0001) and pregnant women (−3.3%; p = .049) (Fig. 1C). Interaction tests showed that the trends over time differed between non-pregnant and pregnant women (interaction p = .002) and between non-pregnant women and men (interaction p ≤ .0001).

3.3. Trends in binge drinking, 2002–2014

Combining all participants ages 18–44, binge drinking showed little change overall (33.8% in 2002, 33.9% in 2014; Table 2), but decreases were observed in pregnant women (prevalence change −1.9%; p = .018) and men (prevalence change −1.4%; p = .017), while in contrast, prevalence increased (+1.7%; p = .0003) in non-pregnant women (Fig. 2A). Interaction tests showed that non-pregnant women differed from pregnant women (interaction p = .0003) and men (interaction p ≤ .0001). Between ages 18–20 and 21–44, trends differed significantly in the whole sample (interaction p ≤ .0001), among men (interaction p ≤ .0001), and among non-pregnant women (interaction p ≤ .0001), although not among pregnant women (interaction p = .73).

Within ages 18–20, binge drinking decreased (prevalence change -8.7%; p ≤ .0001), with decreases in non-pregnant women (prevalence change −5.6%; p ≤ .0001), men (prevalence change −11.8%; p ≤ .0001), and pregnant women (prevalence change −3.7%; p = .089) (Fig. 2B). Interaction tests showed that men decreased more than non-pregnant women (interaction p ≤ .0001), while the rate of change in pregnant and non-pregnant women did not differ (interaction p = .47).

Within ages 21–44, binge drinking increased (prevalence change +1.3%; p = .002). In non-pregnant women, the prevalence change was +2.7% (p ≤ .0001), while in contrast, the prevalence change was −1.8% (p = .045) in pregnant women, and 0.0% in men (Fig. 2C).

Table 2
Change in prevalence of past month binge drinking in men, non-pregnant and pregnant women, NSDUH 2002–2014.

	Prevalence[a] % (SE)		Change over time[d] % (SE)	Difference in change over time between subgroups[e] % (SE)
	2002	2014		
Ages 18-44[b]				
Whole set (n = 379,379)[c]	33.8 (.24)	33.9 (.22)	+0.1 (.38)	
Non-pregnant women (n = 189,923)	24.9 (.27)	26.6 (.30)	+1.7 (.48)[h]	Reference
Pregnant women (n = 10,587)	4.7 (.64)	2.9 (.41)	−1.9 (.80)[f]	−3.8 (.99)[h]
Men (n = 178,869)	43.7 (.36)	42.3 (.33)	−1.4 (.58)[f]	−3.1 (.72)[i]
Ages 18-20				
Whole set (n = 91,041)[c]	38.5 (.45)	29.7 (.46)	−8.7 (.74)[i]	
Non-pregnant women (n = 43,849)	31.8 (.63)	26.2 (.64)	−5.6 (1.05)[i]	Reference
Pregnant women (n = 2280)	7.7 (1.82)	4.0 (.91)	−3.7 (2.18)	1.8 (2.53)
Men (n = 44,912)	45.7 (.62)	33.9 (.59)	−11.8 (1.00)[i]	−6.2 (1.40)[i]
Ages 21-44[b]				
Whole set (n = 288,338)[c]	33.2 (.26)	34.5 (.23)	+1.3 (.42)[g]	
Non-pregnant women (n = 146,074)	24.0 (.28)	26.7 (.32)	+2.7 (.51)[i]	Reference
Pregnant women (n = 8307)	4.5 (.71)	2.7 (.44)	−1.8 (.88)[f]	−4.5 (1.07)[i]
Men (n = 133,957)	43.5 (.40)	43.5 (.36)	+0.0 (.64)	−2.7 (.79)[h]

[a]Adjusted for race/ethnicity, education, income, and marital status.
[b]Also adjusted for age.
[c]Also adjusted for gender/pregnancy status.
[d]Change over time is calculated as prevalence in 2014 minus prevalence in 2002; prevalences were back-transformed from predicted marginal log-odds. A significant difference shows that prevalence changed over time, with a positive value indicating increase over time and a negative value indicating decrease over time.
[e]To determine if rates of change over time differed between gender/pregnancy subgroups, the change over time (prevalence in 2014 minus prevalence in 2002) in the non-pregnant women (reference group) was subtracted from the change over time in each other group. A value significantly different from zero indicates differences in rates of change.
p-values: [f] < .05; [g] ≤ .01; [h] ≤ .001; [i] ≤ .0001.

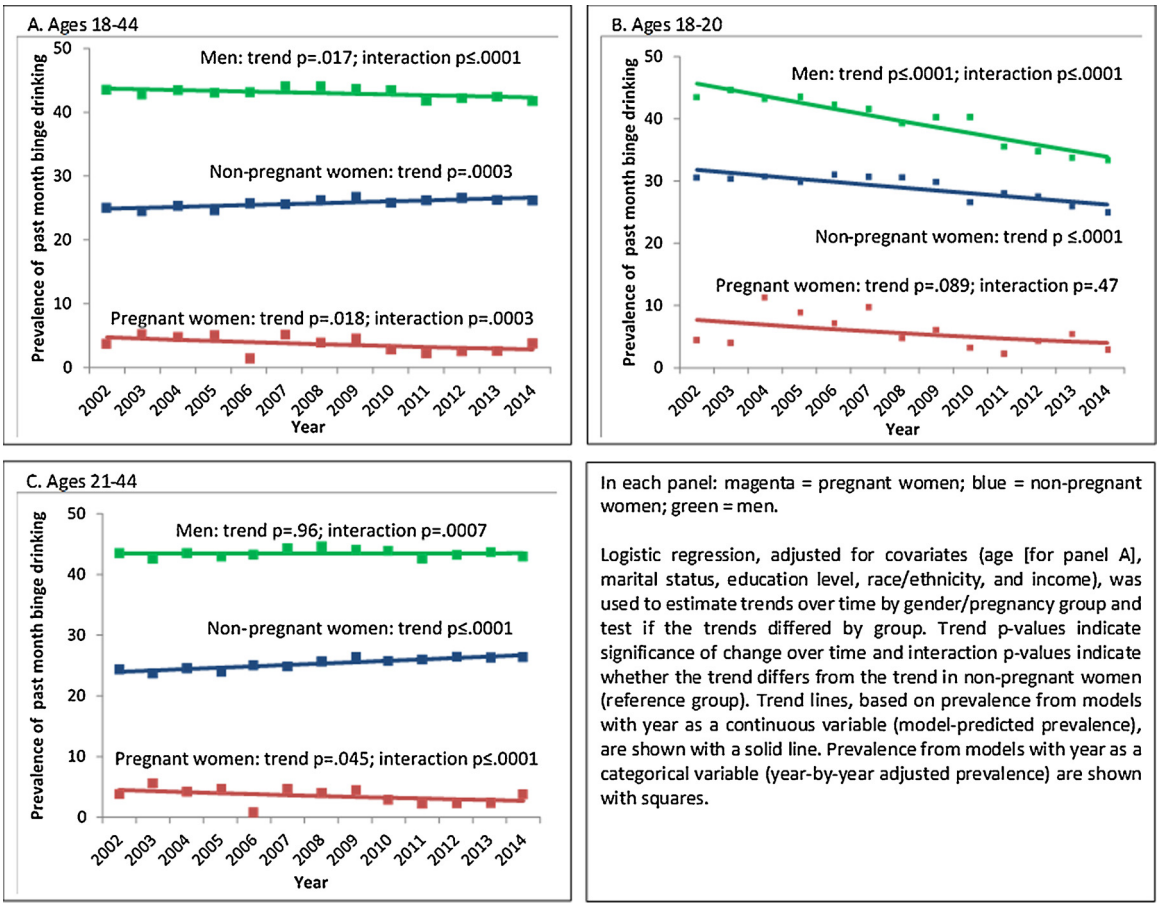

Fig. 2. Change in prevalence of past-month binge drinking among men, pregnant and non-pregnant women, NSDUH 2002–2014.

Interaction tests of differences in trends over time showed that non-pregnant women differed from pregnant women (interaction $p \leq .0001$) and men (interaction $p = .0007$).

3.4. Sensitivity analyses

In adults ages 21–44, after adjusting for changes in age distribution over time (i.e., pregnant women becoming older on average), most results remained similar to the main analysis. The one exception was that for any past month drinking, there was a smaller decrease in pregnant women (prevalence change -2.6%, $p = .22$). However, importantly, the trends in pregnant women and men continued to differ from the trends in non-pregnant women (Supplementary Table 2).

3.5. Exploratory analysis

In ages 21–44, binge drinking prevalence was lower in parenting adults than non-parenting adults (prevalence difference −3.5%, $p \leq .0001$), and among non-pregnant women (−5.4%, $p \leq .0001$), pregnant women (−2.3%, $p = .001$), and men (−2.3%, $p \leq .0001$), with a stronger protective effect (greater difference) in non-pregnant women as compared to pregnant women ($p \leq .0001$) or men ($p \leq .0001$; Supplementary Table 3).

4. Discussion

Using data since 2002 from U.S. nationally representative surveys, the prevalence of past-month alcohol use in adults ages 18–44 decreased overall, while the prevalence of past-month binge drinking was unchanged. However, combining men, non-pregnant and pregnant women obscured important differences by age and gender. Among ages 18–20, alcohol use and binge drinking decreased in men, pregnant- and non-pregnant women, with men decreasing more than women. Among ages 21–44, past-month alcohol use and binge drinking increased in non-pregnant women and decreased or remained unchanged in men and pregnant women. The variation in these changes among adults ages 21–44 illustrates two contrasts. One was the increasing divergence in drinking and binge drinking among pregnant and non-pregnant women, with rates increasing in non-pregnant women and decreasing in pregnant women. The other contrast was the increasing convergence in drinking and binge drinking of non-pregnant women and men, with rates in men remaining relatively stable but increasing in non-pregnant women. Results adjusted for the increasingly older age at which women become pregnant had little effect on these findings.

Different trends in ages 18–20 and 21–44 highlight the importance of age or developmental stage in drinking. These differing trends may be related to the U.S. minimum legal drinking age (21 years). However, the later ages at which adult social roles are now assumed (Arnett et al., 2014; Furstenberg, 2000; Furstenberg et al., 2004) may be making the lives of those ages 18–20 increasingly similar to adolescents rather than to adults. Declines in rates of adolescent drinking and binge drinking have been pronounced (Jang et al., 2017; Monitoring the Future, 2018). The consistency of our findings in ages 18–20 to trends in adolescents suggests the importance of examining ages 18–20 separately from other adults, although NSDUH considers participants ages 18–20 to be adults and typically groups them with other “young adults” ages 18-25. Results also suggest that alcohol prevention efforts focus broadly across the years of transition to adulthood rather than limiting the focus to the teenage years.

The divergent time trends in men, non-pregnant and pregnant women ages 21–44 suggest that influences on drinking differ in these groups, and/or that exposure to such influences is changing over time. For example, the decreases or lack of change in men may reflect decreased interest in drinking or in spending scarce resources on alcohol, decreasing interest in going to bars (Nyaronga et al., 2009), or shifts to other substances as cannabis laws have become more permissive and opioids have become more available. However, although rates in men are not increasing, they remain high. Further, there is no indication that mechanisms that may influence the lack of trends in men such as increased availability of other substances are gender-specific. Thus, more information is needed about factors maintaining the high rates in men so that more effective prevention strategies can be designed and implemented.

For non-pregnant women, the increases are notable, and consistent with a growing body of research indicating increases in alcohol use and binge drinking among women in the U.S. in the past decade (Keyes et al., 2019). The increases in adult non-pregnant women may be due to changing norms around alcohol use (e.g., disseminated through social media) (Lindsay and Supski, 2017), reduced social sanctions against heavy use among those with higher educational attainment (Keyes et al., 2019), or changes in alcohol branding and marketing (Petticrew et al., 2017), with an increasing number of products aimed at women and mothers (Kindy and Keating, 2016). Increases in women are particularly concerning because of the relatively greater negative health consequences of heavy drinking in women (Agabio et al., 2016; Nolen-Hoeksema and Hilt, 2006; Rehm et al., 2010; Shield et al., 2016) and possible fetal damage if binge drinking occurs among women who are unaware that they are pregnant. Further studies are needed to better identify the groups of women ages 21–44 who are at particularly high risk of binge drinking, and the mechanisms underlying such drinking. In the meantime, a need clearly exists for better, clearer public health education about the risks and consequences of binge drinking for adult women.

Rates of drinking and binge drinking in pregnant women since 2002 are markedly lower than they were in the 1980s, when information about the risks of drinking during pregnancy for FASD was first widely disseminated. Furthermore, drinking and binge drinking during pregnancy have decreased over time. In pregnant women ages 21–44, these decreases contrasted sharply with the increases among their non-pregnant counterparts. The widespread, ongoing public health messaging about the risks to the fetus of drinking during pregnancy appears to have influenced women’s drinking behavior when they know they are pregnant. One of the earliest advisories about drinking during pregnancy (1977) recommended low levels but not abstinence, due to uncertainty about the level that actually increases risk (Warren, 2015). Despite this, the 1981 Surgeon General recommended abstinence as the most prudent course to avoid fetal harm. The debate continues about the harmfulness of drinking at low levels during pregnancy (Mamluk et al., 2017; McCormack et al., 2018). Continued recommendations for abstinence from the American Academy of Pediatrics (Williams et al., 2015) and the Centers for Disease Control and Prevention (Centers for Disease Control and Prevention, 2016) can be perceived by the media and lay public as overly restrictive and paternalistic (Haelle, 2016), and a more nuanced public health message about drinking while pregnant may be more consistent with the evidence. However, when public health messages are complex, they are difficult to convey, and attempting to add nuance to the current abstinence recommendations may work against the sharp drop in drinking during pregnancy that has been achieved in the U.S. since the early 1980s.

Despite these decreases, results indicate that a substantial number of women drink or binge-drink alcohol during their pregnancies. Additionally, drinking during pregnancy may be under-reported, either because women who are unaware of their pregnancy are in the “non-pregnant” group, or because pregnant women who know about the negative consequences of heavy drinking may be less likely to accurately report their drinking. Thus, drinking during pregnancy remains a public health issue. During pregnancy, health care providers should address alcohol use in a respectful, non-punitive manner, offering advice or referral to appropriate resources as needed. Additionally, the highest risk for drinking is in early pregnancy (first trimester) (Shmulewitz and Hasin, 2019), due in part to women drinking before they know they are pregnant. Policies that are not helpful in reducing

drinking during pregnancy are those that punish the mother (Roberts et al., 2019; Subbaraman et al., 2018), which may deter women from seeking prenatal care. Strategies to help reduce drinking during pregnancy include ensuring that women who do not wish to become pregnant have reliable birth control, limiting prenatal alcohol exposure in unintended pregnancies. Also, point-of-sale alcohol warning signs decrease binge drinking during pregnancy in studies using individually-reported drinking (Cil, 2017; Roberts et al., 2019). A more innovative approach is to provide pregnancy test dispensing and FASD messaging in restrooms where women are likely to drink heavily, e.g., bars and restaurants (Driscoll et al., 2018). General public health strategies that decrease drinking in non-pregnant women of reproductive age would also decrease drinking in early pregnancy, when alcohol, especially binge drinking, can cause the most severe damage to the fetus (Centers for Disease Control and Prevention, 2019a, b).

In addition to the potential fetal damage due to binge drinking, binge drinking among all parents may prove harmful to their children (Donaldson et al., 2016; Lund et al., 2015). In exploratory analysis, parents were less likely to binge drink, overall, and in men, non-pregnant women, and pregnant women, with the strongest protective effect in non-pregnant women. Yet, binge drinking among parents was prevalent in men and non-pregnant women, and whether trends in drinking differ among parents and non-parents is unknown. Further research into binge drinking among parents and differences by gender/pregnancy is warranted, to limit potential harm to children.

Study limitations are noted. Women unaware of their pregnancy during the survey were included in the non-pregnant group. Alcohol use could be under-reported, although NSDUH's computerized self-administered interviews should encourage honest answers, and pregnancy questions are asked only after the completion of the drinking questions. Drinking, assessed for the past 30 days, did not capture drinking across the entire pregnancy. After 2014, the binge drinking definition for women was changed to ≥ 4 drinks per occasion; additional studies should be conducted when sufficient new data for analysis become available. Because NSDUH is cross-sectional, age trajectories and how these might have differed by birth cohort were not addressed. Due to the low prevalence of drinking and binge drinking in pregnancy, larger samples of pregnant women are needed to provide better trend estimates, particularly in the 18–20 age group and to disaggregate pregnant women by pregnancy stage (Shmulewitz and Hasin, 2019). This study also had important strengths. First, over 470,000 respondents spanning 16 years were analyzed, including almost 13,000 pregnant women. Nationally representative data increased generalizability. This is the first study to examine trends separately in pregnant women and non-pregnant women, overall and within each age group, and to compare these trends to men.

4.1. Conclusions

In conclusion, time trends in drinking and binge drinking differ considerably in men, pregnant and non-pregnant women. Results showed the importance of separating pregnant from non-pregnant women when comparing women and men, given how different the trends were between pregnant and non-pregnant women. While continuing decreases in drinking and binge drinking in pregnant women are encouraging, continued public health efforts to reduce such drinking are important. Further efforts are warranted to stem the increases in non-pregnant adult women, and to bring down the high rates that remain among adult men.

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Contributors

All authors have contributed to and approved the final manuscript. Study concept and design: Hasin, Shmulewitz. Acquisition, statistical analysis, and interpretation of data: Hasin, Shmulewitz, Keyes. Drafting of the manuscript: Hasin, Shmulewitz. Critical revision of the manuscript: Hasin, Shmulewitz, Keyes. Intellectual content: Hasin, Shmulewitz, Keyes. Administrative support and study supervision: Hasin.

Declaration of Competing Interest

No conflict declared.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.drugalcdep.2019.107590.

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