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Frequency of cannabis use during pregnancy and adverse infant outcomes, by cigarette smoking status – 8 PRAMS states, 2017

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Abstract

Background: Research on prenatal cannabis use and adverse infant outcomes is inconsistent, and findings vary by frequency of use or cigarette use. We assess (1) the prevalence of high frequency (≥once/week), low frequency (<once/week), and any cannabis use during pregnancy by maternal characteristics and adverse infant outcomes; (2) the prevalence of infant outcomes by cannabis use frequency, stratified by cigarette smoking; and (3) the association between cannabis use frequency and infant outcomes, stratified by cigarette smoking.

Methods: Cross-sectional data from 8 states' 2017 Pregnancy Risk Assessment Monitoring System (n = 5548) were analyzed. We calculated adjusted prevalence ratios (aPR) between cannabis use frequency and infant outcomes with Modified Poisson regression.

Results: Approximately 1.7 % and 2.6 % of women reported low and high frequency prenatal cannabis use, respectively. Prevalence of use was higher among women with small-for-gestational age (SGA) (10.2 %) and low birthweight (9.7 %) deliveries, and cigarette use during pregnancy (21.2 %). Among cigarette smokers (aPR: 1.8; 95 % CI: 1.1–3.0) and non-smokers (aPR: 2.1; 95 % CI: 1.1–3.9), high frequency cannabis use doubled the risk of low birthweight delivery but did

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Contributors

All authors contributed to the conceptualization and design of the study. In addition, SH led the methodology, investigation, and analysis; and drafted and revised the manuscript. BK, JB, and AG assisted with methodology and investigation and revised the manuscript. KC assisted with methodology, investigation, and analysis; and revised the manuscript. CF assisted with methodology and investigation; provided supervision and oversight; and revised the manuscript. JK assisted with methodology, investigation, and funding acquisition; provided supervision and oversight; and revised the manuscript. All authors approve of the final article.

Declaration of Competing Interest

No conflict declared.

not increase preterm or SGA risk. Regardless of cigarette use, low frequency cannabis use did not significantly increase infant outcome risk.

Conclusions: Prenatal cannabis use was more common among women who smoked cigarettes during pregnancy. High frequency cannabis use was associated with low birthweight delivery, regardless of cigarette use. Healthcare providers can implement recommended substance use screening and provide evidence-based counseling and cessation services to help pregnant women avoid tobacco and cannabis use.

Keywords

Cannabis; Maternal; Low birthweight; Prenatal; Preterm birth; Small for gestational age

1. Introduction

Cannabis, more commonly known as marijuana, is the most commonly used federally illicit substance during pregnancy in the United States; according to the 2018 National Survey on Drug Use and Health, 5.4 % of pregnant women reported marijuana use in the 30 days preceding the survey (Center for Behavioral Health Statistics and Quality, 2018). Notably, 18 % of pregnant women using cannabis met established criteria for substance abuse or dependence (Ko et al., 2015). As more states legalize cannabis for medical and adult non-medical usage, use during pregnancy may increase (Metz and Stickrath, 2015), as previously observed among the general population (Cerdá et al., 2012).

Upon review of existing research, the 2017 National Academies of Sciences, Engineering, and Medicine report concluded that there is evidence of an association between smoking cannabis during pregnancy and lower birthweight in offspring. The report concluded that existing research is too variable and lacks sufficient data for the relationship between cannabis and other reproductive outcomes (National Academies of Sciences, Engineering, and Medicine, 2017). Many studies have similarly concluded that the association between prenatal cannabis use and adverse outcomes attenuates or becomes null after controlling for tobacco use (Crume et al., 2018; Fergusson et al., 2002; Fried et al., 1984; Kliegman et al., 1994; Ko et al., 2018; Linn et al., 1983). After controlling for tobacco use, some studies have found significant associations between prenatal cannabis use and small for gestational age (SGA) (Hayatbakhsh et al., 2012; Kharbanda et al., 2020;Straub et al., 2019), preterm birth (Corsi et al., 2019; Hayatbakhsh et al., 2012; Leemaqz et al., 2016), lower or low birthweight (Gray et al., 2010; Hayatbakhsh et al., 2012; Massey et al., 2018;Straub et al., 2019), smaller head circumference (Gray et al., 2010), reduced body length (Gray et al., 2010), neonatal morbidity (Metz et al., 2017), and admission to a neonatal intensive care unit (NICU) (Hayatbakhsh et al., 2012).

While the inconsistency of these findings could be due to differences in study design (e.g. different country or legalization settings; medical chart review versus cohort studies), they could also be related to the high correlation between cannabis use and other substance use, such as cigarettes and alcohol (Ryan et al., 2018), and inconsistencies in the use of control variables like maternal age. A 2016 systematic review that adjusted for cigarette smoking and other confounders concluded that cannabis use was not associated with preterm birth,

SGA, placental abruption, neonatal intensive care unit admission, or spontaneous abortion, but that cannabis use was associated with lower birthweight, lower Apgar scores, and stillbirth (Conner et al., 2016). In 2015, one study using medical chart data from a medical center in Ohio assessed the risk of adverse infant outcomes with cannabis use by tobacco use and found an increased risk of SGA only among women who used cannabis and were non-smokers (Warshak et al., 2015). In contrast, multiple studies have found associations between cannabis use and adverse infant outcomes only among smokers. Specifically, a 2020 study used medical record data from the UK and found lower birthweight to be associated with cannabis use, but only among cigarette smokers (Sturrock et al., 2020). In 2019, Corsi and colleagues performed a retrospective cohort study and found adjusted risk estimates for self-reported cannabis use and preterm birth to increase in a subgroup analysis performed among tobacco users (Corsi et al., 2019). Similarly, Coleman-Cowger and colleagues analyzed data from two clinics in Maryland and found self-reported and verified prenatal cannabis use combined with cigarette use to be associated with an increased likelihood of small head circumference and birth defects. However, none of these analyses appear to have assessed frequency of cannabis use (Coleman-Cowger et al., 2018; Conner et al., 2016; Corsi et al., 2019; Warshak et al., 2015). Two older studies investigating a dose-response relationship between cannabis use and infant outcomes found that frequent use (e.g., ≥weekly and ≥4x/week, respectively) increased the likelihood of low birthweight; however, they did not stratify or control for cigarette smoking status (English et al., 1997; Linn et al., 1983). Thus, the association between prenatal cannabis use and infant adverse outcomes may differ by both the frequency of cannabis use and concurrent cigarette use, but no study appears to have considered both of these factors in a population-based sample. While Ko and colleagues used Pregnancy Risk Assessment Monitoring System (PRAMS) data to describe differences in infant birth weight and gestational age by prenatal cannabis use, they did not look at frequency of cannabis use or stratify by tobacco use (Ko et al., 2018).

To address these gaps, this study uses PRAMS data to assess the association between adverse infant outcomes and frequency of cannabis use, stratified by cigarette smoking status during pregnancy. The objectives were to: (1) Compare the prevalence of high frequency (once a week or more), low frequency (less than once a week), any, and no cannabis use during pregnancy by maternal characteristics and adverse infant outcomes (preterm birth, SGA, and low birthweight); (2) Determine the prevalence of infant outcomes by frequency of cannabis use, stratified by cigarette smoking status during pregnancy; and (3) Assess the association between frequency of cannabis use during pregnancy and infant outcomes, by cigarette smoking status during pregnancy.

2. Materials and methods

2.1. Data source

Data were from the 2017 Pregnancy Risk Assessment Monitoring System (PRAMS). PRAMS is a surveillance project that collects state-specific, population-based data on maternal behaviors, attitudes, and experiences before, during, and shortly after pregnancy from women 2–6 months after delivery of a live birth, which is conducted by the Centers

for Disease Control and Prevention (CDC) and state health departments ([dataset] Centers for Disease Control and Prevention (CDC), 2017; Shulman et al., 2018). Details on PRAMS sampling methodology, data collection, and response rates can be found elsewhere ([dataset] Centers for Disease Control and Prevention (CDC), 2017; Shulman et al., 2018). Each state can supplement the core survey with CDC-developed questions. In 2017, a supplemental questionnaire related to cannabis use before, during, and after pregnancy was included with the core survey by 8 states (Alaska, Illinois, Maine, New Mexico, New York, North Dakota, Pennsylvania, and West Virginia); each met the required CDC response rate threshold (≥55 %) ([dataset] Centers for Disease Control and Prevention (CDC), 2017; Shulman et al., 2018).

2.2. Measures

2.2.1. Infant outcomes—Birth certificate data linked to PRAMS provided information on infant outcomes. Preterm birth was defined as infants aged <37 weeks by using the clinical estimate of gestational age (Callaghan and Dietz, 2010). SGA was defined as infants weighing below the 10th percentile of infants with the same characteristics (gestational age, maternal race or ethnicity, and gender) (Duryea et al., 2014). Percentiles were calculated from the National Center for Health Statistics' natality files for singleton births for each group with at least 30 births. Low birthweight was defined as infants born weighing <2,500 g.

2.2.2. Cannabis use—Self–reported cannabis use and frequency during pregnancy were ascertained from the PRAMS questions: "At any time during the 3 months before you got pregnant OR during your most recent pregnancy, did you use marijuana or hash in any form?" and "During your most recent pregnancy, about how often did you use marijuana products in an average month?" Respondents answering "no" were categorized as having no cannabis use during pregnancy. Respondents answering "yes" and indicating a frequency other than "no use" were categorized as having cannabis use during pregnancy. Respondents answering "daily," "2–6 times per week," and "once a week" were categorized as having *high frequency* cannabis use and respondents answering "2–3 times per month" or "once a month or less" were categorized as *low frequency* cannabis use. The supplement questions were cognitively tested (Willson and Schoua-Glusberg, 2016).

2.2.3. Cigarette smoking—Cigarette smoking status during pregnancy was categorized by combining information from PRAMS and the linked birth certificate. If cigarette smoking during the last 3 months of pregnancy was indicated on PRAMS, or if cigarette smoking during any trimester was indicated on the birth certificate, then the respondent was categorized as a smoker. If both data sources indicated no cigarette smoking during pregnancy, or if one data source was missing cigarette information and the other indicated no cigarette smoking, then the respondent was categorized as a nonsmoker. If both data sources were missing cigarette information, the respondent was excluded from analyses.

2.2.4. Covariates—Covariates from the linked birth certificate were maternal age, maternal race or ethnicity, marital status, education, pre-pregnancy body mass index (BMI), and cigarette smoking status during pregnancy. Covariates from the PRAMS survey were

insurance during prenatal care, parity, month of entry into prenatal care, and cigarette smoking status during the last 3 months of pregnancy. For observations without prenatal care or missing insurance information, insurance during delivery from the birth certificate was used.

2.3. Analysis

The analytic sample was composed of singleton births from 8 states that included the supplemental marijuana questionnaire in their 2017 survey (n = 7343). Those missing information on cigarette smoking during pregnancy (n = 2) and non-respondents to the supplement or those missing information on frequency of cannabis use (n = 1793) were excluded. Prevalence of frequency of cannabis use during pregnancy (high, low, any, no use) was assessed across maternal characteristics and infant outcomes. Chi–square tests assessed cannabis use by characteristics. *P*-values <.05 were considered to be statistically significant.

Predicted marginal proportions were calculated from a main-effects logistic regression model to estimate adjusted prevalence ratios and 95 % confidence intervals (CI). Models were adjusted for potential confounders determined *a priori* via a directed acyclic graph: maternal age, race or ethnicity, marital status, education, pre–pregnancy BMI, insurance, parity, and month of entry into prenatal care. Likelihood ratio tests were used to assess whether cigarette smoking status during pregnancy modified the relationship between cannabis use and infant outcomes and showed that cigarette smoking modified the associations between cannabis use and preterm birth ($P < .01$) and low birthweight ($P < .01$), but not SGA ($P = .07$). Thus, models included an interaction term between cannabis use and cigarette smoking status and results were stratified by cigarette smoking status.

Sensitivity analyses were performed to guide the final analytic approach. Alcohol use during pregnancy was not in the PRAMS core questionnaire, but may be an important confounder (Ryan et al., 2018). Therefore, a sensitivity analysis controlling for alcohol was performed among the 4 states (Alaska, Maine, New York, and Pennsylvania) that asked about alcohol use in the last 3 months of pregnancy. Because cannabis use during pregnancy may be associated with lower birthweight, but not necessarily low birthweight (<2,500 g) (National Academies of Sciences, Engineering, and Medicine, 2017), we investigated birthweight as a continuous variable, assuming a normal distribution. In addition, PRAMS only assessed cigarette smoking during the last 3 months of pregnancy, whereas the birth certificate provides this information during all trimesters. A sensitivity analysis was performed to assess how our combined variable compared with a variable only including smoking in the last 3 months of pregnancy from both data sources.

All analyses were performed by using SAS–callable SUDAAN (SAS Institute, Cary, NC). Data were weighted to adjust for nonresponse and noncoverage so that weighted percentages represent state residents with live births (Shulman et al., 2018).

3. Results

The analytical sample included 5548 respondents with singleton deliveries. The 1795 excluded respondents were more likely to be non-Hispanic Black or other race and insured

by Medicaid than those included. Among our sample of 5548 respondents, 1.7 % reported low-frequency cannabis use (less than once a week), and 2.6 % reported high-frequency cannabis use (once a week or more), totaling 4.2 % of women with any reported cannabis use during pregnancy. The highest prevalence of any cannabis use during pregnancy was among respondents who were aged <20 years (9.5 %), unmarried (8.5 %), educated <12 years (9.5 %), insured by a public insurance other than Medicaid (e.g., CHIP and other government insurance) (8.8 %), and cigarette smokers (21.2 %; Table 1). By contrast, the prevalence of cannabis use during pregnancy did not significantly differ by race or ethnicity, pre-pregnancy BMI, parity, or entry into prenatal care during pregnancy. The prevalence of any cannabis use during pregnancy was higher among respondents with SGA (10.2 %) and low birthweight (9.7 %) deliveries. The prevalence of cannabis use did not significantly differ by preterm birth status.

Among women who smoked cigarettes during pregnancy, prevalence of delivering an SGA infant was 29.1 %, 41.2 %, and 33.0 % for those with high frequency, low frequency, and any cannabis use during pregnancy, respectively, and 24.3 % among those with no cannabis use (left side of Table 2; $P = 0.49$). Among the same sample of cigarette smokers, prevalence of delivering a low birthweight infant was 18.2 %, 13.7 %, and 16.7 % for those with high frequency, low frequency, and any cannabis use during pregnancy, respectively, and 10.9 % among those with no cannabis use ($P = 0.11$). The prevalence of our third outcome, delivering a preterm infant, among cigarette smokers was 7.8 %, 20.0 %, and 11.7 % among those with high frequency, low frequency, and any cannabis use during pregnancy, respectively, and 10.1 % for those with no cannabis use ($P = 0.38$).

Among those that did not smoke cigarettes during pregnancy, the prevalence of delivering an SGA infant was 18.9 %, 12.9 %, and 16.0 % for those with high frequency, low frequency, and any cannabis use during pregnancy, respectively, and 8.6 % among those with no cannabis use (right side of Table 2; $P = 0.37$). Among the same sample of non-smokers, the prevalence of delivering a low birthweight infant was 12.1 %, 7.4 %, and 9.8 % for those with high frequency, low frequency, and any cannabis use during pregnancy, respectively, and 5.2 % among those with no cannabis use ($P = 0.05$). The prevalence of our third outcome, preterm birth, was 9.4 %, 7.8 %, and 8.6 % for those with high frequency, low frequency, and any cannabis use during pregnancy, respectively, and 6.8 % for those with no cannabis use ($P = 0.67$).

Among cigarette smokers, respondents who used cannabis at a high frequency during pregnancy were 1.8 times as likely as respondents with no cannabis use to deliver a low birthweight infant (aPR: 1.8; 95 % CI: 1.1–3.0). Similarly, among those with no cigarette use during pregnancy, respondents who used cannabis at a high frequency during pregnancy were 2.1 times as likely as respondents with no cannabis use to deliver a low birthweight infant (aPR: 2.1; 95 % CI: 1.1–3.9; Table 2). Regardless of cigarette use, cannabis use at any frequency was not associated with an increased risk of delivering a preterm or SGA infant (Table 2).

Sensitivity analyses assessing the effect of alcohol use in the 4 states with these data (n = 3040) showed that adjusting for alcohol use during the last 3 months of pregnancy did

not affect results (Appendix A). Adjusted analyses investigating continuous birthweight revealed that among cigarette smokers, average birthweight was not significantly lower among infants exposed to cannabis, regardless of frequency. Analyses assessing whether restricting cigarette smokers only to respondents with use during the last three months of pregnancy showed an attenuated association between high frequency cannabis use and low birthweight among smokers (aPR: 1.6; 95 % CI: 1.0–2.8) and an association between high frequency cannabis use and SGA among non–smokers (aPR: 2.4; 95 % CI: 1.1–4.9); all other associations remained consistent.

4. Comment

This analysis of 8 states found that approximately 2.6 % and 1.7 % of respondents reported high (≥once/week), and low (<once/week) frequency cannabis use during pregnancy, respectively. Consistent with the well-established relationship between tobacco use and adverse infant outcomes (American College of Obstetricians and Gynecologists (ACOG, 2020), women who smoked cigarettes during pregnancy had a higher prevalence of cannabis use. However, regardless of cigarette use, respondents who used cannabis at a high frequency during pregnancy were approximately twice as likely as respondents with no cannabis use to deliver a low birthweight infant, after adjusting. Cannabis use, regardless of frequency or concurrent cigarette use, was not associated with an increased likelihood of SGA or preterm birth in adjusted models.

Previous studies assessing the independent association between frequent use of cannabis and low birthweight have reported a dose-response relationship, with more frequent use increasing the likelihood of low birthweight delivery (Conner et al., 2016; English et al., 1997; Linn et al., 1983). As a reflection of the literature, the 2017 National Academies of Sciences, Engineering, and Medicine report concluded that cannabis use may be associated with lower birthweight infants (National Academies of Sciences, Engineering, and Medicine, 2017). These findings are consistent with the current analysis, which found an increased likelihood of low birthweight delivery only among mothers who used cannabis at a higher frequency. Other studies assessing the relationship between cannabis use and birth outcomes by smoking found that cannabis use was associated with an increased risk of intrauterine growth restriction or SGA, but only among respondents without tobacco use (Brar et al., 2019; Warshak et al., 2015). While our findings do not support this association, our small sample size or differences in study design may explain the difference. Our finding of no increased likelihood of preterm birth associated with cannabis use is consistent with most studies (Alhusen et al., 2013; Conner et al., 2016; Hurd et al., 2005; Warshak et al., 2015). To our knowledge, no single previous study has assessed the association between cannabis use and birth outcomes accounting for both frequency of use and the interactive effect of cigarette use on the relationship.

Research findings about the risks associated with perinatal cannabis use are inconsistent for most outcomes (American College of Obstetricians and Gynecologists (ACOG, 2017). Determining these risks is challenging because observational studies among humans are likely to be heavily confounded by other substance use (American College of Obstetricians and Gynecologists (ACOG, 2017) and it is difficult to quantify the potency, dose, or

frequency of cannabis consumption (National Academies of Sciences, Engineering, and Medicine, 2017). The latter is becoming increasingly difficult to assess given the various methods of cannabis consumption, such as combustion, edibles, and e-cigarette, or vaping, products. Similarly, research on the proposed biological mechanisms for how *in utero* cannabis use may lead to adverse outcomes is less well known. It is known that delta-9-tetrahydrocannabinol (THC), the main psychoactive compound in cannabis, crosses the placenta and produces fetal levels at approximately 10 % of maternal levels (Hutchings et al., 1989). In addition, an increased amount of THC may cross the placenta with increased, repetitive exposures (Hutchings et al., 1989). Thus, this may explain the present study finding related to increased likelihood of low birthweight infants among women with high frequency cannabis use during pregnancy.

On the basis of the available scientific evidence, the American College of Obstetricians and Gynecologists (ACOG) recommends verbal screening for cannabis and tobacco use, and if a woman screens positive, providers should counsel about concerns regarding potential adverse health outcomes (American College of Obstetricians and Gynecologists (ACOG, 2017). Our findings that cigarette use during pregnancy was associated with increased rates of cannabis use and the substantial literature linking cigarette smoking with adverse birth outcomes (American College of Obstetricians and Gynecologists (ACOG, 2020) reinforce this recommendation and the importance of strategies to prevent and cease both cannabis and cigarette use during pregnancy (American College of Obstetricians and Gynecologists (ACOG, 2017, 2020). Although there is indication that some cannabis use during pregnancy is reflective of problematic use or use disorder (Ko et al., 2015), existing literature also suggests that women may use cannabis during pregnancy because of perceptions that it is safer than pharmaceutical prescriptions (Chang et al., 2019) or to relieve symptoms of nausea (Roberson et al., 2014; Young-Wolff et al., 2019). Likewise, another study, which used the same data as the current analysis, reported that the top 3 reasons for cannabis use during pregnancy were to relieve stress or anxiety, nausea or vomiting, and pain (Ko et al., 2020). Providers can discuss evidence-based pharmacologic and non-pharmacologic treatments to relieve these symptoms. ACOG recommends that providers encourage patients who are pregnant, or contemplating pregnancy, to discontinue cannabis use because of the absence of evidence demonstrating that cannabis use is safe among this population (American College of Obstetricians and Gynecologists (ACOG, 2017).

4.1. Limitations

This analysis is subject to several limitations. First, data may not be generalizable to states or respondents excluded from this analysis. Of note, those excluded were disproportionately Black and insured by Medicaid. Second, cannabis and tobacco use were self–reported, which could introduce misclassification. Given the stigma associated with drug use during pregnancy, and the varying legality of cannabis use by state (at the time of data collection, medical and adult nonmedical cannabis use was legal in 2 of our states, and medical use was legal in 6 of our states), women may be less likely to accurately report use. However, pregnant women have been found to accurately report cannabis use, but less likely to accurately report timing of use (Yonkers et al., 2011). This analysis used cigarette data from both PRAMS and the birth certificate in order to reduce misclassification of

cigarette use. Second, questions regarding use did not specify whether cannabidiol (CBD) should be considered as 'marijuana' and may have resulted in misinterpretation of the question. However, cognitive testing of the supplement questions showed low levels of misunderstanding and error (Willson and Schoua-Glusberg, 2016). Third, we did not account for THC levels or form of cannabis use, so results were not assessed by strength or mode. Similarly, the amount of cigarettes smoked per day during pregnancy was not considered in this analysis. Fourth, data on alcohol use during pregnancy, a potential confounder, were not available for all states. However, in a sensitivity analyses conducted among the 4 states with these data, adjusting for alcohol use did not alter results. Finally, stratification by cigarette smoking status and cannabis use frequency resulted in small sample sizes, which could have generated unstable estimates.

4.2. Conclusions

This population-based study from 8 states found that regardless of cigarette use, respondents who used cannabis once a week or more during pregnancy were approximately twice as likely as respondents with no cannabis use to deliver a low birthweight infant. Cannabis use, regardless of frequency, was associated with higher likelihood of smoking cigarettes during pregnancy. Health care providers can screen pregnant women for both cannabis use and cigarette smoking, and they can provide evidence-based counseling and other resources to help patients decrease or quit the use of these substances.

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Role of funding source

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Appendix A.: Sensitivity analyses for infant outcomes by cannabis use during pregnancy, stratified by cigarette smoking status during pregnancy – 8 PRAMS states, 2017 (unweighted n = 5548)

CIGARETTE SMOKERS					NONSMOKERS				
SMALL FOR GESTATIONAL AGE[1]									
Cannabis use during pregnancy	Adjusted mean difference in birthweight grams (95 % CI)	Smoking last 3 months only aPR[2] (95% CI)	Sample with alcohol data aPR[2] (95% CI)	Controlling for alcohol aPR[2] (95% CI)	Cannabis Use during Pregnancy	Adjusted mean difference in birthweight grams (95 % CI)	Smoking last 3 months only aPR[2] (95% CI)	Sample with alcohol data aPR[2] (95% CI)	Controlling for alcohol aPR[2] (95% CI)
High Frequency[3]	N/A	1.0 (0.5–1.8)	1.3 (0.6–3.0)	1.3 (0.6–3.0)	High Frequency[3]	N/A	2.4 (1.1–4.9)	2.5 (0.8–7.2)[5]	2.5 (0.8–7.2)[5]
Low Frequency[4]	N/A	1.5 (0.7–3.3)[5]	1.8 (0.8–4.4)[5]	1.8 (0.8–4.4)[5]	Low Frequency[4]	N/A	1.3 (0.4–3.7)[5]	1.7 (0.6–5.0)[5]	1.7 (0.6–5.0)[5]
Any Use[6]	N/A	1.1 (0.7–2.0)	1.1 (0.7–2.0)	1.5 (0.8–2.9)	Any Use[6]	N/A	1.8 (1.0–3.4)	1.8 (1.0–3.4)	2.1 (1.0–4.7)
No Use	N/A	1.0 (Ref.)	1.0 (Ref.)	1.0 (Ref.)	No Use	N/A	1.0 (Ref.)	1.0 (Ref.)	1.0 (Ref.)
LOW BIRTHWEIGHT[7]									
Cannabis use during pregnancy	Adjusted mean difference in birthweight grams (95 % CI)	Smoking last 3 months only aPR[2] (95% CI)	Sample with alcohol data aPR[2] (95% CI)	Controlling for alcohol aPR[2] (95% CI)	Cannabis Use during Pregnancy	Adjusted mean difference in birthweight grams (95 % CI)	Smoking last 3 months only aPR[2] (95% CI)	Sample with alcohol data aPR[2] (95% CI)	Controlling for alcohol aPR[2] (95% CI)
High Frequency[3]	16.3 (−148.5–181.1)	1.6 (1.0–2.8)	1.9 (1.0–3.7)	1.9 (1.0–3.7)	High Frequency[3]	−169.3 (−342.5 to 3.8)	2.3 (1.3–4.2)	1.9 (0.8–4.4)	1.9 (0.8–4.4)
Low Frequency[4]	− 80.1 (−299.0 to 138.8)	0.7 (0.3–1.9)	1.2 (0.5–2.9)[5]	1.2 (0.5–2.9)[5]	Low Frequency[4]	− 28.7 (−218.6 to 161.3)	1.4 (0.6–3.3)[5]	2.3 (1.0–5.5)[5]	2.3 (1.0–5.5)[5]
Any Use[6]	−12.9 (−158.1 to 132.4)	1.3 (0.8–2.2)	1.6 (0.9–2.8)	1.6 (0.9–2.8)	Any Use[6]	−105.7 (−237.0 to 25.6)	1.9 (1.2–3.1)	2.1 (1.1–3.8)	2.1 (1.1–3.8)
No Use	Ref.	1.0 (Ref.)	1.0 (Ref.)	1.0 (Ref.)	No Use	Ref.	1.0 (Ref.)	1.0 (Ref.)	1.0 (Ref.)
PRETERM BIRTH[8]									
Cannabis use during pregnancy	Adjusted mean difference in birthweight	Smoking last 3 months only aPR[2]	Sample with alcohol data aPR[2]	Controlling for alcohol aPR[2] (95% CI)	Cannabis Use during Pregnancy	Adjusted mean difference in birthweight	Smoking last 3 months only aPR[2]	Sample with alcohol data aPR[2]	Controlling for alcohol aPR[2] (95% CI)

CIGARETTE SMOKERS					NONSMOKERS				
	grams (95 % CI)	(95% CI)	(95% CI)			grams (95 % CI)	(95% CI)	(95% CI)	
High Frequency[3]	N/A	0.9 (0.5–1.9)	0.5 (0.2–1.5)[5]	0.5 (0.2–1.5)[5]	High Frequency[3]	N/A	0.8 (0.4–1.8)[5]	0.8 (0.3–2.1)[5]	0.8 (0.3–2.2)[5]
Low Frequency[4]	N/A	1.9 (0.6–6.7)	1.9 (0.6–6.2)[5]	1.9 (0.6–6.2)[5]	Low Frequency[4]	N/A	1.2 (0.5–2.7)[5]	1.5 (0.6–3.7)[5]	1.5 (0.6–3.7)[5]
Any Use[6]	N/A	1.3 (0.6–2.8)	1.1 (0.4–2.8)	1.1 (0.4–2.8)	Any Use[6]	N/A	1.0 (0.6–1.8)	1.1 (0.5–2.3)	1.1 (0.5–2.3)
No Use	N/A	1.0 (Ref.)	1.0 (Ref.)	1.0 (Ref.)	No Use	N/A	1.0 (Ref.)	1.0 (Ref.)	1.0 (Ref.)

PRAMS: Pregnancy Risk Assessment Monitoring System; CI: Confidence Interval; PR: Prevalence Ratio; aPR: Adjusted Prevalence Ratio.

Boldface indicates significance at $P<05$.

[1] Defined as weight <10th percentile for gestational age.

[2] Adjusted for maternal age, race or ethnicity, marital status, education, pre–pregnancy BMI, insurance during prenatal care, parity, and month of entry into prenatal care.

[3] Includes respondents that reported use daily, 2–6 times per week, or once a week.

[4] Includes respondents that reported use 2–3 times per month or once a month or less.

[5] Some unweighted cell sizes <10 so estimates may be unstable.

[6] Includes respondents with any cannabis use (high or low frequency).

[7] Defined as weight <2500 g.

[8] Defined as gestational age <37 weeks.

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Table 1

Characteristics of sample and prevalence of cannabis use during pregnancy - 8 PRAMS states, 2017 (unweighted n = 5548).

		Prevalence of Cannabis Use During Pregnancy			
	Total[1] (n = 5548)	**High Frequency[2] (n = 267)**	**Low Frequency[3] (n = 139)**	**Any Use[4] (n = 406)**	**No Use (n = 5142)**
MATERNAL CHARACTERISTICS	Column % (95 % CI)	Row % (95 % CI)	Row % (95 % CI)	Row % (95 %CI)	Row % (95 %CI)
Total		2.6 (2.0–3.3)	1.7 (1.2–2.3)	4.2 (3.5, 5.1)	95.8 (94.9–96.5)
Age (y)					
<20	3.8 (3.0, 4.6)	**4.0 (1.7–9.3)**	**5.5 (2.3–12.6)**	**9.5 (5.1, 17.0)**	**90.5 (83.0–94.9)**
20–24	17.2 (15.6, 18.9)	**6.0 (4.1–8.8)**	**2.0 (1.1–3.5)**	**8.0 (5.8, 11.0)**	**92.0 (89.1–94.2)**
25–34	59.9 (57.8, 62.0)	**2.1 (1.5–2.9)**	**1.5 (1.0–2.3)**	**3.6 (2.7, 4.7)**	**96.4 (95.4–97.3)**
≥ 35	19.1 (17.5, 20.9)	**0.8 (0.3–1.7)**	**1.1 (0.3–4.0)**	**1.8 (0.8, 4.2)**	**98.2 (95.8–99.2)**
Race or ethnicity					
Non-Hispanic white	66.0 (63.9, 68.0)	2.7 (2.0–3.7)	1.5 (1.0–2.3)	4.3 (3.4, 5.4)	95.8 (94.6–96.7)
Non-Hispanic black	9.3 (8.1, 10.7)	2.5 (1.2–5.0)	2.2 (1.0–4.8)	4.7 (2.7, 7.9)	95.3 (92.1–97.3)
Hispanic	15.8 (14.2, 17.6)	1.4 (0.8–2.6)	2.1 (0.9–5.0)	3.5 (2.0, 6.2)	96.5 (93.8–98.1)
Other	8.9 (7.8, 10.1)	3.7 (1.8–7.3)	1.5 (0.6–3.9)	5.2 (2.9, 9.0)	94.8 (91.0–97.1)
Marital status					
Married	59.4 (57.2, 61.5)	**0.8 (0.5–1.2)**	**0.5 (0.3–0.9)**	**1.3 (0.9, 1.8)**	**98.8 (98.2–99.1)**
Not married	40.6 (38.5, 42.8)	**5.2 (4.0–6.8)**	**3.3 (2.3–4.8)**	**8.5 (6.9, 10.6)**	**91.5 (89.4–93.1)**
Education (y)					
<12	12.3 (10.8, 13.9)	**5.8 (3.3–9.8)**	**3.8 (1.7–8.1)**	**9.5 (6.1, 14.6)**	**90.5 (85.4–93.9)**
12	23.9 (22.0, 25.8)	**4.3 (3.1–6.1)**	**2.9 (1.9–4.5)**	**7.3 (5.5, 9.5)**	**92.8 (90.5–94.5)**
>12	63.9 (61.7, 66.0)	**1.3 (0.9–1.9)**	**0.8 (0.5–1.2)**	**2.1 (1.5, 2.8)**	**97.9 (97.2–98.5)**
Pre-pregnancy BMI					
Underweight	3.4 (2.6, 4.3)	2.1 (1.2–3.9)	3.1 (0.9–10.5)	5.2 (2.3, 11.2)	94.8 (88.8–97.7)
Normal weight	45.5 (43.3, 47.7)	2.7 (1.9–3.8)	2.2 (1.4–3.4)	4.9 (3.7, 6.4)	95.1 (93.6–96.3)
Overweight	25.8 (23.9, 27.7)	3.2 (1.9–5.2)	1.3 (0.7–2.3)	4.5 (3.0, 6.6)	95.5 (93.4–97.0)
Obese	25.4 (23.5, 27.3)	2.1 (1.3– 3.5)	0.8 (0.3–1.9)	2.9 (1.9, 4.5)	97.1 (95.5–98.1)
Insurance during pregnancy[5]					
Medicaid	32.7 (30.7, 34.7)	**5.3 (4.0–6.9)**	**3.1 (2.1–4.5)**	**8.4 (6.7, 10.4)**	**91.7 (89.7–93.3)**

		Prevalence of Cannabis Use During Pregnancy			
	Total[1] (n = 5548)	**High Frequency[2] (n = 267)**	**Low Frequency[3] (n = 139)**	**Any Use[4] (n = 406)**	**No Use (n = 5142)**
Private[6]	60.5 (58.4, 62.5)	**0.9 (0.6–1.6)**	**0.8 (0.5–1.4)**	**1.7 (1.2, 2.5)**	**98.3 (97.5–98.8)**
Other[7]	4.5 (3.6, 5.6)	**5.8 (1.9–16.7)**	**3.0 (0.4–17.8)**	**8.8 (3.3, 21.3)**	**91.2 (78.7–96.7)**
Uninsured	2.4 (1.8, 3.1)	**0.9 (0.3–2.4)**	**0.5 (0.2–1.7)**	**1.4 (0.7, 3.1)**	**98.6 (96.9–99.3)**
Parity					
First birth	37.6 (35.5, 39.6)	2.5 (1.8–3.5)	1.9 (1.2–3.0)	4.4 (3.4, 5.8)	95.6 (94.2–96.7)
Second or later birth	62.4 (60.4, 64.5)	2.6 (1.9–3.6)	1.5 (1.0–2.4)	4.2 (3.2, 5.4)	95.9 (94.6–96.8)
Entry into Prenatal Care					
First trimester	81.8 (79.8, 83.5)	2.2 (1.6–2.9)	1.6 (1.1–2.4)	3.8 (3.0, 4.8)	96.3 (95.3–97.0)
Second trimester	14.4 (12.8, 16.2)	4.3 (2.3–7.8)	1.9 (1.0–3.7)	6.2 (3.9, 9.8)	93.8 (90.2–96.1)
Third trimester or none	3.8 (3.1, 4.7)	4.1 (1.6–10.0)	3.2 (1.0–9.8)	7.3 (3.5, 14.4)	92.7 (85.6–96.5)
Cigarette smoking status during pregnancy[8]					
Cigarette smoker	11.6 (10.3, 13.1)	**14.4 (10.7–19.2)**	**6.8 (4.1–11.1)**	**21.2 (16.5, 26.8)**	**78.8 (73.2–83.5)**
Nonsmoker	88.4 (86.9, 89.7)	**1.0 (0.7–1.5)**	**1.0 (0.7–1.4)**	**2.0 (1.5, 2.6)**	**98.0 (97.4–98.5)**
Small for Gestational Age[9]					
SGA	10.7 (9.6, 12.0)	**6.1 (4.0–9.2)**	**4.1 (1.9–8.6)**	**10.2 (6.9, 14.8)**	**89.8 (85.2–93.1)**
Not SGA	89.3 (88.0, 90.4)	**2.2 (1.6–2.9)**	**1.4 (1.0–1.9)**	**3.5 (2.8, 4.4)**	**96.5 (95.7–97.2)**
Low Birthweight[10]					
Low Birthweight	6.1 (5.8, 6.4)	**6.8 (5.2–8.9)**	**2.8 (1.8–4.3)**	**9.7 (7.7, 12.0)**	**90.3 (88.0–92.3)**
Normal Birthweight	94.0 (93.6, 94.2)	**2.3 (1.7–3.1)**	**1.6 (1.1–2.2)**	**3.9 (3.1, 4.8)**	**96.1 (95.2–96.9)**
Preterm Birth[11]					
Preterm	7.3 (6.5, 8.1)	3.0 (2.0–4.4)	3.1 (1.5–6.2)	6.1 (4.0, 9.0)	93.9 (91.0–96.0)
Term	92.7 (91.9, 93.5)	2.6 (2.0–3.3)	1.5 (1.1–2.2)	4.1 (3.3, 5.0)	95.9 (95.0–96.7)

PRAMS: Pregnancy Risk Assessment Monitoring System; CI: Confidence Interval; BMI: Body Mass Index; SGA: small for gestational age.

Boldface indicates significance from chi-square $P<05$.

[1] Total estimates are column percentages.

[2] Includes respondents that reported use daily, 2–6 times per week, or once per week.

[3] Includes respondents that reported use 2–3 times per month or once a month or less.

[4] Includes respondents with any cannabis use (high or low frequency).

[5] Respondents with no prenatal care or missing information on insurance during prenatal care were imputed with the value of insurance during delivery from the birth certificate.

[6] Includes CHAMPUS and Tricare.

[7] Includes CHIP and other government insurances.

[8] Includes cigarette use from either PRAMS or the birth certificate.

[9] Defined as weight <10th percentile for gestational age.

[10] Defined as weight <2,500 g.

[11] Defined as gestational age <37 weeks.

Table 2.

Prevalence of infant outcomes by cannabis use during pregnancy, stratified by cigarette smoking status during pregnancy – 8 PRAMS states, 2017 (unweighted n = 5548).

CIGARETTE SMOKERS				NONSMOKERS			
SMALL FOR GESTATIONAL AGE[1]							
Cannabis use during pregnancy	Prevalence % (95 % CI)	PR (95 % CI)	aPR[2] (95% CI)	Cannabis use during pregnancy	Prevalence % (95 % CI)	PR (95 % CI)	aPR[2] (95% CI)
High Frequency[3] (n = 165)	29.1 (18.0–43.4)	1.2 (0.7–2.0)	1.1 (0.6–1.9)	High Frequency[3] (n = 99)	18.9 (7.9–38.8)	2.2 (1.0–5.0)	2.2 (0.9–5.1)
Low Frequency[4] (n = 59)	41.2 (18.3–69.6)[5]	1.7 (0.8–3.5)	1.5 (0.7–3.3)	Low Frequency[4] (n = 78)	12.9 (4.1–33.9)	1.5 (0.5–4.5)	1.4 (0.5–3.9)[5]
Any Use[6] (n = 224)	33.0 (21.5, 46.9)	1.4 (0.9–2.2)	1.2 (0.7–2.0)	Any Use[6] (n = 177)	16.0 (8.1–29.2)	1.9 (1.0–3.6)	1.8 (0.9–3.5)
No Use (n = 617)	24.3 (18.6, 30.9)	1.0 (Ref.)	1.0 (Ref.)	No Use (n = 4496)	8.6 (7.5–9.8)	1.0 (Ref.)	1.0 (Ref.)
LOW BIRTHWEIGHT[7]							
Cannabis use during pregnancy	Prevalence % (95 % CI)	PR (95 % CI)	aPR[2] (95% CI)	Cannabis use during pregnancy	Prevalence % (95 % CI)	PR (95 % CI)	aPR[2] (95% CI)
High Frequency[3] (n = 166)	18.2 (11.9–27.7)	**1.7 (1.0–2.6)**	**1.8 (1.1–3.0)** [5]	High Frequency[3] (n = 99)	12.1 (6.7–20.9)	**2.3 (1.3–4.2)**	**2.1 (1.1–3.9)** [5]
Low Frequency[4] (n = 60)	13.7 (6.6–26.3)	1.3 (0.6–2.6)	0.8 (0.3–1.9)[5]	Low Frequency[4] (n = 77)	7.4 (3.3–15.8)	1.4 (0.7–3.2)	1.4 (0.6–3.4)[5]
Any Use[6] (n = 226)	16.7 (11.6–23.4)	1.5 (1.0–2.3)	1.4 (0.9–2.3)	Any Use[6] (n = 176)	9.8 (6.2–15.3)	1.9 (1.2–3.0)	1.7 (1.0–3.0)
No Use (n = 616)	10.9 (8.9–13.4)	1.0 (Ref.)	1.0 (Ref.)	No Use (n = 4492)	5.2 (4.8–5.5)	1.0 (Ref.)	1.0 (Ref.)
PRETERM BIRTH[8]							
Cannabis use during pregnancy	Prevalence % (95 % CI)	PR (95 % CI)	aPR[2] (95% CI)	Cannabis use during pregnancy	Prevalence % (95 % CI)	PR (95 % CI)	aPR[2] (95% CI)
High Frequency[3] (n = 165)	7.8 (4.4–13.3)	0.8 (0.4–1.4)	0.8 (0.4–1.6)[5]	High Frequency[3] (n = 101)	9.4 (4.7–17.8)	1.4 (0.7–2.7)	1.0 (0.5–2.2)[5]
Low Frequency[4] (n = 60)	20.0 (7.3–44.2)	2.0 (0.8–5.2)	1.6 (0.5–5.4)[5]	Low Frequency[4] (n = 79)	7.8 (3.6–16.3)	1.1 (0.5–2.5)	1.3 (0.6–2.9)[5]
Any Use[6] (n = 225)	11.7 (6.5–20.3)	1.2 (0.6–2.2)	1.1 (0.5–2.3)	Any Use[6] (n = 180)	8.6 (5.2–14.1)	1.3 (0.8–2.1)	1.1 (0.6–2.0)
No Use (n = 616)	10.1 (7.5–13.4)	1.0 (Ref.)	1.0 (Ref.)	No Use (n = 4514)	6.8 (6.0–7.8)	1.0 (Ref.)	1.0 (Ref.)

PRAMS: Pregnancy Risk Assessment Monitoring System; CI: Confidence Interval; PR: Prevalence Ratio; aPR: Adjusted Prevalence Ratio.

Boldface indicates significance at $P<05$.

[1] Defined as weight <10th percentile for gestational age.

[2] Adjusted for maternal age, race or ethnicity, marital status, education, pre-pregnancy BMI, insurance, parity, and timing of prenatal care.

[3] Includes respondents that reported use daily, 2–6 times per week, or once per week.

[4] Includes respondents that reported use 2–3 times per month or once a month or less.

[5] Unweighted denominator is <60 or some cell sizes <10 so estimates may be unstable.

[6] Includes respondents with any cannabis use (high or low frequency).

[7] Defined as weight <2,500 g.

[8] Defined as gestational age <37 weeks.