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Impact of marijuana legalization on prevalence of maternal marijuana use and perinatal outcomes

Mayi GNOFAM[1,2], **Ms. Amanda A. ALLSHOUSE**[3], **Elaine H. STICKRATH**[4,5], **Torri D. METZ**[3]

[1]Department of Obstetrics and Gynecology, University of Colorado Denver, Aurora, CO

[2]Department of Obstetrics and Gynecology, Maison Blanche's Hospital, University of Reims Champagne-Ardenne.

[3]Department of Obstetrics and Gynecology, University of Utah Health, Salt Lake City, UT

[4]Department of Obstetrics and Gynecology, Denver Health and Hospital Authority, Denver, CO

[5]University of Colorado School of Medicine, Aurora, CO

Abstract

Objective: We aimed to assess whether marijuana legalization was associated with a difference in prevalence of prenatal use or an increase in incidence of adverse perinatal outcomes.

Study design: Retrospective cohort of September and October deliveries in the years 2012 through 2015 at a tertiary center in Colorado. Primary outcome was marijuana use, defined by self-report, or bio-detection. Secondary outcomes included: growth restriction, spontaneous preterm birth, stillbirth, preeclampsia, and neonatal or maternal death. Marijuana use prevalence was compared by year, and secondary outcomes between two periods – before and after the opening of the first recreational dispensary.

Results: A total of 2392 pregnant women were included (1165 before legalization and 1227 after). More women used marijuana over the period of legalization (trend p=0.01). Odds of marijuana use were higher after legalization versus before (aOR 1.8, 95% CI 1.2–2.6).

Incidence of growth restriction was higher after legalization (2.9% versus 5.1%, p=0.0084). This difference persisted after adjustment for ethnicity and other drugs in multivariable modeling (aOR 1.9, 95%CI 1.2–3.0).

Conclusion: The prevalence of prenatal marijuana use increased over the time of legalization. Further investigation into the population impact of legalization on obstetrical outcomes is warranted given the observed increase in growth restriction.

Keywords

alcohol; cannabis; fetal growth restriction; legalization; marijuana; opioids; pregnancy; prevalence; tobacco

Corresponding author: Torri Metz, MD, MS, University of Utah Health, 30 North 1900 East, 2B200, Salt Lake City, UT, 84132, Work phone: (801) 581-8425, Work fax: (801) 585-2594, torri.metz@hsc.utah.edu.

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Introduction

Marijuana is the most widely used “illicit” drug among pregnant women with estimates ranging from 3–30% (1–4). Many studies have focused on the impact of marijuana use on obstetrical outcomes (5). Use has been associated with lower neonatal birthweights (6–14), altered fetal neurological development (15–20), and stillbirth (21). Despite a potential risk of harm, the prevalence of marijuana use and perceived safety of use has trended up over a period of expanding legalization in the United States (22,23). It remains unclear, however, how legalization of recreational marijuana impacts the prevalence of use among pregnant women.

Most studies evaluating the impact of marijuana legalization on prevalence of use focus on youth, and demonstrate no association between marijuana legalization and increased consumption (24–28). However, these results are mixed. One study focusing on Washington State University undergraduate students highlighted a significant increase in marijuana use after legalization, with the greatest change observed among females, Black and Hispanic students (29). Another study demonstrated a ten-year increase in adolescent marijuana-associated emergency department visits in Colorado, most notably in the years following commercialization of medical and recreational marijuana (30). There was similarly an increase in hospitalizations with marijuana-related codes by 70% between 2013 and 2015 (the years surrounding recreational legalization).

Data regarding the impact of legalization of recreational marijuana on the prevalence of marijuana use among pregnant women are lacking. We therefore aimed to assess whether legalization of marijuana in Colorado was associated with a difference in prevalence of marijuana use during pregnancy or a change in the incidence of adverse pregnancy outcomes. We hypothesized that marijuana use by pregnant women would increase following recreational legalization.

Material and Methods

Over the past two decades, Colorado has legalized marijuana for both medicinal and recreational use. While medical marijuana was legalized in 2000, sales did not begin until 2009. Recreational marijuana was then legalized in November 2012, with the first sales beginning January 1, 2014 (31). To assess whether recreational legalization of marijuana in Colorado was associated with a difference in prevalence of marijuana use during pregnancy, or incidence of adverse perinatal outcomes, we designed a study to compare women who delivered before and after January 1, 2014.

We performed a retrospective cohort study including all deliveries at a university-affiliated tertiary center in Colorado in September and October of the years: 2012, 2013, 2014 and 2015. All women who delivered during the study time period were included. If women had more than one birth during the study time period, only the first birth was included. September and October were selected as the months for analysis as they were remote from policy changes, and not near the beginning or end of the academic year.

Women were identified by using a previously created perinatal database (extracted from an Epic electronic medical record system) that identifies all deliveries occurring at the institution for each monthly interval. Given the increased incidence of adverse pregnancy outcomes among women with multiple gestations, women with multiple gestations were included in the overall marijuana prevalence estimate, but excluded from estimates of perinatal outcomes. This study was approved by the Colorado Multiple Institutional Review Board.

Detailed demographic and delivery data were abstracted from the electronic medical record of each participant by trained perinatal research assistants. Abstracted medical record data were entered into a study-specific instance of Research Electronic Data Capture (REDCap) hosted at the University of Colorado Denver Anschutz Medical Campus, a secure, web-based application designed to support data capture for research studies (32).

Demographic data abstracted included: ethnicity (Hispanic, not Hispanic), race (Black or African American, Native American or Alaskan, Asian, Native Hawaiian or Other Pacific Islander, White, More than one race, other), maternal age at delivery in years, marital status (married or living with partner, single or significant other, divorced or legally separated), employment status (employed, unemployed), education status (less than high school, high school, some college, completed college, higher degree), and gestational age at delivery in weeks.

The primary outcome was marijuana use. Marijuana use was defined by self-report as documented in the medical record, bio-detection with urine toxicology at either the first prenatal visit or at admission for delivery as ordered by a clinician, or meconium testing positive for cannabis metabolites as ordered by a clinician during the neonatal delivery admission. There was no specific hospital protocol for who met criteria for drug testing over the study period. Per hospital protocol, written maternal consent was required for maternal urine toxicology testing. Meconium testing and neonatal urine testing were sent at the discretion of pediatrics without maternal consent.

Secondary outcomes were fetal growth restriction (FGR), as detected antenatally by ultrasound with an estimated fetal weight <10%ile, spontaneous preterm birth at <37 weeks gestation, stillbirth, preeclampsia (with and without severe features), fetal congenital anomalies, gestational diabetes, mode of delivery (spontaneous vaginal, forceps, vacuum or cesarean), neonatal death, maternal death, small for gestational age (SGA), NICU admission, and >2 days in NICU. Fetal growth restriction was ascertained based on the reported estimated fetal weight by ultrasound. Ultrasounds were ordered at the discretion of the providers for lagging fundal height or obstetric indications. Marijuana use was not an indication for obtaining a growth ultrasound over the study time period.

Self-report of other drugs, alcohol and tobacco were recorded. All results from urine toxicology testing and meconium testing were abstracted from the charts of both mothers and neonates when available.

Statistical methods

Deliveries were grouped by year into four categories (2012–15) for test of trend, and then separately into two categories designating time before (2012–2013) and after (2014–2015) legalization for further comparisons and modeling. Demographics and secondary outcomes are reported before and after legalization, and compared using a chi-square test for categorical measures and a t-test for continuous measures. Employment status and education level were missing for the majority of participants, and are therefore not reported.

Prevalence of marijuana use is reported before and after legalization and by year, with differences in prevalence across years tested using a chi-square test for trend. The overall chi-square for the comparison across 4 years is also reported. All demographic variables that were different between groups ($p<0.05$) were considered for inclusion in multivariable modeling for our primary and secondary outcomes. Other drug use was considered a clinically important covariate for perinatal outcomes and was, therefore, included in all models for our secondary outcomes. The final multivariable logistic regression models were estimated adjusting for ethnicity and other drug use as appropriate.

To evaluate the accuracy of manual chart abstraction, 5% of the eligible records were randomly selected. These charts were abstracted again for the primary and secondary outcomes. Repeat data abstraction was completed by the Obstetric Research Team at the University of Colorado, which is comprised of trained perinatal research assistants and nurses. Repeat abstraction was performed without knowledge of the original data entry. Concordance between the two abstractions was evaluated, and they were found to be concordant >95% (range 95.6–99.2%) of the time for all outcomes. If there was a discrepancy between the abstractions, this was corrected through adjudication by one of the investigators. Differences were considered significant at $p < 0.05$. All analyses were performed in SAS. Figures were created using GraphPad PRISM.

Results

Among 2428 deliveries occurring in September or October across 4 years, 36 deliveries were excluded as they were identified as the second delivery from a woman already included in the study. Among the remaining 2392 women who were included: 566 women delivered in 2012, 599 in 2013, 630 in 2014 and 597 in 2015. Women who delivered before (n=1165) and after (n=1227) legalization differed by ethnicity, and by self-reported race as “other”. Other demographic characteristics did not significantly differ between the two groups (Table 1).

Primary outcome

More pregnant women self-reported marijuana use over the period of legalization (2.8% in 2012, 3.7% in 2013, 7.3% in 2014, 4.9% in 2015, trend p=0.01). Similarly, significantly more pregnant women reported using marijuana before compared to after legalization (3.3 vs 6.0%, p=0.001). Among the subset of n=100 women (n=41 before, n=59 after) for whom a urine toxicology test was available at the time of delivery, detected use was significantly different before versus after legalization (7% versus 29% p=0.01). Among the subset of

n=801 neonates with meconium testing available during the delivery admission, detected use was not statistically different before versus after legalization (1.5% versus 3.1%, p=0.13). Combining all sources of marijuana use (self-report or biologically detected), use trended significantly higher over the period of legalization (3.7% in 2012, 4.7% in 2013, 8.6% in 2014, 5.9% in 2015, trend p=0.02, Figure 1). After adjustment for ethnicity, odds of marijuana use remained significantly higher after legalization than before (aOR 1.8, 95% CI 1.2–2.5).

Positivity of both urine sample at delivery and meconium testing significantly differed over time but without a significant trend by year. Positivity of urine sample at the first prenatal visit did not significantly differ over time. The use of other substances (tobacco, alcohol, illegal drugs, opioids) did not differ significantly over time for self-reported or biologically detected use (Table 2).

Secondary outcomes

Perinatal outcomes were compared before versus after legalization for n=2321 singleton deliveries (multiple gestations excluded for this portion of the analysis). The incidence of antenatally diagnosed fetal growth restriction was significantly higher after legalization (2.9% versus 5.1%, p=0.006) (Table 3). This difference persisted after adjustment for ethnicity and other drugs in multivariable modeling (aOR 1.9, 95% CI 1.3–3.1). For all other neonatal, obstetrical outcomes, and delivery characteristics, observed differences were not significantly different before and after legalization (Table 3).

Discussion

We found a significantly higher prevalence of prenatal marijuana use over the time period of recreational legalization in Colorado. More women self-reported marijuana use, and had a positive urine or meconium test at delivery. No difference was found over time for other substances including tobacco, alcohol, illegal drugs or opioids. Among singleton deliveries, fetal growth restriction had a higher incidence after legalization while other evaluated perinatal outcomes did not significantly differ.

Overall, our findings are consistent with those of Miller et al (29) who noted a significant increase in marijuana self-reported use but not in tobacco, alcohol or other drugs in a youth population. Recent data from the Colorado Department of Public Health and Environment similarly highlight a significantly higher prevalence of marijuana use during pregnancy among younger women (less than 24 years old) (33) following legalization, especially in the setting of an unintended pregnancy. Our results are also consistent with those of the 2007–2012 National Surveys on Drug Use and Health as we found a similar prevalence of use among pregnant women in 2012 (4).

The prevalence of use by urine or meconium testing increased from 7% prior to legalization to 26% after legalization. While only a small proportion of the women in our study had biological sampling results available, the results are similar to a previous study using a cross-sectional universal cord homogenate sampling approach at two Colorado hospitals after recreational legalization (34). The cross-sectional study reported a prevalence of use of

22% by cord sampling. Those findings and ours indicate that many women use marijuana during pregnancy in a state with legalization demonstrating the importance of screening for and discussing use in pregnancy. Of note, in this cross-sectional study the proportion of women who self-reported use was much lower (6% on an anonymous survey), which is consistent with the results of this analysis, and reflects a major limitation of studies relying on self-reported use.

To our knowledge, this is one of the first studies to evaluate whether marijuana legalization is associated with differences in use among pregnant women. Data were abstracted from medical records without reliance on administrative coding for substance use, which likely underestimates use. We observed increased self-reported, and biologically detected, prevalence of marijuana use among pregnant women after legalization. The increase was most notable in the year immediately following recreational legalization, which may reflect liberalized reporting of use prior to an understanding of the ongoing ramifications of mandatory reporting of maternal use of schedule I substances regardless of state-level policy.

While we found an increase in diagnosis of fetal growth restriction from before to after legalization, there was not a similar observed increase in the incidence of small for gestational age at birth. This raises the question of whether there was bias in the selection of women for ultrasound to evaluate for fetal growth restriction. This association warrants further investigation with prospective assessment of fetal growth in a cohort of women with and without marijuana use over the course of pregnancy. Marijuana use was associated with decreased fetal growth by ultrasound among a cohort of women participating in the Generation R study (6).

We did not find differences in neonatal outcomes from before to after legalization. Data regarding the association between marijuana use and perinatal outcomes are limited by lack of adjustment for important confounding factors, as well as, the use of self-reported marijuana use as the exclusive means of ascertainment of use (1)(5). However, there are data supporting an association between NICU admission and marijuana exposure (1). Importantly, in our analysis, we compared rates of perinatal outcomes before and after legalization, but did not evaluate the impact of marijuana use directly, which may account for the observed differences between our findings and those previously published.

Our study has several limitations. The results are largely based on self-reported marijuana use and pregnant women may have been more likely to disclose marijuana use in the era of legalization. Self-report is known to have a very high specificity for use at the expense of a low sensitivity, compared to biological sampling (35) (36). Therefore, our results may underestimate use. However, we also considered prevalence of use of other addictive substances (tobacco, alcohol and other illegal drugs) over the same time period using the same self-reported methodology, and found no similar increase. In addition, urine toxicology testing was not completed universally, which may bias the results to a higher estimated prevalence of use by sampling women at higher risk. Similarly, screening for fetal growth restriction with ultrasound was only performed when clinically indicated which may result in bias. Finally, the study was completed at a single tertiary care center and the results may not be generalizable to other populations.

Conclusion

Our results demonstrate that the prevalence of prenatal marijuana use increased over the time period of recreational marijuana legalization in Colorado. For other states preparing for a change in legal status of marijuana, we recommend implementation of systematic biologic testing leading up to and through the time of legalization to thoroughly evaluate the impact of marijuana policy change. In addition, the finding of increased incidence of fetal growth restriction from before to after legalization is concerning, and needs to be evaluated in other populations.

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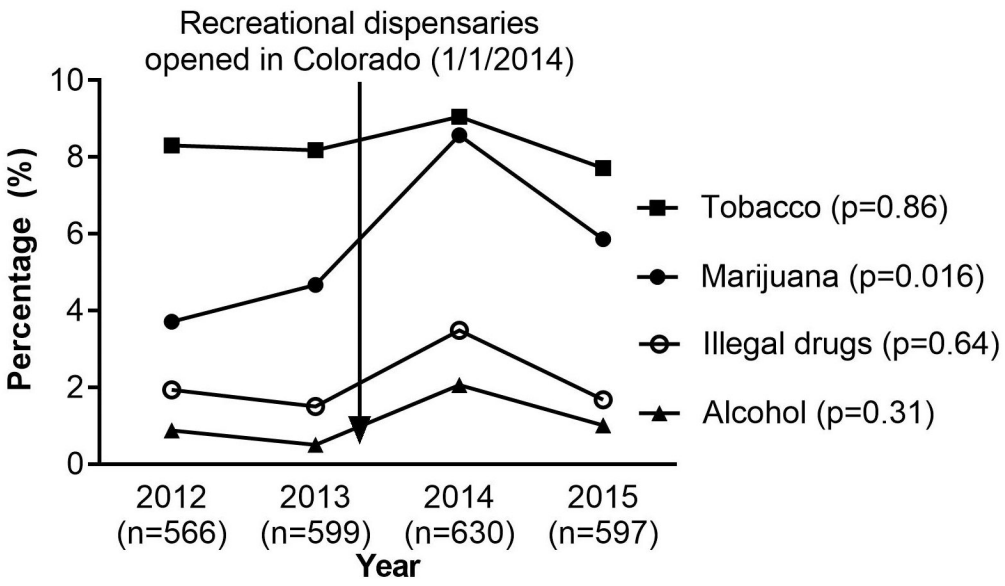

Figure 1. Marijuana and other substance use over time, 2012–15

Substance use by year across marijuana legalization for recreational use in Colorado. Use as measured by self-report or as detected by biological sampling. The arrow indicates the opening of recreational marijuana dispensaries in Colorado on January 1, 2014.

Table 1.

Demographics of study population before and after legalization

Characteristic	Value	Before n=1165 (%)	After n=1227 (%)	*P*
Ethnicity	Hispanic	368 (32.5)	319 (27.4)	0.008
Race	Black or African American	188 (16.1)	205 (16.7)	0.707
	Native American or Alaskan	5 (0.4)	5 (0.4)	0.935
	Asian	37 (3.2)	52 (4.2)	0.17
	Native Hawaiian or Other Pacific Islander	7 (0.6)	3 (0.2)	0.177
	White	562 (48.25)	599 (48.8)	0.777
	More than one race	1 (0.1)	2 (0.2)	0.594
	Other	322 (27.6)	287 (23.4)	0.017
	Patient Refused	1 (0.1)	2 (0.2)	0.594
	Unknown	10 (0.9)	9 (0.7)	0.731
Maternal age (years)	Geometric mean [95%CI]	27.8 [27.40, 28.14]	28.2 [27.83, 28.55]	0.109
Marital Status	Married or Living with Partner	677 (59.8)	699 (60.1)	0.075
	Single or significant other	394 (34.8)	420 (36.1)	
	Divorced or Legally Separated	32 (2.8)	15 (1.3)	
	Unknown	30 (2.6)	30 (2.6)	
Number of fetuses	1	1133 (97.3)	1188 (96.8)	0.705
	2	31 (2.7)	36 (2.9)	
	3	1 (0.1)	2 (0.2)	
	4	0 (0.0)	1 (0.1)	

Table 2.

Marijuana and other substance use, 2012–2015

Substance Use Measure	2012 n=566 (%)	2013 n=599 (%)	2014 n=630 (%)	2015 n=597 (%)	*P*	*P* trend
Self-reported marijuana use	16 (2.8)	22 (3.7)	45 (7.1)	29 (4.9)	0.002	0.0139
Meconium sample at delivery positive for marijuana	6 (1.1)	0 (0.0)	4 (0.6)	8 (1.3)	0.043	0.3319
Urine sample at first prenatal visit positive for marijuana	3 (0.5)	9 (1.5)	13 (2.1)	5 (0.8)	0.076	0.4828
Urine sample at delivery positive for marijuana	2 (8.7)	1 (5.3)	14 (31.8)	2 (13.3)	0.045	0.0523
Any marijuana by self-report or biological sampling	21 (3.7)	28 (4.7)	54 (8.6)	35 (5.9)	0.002	0.0158
Meconium or urine sample positive for opioids	3 (0.5)	3 (0.5)	7 (1.1)	2 (0.3)	0.331	0.9792
Meconium or urine sample positive for illegal drugs	4 (0.7)	5 (0.8)	8 (1.3)	6 (1.0)	0.77	0.4593
Any illegal drugs or opioids by self-report or biological sampling	11 (1.9)	9 (1.5)	22 (3.5)	10 (1.7)	0.064	0.6432
Self-reported tobacco use	47 (8.3)	49 (8.2)	57 (9.0)	46 (7.7)	0.862	0.8587
Self-reported alcohol use	5 (0.9)	3 (0.5)	13 (2.1)	6 (1.0)	0.059	0.3098

P values from both overall chi-square and additionally a test of trend.

Table 3.

Secondary outcomes among singleton deliveries: neonatal, obstetric, and delivery characteristics

Characteristic	Before n=1133 (%)	After n=1188 (%)	*P* value
Preterm Birth	141 (12.6)	144 (12.2)	0.802
Fetal congenital anomaly	58 (5.4)	48 (4.2)	0.191
Fetal growth restriction	32 (2.9)	60 (5.1)	0.006
Stillbirth	15 (1.4)	15 (1.3)	0.904
Neonatal death	11 (1.5)	15 (1.8)	0.567
Maternal death	0	0	-
Preeclampsia	80 (7.1)	78 (6.7)	0.686
Gestational diabetes	74 (6.7)	92 (7.9)	0.252
Spontaneous preterm labor	60 (5.5)	84 (7.3)	0.073
Mode of Delivery			0.87
Spontaneous Vaginal	785 (72.4)	830 (73.8)	
Forceps	16 (1.5)	16 (1.4)	
Vacuum	13 (1.2)	11 (1.0)	
Cesarean	271 (25.0)	268 (23.8)	
Gestational age at delivery, weeks (mean, SE)	38.7 (0.09)	38.6 (0.09)	0.465
Z score group[1]			0.926
SGA (<10th percentile)	165 (15.2)	162 (14.6)	
AGA	859 (79.0)	881 (79.4)	
LGA (>90th percentile)	64 (5.9)	67 (6.0)	
Z score (Mean, SE)	−.28 (0.03)	−.27 (0.03)	0.893
Any time in NICU	170 (15.0)	159 (13.4)	0.263
More than 2 days in NICU	100 (8.8)	113 (9.5)	0.567

SGA is small for gestational age. LGA is large for gestational age. NICU is Neonatal Intensive Care Unit.

[1]Neonatal sex was missing for n=45 women before legalization and n=78 women after legalization, which did not allow for calculation of a Z score in this subset.