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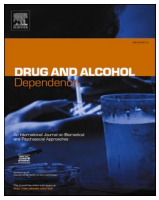

Is legal recreational cannabis associated with cannabis use during pregnancy, beliefs about safety, and perceived community stigma?

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ABSTRACT

Background: Among pregnant and recently pregnant people we investigated whether legal recreational cannabis is associated with pregnancy-related cannabis use, safety beliefs, and perceived community stigma.

Methods: In 2022, we surveyed 3571 currently and recently pregnant English- or Spanish-speaking adults in 37 states. Primary outcomes included cannabis use during pregnancy and two continuous scale measures of beliefs about safety and perceived community stigma. Using generalized linear models and mixed effects ordinal logistic regression with random effects for state, we assessed associations between legal recreational cannabis and outcomes of interest, controlling for state-level and individual-level covariates and specifying appropriate functional form.

Results: Those who reported cannabis use during pregnancy were more likely to believe it is safe and to perceive community stigma compared to those who did not report use during pregnancy. Legal recreational cannabis was not associated with cannabis use during pregnancy, continuation or increase in use, frequency of use, or safety beliefs. Legal recreational cannabis was associated with lower perceived community stigma (coefficient: −0.07, 95% CI: −0.13, −0.01), including among those who reported use during (coefficient = −0.22, 95% CI: −0.40, −0.04) and prior to but not during (coefficient = −0.19, 95% CI: −0.37, −0.01) pregnancy.

Conclusion: Findings do not support concerns that legal recreational cannabis is associated with cannabis use during pregnancy or beliefs about safety. Legal recreational cannabis may be associated with lower community stigma around cannabis use during pregnancy, which could have implications for pregnant people's disclosure of use and care-seeking behavior.

1. Introduction

There have been unprecedented changes in the United States (US) cannabis policy environment in the past two decades, with 23 states and the District of Columbia having legalized adult recreational cannabis as of June 2023 (National Conference of State Legislatures (NCSL), 2023). These efforts have raised concerns among government agencies and some public health organizations about the potential adverse health and safety impacts of legalizing cannabis, including potential increases in cannabis use among pregnant people and in low birthweight babies born to pregnant people who use cannabis (Hall and Weier, 2015; Ghosh et al., 2016; National Academies of Sciences, 2017; Office of the Surgeon General, 2019). However, there is scientific uncertainty regarding the overall magnitude and extent of health effects related to pregnant people's cannabis use (National Academies of Sciences, 2017). There is also inconsistent evidence to support claims that legalization is leading to increases in adverse health effects among babies from cannabis use during pregnancy (Wilson and Rhee, 2022).

Population level trends in cannabis use indicate an increase in past-month cannabis use among pregnant people in the US, from 4.1% in 2014 to 7.2% in 2021 (SAMHSA, 2023). However, this trend mirrors the similar increases in use observed among the general adult population from 8.4% to 13.0% in the same period (SAMHSA, 2023). A study in Northern California, where recreational cannabis became legal in 2016, found increases in cannabis use before and during pregnancy from 2009 to 2017, with daily use increasing most rapidly (from 1.2–3.1% for use in the year before pregnancy and 0.3–0.7% for use during pregnancy) (Young-Wolff et al., 2019). If and how these increases in use prevalence and frequency are related to legal recreational cannabis is unclear.

Several studies find evidence of increased cannabis use during pregnancy associated with legalization. The four most rigorous of these assess changes in use pre-to-post legalization (Wilson and Rhee, 2022;

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Skelton et al., 2021; Lee et al., 2020; Gnofam et al., 2020; Rodriguez et al., 2016) (rather than only post-legalization changes (Skelton et al., 2020; Young-Wolff et al., 2021; Vachhani et al., 2022)). Yet, three of these studies lack rigorous comparison groups by including only one state (Gnofam et al., 2020; Rodriguez et al., 2016) or a single health system or center (Lee et al., 2020; Gnofam et al., 2020). Skelton 2021 (Skelton et al., 2021) makes comparisons across states but is limited geographically to four states (Alaska, Maine, New Hampshire, and Vermont). Other studies, which examined pre-to-post legalization changes in only one state (Allshouse and Metz, 2016; Straub et al., 2021) or province (Bayrampour and Asim, 2021), found no significant associations between legalization and pregnant people's cannabis use. Only one study assessed associations between legal cannabis and pregnant people's use among a nationally representative sample. Using logistic regression, they found significantly higher odds of cannabis use during pregnancy in legal recreational and medical cannabis states compared to states with neither legal medical nor legal recreational cannabis (Vachhani et al., 2022). Yet the analysis did not account for clustering of participants within states, a key aspect of multi-level analyses. Further, data for this study were collected in 2017–2020, after which 13 states legalized recreational cannabis (NIAAA, 2020).

Understanding beliefs about safety and stigma associated with cannabis use during pregnancy is important for public health interventions, particularly as many states allow increased availability of cannabis as a legal substance. Beliefs about safety and perceptions of community stigma can influence decisions to discontinue or reduce cannabis use during pregnancy (Mark et al., 2017; Chang et al., 2019; Weisbeck et al., 2021), and community stigma can hinder willingness to disclose use and utilize health care, resulting in adverse health outcomes (Weber et al., 2021; Stringer and Baker, 2018). Data from two studies among women showed that the perception that general cannabis use has no or only slight risk increased 3-fold from 2005 to 2015 (Jarlenski et al., 2017) and that most pregnant and nonpregnant women who reported recent cannabis use perceived slight or no risk (Jarlenski et al., 2017; Ko et al., 2015). These studies used a single question ("*how much do people risk harming themselves physically and in other ways when they smoke marijuana once or twice a week?*") to quantify perceptions of risk as no, low, moderate, high or uncertain and did not ask about people's use during pregnancy (Jarlenski et al., 2017). Several qualitative studies have explored beliefs about people's cannabis use during pregnancy, primarily among people with experience using cannabis during pregnancy. One found a notable decrease in stigma, greater willingness to disclose cannabis use during pregnancy, and an increased trust in cannabis retailers with regard to safety and effectiveness of products after legalization (Young-Wolff et al., 2022). Another, conducted in a non-legal context, revealed complexity of beliefs, including that most thought using cannabis during pregnancy was relatively "natural" and "safe", had conflicting opinions about whether it was addictive, and were uncertain about potential risks (Chang et al., 2019).

The present study explores whether legal recreational cannabis is associated with pregnant people's cannabis use, beliefs about the safety of using cannabis during pregnancy, and perceived community stigma around pregnant people's cannabis use among a large multi-state sample of pregnant or recently pregnant people. We hypothesized that legal recreational cannabis would be associated with increased use during pregnancy, beliefs that using cannabis during pregnancy is safe, and lower community stigma. We sought to capture nuanced beliefs about safety and stigma and to avoid stigmatization of pregnant people who use substances by using multi-item scales with survey items generated based on peer-reviewed literature as well as feedback from a community advisory board, which included people with lived experience using cannabis during pregnancy.

2. Methods

In May-June 2022, we administered an online survey to pregnant and recently pregnant members of Ipsos's national probability sample. The market research firm added members of non-probability panels to meet sample size targets for pregnant and recently pregnant people by state. Eligible participants were pregnant or pregnant within the past 2 years, non-institutionalized, ages 18–49 years, and English- or Spanish-speaking. Participants were recruited from 37 study states, including all states with legal recreational cannabis at the time of the survey plus a purposively sampled subset of states without legal recreational cannabis (Roberts et al., 2023). Participants provided electronic informed consent before completing the survey. The market research firm invited 12,045 panel members to participate in the national probability survey; 6163 people (51%) completed the eligibility screener, of whom 747 (12%) were eligible and participated. Then, among the non-probability panel members also invited to participate, 8302 completed the eligibility screener, of whom 2824 (34%) were eligible and participated. Eligibility in the non-probability panels was higher because one of the non-probability samples pre-screened for pregnancy prior to assessing eligibility. In total, the market research firm received 3571 valid responses to our survey questions; we removed from analyses one respondent who did not answer any questions related to the outcome measures. Additional details about the survey design are published elsewhere (Roberts et al., 2023). The University of California, San Francisco institutional review board provided ethical approval.

2.1. Measures

Our main exposure of interest was living in a state with legal recreational cannabis (Alaska, Arizona, California, Colorado, Connecticut, District of Columbia, Illinois, Maine, Massachusetts, Michigan, Montana, Nevada, New Jersey, New Mexico, New York, Oregon, Vermont, Virginia, and Washington) compared to living in a state without legal recreational cannabis (Delaware, Hawaii, Idaho, Indiana, Iowa, Maryland, Minnesota, Missouri, New Hampshire, North Carolina, North Dakota, Ohio, Pennsylvania, Rhode Island, South Dakota, Utah, Wisconsin, and Wyoming) at the time of responding to the survey in May–June 2022. Rhode Island legalized cannabis for recreational use on May 25, 2022, so in sensitivity analyses we removed Rhode Island participants (n=10) from the sample. The three primary outcomes of interest included 1) self-reported cannabis use during pregnancy compared to no use during pregnancy (dichotomous) and beliefs (linear) about cannabis use during pregnancy regarding 2) safety and 3) perceived community stigma. Secondary outcomes included changes in cannabis use from pre-pregnancy to pregnancy among those who reported any use in the past 12 months (continuation or increase in use versus discontinuation or decrease in use) and an ordinal measure of frequency of use among those who reported any use during pregnancy (daily or almost daily use versus weekly or monthly use versus less than monthly use).

Participants were informed of the following before being asked about their cannabis use during pregnancy: "The following questions are about your views about and experiences with cannabis. Cannabis is also known as marijuana, pot, weed, grass, hash, Mary Jane, 420, or chronic. … When answering these next questions, please include any type of cannabis, including cannabis you smoked, vaped, ate, drank, or consumed. Do **not** include topical cannabis or CBD products such as creams or oils." We asked participants to report on their cannabis use before and during their pregnancy. First, all participants were asked how frequently they used cannabis in the 12 months before pregnancy discovery and in the past 30 days. Response options for both questions included "never", "less than monthly", "monthly", "weekly", and "daily or almost daily". Those who were currently pregnant and responded "never" to use in the 12 months prior to pregnancy and in the past 30 days were asked a follow-up question: "Have you used cannabis at all during your pregnancy?" with options including "yes", "no", or "not sure". Recently pregnant participants were asked: "During your pregnancy, how often did you use cannabis?" and those who responded

"never" or refused were then asked whether they used cannabis at all during their pregnancy. For analyses, we coded those who answered "not sure" about whether they used cannabis during pregnancy (n=29) as having used cannabis during pregnancy. We categorized changes in cannabis use from pre-pregnancy to pregnancy based on responses to questions about frequency of use. We defined frequency of cannabis use as an ordinal variable for analyses: less than monthly, monthly or weekly, or daily or almost daily. Those who responded "no" to use in the prior 30 days (if currently pregnant) or "never" to the frequency of use during pregnancy (if recently pregnant) and then answered "yes" or "not sure" about use at all during pregnancy (n=106) were removed from the main model predicting frequency of cannabis use during pregnancy. In sensitivity analyses, we added these respondents back into the sample, categorizing them as having used cannabis "less than monthly" for the frequency model.

We used a series of items with 5-point Likert-scaled response options to create two scales to measure beliefs about the safety of cannabis use during pregnancy and perceived community stigma related to cannabis use during pregnancy (Likert, 1932). For each scale, our team created items intended to reflect existing beliefs about cannabis use during pregnancy, based on reviews of the literature, our own knowledge of the field, and consultations with the study's community advisory board (Roberts et al., 2023). The community advisory board included six people with lived experience related to pregnant people's cannabis use and health care providers' reporting of pregnant and birthing people to government authorities for substance use or self-managed abortion. The community advisory board suggested questions to include in the survey and provided feedback on the wording of survey items. We computed the Cronbach's alpha reliability coefficient for each scale, considering alpha above 0.80 acceptable. The final beliefs about safety scale included 12 items (alpha=0.92). The community stigma scale included six items (alpha=0.80) reflecting a community's attitudes toward people who use or have used cannabis during pregnancy, how people treat those individuals, and opinions toward policies that govern use during pregnancy. Item responses ranged from strongly disagree (−2) to strongly agree (+2). We reverse coded certain items and estimated the standardized mean score (mean=0, variance=1) for each scale, such that higher scale scores reflected more agreement with the belief that cannabis use during pregnancy is safe and with greater perceived community stigma.

In multivariate models, we adjusted for individual-level factors conceptually associated with outcomes of interest based on prior literature (Gonzalez et al., 2017; Roppolo et al., 2019; Brown et al., 2019). These included age group (18–20, 21–24, 25–29, 30–34, 35–39, and >=40 years), a combined race/ethnicity and language variable (Non-Hispanic [NH] White, NH Black, NH other/multiple, Hispanic English-speaking, and Hispanic Spanish-only or bilingual), employment (full-time, part-time, or unemployed), income (<$10,000, $10,000-$24,999, $25,000-$49,999, $50,000-$74,999, $75,000-$99,999, $100,000-$149,999, and $150,000 or more), sexual or gender minority (yes or no), gravidity (0, 1, 2, and 3 or more), and marital status (married, widowed/divorced/separated, never married, and living with partner). We also adjusted for pregnancy outcome (currently pregnant, recent pregnancy ending in birth, recent pregnancy ending without a birth) to account for the time since someone was pregnant, unmeasured confounders associated with time (i.e., potential differences in reporting related to time since pregnancy and time since legalization), and the possibility that people may have different beliefs after they give birth (or have a miscarriage). We did not adjust for individual-level education due to collinearity. Individual-level data on tobacco and alcohol use were not available.

We also adjusted for state-level controls from 2021 available from secondary sources, including the unemployment rate (US Bureau of Labor Statistics, 2023), proportion of state residents living below the poverty level (US Census Bureau, 2023), and per-capita total alcohol consumption (Slater and Alpert, 2023). We controlled for per-capita alcohol consumption only in models predicting cannabis use during pregnancy because of documented clustering of risks between cannabis, alcohol, and tobacco (Passey et al., 2014). We did not adjust for state-level per-capita cigarette consumption because of collinearity. Finally, we included indicator variables (yes/no) for each of seven state-level pregnancy-specific drug use policies, which varied within state legal cannabis status (i.e., child abuse or neglect; child protective services reporting requirements; reporting requirements related to data; reporting requirements for assessments and treatment; priority treatment for pregnant people only; priority treatment for pregnant people and women with children; and limits on criminal prosecution) (NIAAA, 2020; Thomas et al., 2018).

2.2. Analysis

We described participant characteristics, legal cannabis groups, cannabis use variables, and beliefs about safety and perceived community stigma related to cannabis use during pregnancy. We assessed differences in demographic factors and cannabis use during pregnancy by legal cannabis status using chi-squared tests for binary variables and t-tests for continuous variables. We assessed differences in mean safety and stigma scores (for scales and individual items) by legal cannabis status and by cannabis use groups using linear regression accounting for survey weighting and clustering by state at the $p<0.05$ level. In adjusted multi-level models exploring the association between legal cannabis and our outcomes of interest, we used generalized linear regression specifying the appropriate functional form for the outcome (gaussian for continuous safety and stigma scales; binomial for any cannabis use and changes in cannabis use pre to post pregnancy). To assess the association of legal cannabis with frequency of cannabis use during pregnancy, we used mixed effects ordinal logistic regression and restricted to a subsample of those who reported any use during pregnancy. For all multilevel models, we included random effects for state and controlled for individual-level and state-level covariates. We also conducted analyses of associations between legal cannabis and beliefs about safety and stigma stratified by self-reported cannabis use (no use in the 12 months or during pregnancy, use in the 12 months prior to but not during pregnancy, and use during pregnancy), given that beliefs about safety and perceived stigma may vary depending on one's personal experience. We also calculated average marginal effects for the perceptions of stigma scale and beliefs about safety scale, among the full sample and among samples stratified by reported cannabis use during pregnancy. We used case-wise deletion for missing data, which was less than 1% for any covariate (race/ethnicity/language = 0.36%, employment = 0.20%, income = 0.03%, gravida = 0.06%) and outcomes (cannabis use during pregnancy = 0.03%, frequency of use during pregnancy = 0.78%).

We coded and ran all analyses in Stata 15 (Statacorp, 2017) from September 2022– August 2023 and used a 2-sided statistical significance level of $p<0.05$. We applied survey weights provided by the market research firm designed to weight the sample such that it is representative of noninstitutionalized females ages 18–49 years living in the study states with respect to demographic factors, including age group, race/-ethnicity, education, household income, and language. We present actual numbers and their corresponding weighted percentages.

3. Results

3.1. Sample characteristics

Of the 3570 participants with study outcome responses, 72% were recently pregnant and gave birth, 22% were currently pregnant, and 6% had a recent pregnancy that ended without a live birth (Table 1). Most participants were non-Hispanic White (58%), currently married (70%), and had been pregnant before their most recent pregnancy (74%). Thirteen percent identified as a sexual/gender minority. Most participants were living in states with legal recreational cannabis (64%).

Table 1
Sample characteristics, overall and by whether respondent lives in a legal cannabis state.

	Total N=3570	Among those in legal cannabis states n=2062	Among those in non-legal cannabis states n=1508
	Unweighted n (weighted %)	Unweighted n (weighted %)	Unweighted n (weighted %)
Individual-level characteristics			
*Age (years) **			
18–20	137 (3)	85 (3)	52 (2)
21–24	501 (10)	279 (9)	222 (12)
25–29	823 (24)	476 (23)	347 (27)
30–34	1047 (31)	578 (30)	469 (32)
35–39	706 (21)	442 (22)	264 (19)
>=40	356 (11)	202 (12)	154 (9)
*Race ****			
NH White	2315 (58)	1203 (53)	1112 (67)
NH Black	365 (11)	186 (10)	179 (13)
NH Other/Multi	291 (12)	200 (13)	91 (9)
Hispanic – English-only speaking	214 (7)	169 (9)	45 (4)
Hispanic – Spanish-only speaking/Bilingual	385 (12)	304 (15)	81 (7)
Employment			
Full-time	1639 (51)	930 (52)	709 (50)
Part-time	686 (17)	417 (18)	269 (15)
Not working	1238 (32)	708 (30)	530 (34)
*Household income ****			
<$10,000	377(5)	237 (6)	140 (5)
$10,000-$24,999	397 (4)	213 (4)	184 (5)
$25,000-$49,999	858 (17)	470 (16)	388 (21)
$50,000-$74,999	671 (17)	365 (16)	306 (19)
$75,000-$99,999	516 (13)	291 (12)	225 (14)
$100,000- $149,999	480 (27)	300 (27)	180 (25)
$150,000 or more	270 (16)	186 (19)	84 (12)
Marital status			
Married	2107 (70)	1225 (70)	882 (70)
Widowed, divorced, separated	264 (5)	151 (5)	113 (6)
Never married	457 (9)	284 (10)	173 (8)
Living with partner	742 (16)	402 (15)	340 (16)
*Gravida (Excluding recent pregnancy) **			
0	828 (26)	513 (27)	315 (23)
1	949 (27)	546 (27)	403 (27)
2	754 (21)	420 (21)	334 (21)
3+	1037 (26)	582 (25)	455 (29)
Pregnancy status			
Recently pregnant - Birth	2494 (72)	1420 (71)	1074 (72)
Recently pregnant - No birth	251 (6)	148 (7)	103 (6)
Currently pregnant	825 (22)	494 (22)	331 (22)
*Sexual or gender minority **			
Yes	602 (13)	370 (14)	232 (11)
No	2968 (87)	1692 (86)	1276 (89)
*Cannabis use ****			
No cannabis use before or during pregnancy	1940 (66)	1509 (64)	881 (70)
Cannabis use before but not during pregnancy	648 (17)	418 (19)	230 (13)
Cannabis use during pregnancy	982 (17)	585 (17)	397 (17)
Frequency of cannabis use during pregnancy			
Never	2563 (83)	1459 (83)	1104 (83)
Less than monthly	383 (8)	235 (8)	148 (8)
Monthly or weekly	284 (5)	172 (5)	112 (5)
Daily or almost daily	313 (4)	177 (5)	136 (4)
*Change in cannabis use during pregnancy among those who reported cannabis use before or during pregnancy **			
Stopped or reduced use	1044 (72)	661 (75)	383 (66)
Continued, increased, or started use	554 (28)	320 (25)	234 (34)
State-level characteristics			
Mean (se) % living below poverty line***	10.6 (0.05)	10.8 (0.07)	10.1 (0.07)
Mean (se) % unemployed***	5.6 (0.03)	6.1 (0.04)	4.6 (0.04)
Mean (se) per capita alcohol consumption in gallons per year***	829 (36.6)	688 (43.1)	1077 (64.6)
State-level pregnancy-specific substance use policies			
Child abuse or neglect ***	1504 (42)	975 (44)	529 (60)
Reporting for Child Protective Services purposes ***	1777 (57)	1198 (65)	579 (42)
Reporting for treatment purposes ***	1908 (57)	1473 (73)	435 (29)
Reporting for data purposes ***	2014 (56)	1499 (70)	515 (30)
Priority treatment for pregnant women and children ***	401 (8)	266 (8)	135 (8)
Priority treatment for pregnant women ***	1381 (38)	893 (31)	488 (42)
Limits on criminal prosecution	479 (13)	280 (12)	199 (13)

Significant differences by legal recreational cannabis status assessed with chi squared (categorical variables) and t-tests (continuous variables); one star (*) indicates significance at the p<0.05 level, two stars (**) indicate significance at the p<0.01 level, and three stars (***) indicate significance at the p<0.001 level.

Thirty-four percent reported any cannabis use in the 12 months prior to finding out about the pregnancy, including daily (12%), weekly (6%), monthly (5%), and less than monthly (11%) use. Of those who reported use prior to pregnancy, 72% stopped or reduced use and 28% continued or increased use during pregnancy. The proportion who stopped or reduced using cannabis when they became pregnant was higher in states with legal cannabis (75% vs 66%, p=0.01). Seventeen percent of the sample reported using cannabis during pregnancy, including daily (4%), weekly (4%), monthly (2%), and less than monthly (6%).

We found a negative weighted mean score on the safety scale reflecting overall low degree of belief that cannabis use during pregnancy is safe (−0.17, 95% CI: −0.20, −0.13). Regarding individual items, 70% and 64% of the sample believed that reducing and stopping cannabis use during pregnancy, respectively, is "good for the baby's health." A plurality believed that during pregnancy cannabis use is safer than alcohol use (40%) and safer than tobacco use (38%). Uncertainty (defined as neither agree nor disagree) ranged from 24%−50% and was highest for items focused on specific effects of cannabis use during pregnancy: "born too small" (40%), "birth defects" (50%), and "usually just fine" (47%) (Fig. 1). Uncertainty was lowest (24%) for the belief that "cutting back on cannabis use during pregnancy is good for the baby's health." Beliefs about the safety of cannabis use differed by cannabis use experience (Fig. 2). Specifically, those who reported no use in the 12

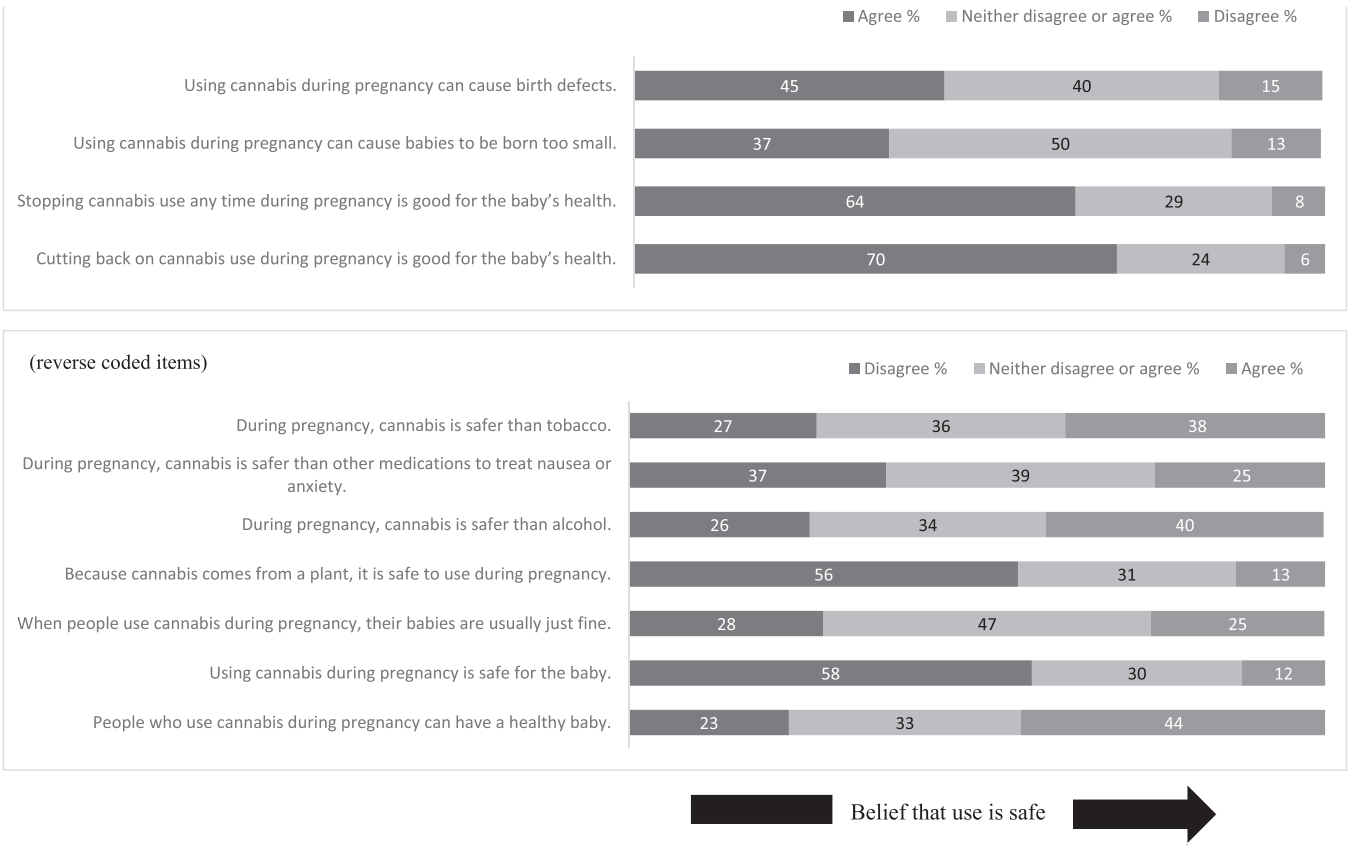

Fig. 1. Beliefs about safety of cannabis use during pregnancy.

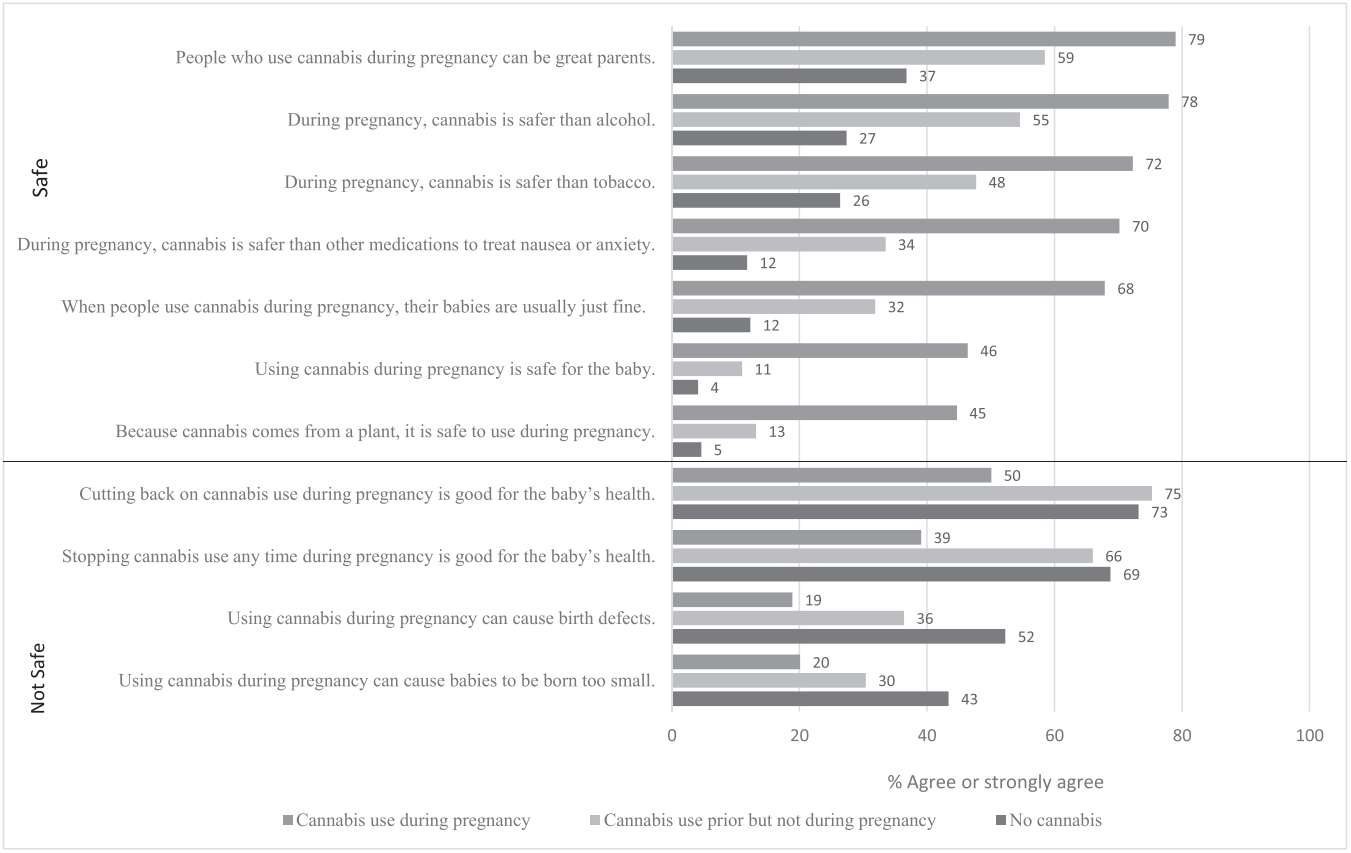

Fig. 2. Beliefs about safety of cannabis use during pregnancy, by cannabis use experience.

months prior to pregnancy were significantly less likely to believe cannabis use during pregnancy is safe (mean scale score: −0.40, 95% CI: −0.43, −0.36, p<0.001) and those who reported use during pregnancy were significantly more likely to believe it is safe (mean scale score: 0.61, 95% CI: 0.55, 0.67, p<0.001), compared to those who reported use prior to but not during pregnancy (mean scale score: −0.05, 05% CI: −0.13, 0.02).

The weighted mean stigma scale score was 0.45 (95% CI: 0.41, 0.48). Nearly one-quarter (24%) of the sample had a stigma scale score of zero, representing uncertainty about the presence of perceived community stigma. More than 40% of the sample was uncertain about five of the six stigma scale items, with the highest proportion uncertain about items related to pregnant people's comfort talking with their prenatal care providers about cannabis (49%) and with other people's knowledge of their cannabis use (47%) (Fig. 3). Perceived community stigma was significantly lower among those who reported no cannabis use (mean scale score: 0.40, 95% CI: 0.36, 0.44) compared to those who reported use prior to but not during pregnancy (mean scale score: 0.55, 95% CI: 0.48, 0.63, p<0.001). And there was no significant difference between those who reported use prior to pregnancy (mean scale score: 0.55, 95% CI: 0.48, 0.63) and those who reported use during pregnancy (mean scale score: 0.52, 95% CI: 0.45, 0.60, p=0.60) (Fig. 4).

In bivariate analyses, residing in a state with legal recreational cannabis was not associated with cannabis use during pregnancy (OR=1.17, 95% CI: 0.92, 1.50, p=0.21), frequency of use (OR=0.88, 95% CI: 0.67, 1.15, p=0.35), or safety beliefs (coef=0.00, 95% CI: −0.08, 0.09, p=0.93). Legal cannabis was negatively associated with continuation or increase in use compared to discontinuation or reduction in use (OR=0.79, 95% CI: 0.64, 0.98, p=0.03) and negatively associated with perceived community stigma (coef=−0.08, 95% CI: −0.13, −0.03, p=0.002).

In adjusted models, residing in a state with legal recreational cannabis was not significantly associated with cannabis use during pregnancy (aOR=1.05, 95% CI: 0.78, 1.41, p=0.74), with continuation or increase in use from pre-pregnancy to pregnancy among those who reported ever using cannabis (aOR=0.76, 95% CI: 0.50, 1.16, p=0.20), or with the frequency of cannabis use during pregnancy among those who reported any use during pregnancy (aOR=1.06, 95% CI: 0.73, 1.53, p=0.78) (Table 2). Results were similar in sensitivity analyses. Legal cannabis was not associated with safety beliefs (coef= 0.05, 95% CI: −0.08, 0.19, p=0.50), even after stratifying by reported use during pregnancy (Fig. 5). Legal cannabis was associated with lower perceived community stigma overall (coef= −0.07, 95% CI: −0.13, −0.01, p=0.02), including among those who reported cannabis use during pregnancy (coef= −0.22, 95% CI: −0.40, −0.04, p=0.02) and among those who reported use prior to but not during pregnancy (coef= −0.19, 95% CI: −0.37, −0.01, p=0.04) but not among those who reported no use in the 12 months prior to pregnancy (coef= −0.01, 95% CI: −0.08,. 0.05, p=0.73) (Table 3, Fig. 5).

4. Discussion

We found no evidence of an association between legal recreational cannabis and pregnant people's use of cannabis, including changes in cannabis use from before to during pregnancy or in frequency of use. Trends showing increases in the prevalence of cannabis use during pregnancy over time, including from before to after legalization in some states (SAMHSA, 2023; Young-Wolff et al., 2019), may be related to other factors. These other factors may include evolving social norms about the morality of cannabis use (Chang et al., 2019; Cameron et al., 2022; Kohlwes et al., 2023), a greater willingness to disclose cannabis use during pregnancy, increasingly blurred boundaries between medical and recreational applications of cannabis (Bostwick, 2012), more availability and lower cost of cannabis products, and increased awareness of and demand for cannabis as a potential treatment for symptoms related to pregnancy (Young-Wolff et al., 2019). Our findings suggest that the concerns of public health and other health professionals about possible implications of cannabis legalization for pregnant people's cannabis use are not supported by our data.

The proportion reporting cannabis use during pregnancy in our sample is greater than that reported in a recent national study (Vachhani et al., 2022). This recent national study (Vachhani et al., 2022) focused on past-month cannabis use specifically among currently pregnant people, rather than any use at any point during a current or recent pregnancy, which may contribute to relatively lower estimates. Also, studies conducted by government agencies (like (Vachhani et al., 2022)) may be prone to underestimates given reporting requirements in many states. Further, our sample included nonprobability panel participants, some of whom may have opted to participate due to interest in or experience with the topic, which could also influence the proportion reporting use during pregnancy in our sample.

Most people in our sample believed that using cannabis during pregnancy was unsafe, supporting prior findings from another national probability-based survey that found over 92% believed that it is completely or somewhat unsafe (Keyhani et al., 2018). Ongoing scientific uncertainty about the magnitude and extent of potential harm of cannabis use during pregnancy, combined with recommendations from national medical agencies against the use of cannabis during pregnancy

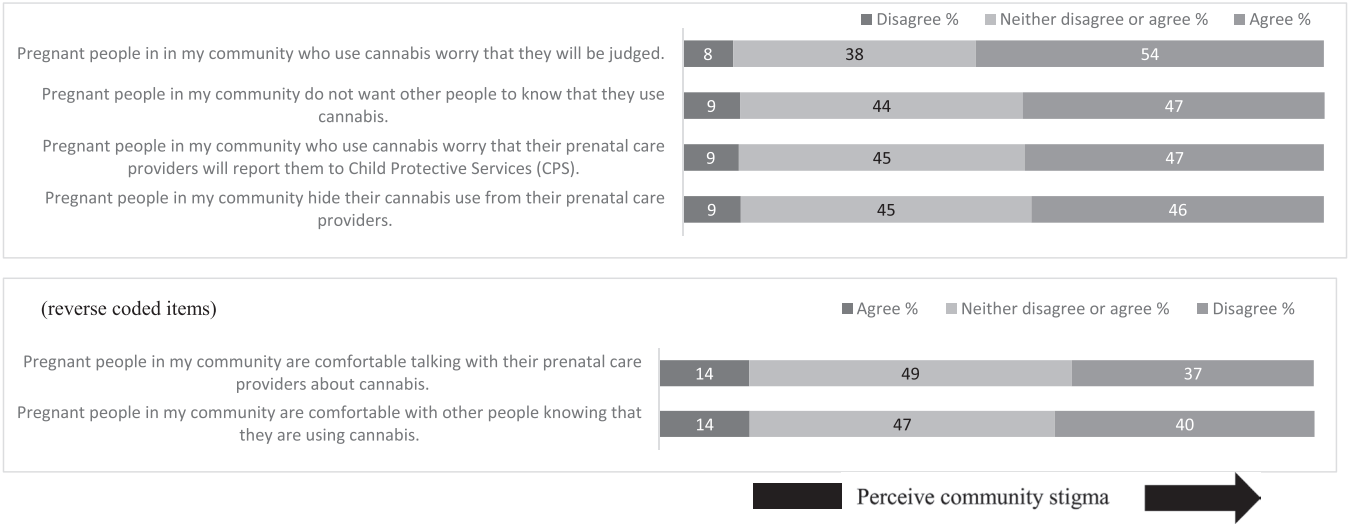

Fig. 3. Perceived community stigma about cannabis use during pregnancy.

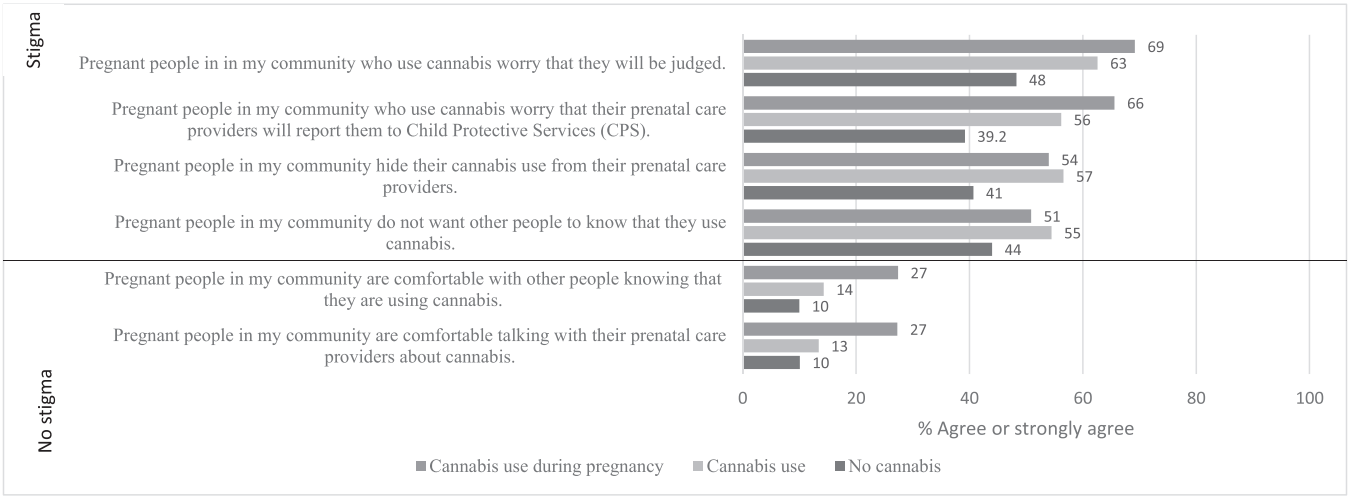

Fig. 4. Perceived community stigma about cannabis use during pregnancy, by cannabis use experience.

Table 2
Associations between legal cannabis and three different measures of cannabis use during pregnancy.

Outcome	N	Adjusted Odds Ratio (95% CI)
Any cannabis use during pregnancy, among the full sample (reference: no cannabis use during pregnancy)	3547	1.05 (0.78, 1.41), p=0.74
Frequency of cannabis use during pregnancy, among those who reported any cannabis use during pregnancy (categories: less than monthly, monthly or weekly, daily or almost daily)	868	1.06 (0.73, 1.53), p=0.78
Continuation or increase in cannabis use during pregnancy, among those who reported any cannabis use before and/or during pregnancy (reference: stopped or decreased cannabis use during pregnancy)	1589	0.76 (0.50, 1.16), p=0.20

Models adjusted for state percent living under poverty line, state percent unemployed, state-level pregnancy-specific substance use policies, age group, race/ethnicity/language, employment, household income, marital status, gravida, pregnancy outcome, sexual/gender minority.

(ACOG, 2023; Ryan and Ammerman, 2018), likely contribute to concerns about safety among the public (National Academies of Sciences, 2017). The lack of apparent association between legal cannabis and beliefs about safety may be partially due to spillover effects whereby state legalization policies resulted in changes in safety beliefs about cannabis use during pregnancy in both legal and non-legal cannabis states, which could obscure any true association. Alternatively, changes in beliefs could be associated with medical cannabis legalization, which typically precedes legal recreational cannabis. It is also possible that our models omit other factors beyond state legalization policy that play a role in forming beliefs about safety. Commonly reported sources of information about the effects of cannabis use during pregnancy include the internet, friends and family, and the media (Jarlenski et al., 2016, 2018; Dakkak et al., 2018; Lebron et al., 2022), which are accessible across state lines.

Our findings that participants who reported using cannabis during their pregnancy perceived more community stigma overall and greater decreases in perceived community stigma associated with state legalization, compared to those who did not report use during pregnancy, are in line with prior research. This prior research shows that people who personally experience a stigmatized event or behavior report higher perceived stigma compared to people who do not (Biggs et al., 2020). These findings are also supported by literature highlighting the potential of policy to play an important role in reducing or invigorating stigma more generally (Link and Hatzenbuehler, 2016). In this case, the association between legal cannabis and reduced perceived community stigma could have important implications for helping more pregnant people who use cannabis get the information, education, and resources they need. Stigma experienced by pregnant people who use substances can impact their willingness to disclose use, care-seeking, and access to treatment and contribute to adverse health outcomes (Weber et al., 2021; Stringer and Baker, 2018). Policy changes that result in reductions in community stigma around cannabis use during pregnancy could therefore be an important public health approach.

Our results are strengthened by our large and geographically diverse sample, the anonymity of responses and a nuanced approach to measuring beliefs about safety and perceived stigma with itemized scales, as well as our engagement with a community advisory board.

Limitations include that this study explored associations, not causal effects. Due to the cross-sectional study design, we could not account for underlying time trends or assess the directionality of potential causal associations. Lower perceived stigma in legal recreational cannabis states may have preceded legalization efforts, or perhaps the relationship between legal recreational cannabis and perceived community stigma was bidirectional. Longitudinal cohort or repeated cross-sectional studies are needed to rigorously investigate state policy effects. Our use of a binary policy predictor, which likely does not fully reflect the legal status of cannabis, is another limitation. Other factors worth considering, but not accounted for in these analyses, include the availability, cost, and type of cannabis products permitted for sale, all of which could influence cannabis use (Ghosh et al., 2016). Legal medical cannabis may be a confounder, given that it preceded legal recreational cannabis in many states (Hasin et al., 2017; Martins et al., 2016) and may be associated with increases in general cannabis use and changes in beliefs about safety and stigma. Self-reported measures of using cannabis during pregnancy are known to have low sensitivity, which can lead to underestimation (Garg et al., 2016; El Marroun et al., 2011). Nevertheless, we would expect more underreporting of cannabis use during pregnancy in states without legal cannabis relative to states with legal cannabis (Woodruff et al., 2021), which would bias analyses away from the null. Finally, though the safety and stigma outcome scales were internally consistent, they have not been formally validated.

Our sample was large and geographically diverse, but it did not include data from people in all states without legal recreational cannabis, so perspectives and experiences in those states are not included. A larger proportion of our sample (64%) was living in states with legal cannabis compared to that of the US population at the time (43%) (US Census Bureau, 2023). About half of those invited to

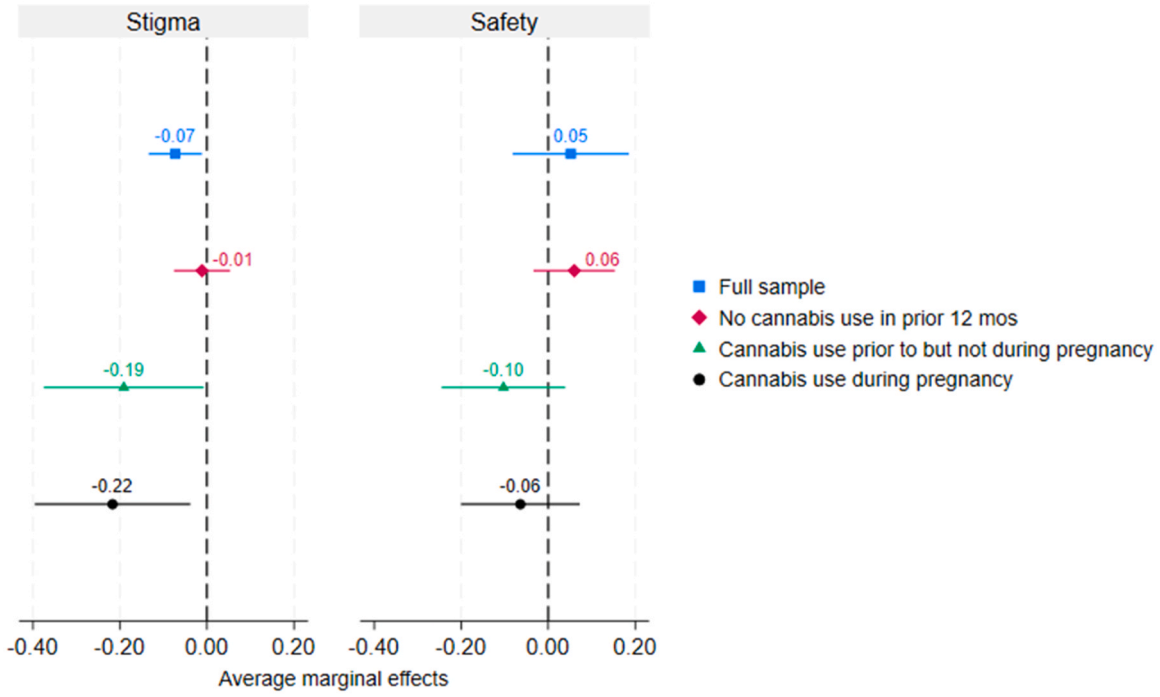

Fig. 5. Average marginal effects for perceptions of stigma scale and beliefs about safety scale, by sample.

Table 3
Associations between legal cannabis and beliefs about the safety of and community stigma regarding cannabis use during pregnancy.

		Cannabis use during pregnancy		
	Full sample (N=3547)	No use in the 12 months prior to pregnancy (n=1927)	Use before but not during pregnancy (n=645)	Use during pregnancy (n=975)
Outcome	**Adjusted Coef. (95% CI)**	**Adjusted Coef. (95% CI)**	**Adjusted Coef. (95% CI)**	**Adjusted Coef. (95% CI)**
Cannabis use during pregnancy is not safe	0.05 (−0.08, 0.19), p=0.50	0.06 (−0.03, 0.15), p=0.20	−0.10 (−0.25, 0.04), p=0.16	−0.06 (−0.20, 0.07), p=0.36
Perceived community stigma around cannabis use during pregnancy	−0.07 (−0.13, −0.01), p=0.02	−0.01 (−0.08, 0.05), p=0.73	−0.19 (−0.37, −0.01), p=0.04	−0.22 (−0.40, −0.04), p=0.02

Models adjusted for state percent living under poverty line, state percent unemployed, state-level pregnancy-specific substance use policies, age group, race/ethnicity/language, employment, household income, marital status, gravida, pregnancy outcome, sexual/gender minority.

participate completed the eligibility screener, and these individuals may have differed from those who did not screen. However, we weighted our sample to represent noninstitutionalized females ages 18–49 years with respect to age group, race/ethnicity, education, household income, and language, which should address differential enrollment at least on measured characteristics. Pregnancy status at the time of the survey may have influenced participants' willingness to report cannabis use, yet we account for pregnancy status in the analyses and the proportions currently versus recently pregnant do not vary by exposure group. While our study was weighted so estimates represent national estimates, we did not oversample people from particular population groups, so did not have sufficient power to conduct interaction analyses to examine subgroup differences, including differences by race/ethnicity. Given that Black birthing people are more likely to experience punishment related to drug use (Roberts and Nuru-Jeter, 2012), future research should consider examining whether findings differ by race/ethnicity.

5. Conclusions

Concerns that legal cannabis is associated with increased cannabis use during pregnancy or with changing beliefs about the safety of cannabis use during pregnancy are not supported by our findings. Legal recreational cannabis is associated with lower perceived stigma, particularly among those who report cannabis use prior to or during pregnancy. Legal recreational cannabis could have important implications for reducing community stigma around cannabis use during pregnancy, increasing willingness to disclose and care-seeking among those who need it, and ultimately improving health outcomes for those who use cannabis during pregnancy.

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Role of the funding source

The funder had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Author contributions

Raifman contributed to the concept and design of the study, statistical analysis and interpretation of data, and drafting and revising of the manuscript. Biggs contributed to the concept and design and critical revision of the manuscript. Roberts contributed to the concept and

design, acquisition, analysis, and interpretation of the data, and critical revision of the manuscript; she also obtained funding and provided supervision on the study.

CRediT authorship contribution statement

Sarah Raifman: Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Conceptualization. **Corinne Rocca:** Writing – review & editing, Methodology. **M. Antonia Biggs:** Writing – review & editing, Visualization, Methodology. **Sarah C. M. Roberts:** Writing – review & editing, Supervision, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization.

Declaration of Competing Interest

We have no conflicts of interest to disclose.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.drugalcdep.2023.111079.

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