Is Preconception Substance Use Associated with Unplanned or Poorly Timed Pregnancy?

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Abstract

Objective—Unplanned and poorly timed pregnancies are associated with adverse maternal and neonatal outcomes. Further understanding of preconception substance use with unplanned and poorly timed pregnancy is warranted.

Methods—Data were analyzed from a prospective study enrolling women early in pregnancy. Preconception tobacco, alcohol, marijuana, opioid, and cocaine use was ascertained. Participants reported whether their current pregnancy was planned and whether it was a good time to be pregnant. Multivariable logistic regression modeling generated risk estimates for preconception substance use and pregnancy planning and timing, adjusting for confounders.

Results—Overall 37.2% reported unplanned pregnancy, 13.0% poorly timed pregnancy, and 39.0% reported either unplanned and/or poorly timed pregnancy. Within six months preconception, one-fifth (20.2%) reported nicotine cigarette use. In the month before conception, 71.8% reported alcohol use, 6.5% marijuana, and approximately 1% opioid or cocaine use. Multivariable analysis demonstrated preconception opioid use was associated with increased odds of poorly timed pregnancy, OR=2.87, 95% CI 1.03–7.99. Binge drinking the month prior to conception was associated with increased odds of poorly timed pregnancy and unplanned pregnancy, OR=1.75, 95% CI 1.01–3.05 and OR=1.68, 95% CI 1.01–2.79, respectively. Marijuana use 2–3 times in the month preconception was associated with increased risk of unplanned pregnancy and unplanned and/or poorly timed pregnancy compared to nonuse, OR=1.78 (95% CI 1.03–3.08) and OR=1.79 (95% CI 1.01, 3.17), respectively. Preconception tobacco or cocaine use was not associated with unplanned or poorly timed pregnancy following adjustment.

Conclusions—We demonstrate increased odds of unplanned or poorly timed pregnancy among women with preconception binge drinking, marijuana use, and opioid use; however, no association is observed with other substances after multivariable adjustment, including tobacco. Further research to evaluate high-level preconception substance use and substance disorders with

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pregnancy planning and timing is warranted. Focused efforts optimizing preconception health behaviors and reducing risk of unplanned or poorly timed pregnancy are needed.

Keywords

preconception; substance use; unintended pregnancy; unplanned pregnancy

INTRODUCTION

Unplanned and unintended pregnancies are important to individuals and society as they are associated with poor psychological, emotional and social outcomes for mothers including depression and anxiety, adverse neonatal outcomes, later initiation of prenatal care, and lower rates of breastfeeding (Brown & Eisenberg, 1995; Gariepy et al., 2016: Lindberg et al., 2015). Almost half of all pregnancies in the United States are unintended (Finer & Zolna, 2016), with unintended pregnancy often assessed retrospective to pregnancy. As such, there is a need for improved assessment and definition of these unique pregnancy perspectives (Mumford et al. 2016; Aiken et al, 2016). Unplanned pregnancy represents multiple dimensions and constructs that may include pregnancies that are unintended, unwanted (pregnancies that occurred when the woman did not want to be pregnant now or in the future) and mistimed (occurred earlier than desired). We can better understand paradigms of pregnancy planning through a conceptual model (Aiken et al., 2016), accounting for external (e.g. socioeconomic, environmental) and internal (e.g. perceptions regarding contraception) factors as well as perceptions of pregnancy when evaluating pregnancy-related behaviors. Such a framework may serve to further expand the scope of pregnancy perspectives beyond unintended pregnancy, address preconception behaviors including substance use, and better understand the public health impact associated with these measures.

For women who are not planning or intending to become pregnant, some health behaviors and exposures that occur prior to conception may not be optimal for a pregnancy. Guidelines for optimizing preconception care include promotion of healthy behaviors and avoidance of alcohol, tobacco, and illicit drugs (ACOG 2005; CDC 2012; Shawe et al., 2015). However, preconception health guidance varies and may not address parameters of pregnancy intention, gaps in preconception health knowledge, and specific preconception behaviors (Toivonen et al., 2017). To date, research examining preconception substance use and unplanned pregnancy is limited, and often based on retrospective study methodology including assessment of substance use after pregnancy resolution, and often lacking appropriate control of confounders. Findings previously reported that women who binge drink or use illicit substances including marijuana engage in sexual behaviors that place them at increased risk for unplanned or poorly timed pregnancies including early sexual initiation, multiple sexual partners, inconsistent use of condoms or unprotected intercourse, and unintended intercourse while intoxicated or under the influence (Baskin-Sommers & Sommers, 2006; Brook et al., 2004; Tapert et al., 2001; van Gelder et al., 2011). However, differences in study methodology including evaluation of pregnancy intention and preconception substance use among a non-pregnant population of women (Chuang et al., 2010; Chuang et al., 2011), or postpartum assessment of preconception substance exposure

among individuals with livebirths only (Dott et al., 2010; Krans et al., 2013; Niami et al., 2003) may contribute to inconsistent findings. Therefore, the relationship between preconception substance use and poorly timed or unplanned pregnancy warrants further investigation.

To address this issue, we evaluated the association between preconception tobacco, alcohol, marijuana, opioid, and cocaine use with unplanned or poorly timed pregnancy among a cohort of pregnant women. Given the association of alcohol, tobacco, and illicit substances with high risk sexual behavior, including lack of contraception use which can lead to unplanned and poorly timed pregnancies, we hypothesized that women with preconception substance use (tobacco, alcohol, marijuana, opioid, cocaine) would be more likely to have an unplanned or poorly timed pregnancies compared to women without substance use. By investigating this relationship, there may be an opportunity to identify women at risk for unplanned or poorly timed pregnancy and develop interventions focused on increasing contraception access and use, and optimizing healthy preconception behaviors.

METHODS

Study cohort

We performed a secondary analysis of data from a prospective cohort study examining the association of Major Depressive Episodes (MDE) and/or antidepressant medication use in pregnancy with adverse birth outcomes (Yonkers et al, 2011; Yonkers et al., 2012). Research staff recruited and enrolled pregnant women receiving prenatal care from 137 obstetric practices and hospital-based clinics in Connecticut and western Massachusetts between 2005 and 2009. Eligibility criteria included women 16–18 years and older (depending on enrollment site), less than 17 weeks estimated gestational age (EGA) at enrollment with a presumed singleton pregnancy, speaking English or Spanish, and having access to a telephone. Women were excluded if they were planning to terminate their pregnancy, intending to relocate, or had insulin dependent diabetes. The initial home interview was conducted before 18 weeks' EGA. Detailed study methods, including recruitment, enrollment, and assessment procedures, and research staff training have been reported previously (Yonkers et al., 2011; Yonkers et al., 2012). Yale University Institutional Review Board provided human subjects approval for the original study.

Preconception substance use assessment

At the initial interview, preconception substance use was ascertained, including: tobacco use in the 6 months prior to conception, and alcohol, marijuana, opioid (methadone and oxycontin), and cocaine use in the month before conception. Preconception tobacco use was categorized as: none, 1–9 cigarettes per day, 10–19 cigarettes per day, and 20+ cigarettes per day (Fergusson, 1998). We evaluated preconception alcohol use using detailed information ascertained for beverage type, amount of consumption, and frequency of use during the month before conception. Alcohol exposure was categorized as: none, up to one drink per day, 1< 2 drinks per day, 2 or more drinks per day, binge drinking (defined as 4 or more drinks per occasion), and 'heavy drinking'. The category of 'heavy drinking' was defined using National Institute of Alcohol Abuse and Alcoholism (NIAAA) criteria as: binge

drinking (4 or more drinks per occasion for women) on 5 or more days during the past month (NIAAA). Levels of preconception alcohol use including binge drinking and heavy drinking were evaluated as mutually exclusive categories, therefore 'binge' drinking only included women who did not meet the criteria of 'heavy drinking.' Alcohol exposure categories were developed to provide distinction regarding level of exposure and specific behavior or patterns of exposure (e.g. binge drinking). Marijuana use was defined as: none, 2–3 times per month, 1–6 times per week, and 1–4 times per day. Tobacco, alcohol, and marijuana assessment also included dichotomous measures of any exposure (yes/no). Opioid and cocaine use were defined as any reported use (yes/no) the month before pregnancy. While the interview included assessment of other illicit exposures including lysergic acid diethylamide (LSD), methamphetamines, and heroin, the number of participants reporting preconception exposure to these substances (<0.2% of study sample) was too few for statistical analysis.

Pregnancy planning and timing outcome assessment

Pregnancy planning and timing were assessed at the home interview. Participants were asked: "Was this pregnancy planned? Yes/No" defining planned/unplanned pregnancy. Study participants were also asked: "Do you think this is a good time for you to be pregnant? Yes/No" defining well timed/poorly timed pregnancy. Additionally, we developed a dichotomous measure of planning and timing by grouping individuals indicating their pregnancy was poorly timed and/or unplanned, compared to those who indicated their pregnancy was both planned and well-timed.

Potential confounding variables

Sociodemographic and clinical data were obtained, including maternal age, race and ethnicity, level of education, relationship status, parity, medical history, and reproductive history. Psychiatric diagnoses within 6 months prior to pregnancy including Major Depressive Episode (MDE), minor depressive symptoms, Post-Traumatic Stress Disorder (PTSD), Generalized Anxiety Disorder (GAD), Panic disorder, and sexual molestation or abuse prior to age 18 were also ascertained at the home interview and evaluated for this analysis, as substance use disorders are associated with psychiatric conditions (SAMSHA, 2016) and history of adolescent physical or sexual abuse (Kilpatrick et al., 2003). MDE was evaluated using the World Mental Health Composite International Diagnostic Interview v2.1 (WMH-CIDI) (CIDI) module for depression (Wittchen H-U 1994); Panic disorder and GAD were assessed using CIDI modules and PTSD determined through administration of the modified posttraumatic Stress Disorder Symptom Scale (Falsetti et al., 1993).

Statistical analysis

Bivariate analyses of demographic variables and preconception substance use with dichotomized measures of pregnancy planning and timing were performed using chi-square or Fisher exact test where appropriate. Potential confounders were evaluated by examining bivariate tests of association. Covariates meeting criteria of $p<0.15$ for association with specific preconception substance use and outcome (planning/timing) under consideration were included in specific multivariable models accordingly as potential confounders. Unadjusted and multivariable logistic regression was used to calculate odds ratios (OR) and

95% confidence intervals (CI) for preconception substance use and pregnancy planning and timing. Separate models were generated for individual preconception substance exposures with pregnancy planning and timing as independent dichotomous outcomes. Final models were developed using multivariable logistic regression including potential confounders. SAS 9.4 (SAS Institute, Cary, NC) was used for statistical analysis.

RESULTS

Among this cohort of 2654 women with singleton live births, 37.2% of participants reported unplanned pregnancies and 13.0% reported that it was not a good time to be pregnant; 39.0% reported either unplanned or poorly timed pregnancies (Table 1). Most study participants were 30 years or older (59.7%), white or Caucasian (73.7%), married (71.2%), had mean household income of greater than $30,000 (83%), and at least a college degree (56.6%). GAD and MDE diagnosed at least 6 months prior to pregnancy was reported by 7.8% and 8.8% of the cohort, respectively. Pre-existing diagnosis of PTSD was reported by 10.5%, Panic Disorder reported by 4.5%, and history of sexual molestation before age 18 was reported by 16.7%. Participant characteristics demonstrated a significant association with pregnancy planning and timing (p<0.05), with the exception of minor depressive symptoms in the 6 months prior to conception and pregnancy planning, and Panic Disorder in the 6 months prior to conception and pregnancy timing (Table 1).

Overall, 20.2% smoked cigarettes at least 6 months prior to pregnancy, while in the month prior to pregnancy, 71.8% reported drinking alcohol (of which 4.0% reported binge drinking and 3.6% reported heavy drinking as defined by NIAAA), 6.5% reported using marijuana, and approximately 1% reported using opioids or cocaine (Table 2). Unadjusted odds ratio estimates demonstrate a dose-response effect of preconception cigarette smoking with pregnancy planning and timing, with increasing daily tobacco use associated with an increased risk of unplanned or poorly timed pregnancy. Risk estimates ranged from OR=2.10 (95% CI 1.46–3.02) among those smoking <10 cigarettes per day in the 6 months preconception and poorly timed pregnancy compared to non-smokers, to OR=3.87 (95% CI 2.70–5.55) among women smoking 20+ cigarettes per day and poorly timed and/or unplanned pregnancy compared to non-smokers. A curvilinear effect is observed for categories of increasing preconception alcohol exposure with unplanned and unplanned and/or poorly timed pregnancy; reduced risk estimates are observed for preconception alcohol exposure up to 2 drinks per day and increased risk estimates for binge drinking and heavy drinking compared to non-drinkers. Dichotomous measures of preconception smoking demonstrate an increased risk for unplanned or poorly timed pregnancy, while alcohol use demonstrates a reduced risk for these outcomes compared to no exposure. Preconception marijuana and opioid use was associated with an increased risk for poorly timed or unplanned pregnancies compared to no use, while cocaine use the month before pregnancy was associated with unplanned pregnancies, and unplanned and/or poorly timed pregnancies, compared to individuals who did not use cocaine.

Following multivariable adjustment for potential confounding variables (Table 3; Supplemental Figure 1), binge drinking the month before pregnancy (excluding NIAAA-defined heavy drinking) was associated with increased odds of poorly timed as well as

unplanned pregnancy (OR=1.75, 95% CI 1.01–3.05 and OR=1.68, 95% CI 1.01–2.79, respectively) compared to those who abstained from alcohol. Marijuana use 2–3 times in the month before pregnancy was associated with unplanned pregnancy (OR=1.78, 95% CI 1.03–3.08) and poorly timed and/or unplanned pregnancy (OR=1.79, 95% CI 1.01–3.17) compared to those who did not use marijuana. Similarly, any reported marijuana use compared to no use was associated with an increased risk of unplanned pregnancy, OR=1.60, 95% CI 1.05–2.43. Opioid use the month prior to conception was associated with a nearly 3-fold risk of poorly timed pregnancy, OR=2.87, 95% CI 1.03–7.99, compared to those not using opioids. Adjusted estimates for preconception cigarette smoking and cocaine use were not associated with pregnancy planning or timing.

DISCUSSION

Our analysis of preconception substance use and pregnancy timing and planning among a cohort of pregnant women demonstrated an increased risk for unplanned pregnancy as well as poorly timed pregnancy among women reporting binge drinking (not including NIAAA-defined heavy drinking) and marijuana use the month prior to conception. Additionally, preconception opioid use showed increased odds of poorly timed pregnancy compared to no use. Associations between smoking or cocaine use with pregnancy planning and timing were attenuated after performing multivariable modeling. By assessing preconception substance use and pregnancy planning and timing early in pregnancy, and performing multivariable adjustment for comprehensive confounding factors including maternal demographic, medical, reproductive, and psychiatric variables, our analysis extends and improves upon previous literature of preconception substance use among a general obstetrics population and measures of pregnancy perspectives, including pregnancy planning and timing.

Previous studies have reported a relationship between preconception alcohol and cigarette smoking with unintended pregnancies (Hellerstedt et al., 1998; Oulman et al., 2015), yet studies are often limited by retrospective ascertainment of substance use and pregnancy context (including planning and timing), which may be prone to recall and social desirability bias. Earlier analysis of the Pregnancy Risk Assessment Monitoring System (PRAMS) data reported binge drinking was associated with unplanned pregnancy in White women but not Black women (Niami et al., 2003), however this retrospective assessment of substance use is also subject to potential bias. We found an increased risk of binge drinking (excluding NIAAA-defined heavy drinking) and poorly timed or unplanned pregnancy after adjusting for confounders including race and ethnicity. However, comparisons across studies are complicated by inherent differences in defined measures of intention, timing and planning; evaluation of unintended pregnancy in PRAMS data (Niami et al., 2003) includes pregnancies defined as both unwanted and mistimed, hence may be subject to misclassification. Our outcome measures of poorly timed and unplanned were assessed as discrete response options among study participants, thus reflecting a direct response to the pregnancy perspective under consideration.

Our study differed from previous studies that have reported preconception substance exposure to cigarette smoking increased the likelihood of unintended pregnancy (Dott et al., 2010; Hellerstedt et al., 1998; Oulman et al., 2015; Than et al., 2005). While unadjusted

estimates were elevated for preconception smoking and poorly timed or unplanned pregnancies in our study, controlling for potential confounders resulted in attenuated estimates, demonstrating the importance of robust multivariable analysis. Previous studies have also reported pregnant women abusing opioids have high rates of unintended pregnancies (Heil et al., 2011); while we did not specifically assess opioid use disorders or methadone maintenance, our data showed preconception opioid use was associated with poorly timed pregnancy but not unplanned pregnancy, albeit exposure to opioids among our cohort was low. Overall, differences in our findings compared to previous studies may be due to variation in study methodology, assessment of substance and pregnancy perspectives, and lack of comprehensive multivariable adjustment for confounders.

This study extends the literature on the association between preconception substance use and unplanned or poorly timed pregnancy. Previous studies have ascertained pregnancy intention or planning, as well as preconception alcohol, smoking and substance use after delivery, with information ascertainment ranging from the first six months postpartum (Naimi et al., 2003), up to 24 months after delivery (Dott et al., 2010), or up to 15 years postpartum (Than et al., 2005). Compared to previous studies, we ascertained pregnancy planning, timing, and preconception substance use in early gestation (less than 18 weeks EGA) and prospective to delivery, thus minimizing recall and social desirability bias compared to studies with assessments completed after birth outcome. However, future studies with preconception assessment of pregnancy perspectives including planning and timing would be particularly informative and further reduce potential bias. Similar to previous studies (Dott et al., 2010; Krans et al., 2013; Oulman et al., 2015; Than et al., 2005; Niami et al, 2003), our cohort was restricted to pregnancies resulting in livebirth deliveries only, excluding the population of women with miscarriage or termination and therefore limiting generalizability to the population of pregnant women. In addition, individuals with miscarriage or termination may vary in preconception substance exposure compared to those delivering; further research regarding this population is warranted. Finally, we objectively defined and controlled for psychiatric and mental health disorders in the 6 months prior to conception, improving upon earlier studies that did not account for these potential confounders (Heil et al., 2011; Hellerstedt et al., 1998; Niami et al., 2003; Oulman et al., 2015; Than et al., 2005). Psychiatric variables are important factors to consider in the analysis of pregnancy planning and timing, as studies have reported associations of mental health and substance use (SAMSHA 2016) as well as psychiatric conditions and unplanned or unintended pregnancies (Gariepy et al., 2016; Hall et al., 2014; Takahashi et al., 2011).

In the current analysis, we evaluated pregnancy planning and timing as separate pregnancy perspectives. Recent studies have noted the importance of extending patient-centered reproductive and pregnancy context measures, including further evaluation of traditional constructs of pregnancy planning and intention (Aiken et al., 2016; Gariepy et al., 2017; Mumford et al., 2016). Our analysis considered pregnancy planning and timing both independently and collectively, based on discrete questions that elicited dichotomous responses for whether the pregnancy was planned or whether the pregnancy occurred at a good time (Gariepy et al., 2016).

There are several study limitations that should be acknowledged. Our study sample comprised women from a general obstetric population delivering singleton, liveborn infants, and excluded pregnancy terminations and miscarriage, thus limiting generalizability of our findings to the general population with all pregnancy experiences. Further, the cohort was comprised of women who were primarily married, college graduates (16 years of school or more), Caucasian, and 30 years or older, and therefore may not reflect the general population of reproductive aged women. While pregnancies resulting in termination or miscarriage were not included, overall 39% reported unplanned or poorly timed pregnancies, which is just slightly below national rates of unintended pregnancy (45%) (Finer & Zolna, 2016). Our observed proportion of unplanned and/or poorly timed pregnancy may be influenced by the exclusion of terminations and miscarriage, as well as sociodemographic characteristics of the study cohort. Future studies of pregnancy planning and timing including women who did not become pregnant and follow up of pregnant women with all pregnancy outcomes would yield further insight regarding the risk of substance use.

Recruitment from this obstetrics population may not include women with substance use disorders, who may enter prenatal care later if it all, and may be seen by high-risk obstetric clinics offering specialized care. We did not assess chronic substance use or substance use disorders, which may represent unique risk behaviors, including infrequent use of effective contraception (Terplan et al., 2015). Additionally, women with substance use may be more likely to have unplanned pregnancies leading to termination; however, this complex relationship warrants further evaluation (Martino et al., 2006). Interviewing women at the time of pregnancy diagnosis would permit assessment of substance use as well as pregnancy planning and timing prior to pregnancy resolution, including women who have pregnancy terminations. For the current study, the initial interview was conducted in-person and interviewer administered, hence may be subject to social desirability bias which could affect reporting of substance use and pregnancy planning and timing. However, research team members completed in-depth training in interview techniques and periodic validity checks were employed during the study to ensure quality control.

Assessments of substance use during pregnancy may also be subject to potential underreporting (Garg et al., 2017); however, our questions regarding preconception substance use were administered early in pregnancy prior to delivery to minimize recall bias and close in temporality to the preconception period. Our study reports a greater proportion of preconception alcohol exposure than other studies of preconception substance use and pregnancy intention (Hellersted et al., 1998; Than et al., 2003), which would not suggest underreporting. Further, prevalence of preconception substance use among the cohort is similar to previously reported preconception tobacco use (Krans et al., 2013), and similar to median estimates of smoking among U.S. reproductive age women of 22.4% (CDC 2008). While preconception marijuana use in our study (6.5%) is lower than estimates from the National Survey of Family Growth (NSFG) of 13% among non-pregnant women ages 15–44 (van Gelder et al., 2011), it exceeds estimated rates of use during pregnancy ranging from 2–5% (ACOG 2017).

Among the current study sample preconception substance exposure was not biologically confirmed using laboratory markers for substance use; however, such confirmation is often

restricted to a limited window following exposure. Our cohort was also limited by having only a small percentage of women reporting preconception opioid (0.9%) and cocaine (0.9%) use, and opioid use could not be distinguished as prescribed or not prescribed. With an estimated one-fifth (20%) of reproductive-aged women on Medicaid receiving opioid prescriptions during 2008–2013 (Gallagher 2016), further evaluation of opioid and other substance exposures during the preconception period is warranted. Finally, few participants reported use of other illicit drugs including heroin, LSD, and methamphetamines, thus precluding analysis of these illicit substances and pregnancy planning and timing.

In summary, our study demonstrates preconception binge drinking, marijuana use, and opioid use was associated with an increased risk of unplanned pregnancy and poor pregnancy timing. While we did not observe an increased risk for unplanned or poorly timed pregnancies among women reporting tobacco or cocaine use prior to conception, the prevalence of preconception substance exposure among this cohort of reproductive aged women points to opportunities for targeted efforts to improve preconception health, provide treatment for individuals using substances, and optimize access and use of effective methods of contraception. Future public health interventions should also consider the complexity of the relationship between substance use, pregnancy planning and timing, and other variables including coexisting psychiatric conditions when addressing the needs of this population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Table 1

Participant characteristics and sociodemographics by pregnancy timing and planning, N=2654

Characteristics	n (%)	Pregnancy Timing			Pregnancy Planning			Pregnancy Timing and Planning		
		Well-timed 2288 (87.0)	Poorly time 343 (13.0)	p-value	Planned 1664 (62.8)	Unplanned 987 (37.2)	p-value	Well-timed and planned 1602 (61.0)	Poorly timed and/or unplanned 1026 (39.0)	p-value
Age				<0.0001			<0.0001			<0.0001
<25	438 (16.5)	294 (68.1)	138 (31.9)		123 (28.2)	314 (71.8)		110 (25.5)	321 (74.5)	
25–29	632 (23.8)	544 (86.8)	83 (13.2)		377 (59.8)	254 (40.2)		361 (57.7)	265 (42.3)	
30–34	877 (33.1)	805 (92.6)	64 (7.4)		666 (76.0)	210 (24.0)		650 (74.9)	218 (21.3)	
35+	705 (26.6)	643 (91.7)	58 (8.3)		497 (70.5)	208 (29.5)		480 (68.5)	221 (31.5)	
Race-Ethnicity				<0.0001			<0.0001			<0.0001
White	1957 (73.7)	1770 (91.0)	175 (9.0)		1349 (69.0)	606 (31.0)		1313 (67.6)	630 (32.4)	
Black, African American	195 (7.4)	126 (66.0)	65 (34.0)		60 (30.8)	135 (69.2)		53 (27.8)	138 (72.2)	
Hispanic	383 (14.4)	289 (76.5)	89 (23.5)		170 (44.5)	212 (55.5)		154 (40.9)	223 (59.1)	
Other (Asian, mixed, other)	119 (4.5)	103 (88.0)	14 (12.0)		85 (71.4)	34 (28.6)		82 (70.1)	35 (29.9)	
Relationship status				<0.0001			<0.0001			<0.0001
Married	1889 (71.2)	1772 (94.2)	110 (5.8)		1458 (77.3)	429 (22.7)		1425 (75.8)	455 (24.2)	
Living with partner	425 (16.0)	325 (77.9)	92 (22.1)		139 (32.7)	286 (67.3)		127 (30.5)	290 (69.5)	
Divorced, separated, widowed	65 (2.5)	41 (63.1)	24 (36.9)		18 (28.1)	46 (71.9)		15 (23.4)	49 (76.6)	
Never married	275 (10.4)	150 (56.2)	117 (43.8)		49 (17.8)	226 (82.2)		35 (13.1)	232 (86.9)	
Annual household income				<0.0001			<0.0001			<0.0001
<$30,000	440 (17.0)	284 (65.4)	150 (34.6)		124 (28.2)	316 (71.8)		109 (25.1)	325 (74.9)	
$30,000	2149 (83.0)	1965 (92.2)	167 (7.8)		1518 (70.7)	628 (29.3)		1474 (69.2)	655 (30.8)	
Education				<0.0001			<0.0001			<0.0001
<12 years	172 (6.5)	112 (65.5)	59 (34.5)		60 (35.1)	111 (64.9)		53 (31.2)	117 (68.8)	
12 years/high school equivalent	382 (14.4)	278 (74.1)	97 (25.9)		149 (39.0)	233 (61.0)		135 (36.0)	240 (64.0)	
13–15 years	599 (22.6)	491 (82.8)	102 (17.2)		293 (49.0)	305 (51.0)		278 (47.0)	314 (53.0)	
16+ years	1501 (56.6)	1407 (94.3)	85 (5.7)		1162 (77.5)	338 (22.5)		1136 (76.2)	355 (23.8)	
Parity				0.0008			<0.0001			<0.0001
0	742 (28.0)	646 (87.4)	93 (12.6)		474 (64.0)	267 (36.0)		458 (62.1)	280 (37.9)	

Characteristics	n (%)	Pregnancy Timing			Pregnancy Planning			Pregnancy Timing and Planning		
		Well-timed	Poorly time	p-value	Planned	Unplanned	p-value	Well-timed and planned	Poorly timed and/or unplanned	p-value
		2288 (87.0)	343 (13.0)		1664 (62.8)	987 (37.2)		1602 (61.0)	1026 (39.0)	
1	787 (29.7)	704 (90.1)	77 (9.9)		553 (70.3)	234 (29.7)		532 (68.1)	249 (31.9)	
2	563 (21.2)	481 (86.2)	77 (13.8)		336 (59.9)	225 (40.1)		322 (57.9)	234 (42.1)	
3+	560 (21.1)	455 (82.6)	96 (17.4)		300 (53.6)	260 (46.4)		289 (18.1)	262 (47.6)	
Chronic medical condition				0.0022			0.0115			0.0023
No	1750 (65.9)	1533 (88.4)	201 (11.6)		1127 (64.5)	621 (35.5)		1092 (63.1)	640 (36.9)	
Yes	904 (34.1)	755 (84.2)	142 (15.8)		537 (59.5)	366 (40.5)		510 (56.9)	386 (43.1)	
Generalized Anxiety Disorder				0.0037			0.0144			0.0005
No	2448 (92.2)	2124 (87.5)	303 (12.5)		1551 (63.4)	894 (36.6)		1501 (61.9)	923 (38.1)	
Yes	206 (7.8)	164 (80.4)	40 (19.6)		113 (54.9)	93 (45.1)		101 (49.5)	103 (50.5)	
Major Depressive Episode (MDE)				<0.0001			<0.0001			<0.0001
No	2421 (91.2)	2119 (88.2)	284 (11.8)		1553 (64.2)	865 (35.8)		1503 (62.6)	897 (37.4)	
Yes	233 (8.8)	169 (74.1)	59 (25.9)		111 (47.6)	122 (52.4)		99 (43.4)	129 (56.6)	
Minor Depressive symptoms				<0.0001			0.2695			0.026
No	2617 (98.6)	2264 (87.3)	330 (12.7)		1644 (62.9)	970 (37.1)		1586 (61.2)	1005 (38.8)	
Yes	37 (1.4)	24 (64.9)	13 (35.1)		20 (54.1)	17 (45.9)		16 (43.2)	21 (56.8)	
Post-traumatic stress disorder				0.0074			0.0084			0.0059
No	2374 (89.5)	2063 (87.6)	293 (12.4)		1509 (63.6)	863 (36.4)		1456 (61.9)	898 (38.1)	
Yes	280 (10.5)	225 (81.8)	50 (18.2)		155 (55.6)	124 (44.4)		146 (53.3)	128 (46.7)	
Panic disorder				0.0581			<0.0001			<0.0001
No	2535 (95.5)	2193 (87.2)	321 (12.8)		1614 (63.7)	918 (36.3)		1555 (61.9)	956 (38.1)	
Yes	119 (4.5)	95 (81.2)	22 (18.8)		50 (42.0)	69 (58.0)		47 (40.2)	70 (59.8)	
Sexual molestation before age 18				<0.0001			<0.0001			<0.0001
No	2171 (83.3)	1924 (89.3)	230 (10.7)		1424 (65.7)	745 (34.4)		1380 (64.2)	771 (35.8)	
Yes	437 (16.7)	327 (75.7)	105 (24.3)		218 (49.9)	219 (50.1)		201 (46.5)	231 (53.5)	

P-value based on chi-square test statistic

Chronic medical condition defined as ever diagnosed with the following medical conditions: diabetes, heart disease, sickle cell anemia, high blood pressure, thyroid disease, HIV/AIDS, tuberculosis, asthma

Generalized anxiety disorder, Major Depressive Episode, minor depressive symptoms, Post-traumatic Stress Disorder, Panic disorder within 6 months prior to conception

Table 2

Unadjusted OR estimates for preconception substance use and pregnancy timing/planning

Preconception substance use	n (%)	Poorly Timed 343 (13.0)	OR	95% CI	Unplanned 987 (37.2)	OR	95% CI	Poorly Timed and/or Unplanned 1026 (39.0)	OR	95% CI
Tobacco use (at least 1 cigarette) during 6 months before pregnancy										
No	2113 (79.8)	217 (10.4)	Ref		663 (31.4)	Ref		688 (32.9)	Ref	
Yes	535 (20.2)	124 (23.4)	2.64	2.06–3.37	320 (59.9)	3.27	2.68–3.97	334 (63.0)	3.48	2.85–4.24
Number of cigarettes during 6 months before pregnancy										
0	2113 (79.8)	217 (10.4)	Ref		663 (31.4)	Ref		688 (32.9)	Ref	
<10	223 (8.4)	43 (19.6)	2.10	1.46–3.02	128 (57.7)	2.97	2.24–3.94	132 (60.3)	3.10	2.33–4.12
10–19	169 (6.4)	41 (24.3)	2.77	1.90–4.05	102 (60.4)	3.32	2.41–4.59	109 (64.5)	3.71	2.67–5.15
20+	140 (5.3)	39 (28.1)	3.37	2.27–5.01	88 (62.9)	3.70	2.59–5.27	91 (65.5)	3.87	2.70–5.55
Drinking alcohol month before pregnancy										
No	744 (28.2)	123 (16.8)	Ref		328 (44.1)	Ref		343 (46.7)	Ref	
Yes	1899 (71.8)	216 (11.4)	0.64	0.51–0.82	652 (34.4)	0.67	0.56–0.79	675 (35.8)	0.64	0.54–0.76
Drinking alcohol month before pregnancy (drinks/day, binge, heavy drinking) *										
None	744 (28.2)	123 (16.8)	Ref		328 (44.1)	Ref		343 (46.7)	Ref	
Up to 1 drink/day	1497 (56.7)	155 (10.4)	0.58	0.45–0.78	460 (30.8)	0.56	0.47–0.68	480 (32.3)	0.54	0.45–0.65
1–1.99 drinks/day	120 (4.5)	7 (5.9)	0.31	0.14–0.68	38 (31.9)	0.60	0.39–0.90	39 (33.1)	0.56	0.37–0.85
2+ drinks/day	78 (3.0)	7 (9.0)	0.49	0.22–1.09	33 (42.3)	0.93	0.58–1.49	33 (42.3)	0.84	0.52–1.34
Binge	107 (4.0)	31 (9.1)	2.08	1.31–3.30	67 (62.6)	2.12	1.40–3.22	67 (63.8)	2.01	1.32–3.07
Heavy drinking	95 (3.6)	16 (17.0)	1.02	0.58–1.81	53 (55.2)	1.56	1.02–2.40	55 (58.5)	1.61	1.04–2.48
Marijuana use month before pregnancy										
No	2475 (93.5)	295 (12.0)	Ref		870 (35.2)	Ref		906 (37.0)	Ref	
Yes	171 (6.5)	45 (26.5)	2.63	1.83–3.78	112 (65.5)	3.94	2.52–4.84	115 (67.6)	3.56	2.56–4.96
Marijuana use month before pregnancy										
None	2475 (93.5)	295 (12.0)	Ref		870 (35.2)	Ref		906 (37.0)	Ref	
Up to 2–3 times per month	84 (3.2)	23 (27.4)	2.76	1.68–4.52	53 (63.1)	3.15	2.01–4.94	55 (65.5)	3.23	2.05–5.11
1–6 times per week	42 (1.6)	9 (21.4)	1.99	0.95–4.21	26 (61.9)	2.99	1.60–5.61	26 (61.9)	2.77	1.48–5.19
1–4 times per day	45 (1.7)	13 (29.5)	3.07	1.59–5.93	33 (73.3)	5.06	2.60–9.85	34 (77.3)	5.79	2.85–11.77

Opioid use (methadone, oxycontin) month before pregnancy

Preconception substance use	n (%)	Poorly Timed			Unplanned			Poorly Timed and/or Unplanned		
		343 (13.0)	OR	95% CI	987 (37.2)	OR	95% CI	1026 (39.0)	OR	95% CI
No	2626 (99.1)	329 (12.7)	Ref		967 (36.9)	Ref		1002 (38.6)	Ref	
Yes	24 (0.9)	11 (45.8)	**5.84**	**2.59–13.14**	15 (62.5)	**2.85**	**1.24–6.53**	19 (79.2)	**6.05**	**2.25–16.24**
Cocaine use month before pregnancy										
No	2622 (99.1)	335 (12.9)	Ref		967 (36.9)	Ref		1004 (38.7)	Ref	
Yes	24 (0.9)	5 (20.8)	1.78	0.66–4.79	15 (62.5)	**2.85**	**1.24–6.53**	17 (70.8)	**3.85**	**1.59–9.32**

*

Binge drinking defined as 4 drinks per occasion; heavy drinking defined as: binge drinking (4 drinks per occasion) on 5 or more days in the past month (NIAAA)

Opioid use defined and methadone or oxycontin use month before conception

Table 3

Adjusted OR estimates for preconception substance use and pregnancy timing/planning

Substance	Poorly Timed		Unplanned		Poorly timed/unplanned	
	OR	95% CI	OR	95% CI	OR	95% CI
Tobacco use (at least 1 cigarette) during 6 months before pregnancy						
No	Ref		Ref		Ref	
Yes	0.87	0.62–1.21	1.14	0.88–1.49	1.20	0.92–1.58
Number of cigarettes during 6 months before pregnancy						
0	Ref		Ref		Ref	
<10	0.73	0.47–1.13	1.05	0.73–1.51	1.10	0.76–1.59
10–19	0.97	0.59–1.60	1.27	0.85–1.91	1.41	0.93–2.14
20+	1.03	0.62–1.72	1.15	0.73–1.81	1.17	0.73–1.86
Drinking alcohol month before pregnancy						
No	Ref		Ref		Ref	
Yes	1.11	0.83–1.49	1.06	0.85–1.32	1.01	0.81–1.26
Drinking alcohol month before pregnancy (drinks/day, binge, heavy) *						
None	Ref		Ref		Ref	
Up to 1	1.12	0.82–1.55	1.01	0.80–1.27	0.96	0.76–1.21
1–1.99	0.63	0.27–1.49	1.08	0.67–1.75	1.04	0.64–1.68
2+	0.59	0.23–1.53	1.35	0.76–2.39	1.14	0.64–2.04
Binge	**1.75**	**1.01–3.05**	**1.68**	**1.01–2.79**	1.56	0.92–2.59
Heavy drinking	0.56	0.28–1.13	0.75	0.43–1.29	0.74	0.42–1.30
Marijuana use month before pregnancy						
No	Ref		Ref		Ref	
Yes	1.19	0.75–1.91	**1.60**	**1.05–2.43**	1.53	0.99–2.37
Marijuana use month before pregnancy						
None	Ref		Ref		Ref	
Up to 2–3 times per month	1.39	0.76–2.56	**1.78**	**1.03–3.08**	**1.79**	**1.01–3.17**
1–6 times per week	1.09	0.43–2.73	1.36	0.60–3.09	1.19	0.52–2.74
1–4 times per day	0.87	0.39–1.95	1.15	0.53–2.51	1.10	0.48–2.51
Opioid use month before pregnancy						

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Substance	Poorly Timed		Unplanned		Poorly timed/unplanned	
	OR	95% CI	OR	95% CI	OR	95% CI
No	Ref		Ref		Ref	
Yes	**2.87**	**1.03–7.99**	0.76	0.26–2.17	2.42	0.67–8.69
Cocaine use month before pregnancy						
No	Ref		Ref		Ref	
Yes	0.32	0.10–1.05	0.59	0.20–1.80	0.67	0.19–2.29

*
Binge drinking defined as ≥ 4 drinks per occasion; heavy drinking defined as: binge drinking (≥ 4 drinks per occasion) on 5 or more days in the past month (NIAAA)

Opioid use defined as reported methadone or oxycontin use in month before conception