

Perceived Risk of Weekly Cannabis Use, Past 30-Day Cannabis Use, and Frequency of Cannabis Use Among Pregnant Women in the United States

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Background: While accumulated evidence has shown that the prevalence of cannabis use among pregnant women in the US has increased in recent years, little is known about the specific subpopulations affected. The aim of this study was to estimate the prevalence and correlates of the perceived risk of weekly cannabis use, past 30-day cannabis use, and frequency of past 30-day cannabis use among US pregnant women.

Methods: We analyzed data from 2,247 pregnant women 14 to 44 years of age surveyed in the 2015 to 2017 cross-sectional National Survey on Drug Use and Health. Analyses account for the sampling design. Primary outcomes included perceived risk of weekly cannabis use, past 30-day cannabis use, and frequency of cannabis use. We conducted multivariable logistic and negative binomial regression models to assess the associations between the primary outcomes and multiple correlates.

Results: Among US pregnant women, 21.6% (95% CI=19.4, 23.8) did not perceive any risk associated with weekly cannabis use, 5.3% (95% CI=4.2, 6.5) used cannabis in the past 30 days, and among past-month users, the average number of days of use was 15.6 (95% CI=13.5, 17.7). Pregnant women living below the poverty line were both more likely to perceive no risk of weekly cannabis use (aOR=1.8; 95% CI=1.3, 2.5) and use cannabis more often in the past 30 days (aOR=2.9; 95% CI=1.5, 5.7) than pregnant women within an income bracket of more than two times the federal poverty threshold. Age, race, trimester of pregnancy, co-use of tobacco and/or alcohol were also associated with these outcomes.

Conclusion: Younger age, living in poverty, early trimester of pregnancy, and co-use of tobacco and/or alcohol increased the odds of cannabis use among pregnant women. As cannabis legalization spreads and cannabis use is increasingly perceived as safe, there is a growing need for research to determine the reasons why women in the identified at-risk subgroups are using cannabis during pregnancy.

Keywords: marijuana, cannabis, pregnant women, perceived risk, prenatal exposure

Background

Analyses of the National Household Survey on Drug Use and Health (NSDUH) among pregnant women have shown that unlike alcohol and tobacco use, cannabis use has significantly increased in recent years.¹⁻⁷ Recent estimates show an increase in past 30-day use among pregnant women from 3.4% between 2002 and 2003 to 7.0% between 2016 and 2017.⁵ Furthermore, this increase in cannabis use among pregnant women is coupled with significant increases in daily cannabis use, based on 2002 to 2017 NSDUH data,⁵ and an increase in the prevalence of cannabis use

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disorder among all age and race/ethnic subgroups between 1993 and 2014, based on national data on hospitalized pregnant women.⁸

Changes in attitudes may relate to changes in cannabis use as legality shifts with 33 states, four US territories, and the District of Columbia to date having chosen to legalize cannabis for medicinal or recreational use. A 2018 Gallup poll reports 66% of Americans think cannabis should be made recreationally legal, the highest percentage of support they have reported historically.⁹ The need to understand how attitudes towards cannabis and cannabis use change among pregnant women is a priority. Perceived risk is an important factor in personal decision-making, and thus it may effect whether or not specific populations will engage in certain behaviors.¹⁰ As such, a significant relationship between higher rates of cannabis use and not perceiving risk of cannabis use has been widely documented,^{11–13} Rates of not perceiving any risk associated with cannabis use were almost four times higher among adult pregnant women who used cannabis in the past 30 days (65.4%) compared with rates among pregnant non-cannabis users (16.5%).¹⁴ A 2015 study showed that approximately 70% of both pregnant and non-pregnant women believed there was no risk or a slight risk of harm from using cannabis once or twice a week.³

Besides changes in attitudes towards cannabis use, medicalization of cannabis may also explain increases in past 30-day cannabis use and daily use among pregnant women.⁵ Potential use of cannabis for treating nausea and vomiting during pregnancy and other conditions common among pregnant and childbearing age women, such as IBS and headaches/migraines,^{14–17} may explain the observed trends. A recent study among 4,735 pregnant women showed that those with nausea and vomiting during pregnancy had nearly 2 to 4 times greater odds of prenatal cannabis use during the first trimester of pregnancy than women without nausea and vomiting during pregnancy.¹⁷ In addition, use of cannabis during pregnancy has been associated with past history of depression, anxiety, and trauma and recent studies suggest that some women use cannabis as a coping strategy to deal with daily stressors and mental health problems.^{18,19} Other correlates that have shown to influence past 30-day cannabis use among pregnant women include income, marital status, and previous tobacco, alcohol, or illicit drug use.^{3,17,20–22}

Existing studies on the effects of prenatal exposure to cannabis remain controversial.²² Animal models suggest that prenatal cannabis exposure can lead to low birth weight and

a negative impact on the offspring's neurocognitive function.^{23–26} Dose-response studies suggest that maternal exposure to low doses of tetrahydrocannabinol (THC), one of the at least 100 cannabinoids identified in cannabis, results in atypical locomotor activity, alterations in the dopamine system, and altered neurotransmitter and neuronal circuit settings, with moderate and higher doses causing increased severity of these symptoms, as well as lasting cognitive impairments and other negative outcomes in the adult rodent's offspring.²⁵ Moreover, prenatal exposure to cannabis has also been associated with altered breathing patterns and increased the length of apnoeas in newborn mice.²⁶ Complementarily, human studies have shown that prenatal use of cannabis alters folic acid uptake,²⁷ may lead to increases in the risk of miscarriage,^{28,29} delays embryo development,^{30,31} and may lead to preterm birth and low birth weight.^{32,33} Other outcomes may include: stillbirth, spontaneous abortion, and prenatal death.^{28,29,34} Potential later life outcomes include deficits in verbal and visual reasoning skills, short-term memory recollection, hyperactivity, and reduced executive functioning in children, while adolescents and young adults may experience deficits in executive functioning, working memory, response inhibition, and may initiate substance use at an earlier age.^{35–37}

As cannabis use is considered less risky and becomes accepted in society and more widely available, studies regarding cannabis use and correlates of use among pregnant women are becoming more relevant. Increases in the prevalence and frequency of cannabis use among pregnant women are well documented, but less is known about specific sub-populations at higher risk of use. Therefore, the main objective of this study was to complement current epidemiological estimates by identifying correlates of perceiving no risk associated with weekly cannabis use, past 30-day cannabis use, and frequency of cannabis use in the past 30 days among a nationally representative sample of pregnant women aged 14 to 44 over a recent three-year period. These findings can assist in identifying at-risk sub-populations who can be targeted for future studies on the etiology of cannabis use during pregnancy or the design and implementation of future intervention strategies.

Materials and Methods

Data Source and Study Population

The National Survey on Drug Use and Health (NSDUH) series primarily measures the prevalence and correlates of drug use in the United States annually among members of

United States households aged 12 and older. NSDUH Surveys are administered by computer-assisted personal interviewing (CAPI) conducted by an interviewer and audio computer-assisted self-interviewing (ACASI). For this report, we analyzed public data from the 2015, 2016, and 2017 NSDUH among a nationally representative sample of 2,247 women age 14 to 44 with complete data and who reported to be pregnant when completing the survey. Response rates for each year were 69.66%, 68.44% and 67.12%, respectively. The data collection protocol of the NSDUH was approved by the institutional review board at the Research Triangle Institute (RTI) International. Written informed consent was obtained from each study participant and other guidelines outlined in the Declaration of Helsinki were followed. This manuscript is based on a master's thesis presented to the Graduate School of the University of Florida.³⁸ Institutional Review Board evaluation of the proposed project that analyses public HIPAA-compliant de-identified data sets was determined as exempt (IRB201900224). Additional information on survey procedures is available elsewhere.³⁹

Measures

Dependent variables included perceived risk of weekly cannabis use, cannabis use in the past 30 days, and frequency of past 30-day cannabis use. Perceived Risk of weekly cannabis use was defined by recoding the original variable “perceived risk of smoking cannabis once or twice a week” into a binary variable where respondents who perceived no risk ($n=560$) or do not know of any risk ($n=22$) were coded as 1 (ie, no risk), and respondents who perceived any level of risk [slight ($n=541$), moderate ($n=487$), or great risk ($n=637$)] were coded as 0 (ie, any risk). Past 30-day cannabis use was assessed with a binary question (yes/no), and frequency of past 30-day cannabis use was assessed by asking participants who had used cannabis in the past 30 days the mean number of days of use.

Other covariates included socio-demographic factors such as age group (“14 to 17”, “18 to 29”, or “30 to 44”), self-identified race/ethnicity (Non-Hispanic White – NHW, Non-Hispanic Black – NHB, Non-Hispanic Other – NHO, and Hispanic – H), population density (CBSA – Core Based Statistical Area classification – with 1 million or more persons or Large Metropolitan, CBSA with fewer than 1 million persons or Small Metropolitan, or those not in a CBSA or non-metropolitan), poverty level (determined by the age, family size, the number of children in the household

and total family income and categorized into living in poverty, Income up to 2X federal poverty threshold – FPT, and Income more than 2X FPT), health insurance coverage, residence in a state with medical marijuana legalized when the survey was applied and survey year. Substance use-related factors included past 30-day alcohol and/or tobacco use (No past 30-day use of alcohol or tobacco, past 30-day use of alcohol only, past 30-day use of tobacco only, and past 30-day use of alcohol and tobacco), and past 30-day use of drugs other than cannabis (past 30-day use of cocaine, hallucinogens, heroin, inhalants, methamphetamines, or psychedelics, or nonmedical use of prescription drugs, including pain relievers, tranquilizers, stimulants, and sedatives). Health and pregnancy-related factors included trimester of pregnancy, self-reported health status (fair/poor health, vs good/very good/excellent health), and past-year DSM-IV major depression episode (binary yes/no question).

Statistical Analysis

NSDUH analysis weights and Taylor series linearization methods were applied to accommodate for the sampling design.^{40,41} The total sample was characterized based on its socio-demographic, substance abuse, and health and pregnancy-related characteristics. Respondents' characteristics were also described by perceived risk of weekly cannabis use, past 30-day cannabis use, and the mean number of days of past 30-day cannabis use in the total sample and among pregnant women who used cannabis in the past 30 days. Associations between perceived risk of weekly cannabis use and past 30-day cannabis use and covariates under study were estimated using logistic regression models. Perceived risk was included as a covariate in the past 30-day and frequency of use models. Univariate and multivariable logistic regression model associations were expressed as Odds Ratios (OR) and adjusted Odds Ratios (aOR) with corresponding 95% confidence Intervals (CI). Association between the number of days of past 30-day cannabis use and the covariates of interest were assessed using negative binomial regression models. Univariate and multivariable negative binomial regression model associations were expressed as Incident Rate Ratios (IRR) and adjusted Incident Rate Ratios (aIRR) with corresponding 95% confidence intervals (CI). Supplementary analyses were conducted and included in the [appendices](#) to examine changes in the outcomes over the years ([Supplementary Figure 1](#)), and compare predicted probabilities derived from the adjusted models across self-identified racial-ethnic subgroup

(Supplementary Figure 2). Analyses were conducted using SAS 9.4 and STATA 14.0.

Results

Characteristics of the study population are presented in Table 1. One-fifth of women (21.6%, 95% CI=19.4, 23.8) said there was no risk, associated with weekly cannabis use. Overall, 5.3% (95% CI=4.2, 6.5) of pregnant women in our sample (n=2,247) used cannabis in the past 30 days. The mean number of days of cannabis use was 0.8 (95% CI=0.6, 1.1) in the total population and 15.6 (95% CI=13.5, 17.7) among past 30-day cannabis users. Figure 1 Appendix-Supplementary shows changes over time for the dependent variables.

Correlates of Perceiving No Risk of Weekly Cannabis Use

Young pregnant women (ages 18 to 29) were more likely than older pregnant women (ages 30 to 44) (aOR=1.7; 95% CI=1.3, 2.2) to perceive no risk or have no knowledge of any risk of weekly cannabis use. Self-identified Hispanics were less likely than Non-Hispanic Whites to perceive no risk or have no knowledge of risk of weekly cannabis use (aOR=0.4; 95% CI=0.3, 0.6). Pregnant women living in poverty (aOR=1.8; 95% CI=1.3, 2.5) were more likely to perceive no risk or have no knowledge of any risk of weekly cannabis use than respondents with income higher than 2X FPT. Pregnant women who used tobacco only (aOR=1.7; 95% CI=1.1, 2.6) in the past 30 days were more likely than those who did not to perceive no risk or have no knowledge of risk of weekly cannabis use (Table 2).

Correlates of Cannabis Use in the Past 30 Days

Pregnant young women (ages 18 to 29) were nearly twice as likely as pregnant women in the oldest age group (ages 30 to 44) (aOR=1.8; 95% CI=1.1, 2.8) to report past 30-day cannabis use. Pregnant women who reside in a state where medical cannabis is legalized (aOR=2.1; 95% CI=1.3, 3.4) were more likely than those not living in medical cannabis legalized states to have used cannabis in the past 30 days. Past 30-day alcohol use (aOR=8.1; 95% CI=3.6, 18.3), past 30-day tobacco use (aOR=6.0; 95% CI=3.4, 10.6), and past 30-day alcohol and tobacco use (aOR=16.9; 95% CI=7.4, 38.4) significantly increased the likelihood of past 30-day cannabis use. Being in the

Table 1 Characteristics of the Overall Study Sample (n=2,247), 2015 to 2017 National Survey of Drug Use and Health

Characteristics		% ^a	(95% CI)
Age Group (years old)			
	14 to 17	1.7	(1.1, 2.3)
	18 to 29	32.4	(30.2, 34.6)
	30 to 44	65.9	(63.6, 68.1)
Self-identified race/ethnicity			
	Non-Hispanic White	55.4	(52.1, 58.7)
	Non-Hispanic Black	14.9	(13.3, 16.6)
	Non-Hispanic Other	9.4	(7.5, 11.2)
	Hispanic	20.3	(17.7, 23.0)
Population density			
	Large metropolitan	55.2	(52.4, 58.1)
	Small metropolitan	39.6	(36.7, 42.2)
	Non-metropolitan	5.2	(4.1, 6.3)
Poverty level			
	Living in poverty	23	(20.7, 25.0)
	Income up to 2X FPT ^b	19.7	(17.4, 22.0)
	Income more than 2X FPT	57.3	(54.6, 60.2)
Residence in medical marijuana			
	No	48.2	(45.0, 51.4)
	Yes	51.8	(48.6, 55.0)
Alcohol and/or tobacco use in the past			
	Neither	79.9	(78.3, 81.6)
	Alcohol use only	6.7	(5.3, 8.0)
	Tobacco use only	10.6	(9.2, 12.0)
	Alcohol and tobacco use	2.8	(1.8, 3.7)
Past 30-day use of drugs other than cannabis			
	No	98.1	(97.3, 99.0)
	Yes	1.9	(1.0, 2.7)
Trimester of pregnancy			
	First	32.3	(29.0, 35.4)
	Second	35	(32.4, 37.7)
	Third	32.7	(29.9, 35.5)
Self-reported overall health status			
	Excellent to good	94.8	(93.6, 95.9)
	Fair to Poor	5.2	(4.1, 6.4)
Past 12-months MDE ^c			
	No	93	(91.7, 94.3)
	Yes	7	(5.7, 8.3)
Year of the survey			
	2015	33	(30.6, 35.6)

(Continued)

Table 1 (Continued).

Characteristics		% ^a	(95% CI)
	2016	33	(31.2, 35.7)
	2017	34	(30.7, 36.2)
Risk perception of weekly cannabis use			
	Any risk	78.4	(76.1, 80.5)
	No risk	21.6	(19.4, 23.8)
Past 30-day cannabis use			
	No	94.7	(93.5, 95.8)
	Yes	5.3	(4.2, 6.5)
Mean number of days of cannabis use in the overall sample		0.8	(0.6, 1.1)
Mean number of days of cannabis use among past 30-day users		15.6	(13.5, 17.7)

Notes: ^aEstimates from weighted analyses; ^bFederal Poverty Threshold; ^cMajor Depressive Episode as defined by DSM-IV.

first trimester of pregnancy (aOR=1.7; 95% CI=1.1, 2.9) increased the likelihood of past 30-day cannabis use, compared to those in the third trimester of pregnancy. Having no risk perception of weekly cannabis use (aOR=6.0; 95% CI=3.4, 10.7) significantly increased the likelihood of past 30-day cannabis use (Table 3).

Correlates of Cannabis Use Frequency in the Past 30 Days

Our negative binomial regression models (Table 4) identified correlates of frequent past 30-day cannabis use among the total sample of pregnant women. Among respondents, those who were between the ages of 18 to 29 were nearly three times more likely (aIRR, 2.7; 95% CI=1.3, 5.4) to use cannabis more often in the past 30 days than those who were between the ages of 30 to 44. Pregnant women living in large metropolitan areas were twice as likely (aIRR, 2.2; 95% CI=1.0, 4.9) to use cannabis in the past 30 days more often than pregnant women living in a non-metropolitan area. Pregnant women living in poverty were nearly three times (aIRR, 2.9; 95% CI=1.5, 5.7) as likely to use cannabis in the past 30 days more often than pregnant women in the highest income category. Pregnant women who also used alcohol only (aIRR, 8.8; 95% CI=3.1, 18.1), tobacco only (aIRR, 11.7; 95% CI=4.7, 29.5), or both tobacco and alcohol in the past 30 days (aIRR, 39.4; 95% CI=16.1, 96.7) were more likely to use cannabis use in the past 30 days more often than women who did not use tobacco or alcohol in the past

30 days. Pregnant women who used any illicit drug other than cannabis in the past 30 days also more likely to use cannabis more often than non-users (aIRR, 4.9; 95% CI=1.3, 38.18.2). Women in the first (aIRR, 2.8; 95% CI=1.1, 6.9) or second (aIRR, 3.2; 95% CI=1.3, 7.9) trimester of pregnancy used cannabis in the past 30 days more often than women in their third trimester of pregnancy. Pregnant women who did not know of any risk or did not think there was any risk of weekly cannabis use were 23 times more likely to use cannabis more often than pregnant women who perceived any risk associated with weekly cannabis use (aIRR, 23.4; 95% CI=10.8, 50.7).

Discussion

The main findings of our study can be summarized as follows: 1) Risk perception of weekly cannabis use has changed overtime among pregnant women, with more women perceiving no risk in 2017 compared to 2015; 2) The prevalence of past 30-day cannabis use and the mean number of days of cannabis use significantly increased from 2015 to 2017 among US pregnant women; 3) Younger maternal age, early trimester of pregnancy, and co-use of tobacco and/or alcohol were all associated with no perceiving any risk associated with weekly cannabis use, past 30-day cannabis use, and frequent cannabis use in the past 30 days. Self-identified Hispanic race/ethnicity was associated negatively with perceiving no risk of weekly cannabis use. Lower income was positively associated with perceiving no risk of weekly cannabis use and the number of days of cannabis use in the past 30 days. Early pregnancy and no risk perception were positively associated with past 30-day cannabis use and the number of days of cannabis use. Finally, residence in a state with legal medicinal cannabis was positively associated only with past 30-day cannabis use.

Attitudes regarding the risk of cannabis use among all population groups have been changing as legalization grows. Our results are consistent with prior studies showing reductions in risk perception of regular cannabis use, including among pregnant women.^{1,11,13,14} We also found a positive relationship between not perceiving any risk associated with weekly cannabis use and both past 30-day cannabis use and frequency of past 30-day cannabis use, which provides additional support for the well-documented relationship between risk perception and use and may explain the observed trends of cannabis use among pregnant women. Since our study is a cross-sectional study, it was not possible to assess causality or

Table 2 Characteristics of the Study Sample by Perceived Risk of Weekly Cannabis Use and Correlates of Perceiving No Risk of Weekly Cannabis Use Among US Pregnant Women (n=2,247). Results of Univariate and Multivariable Logistic Regression Models, 2015–2017 National Survey of Drug Use and Health

Characteristics	Perceived Risk of Weekly Cannabis Use				p-value	Perceiving no risk associated with weekly cannabis use			
	Any Risk		No Risk			OR	95% CI	aOR	95% CI
Sample Size and Weighted Proportion	n=1,665 ^a		n=582 ^a						
	78.4%	(76.2, 80.6)	21.6%	(19.4, 23.8)					
	% ^b	(95% CI)	% ^b	(95% CI)					
Socio-demographic factors									
Age group (years old)					<0.01				
14 to 17	1.5	(1.0, 2.1)	2.3	(0.6, 4.1)		2.0	(0.8, 4.9)	1.4	(0.5, 4.8)
18 to 29	29.2	(26.8, 31.6)	44.1	(38.9, 49.4)		2.0	(1.6, 2.6)	1.7	(1.3, 2.2)
30 to 44	69.3	(66.8, 71.8)	53.6	(48.4, 58.7)		1		1	
Self-identified race/ethnicity					<0.01				
Non-Hispanic White	54.0	(50.4, 57.6)	60.2	(54.6, 65.9)		1		1	
Non-Hispanic Black	13.8	(11.8, 15.7)	19.3	(14.7, 23.9)		1.3	(0.9, 1.8)	1.0	(0.7, 1.5)
Non-Hispanic Other	9.4	(7.3, 11.5)	9.2	(5.4, 13.0)		0.9	(0.5, 1.4)	1.0	(0.6, 1.7)
Hispanic	22.8	(19.9, 25.7)	11.2	(7.7, 14.8)		0.4	(0.3, 0.6)	0.4	(0.3, 0.6)
Population density					<0.05				
Large metropolitan	57.1	(53.9, 60.2)	48.3	(43.0, 53.7)		0.6	(0.4, 1.0)	1.1	(0.9, 1.5)
Small metropolitan	38.1	(34.8, 41.3)	45.0	(39.8, 50.2)		0.8	(0.5, 1.4)	1.1	(0.7, 1.7)
Non-metropolitan	4.8	(3.5, 6.1)	6.6	(4.4, 8.8)		1		1	
Poverty level					<0.01				
Living in poverty	20.4	(18.1, 22.8)	32.1	(28.0, 36.3)		2.2	(1.7, 2.9)	1.8	(1.3, 2.5)
Income up to 2X FPT ^c	18.7	(16.0, 21.4)	23.5	(18.2, 28.8)		1.7	(1.2, 2.5)	1.4	(0.9, 2.2)
Income more than 2X FPT	60.8	(57.7, 64.0)	44.4	(39.1, 49.7)		1		1	
Residence in medical marijuana legalized State					0.79				
No	48.4	(44.7, 52.1)	47.6	(42.7, 52.6)		1		1	
Yes	51.6	(47.9, 55.3)	52.4	(47.4, 57.3)		1	(0.8, 1.2)	1.1	(0.9, 1.4)
Substance use related factors									
Alcohol and/or tobacco use in the past 30 days					<0.01				
Neither	83.7	(81.8, 85.6)	66.3	(61.2, 71.4)		1		1	
Alcohol use only	6.4	(5.0, 7.8)	7.6	(4.7, 10.5)		1.5	(1.0, 2.3)	1.1	(0.7, 1.8)
Tobacco use only	7.9	(6.4, 9.5)	20.4	(16.8, 24.0)		3.2	(2.3, 4.6)	1.7	(1.1, 2.6)
Alcohol and tobacco use	2.0	(1.2, 2.8)	5.7	(2.9, 8.4)		3.5	(2.0, 6.5)	1.6	(0.7, 3.3)
Past 30-day use of drugs other than cannabis					<0.01				
No	99.1	(98.6, 99.6)	94.7	(91.6, 97.9)		1		1	
Yes	0.9	(0.4, 1.4)	5.3	(2.1, 8.4)		5.8	(2.6, 13.0)	3.1	(1.2, 8.1)
Health and pregnancy related factors									
Trimester of pregnancy					0.21				
First	31.7	(28.0, 35.4)	34.2	(29.0, 39.5)		1.0	(0.7, 1.3)	0.8	(0.6, 1.1)
Second	36.3	(32.9, 39.8)	30.4	(24.7, 36.1)		0.7	(0.5, 1.1)	0.7	(0.5, 1.1)
Third	31.9	(28.7, 35.1)	35.4	(29.9, 40.9)		1		1	

(Continued)

Table 2 (Continued).

Characteristics	Perceived Risk of Weekly Cannabis Use				p-value	Perceiving no risk associated with weekly cannabis use			
	Any Risk		No Risk			OR	95% CI	^a OR	95% CI
Sample Size and Weighted Proportion	n=1,665 ^a		n=582 ^a		0.44				
	78.4%	(76.2, 80.6)	21.6%	(19.4, 23.8)					
	% ^b	(95% CI)	% ^b	(95% CI)					
Self-reported health status									
Excellent to good	95.0	(93.7, 96.2)	94.0	(91.6, 96.4)					
Fair to Poor	5.0	(3.8, 6.3)	6.0	(3.6, 8.4)					
Past 12-months MDE ^d					<0.01				
No	94.2	(92.7, 95.7)	88.6	(84.8, 92.5)		1		1	
Yes	5.8	(4.3, 7.3)	11.4	(7.5, 15.2)		2.1	(1.3, 3.6)	1.6	(0.9, 2.8)
Year of the survey					<0.01				
2015	34.9	(31.9, 37.8)	26.8	(22.4, 31.3)		1		1	
2016	33.9	(31.5, 36.3)	31.8	(26.5, 37.0)		1.2	(0.9, 1.6)	1.3	(0.9, 1.7)
2017	31.2	(28.0, 34.5)	41.4	(36.1, 46.7)		1.7	(1.3, 2.4)	1.6	(1.2, 2.3)

Notes: ^aUnweighted number; ^bEstimates from weighted analyses; ^cFederal Poverty Threshold; ^dMajor Depressive Episode as defined by DSM-IV.

study the reciprocal relation between risk perception and use, for example, how use affects risk perception overtime or across multiple pregnancies.

Our findings are consistent with prior reports,^{3–5} showing increases in prevalence rates of 30-day cannabis use over a 3-year time span and increases in the frequency of use.^{5,42} In addition to changes in attitudes, increases in the numbers of days of use suggest that medicalization of cannabis may play an important role in explaining the observed trends. Evidence shows cannabis is often used during pregnancy to treat nausea and vomiting, with prenatal cannabis use increasing each year from 2009 to 2016 among pregnant women with nausea and vomiting.¹⁷ The small subsample of pregnant women using cannabis exclusively for medical reasons in the past year in the NSDUH (n=15) precluded us from conducting additional analyses to identify at-risk groups. More studies on the reasons and patterns of use of cannabis for medical and recreational reasons among pregnant women are needed.

Notably, after controlling for self-identified race ethnicity, age, trimester of pregnancy, use of alcohol, tobacco or other drugs, and other potential confounders, our results showed a negative relationship between cannabis attitudes and frequency of use and annual household levels of income among pregnant women. Specifically, pregnant women living below the poverty line were both more likely to perceive no risk of weekly

cannabis use, and nearly three times as likely to use cannabis more often in the past 30 days than pregnant women within an income bracket of more than 2X the federal poverty threshold. Pregnant women living in poverty might endorse more positive attitudes towards regular cannabis use and use cannabis more regularly due to multiple interconnected psychosocial and systemic reasons.¹⁹ For instance, growing in neighborhoods with high levels of social disadvantage and instability has been linked to problematic cannabis use in adulthood.⁴³ Women living and growing in the context of poverty may perceive cannabis use as less risky because cannabis use might be more prevalent, and its use might be normalized. In addition, when the consequences of using cannabis are compared to the consequences from exposure to other more severe contextual stressors (e.g., violence, discrimination), the perceived risk associated with using cannabis might become less relevant. The cycle of poverty and stress might also influence cannabis onset and regular use among pregnant women, as cannabis use could be perceived as a coping strategy to deal with daily stressors.¹⁹ Added to the regular financial stressors and the pregnancy-related social and financial stressors, physiological and hormonal pregnancy-related changes,⁴⁴ might increase the levels of stress and contribute to perpetuate the above-mentioned cycle. Finally, poverty can influence

Table 3 Characteristics of the Study Sample by Past 30-Day Cannabis Use and Correlates of Cannabis Use in the Past 30 Days Among US Pregnant Women (n=2,247). Results of Univariate and Multivariable Logistic Regression Models, 2015 to 2017 National Survey of Drug Use and Health

Characteristics	Cannabis Use in the Past 30 Days				p-value	Cannabis Use in the Past 30 Days			
	Yes		No						
Sample Size and Weighted Proportion (95% CI)	n = 152 ^a		n = 2,095 ^a						
	5.3%	(4.2, 6.5)	94.7%	(93.5, 95.8)					
	% ^b	(95% CI)	% ^b	(95% CI)		OR	95% CI	^a OR	95% CI
Socio-demographic factors									
Age group (years old)					<0.01				
14 to 17	3.8	(0.1, 7.4)	1.6	(1.0, 2.2)		3.5	(1.2, 10.4)	2.9	(0.9, 9.5)
18 to 29	48.7	(38.6, 58.9)	31.5	(29.3, 33.7)		2.3	(1.5, 3.5)	1.8	(1.1, 2.8)
30 to 44	47.5	(37.7, 57.3)	66.9	(64.6, 69.2)		1		1	
Self-identified race/ethnicity					<0.01				
Non-Hispanic White	55.4	(43.0, 67.9)	55.4	(52.0, 58.7)		1		1.7	(0.9, 3.4)
Non-Hispanic Black	27.8	(17.0, 38.7)	14.2	(12.5, 15.9)		2.0	(1.1, 3.7)	2.0	(0.9, 4.1)
Non-Hispanic Other	8.0	(0.8, 15.2)	9.4	(7.6, 11.3)		0.8	(0.3, 2.2)	0.9	(0.3, 2.9)
Hispanic	8.8	(5.0, 12.6)	21.0	(18.1, 23.8)		0.4	(0.2, 0.7)	0.6	(0.3, 1.2)
Population density					0.23				
Large metropolitan	47.3	(36.3, 58.2)	55.6	(53.0, 58.5)		0.6	(0.3, 1.1)	1.2	(0.6, 2.2)
Small metropolitan	45.3	(34.0, 56.6)	39.3	(36.5, 42.0)		0.8	(0.4, 1.6)	1.3	(0.6, 3.1)
Non-metropolitan	7.4	(2.8, 12.1)	5.1	(4.0, 6.3)		1		1	
Poverty level					<0.01				
Living in poverty	31.3	(22.7, 40.0)	22.5	(20.4, 24.6)		2.0	(1.3, 3.2)	0.9	(0.5, 1.7)
Income up to 2X FPT ^c	28.5	(18.0, 39.1)	19.3	(16.8, 21.7)		2.2	(1.2, 3.9)	1.3	(0.8, 2.3)
Income > than 2X FPT	40.2	(30.0, 50.3)	58.3	(55.4, 61.1)		1		1	
Residence in medical marijuana legalized state					<0.05				
No	39.2	(30.1, 48.3)	60.8	(51.7, 69.9)		1		1	
Yes	48.7	(45.5, 52.0)	51.3	(48.0, 54.5)		1.4	(0.9, 2.0)	2.1	(1.3, 3.4)
Substance use related factors									
Alcohol and/or tobacco use in the past 30 days					<0.01				
Neither	28.1	(18.2, 37.9)	82.9	(81.2, 84.6)		1		1	
Alcohol use	20.1	(9.8, 30.4)	5.9	(4.6, 7.2)		9.9	(4.6, 21.7)	8.1	(3.6, 18.3)
Tobacco use	32.2	(22.6, 41.8)	9.4	(8.0, 10.8)		10.2	(5.9, 17.5)	6.0	(3.4, 10.6)
Alcohol and tobacco use	19.6	(11.4, 27.9)	1.8	(1.0, 2.6)		33.0	(16.8, 65.0)	16.9	(7.4, 38.4)
Past 30-day use of drugs other than cannabis					<0.01				
No	87.6	(78.4, 96.7)	98.7	(98.1, 99.4)		1		1	
Yes	12.4	(3.3, 21.6)	1.3	(0.6, 1.9)		10.7	(4.0, 28.2)	2.6	(0.7, 9.3)
Health and pregnancy related factors									
Trimester of pregnancy					<0.01				
First	54.4	(45.6, 63.3)	31.0	(27.7, 34.4)		2.5	(1.6, 4.1)	1.7	(1.1, 2.9)
Second	22.6	(14.3, 31.0)	35.8	(33.0, 39.0)		0.9	(0.5, 1.6)	1.0	(0.5, 1.9)
Third	23.0	(14.7, 31.2)	33.2	(30.4, 36.1)		1		1	

(Continued)

Table 3 (Continued).

Characteristics	Cannabis Use in the Past 30 Days				p-value	Cannabis Use in the Past 30 Days			
	Yes		No			OR	95% CI	ªOR	95% CI
Sample Size and Weighted Proportion (95% CI)	n = 152ª		n = 2,095ª						
	5.3%	(4.2, 6.5)	94.7%	(93.5, 95.8)					
	%ª	(95% CI)	%ª	(95% CI)					
Self-reported health status					<0.01				
Excellent to good	88.0	(80.9, 95.1)	95.2	(94.0, 96.3)		I		I	
Fair to Poor	12.0	(4.9, 19.1)	4.8	(3.7, 6.0)		2.7	(1.3, 5.5)	1.3	(0.5, 3.3)
Past 12-months MDEª					<0.01				
No	83.5	(75.8, 91.2)	93.5	(92.3, 94.8)		I		I	
Yes	16.5	(8.8, 24.2)	6.5	(5.2, 7.7)		2.9	(1.6, 5.4)	1.6	(0.8, 3.5)
Risk perception of weekly cannabis use					<0.01				
Any risk	31.1	(21.4, 40.7)	81.1	(78.7, 83.4)		I		I	
No risk	68.9	(59.3, 78.6)	18.9	(16.6, 21.3)		9.0	(5.3, 15.3)	6.0	(3.4, 10.7)
Year of the survey					<0.01				
2015	19.8	(12.7, 27.0)	33.9	(31.4, 36.4)		I		I	
2016	31.4	(19.3, 43.4)	33.5	(31.3, 35.8)		1.6	(0.9, 3.0)	1.8	(0.9, 3.9)
2017	48.8	(37.3, 60.4)	32.6	(29.9, 35.2)		2.6	(1.6, 4.0)	2.1	(1.2, 3.6)

Notes: ^aUnweighted number; ^bEstimates from weighted analyses; ^cFederal Poverty Threshold; ^dMajor Depressive Episode as defined by DSM-IV.

cannabis use directly by limiting treatment-seeking opportunities or access to treatment.¹⁹ With accumulating evidence on the positive effects of supplemented income programs during pregnancy on pregnancy outcomes,⁴⁵ future studies are needed to establish which specific programs can also reduce drug use during pregnancy.

The subsample of self-identified Hispanic pregnant women showed lower rates of not perceiving risk associated with weekly cannabis use than Non-Hispanic Whites. Subsidiary analyses depicted in [Supplementary Figure 2](#) suggest that compared to all other self-identified racial-ethnic subgroups, Hispanics showed lower probabilities of perceiving weekly cannabis use as safe. The higher risk perception of regular cannabis use among pregnant Hispanic women is not surprising and is consistent with previous studies showing lower levels of use in this subgroup.^{46,47} Further, within the Hispanic community, pregnant Hispanic women with lower acculturation levels show even lower levels of alcohol use than those more acculturated.^{47,48} The study emphasizes the role that cultural values might play on preventing women from using cannabis while pregnant, and suggest potential areas for intervention design.

In this national sample, approximately one out of every five women used alcohol and/or tobacco while pregnant, and as many as one-third of pregnant women who used cannabis in the past 30 days had also co-used tobacco. Use of tobacco and/or alcohol was strongly associated with the use and frequency of use of cannabis in the past 30 days, even after controlling for trimester of pregnancy and use of other drugs than cannabis. The pervasive effects of tobacco and alcohol use during pregnancy have been widely studied,^{2,46,49} however less is known regarding the effects of concomitant prenatal exposure to all these drugs. Based on our findings, as well as other previous literature^{49–51} co-use of cannabis with other substances, occurs among pregnant women; therefore, additional screening and intervention development and implementation efforts are a priority. Typically, substance use screening and intervention are not integrated into routine prenatal care,^{52–58} and pregnant women, who are more likely to be in need for these services, are less likely to receive them compared to non-pregnant women.⁵⁵ In addition, drug screening and effective interventions for cannabis use prevention during pregnancy are underdeveloped. Current recommendations include early screening of cannabis use⁵³ and

Table 4 Characteristics of the Study Sample by Mean Number of Days of Cannabis Use in the Past 30 Days and Modeled Number of Days of Cannabis Use in the Past 30 Days Among US Pregnant Women (n=2,247). Results of Negative Binomial Regression Models. National Survey of Drug Use and Health, 2015–2017

Characteristics	Number of Days of Cannabis Use in the Past 30 Days						Frequency of Past 30-Day Cannabis Use			
	Total Sample			Past 30-Day Users			in the Total Sample			
Sample Size and Mean ^b (95% CI)	n = 2,247 ^a			n = 152 ^a			IRR	95% CI	^a IRR	95% CI
	0.8	(0.6, 1.1)		15.6	(13.5, 17.7)					
	Mean ^b	(95% CI)		Mean ^b	(95% CI)					
Socio-demographic factors										
Age group (years old)			<0.01			<0.01				
14 to 17	1.1	(−0.2, 2.3)		9.2	(1.6, 16.7)		4.2	(1.2,14.7)	0.8	(0.3, 2.2)
18 to 29	1.2	(0.8, 1.7)		15.5	(12.7, 18.3)		3.8	(2.2, 6.7)	2.7	(1.3, 5.4)
30 to 44	0.6	(0.4, 0.9)		16.3	(13.5, 19.0)		1		1	
Self-identified race/ethnicity			<0.01			<0.01				
Non-Hispanic White	0.8	(0.4, 1.1)		14.2	(11.3, 17.2)		1		1	
Non-Hispanic Black	1.8	(0.8, 2.9)		18.3	(14.0, 22.6)		2.1	(1.2, 5.5)	1.3	(0.8, 3.5)
Non-Hispanic Other	0.7	(−0.0, 1.5)		16.1	(5.1, 27.2)		0.7	(0.2, 2.2)	0.8	(0.3, 2.2)
Hispanic	0.4	(0.2, 0.5)		15.4	(10.6, 20.2)		0.5	(0.2, 1.0)	0.5	(0.2, 1.3)
Population density			<0.01			<0.01				
Large metropolitan	0.7	(0.3, 1.0)		14.6	(10.8, 18.3)		1.9	(1.0, 3.4)	2.2	(1.0, 4.9)
Small metropolitan	1.1	(0.7, 1.4)		17.3	(14.2, 20.4)		2.2	(0.8, 6.0)	0.6	(0.2, 1.8)
Non-metropolitan	0.9	(0.2, 1.7)		12.2	(4.9, 19.5)		1		1	
Poverty level			<0.01			<0.01				
Living in poverty	0.2	(0.7, 1.4)		14.2	(10.9, 17.4)		2.0	(1.2, 3.5)	2.9	(1.5, 5.7)
Income up to 2X FPT ^c	0.4	(0.5, 2.1)		16.6	(12.5, 20.8)		2.3	(1.0, 5.1)	0.7	(0.3, 1.6)
Income more than 2X FPT	0.1	(0.4, 0.8)		16.1	(13.0, 19.2)		1		1	
Residence in medical marijuana legalized state										
No	0.7	(0.4, 1.0)		15.6	(12.7, 18.5)		1		1	
Yes	1.0	(0.7, 1.3)		15.7	(13.2, 18.1)		1.1	(0.7, 1.7)	1.6	(0.8, 3.2)
Substance use related factors										
Alcohol and/or tobacco use in the past 30 days			<0.01			<0.01				
Neither	0.3	(0.1, 0.4)		15.7	(11.5, 19.9)		1		1	
Alcohol use	1.7	(0.4, 3.0)		10.6	(5.4, 15.9)		8.8	(3.1, 25.2)	7.4	(3.1, 18.1)
Tobacco use	2.4	(1.5, 3.3)		14.8	(12.0, 17.7)		13.0	(5.6, 28.6)	11.7	(4.7, 29.5)
Alcohol and tobacco use	8.3	(4.2, 12.5)		22.0	(18.0, 26.1)		36.0	(14.3, 91.4)	39.4	(16.1, 96.7)
Past 30-day use of drugs other than cannabis										
No	0.7	(0.5, 0.9)		15.3	(13.3, 17.3)		1		1	
Yes	6.5	(1.8, 11.3)		18.2	(12.7, 23.7)		8.2	(3.8, 17.7)	4.9	(1.3, 18.2)
Health and pregnancy related factors										
Trimester of pregnancy			<0.01			<0.01				
First	1.4	(1.0, 1.9)		16.0	(13.7, 18.4)		3.1	(1.6, 6.1)	2.8	(1.1, 6.9)
Second	0.6	(0.3, 0.8)		16.3	(12.4, 20.3)		1.6	(0.8, 3.3)	3.2	(1.3, 7.9)
Third	0.5	(0.2, 0.9)		14.5	(9.8, 19.1)		1		1	

(Continued)

Table 4 (Continued).

Characteristics	Number of Days of Cannabis Use in the Past 30 Days					Frequency of Past 30-Day Cannabis Use				
	Total Sample			Past 30-Day Users			in the Total Sample			
Sample Size and Mean ^b (95% CI)	n = 2,247 ^a			n = 152 ^a			IRR	95% CI	^a IRR	95% CI
	0.8	(0.6, 1.1)		15.6	(13.5, 17.7)					
	Mean ^b	(95% CI)		Mean ^b	(95% CI)					
Self-reported health status										
Excellent to good	0.8	(0.6, 1.0)		15.4	(13.4, 17.5)		I		I	
Fair to Poor	2.1	(0.4, 3.7)		17.0	(11.7, 22.3)		2.4	(1.1, 5.2)	1.3	(0.4, 4.3)
Past 12-months MDE ^d			<0.01			<0.01				
No	0.8	(0.6, 1.0)		16.0	(14.1, 17.9)		I		I	
Yes	1.8	(0.7, 2.8)		13.9	(9.7, 18.2)		2.0	(1.1, 3.6)	2.1	(0.8, 5.9)
Risk perception of weekly cannabis use										
Any risk	0.3	(0.1, 0.4)		12.4	(8.7, 16.1)		I		I	
No risk	2.9	(2.1, 3.7)		17.1	(15.2, 19.0)		10	(6.0, 17.7)	23.4	(10.8, 50.7)
Year of the survey			<0.01			<0.01				
2015	0.3	(0.2, 0.4)		9.7	(6.0, 13.4)		I		I	
2016	0.9	(0.5, 1.4)		18.2	(14.3, 22.0)		2.9	(1.6, 5.4)	9.7	(3.3, 28.3)
2017	1.3	(0.8, 1.8)		16.4	(13.3, 19.5)		4.1	(2.5, 6.8)	4.4	(2.6, 7.5)

Notes: ^aUnweighted number; ^bWeighted mean; ^cFederal Poverty Threshold; ^dMajor Depressive Episode as defined by DSM-IV.

cognitive-behavioral therapy;⁵² however, availability of screening tests with both a high sensitivity and specificity for pregnant women remains an issue.⁵⁸

As expected and previously reported,⁵ early pregnancy was associated with use and frequency of use in the past 30 days. This finding is of concern as use in the first months of pregnancy may compromise embryonic development, specifically neuronal development.^{24,30,31} Another concern is that past 30-day cannabis use during the second and third trimester also occurred among 3% to 4% of pregnant women, with those who had used cannabis in the past 30 days using a mean number of 15.6 days per month. These findings re-iterate the importance of screening and intervention even in advanced pregnancy stages.

We were able to show in our models that cannabis use in the past 30 days among pregnant women doubles when those women reside in a state where medical cannabis has been legalized, however, no association was observed between residence in a state with legalized medical cannabis and risk perception of weekly cannabis use, or frequency of cannabis use in the past 30 days. Since the frequency of use did not increase in states where medical marijuana is legalized, medical reasons may not be the driver of increased use. Contrasting our findings, recent

studies using data from 2002 to 2014 of substance treatment admissions to substance use treatment facilities show that among pregnant women, the rate of marijuana treatment admission between those years increased in states where medical cannabis is legalized, compared to those states where medical cannabis is not legalized.⁵⁹ These results underscore the need for understanding the motives of cannabis use and use recommendations during pregnancy, both among pregnant women and their health-care providers.

There are some limitations to our study that should be noted such as NSDUH's reliance on self-reported substance use, which may be subject to bias due to the historically illicit status of the drug and the government-sponsored nature of the survey.⁶⁰ NSDUH uses ACASI technology to encourage respondents to report their behaviors directly to a computer rather than via an in-person interviewer which reduces social desirability bias and other potential biases. This technology may be especially effective for our population in question, pregnant women, who may face more social pressures than other women to under-report drug use behaviors given potential legal implications. However, a recent study showed that self-report bias may have become less pronounced over time as

general attitudes towards cannabis use across the US are shifting.^{3,9} The available variable on residence in a state with medical marijuana legalized does not fully capture the complexity of marijuana policy in the US, which might introduce a series of biases. For example, there is potential residual confounding as this variable does not differentiate states in which both medical and recreational marijuana was legalized from states where only medical marijuana is legalized. In addition, as the policies become more liberal, self-report of non-normative behaviors might become more accurate and better reflect predominant societal norms. Despite these limitations, our study, which is based on a nationally representative sample of pregnant women, complements prior studies and serves as a baseline for assessing the impact of changes in recreational and medical cannabis legalization, as well as assists to identify women at risk of using cannabis during pregnancy and in need for intervention.

Conclusion

Overall, this study helps to confirm reductions in perception of risk of weekly cannabis use over time, increases in past 30-day cannabis use and increases in days used, as well as identifying specific population subgroups more at risk for increases in past 30-day cannabis use, such pregnant women between the ages of 18 to 29 living in poverty, those who have used alcohol and/or tobacco in the past 30 days, and those with no perception of risk of weekly cannabis use. As more states legalize some form of cannabis use, and its use is increasingly perceived as safe, there is a growing need for additional research on the etiology (e.g., psychosocial stress) and outcomes of cannabis use during pregnancy, particularly among the at-risk subpopulations identified in this study.

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Disclosure

The authors of this publication declare that this manuscript is based on a master thesis presented to the Graduate School of the University of Florida in partial fulfillment

of the requirements for the degree of Master of Science in Epidemiology.³⁸ The terms of this arrangement adhere to the publishing agreement signed by the author.

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References

1. Carliner H, Brown QL, Sarvet AL, Hasin DS. Cannabis use, attitudes, and legal status in the US: a review. *Prev Med*. 2017;104:13–23. doi:10.1016/j.ypmed.2017.07.008
2. Agrawal A, Rogers CE, Lessov-Schlaggar CN, Carter EB, Lenze SN, Grucza RA. Alcohol, cigarette, and cannabis use between 2002 and 2016 in pregnant women from a nationally representative sample. *JAMA Pediatr*. 2019;173(1):95. doi:10.1001/jamapediatrics.2018.3096
3. Brown QL, Sarvet AL, Shmulewitz D, Martins SS, Wall MM, Hasin DS. Trends in marijuana use among pregnant and nonpregnant reproductive-aged women, 2002–2014. *JAMA*. 2017;317(2):207. doi:10.1001/jama.2016.17383
4. Ko JY, Farr SL, Tong VT, Creanga AA, Callaghan WM. Prevalence and patterns of marijuana use among pregnant and nonpregnant women of reproductive age. *Am J Obstet Gynecol*. 2015;213:2. doi:10.1016/j.ajog.2015.03.021
5. Volkow ND, Han B, Compton WM, Mccance-Katz EF. Self-reported medical and nonmedical cannabis use among pregnant women in the United States. *JAMA*. 2019;322(2):167. doi:10.1001/jama.2019.7982
6. Alshaarawy O, Anthony JC. Cannabis use among women of reproductive age in the United States: 2002–2017. *Addict Behav*. 2019;99:106082. doi:10.1016/j.addbeh.2019.106082
7. Singh S, Filion K, Abenhaim H, Eisenberg M. Prevalence and outcomes of prenatal recreational cannabis use in high-income countries: a scoping review. *BJOG*. 2019. doi:10.1111/1471-0528.15946
8. Shi Y, Zhong S. Trends in cannabis use disorder among pregnant women in the U.S., 1993–2014. *J Gen Intern Med*. 2018;33(3):245–246. doi:10.1007/s11606-017-4201-0
9. Gallup News. Two in three Americans now support legalizing marijuana. 1970–2018 [News article] in Gallup Poll. 2018. Available from: <https://news.gallup.com/poll/243908/two-three-americans-support-legalizingmarijuana.aspx>. Accessed October 13, 2020.
10. Janz NK, Becker MH. The health belief model: a decade later. *Health Educ Q*. 1984;11(1):1–47. doi:10.1177/109019818401100101
11. Piontek D, Kraus L, Bjarnason T, Demetrovics Z, Ramstedt M. Individual and country-level effects of cannabis-related perceptions on cannabis use. A multilevel study among adolescents in 32 European countries. *J Adolesc Health*. 2013;52(4):473–479. doi:10.1016/j.jadohealth.2012.07.010
12. Cuttler C, Mischley LK, Sexton M. Sex differences in cannabis use and effects: a cross-sectional survey of cannabis users. *Cannabis Cannabinoid Res*. 2016;1(1):166–175. doi:10.1089/can.2016.0010
13. Lopez-Quintero C, Neumark Y. Effects of risk perception of marijuana use on marijuana use and intentions to use among adolescents in Bogotá, Colombia. *Drug Alcohol Depend*. 2010;109(1–3):65–72. doi:10.1016/j.drugalcdep.2009.12.011
14. Jarlenski M, Koma JW, Zank J, Bodnar LM, Bogen DL, Chang JC. Trends in perception of risk of regular marijuana use among US pregnant and nonpregnant reproductive-aged women. *Am J Obstet Gynecol*. 2017;217(6):705–707. doi:10.1016/j.ajog.2017.08.015
15. Westfall RE, Janssen PA, Lucas P, Capler R. Survey of medicinal cannabis use among childbearing women: patterns of its use in pregnancy and retroactive self-assessment of its efficacy against ‘morning sickness.’. *Complement Ther Clin Pract*. 2006;12(1):27–33. doi:10.1016/j.ctcp.2005.09.006

16. Martin CE, Longinaker N, Mark K, Chisolm MS, Terplan M. Recent trends in treatment admissions for marijuana use during pregnancy. *J Addict Med.* 2015;9(2):99–104. doi:10.1097/adm.0000000000000095
17. Young-Wolff KC, Sarovar V, Tucker L-Y, et al. Association of nausea and vomiting in pregnancy with prenatal marijuana use. *JAMA Intern Med.* 2018;178(10):1423. doi:10.1001/jamainternmed.2018.3581
18. Young-Wolff KC, Sarovar V, Tucker LY, et al. Association of depression, anxiety, and trauma with cannabis use during pregnancy. *JAMA Network Open.* 2020;3(2):e1921333. doi:10.1001/jamanetworkopen.2019.21333
19. Latuskie KA, Andrews NC, Motz M, et al. Reasons for substance use continuation and discontinuation during pregnancy: a qualitative study. *Women Birth.* 2019;32(1):e57–64. doi:10.1016/j.wombi.2018.04.001
20. Marroun HE, Tiemeier H, Jaddoe VW, et al. Demographic, emotional and social determinants of cannabis use in early pregnancy: the generation R study. *Drug Alcohol Depend.* 2008;98(3):218–226. doi:10.1016/j.drugalcdep.2008.05.010
21. Oh S, Salas-Wright CP, Vaughn MG, Dinitto DM. Marijuana use during pregnancy: a comparison of trends and correlates among married and unmarried pregnant women. *Drug Alcohol Depend.* 2017;181:229–233. doi:10.1016/j.drugalcdep.2017.09.036
22. Marroun HE, Brown QL, Lund IO, et al. An epidemiological, developmental and clinical overview of cannabis use during pregnancy. *Prev Med.* 2018;116:1–5. doi:10.1016/j.ypmed.2018.08.036
23. Benevenuto SG, Domenico MD, Martins MAG, et al. Recreational use of marijuana during pregnancy and negative gestational and fetal outcomes: an experimental study in mice. *Toxicology.* 2017;376:94–101. doi:10.1016/j.tox.2016.05.020
24. Salas-Quiroga AD, Diaz-Alonso J, García-Rincón D, et al. Prenatal exposure to cannabinoids evokes long-lasting functional alterations by targeting CB1 receptors on developing cortical neurons. *Proc Natl Acad Sci.* 2015;112(44):13693–13698. doi:10.1073/pnas.1514962112
25. Campolongo P, Trezza V, Ratano P, Palmery M, Cuomo V. Developmental consequences of perinatal cannabis exposure: behavioral and neuroendocrine effects in adult rodents. *Psychopharmacology.* 2010;214(1):5–15. doi:10.1007/s00213-010-1892-x
26. Tree KC, Perretolo MSD, Peyronnet J, Cayetanot F. In utero cannabinoid exposure alters breathing and the response to hypoxia in newborn mice. *Eur J Neurosci.* 2014;40(1):2196–2204. doi:10.1111/ejn.12588
27. Sebastiani G, Borrás-Novell C, Casanova MA, et al. The effects of alcohol and drugs of abuse on maternal nutritional profile during pregnancy. *Nutrients.* 2018;10(8):1008. doi:10.3390/nu10081008
28. Correa F, Wolfson ML, Valchi P, Aisemberg J, Franchi AM. Endocannabinoid system and pregnancy. *Reproduction.* 2016;152(6):R191–R200. doi:10.1530/rep-16-0167
29. Yonekura MD; FACOG Executive Director, LA Best Babies Network Dignity Health California Hospital Medical Center, M. L. Impact of marijuana on pregnancy, the fetus and neonate. n.d. Available from http://paclac.org/wp-content/uploads/2017/06/Margaret-Yonekura_Impact-of-Marijuana-on-Pregnancy-the-Fetus_6_5_17.pdf.
30. Alpár A, Marzo VD, Harkany T. At the tip of an iceberg: prenatal marijuana and its possible relation to neuropsychiatric outcome in the offspring. *Biol Psychiatry.* 2016;79(7):e33–e45. doi:10.1016/j.biopsych.2015.09.009
31. Vitalis T, Lainé J, Simon A, Roland A, Leterrier C, Lenkei Z. The type 1 cannabinoid receptor is highly expressed in embryonic cortical projection neurons and negatively regulates neurite growth in vitro. *Eur J Neurosci.* 2008;28(9):1705–1718. doi:10.1111/j.1460-9568.2008.06484.x
32. Gunn JKL, Rosales CB, Center KE, et al. Prenatal exposure to cannabis and maternal and child health outcomes: a systematic review and meta-analysis. *BMJ Open.* 2016;6(4). doi:10.1136/bmjopen-2015-009986
33. Petrangelo A, Czuzoj-Shulman N, Balayla J, Abenhaim HA. Cannabis abuse or dependence during pregnancy: a population-based cohort study on 12 million births. *J Obstet Gynaecol Can.* 2019;41(5):623–630. doi:10.1016/j.jogc.2018.09.009
34. Metz TD, Allshouse AA, Hogue CJ, et al. Maternal marijuana use, adverse pregnancy outcomes, and neonatal morbidity. *Am J Obstet Gynecol.* 2017;217(4):478.e1–478.e8. doi:10.1016/j.ajog.2017.05.050
35. Huizink A. Prenatal cannabis exposure and infant outcomes: overview of studies. *Prog Neuropsychopharmacol Biol Psychiatry.* 2014;52:45–52. doi:10.1016/j.pnpbp.2013.09.014
36. Grant KS, Petroff R, Isoherranen N, Stella N, Burbacher TM. Cannabis use during pregnancy: pharmacokinetics and effects on child development. *Pharmacol Ther.* 2018;182:133–151. doi:10.1016/j.pharmthera.2017.08.014
37. Sharapova SR, Phillips E, Sirocco K, Kaminski JW, Leeb RT, Rolle I. Effects of prenatal marijuana exposure on neuropsychological outcomes in children aged 1–11 years: a systematic review. *Paediatr Perinat Epidemiol.* 2018;32(6):512–532. doi:10.1111/ppe.12505
38. Odom G. Perceived risk of weekly cannabis use, past 30-day cannabis use, and frequency of cannabis use among pregnant women in the United States Master of Science in Epidemiology [thesis]. Gainesville: University of Florida; 2019. Available from: https://ufdimages.uflib.ufl.edu/UF/E0/05/62/12/00001/Odom_G.pdf. Accessed October 13, 2020.
39. Center for Behavioral Health Statistics and Quality. 2017 National Survey on Drug Use and Health: Methodological Summary and Definitions. Rockville, MD: Substance Abuse and Mental Health Services Administration; 2018.
40. A comparison of variance estimation methods for regression analyses with the mental health surveillance study clinical sample. n.d. Available from: <https://www.samhsa.gov/data/node/5879154>.
41. Centers for Disease Control and Prevention. Guidelines for using NSDUH restricted use data [PDF file]. 2018. Available from: <https://www.cdc.gov/rdc/b1datatype/datafiles/Guidelines-for-Using-NSDUHRestricted-use-Data.pdf>.
42. Young-Wolff KC, Sarovar V, Tucker L-Y, et al. Self-reported daily, weekly, and monthly cannabis use among women before and during pregnancy. *JAMA Network Open.* 2019;2(7):e196471. doi:10.1001/jamanetworkopen.2019.6471
43. Lee JO, Jones TM, Kosterman R, et al. Childhood neighborhood context and adult substance use problems: the role of socio-economic status at the age of 30 years. *Public Health.* 2018;165:58–66. doi:10.1016/j.puhe.2018.09.011
44. Brunton PJ, Russell JA. Endocrine induced changes in brain function during pregnancy. *Brain Res.* 2010;10(1364):198–215. doi:10.1016/j.brainres.2010.09.062
45. Brownell MD, Chartier MJ, Nickel NC, et al. Unconditional prenatal income supplement and birth outcomes. *Pediatrics.* 2016;137(6):e20152992. doi:10.1542/peds.2015-2992
46. Hernandez M, Sternberg KLV, Castro Y, Velasquez MM. The role of acculturation and alcohol problems on frequency of cannabis use among latinas at risk of an alcohol-exposed pregnancy. *Subst Use Misuse.* 2019;54(12):1980–1990. doi:10.1080/10826084.2019.1625399
47. Bakhireva LN, Young BN, Dalen J, Phelan ST, Rayburn WF. Periconceptional binge drinking and acculturation among pregnant Latinas in New Mexico. *Alcohol.* 2009;43(6):475–481. doi:10.1016/j.alcohol.2009.08.002
48. Coleman-Cowger VH, Schauer GL, Peters EN. Marijuana and tobacco co-use among a nationally representative sample of US pregnant and non-pregnant women: 2005–2014 national survey on drug use and health findings. *Drug Alcohol Depend.* 2017;177:130–135. doi:10.1016/j.drugalcdep.2017.03.025

49. Forray A, Foster D. Substance use in the perinatal period. *Curr Psychiatry Rep.* **2015**;17(11):91. doi:10.1007/s11920-015-0626-5
50. Louw K-A. Substance use in pregnancy: the medical challenge. *Obstetric Med.* **2018**;11(2):54–66. doi:10.1177/1753495x17750299
51. Stinson FS, Ruan WJ, Pickering R, Grant BF. Cannabis use disorders in the USA: prevalence, correlates and co-morbidity. *Psychol Med.* **2006**;36(10):1447–1460. doi:10.1017/s0033291706008361
52. Williams PP, Petersen Z, Sorsdahl K, Mathews C, Everett-Murphy K, Parry CD. Screening and brief interventions for alcohol and other drug use among pregnant women attending midwife obstetric units in Cape Town, South Africa: a qualitative study of the views of health care professionals. *J Midwifery Womens Health.* **2015**;60(4):401–409. doi:10.1111/jmwh.12328
53. Gotham HJ, Wilson K, Carlson K, Rodriguez G, Kuofie A, Witt J. Implementing substance use screening in family planning. *J Nurse Pract.* **2019**;15(4):306–310. doi:10.1016/j.nurpra.2019.01.009
54. Bayrampour H, Zahradnik M, Lisonkova S, Janssen P. Womens perspectives about cannabis use during pregnancy and the postpartum period: an integrative review. *Prev Med.* **2019**;119:17–23. doi:10.1016/j.ypmed.2018.12.002
55. Terplan M, Mcnamara EJ, Chisolm MS. Pregnant and non-pregnant women with substance use disorders: the gap between treatment need and receipt. *J Addict Dis.* **2012**;31(4):342–349. doi:10.1080/10550887.2012.735566
56. Jaques SC, Kingsbury A, Henshcke P, et al. Cannabis, the pregnant woman and her child: weeding out the myths. *J Perinatol.* **2014**;34(6):417–424. doi:10.1038/jp.2013.180
57. Stickrath E. Marijuana use in pregnancy. *Clin Obstet Gynecol.* **2019**;62(1):185–190. doi:10.1097/grf.0000000000000415
58. Ondersma SJ, Chang G, Blake-Lamb T, et al. Accuracy of five self-report screening instruments for substance use in pregnancy. *Addiction.* **2019**;114(9):1683–1693. doi:10.1111/add.14651
59. Meinhofer A, Witman A, Murphy SM, Bao Y. Medical marijuana laws are associated with increases in substance use treatment admissions by pregnant women. *Addiction.* **2019**;114(9):1593–1601. doi:10.1111/add.14661
60. Johnson T, Fendrich M. Modeling sources of self-report bias in a survey of drug use epidemiology. *Ann Epidemiol.* **2005**;15(5):381–389. doi:10.1016/j.annepidem.2004.09.004

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