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Adult use cannabis legalization and cannabis use disorder treatment in California, 2010–2021

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ABSTRACT

Introduction: Many nations and jurisdictions have legalized non-medical adult use of cannabis, or are considering doing so. This paper contributes to knowledge of adult use legalization's associations with cannabis use disorder (CUD) treatment utilization.

Methods: This study collected data from a dataset of all publicly funded substance use disorder treatment delivered in California from 2010 to 2021 (1,460,066 episodes). A logistic regression model estimates adult use legalization's impacts on CUD treatment utilization using an individual-level pre-post time series model, including individual and county-level characteristics and county and year-fixed effects.

Results: Adult use legalization was associated with a significant decrease in the probability of admission to CUD treatment (average marginal effect (AME): −0.005, 95 % CI: −0.009, 0.000). Adult use legalization was also associated with a decrease in the probability of admission to CUD treatment for males (AME: −0.025, 95 % CI: −0.027, −0.023) Medi-Cal beneficiaries (AME: −0.025, 95 % CI: −0.027, −0.023) adults ages 21+ (AME: −0.011, 95 % CI: −0.014, −0.009) and Whites (AME: −0.012, 95 % CI: −0.015, −0.010), and an increase in the probability of admission to CUD treatment for patients referred from the criminal justice system (AME: 0.017, 95 % CI: 0.015, 0.020) and Blacks (AME: 0.004, 95 % CI: 0.000, 0.007) and Hispanics (AME: 0.009, 95 % CI: 0.006, 0.011).

Conclusions: Adult use legalization is associated with declining CUD treatment admissions, even though cannabis-related problems are becoming more prevalent. Policies and practices that protect public health, and engage people with CUD in treatment are needed.

1. Introduction

Cannabis is the most widely used psychoactive substance other than alcohol or tobacco, and its use has been increasing. In 2020, approximately 209 million people worldwide used cannabis in the previous year, and the prevalence of past-year use increased by 8 % from 2010 to 2020 (UNODC, 2022). Though cannabis remains illegal in most places, the United Nations has removed it from its schedule of most tightly controlled substances (United Nations, 2020), and many nations and jurisdictions have legalized or are considering legalizing non-medical adult use (UNODC, 2022; U.S. White House, 2022). Adult use legalization is associated with increases in the prevalence of cannabis use (Cerda et al., 2020; Hall & Lynskey, 2020; UNODC, 2022), more frequent cannabis use, and increased prevalence of cannabis use disorder (CUD) among adults (Cerda et al., 2020).

This paper aims to build upon previous work to improve understanding of adult use legalization's impacts on CUD treatment admissions. Though our focus is narrower than that of Bourdon et al. (2021), Maxwell and Mendelson (2016), and Rhee and Rosenheck (2022), who study the impacts of legalization on specialty treatment utilization in multiple states, because we only examine one state (California), our analyses will make several important contributions to the literature on legalization and its associations with treatment.

Specifically, we examine changes within a single state that

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previously adopted decriminalization of possession of small amounts of cannabis in 2010 and passed a mandatory diversion to treatment policy for various non-violent drug-related offenses (Proposition 36-2000). As such, we can more carefully isolate the role of legalization specifically on treatment admissions, by isolating it from the effects of decriminalization and criminal justice reform. Second, unlike these papers that only include data through 2017, our analysis includes data through the end of 2021. Legalization's impacts on CUD treatment could have changed between 2017 and 2021 because of the increasing THC potency of cannabis products that have come to market in recent years, particularly in states that have legalized adult use (ElSholy et al., 2021; Firth et al., 2020; Hall & Lynskey, 2020; Hasin et al., 2021; Smart et al., 2017). More potent cannabis products can lead to more rapid progression from cannabis use to CUD (Arterberry et al., 2019) and more severe CUD symptoms (Freeman & Winstock, 2015).

2. Materials and methods

This observational study uses logistic regressions to determine associations between non-medical adult use legalization of cannabis in California and CUD treatment admissions among individuals who received publicly funded substance use disorder (SUD) treatment in California between January 2010 and December 2021 ($n = 1{,}460{,}066$). The study collected all data from the California Outcomes Measurement System, Treatment (CalOMS-Tx), a reporting system for all publicly funded SUD treatment services delivered in California. To our knowledge, CalOMS-Tx has not yet been used for research on CUD treatment or the impacts of cannabis policy change.

2.1. Variables

2.1.1. Treatment variable

2.1.1.1. Cannabis adult use legalization (Proposition 64). On November 8, 2016, California voters passed Proposition 64, which legalized the personal use and cultivation of marijuana for adults 21 years of age or older, reduced criminal penalties for specified marijuana-related offenses, and authorized dismissal and sealing of some prior marijuana-related convictions. We created a binary variable equal to 1 for all patients admitted to treatment in or after November 2016 and 0 for patients admitted before.

2.1.2. Dependent variable

2.1.2.1. Cannabis use disorder (CUD) treatment admission. The study identified patients as being in treatment for CUD if they indicated marijuana/hashish as their "Primary Drug" in CalOMS-Tx as a proxy. Since an SUD diagnosis is required for a client to receive publicly-funded treatment services, cannabis is a strong indicator of CUD (DHCS, 2023). We created a binary variable equal to 1 if the patient was admitted to CUD treatment and equal to 0 if the patient was admitted to treatment for any other SUD for all outpatient and residential levels of care.

2.1.3. Control variables

We include several individual-level covariates to control for individual-specific characteristics that may affect admission to specialty treatment. Specifically, we include age at admission, race/ethnicity, sex, employment status, high school graduate status, homeless at admission status, Medi-Cal beneficiary status, mental illness diagnosis, number of prior treatment episodes, veteran status, indicators for source or referral (including alcohol/drug program, criminal justice system, child protective services, individual/self-referral, school, or other), involvement in the criminal justice system at admission, and past 30-day behaviors at admission, including indicators for having been arrested, use of primary drug, jail time, emergency room visits, and any overnight hospital stays.

Table 1
Descriptive statistics of analysis variables, January 2010–December 2021.

	Pre-Proposition 64 (January 2010–October 2016)		Post-Proposition 64 (November 2016–December 2021)	
	Mean	Standard deviation	Mean	Standard deviation
Outcome				
Cannabis admission	0.19	0.39	0.09	0.29
Individual-level covariates				
Arrested past 30 days	0.10	0.30	0.08	0.26
Primary drug use past 30 days	0.61	0.49	0.66	0.47
Jail in past 30 days	0.14	0.35	0.12	0.33
ER visit past 30 days	0.09	0.29	0.13	0.33
Hospital overnight past 30 days	0.03	0.18	0.05	0.23
Involved in CJ system	0.50	0.50	0.40	0.49
High school graduate	0.59	0.49	0.71	0.45
Employed	0.16	0.37	0.21	0.40
Male	0.62	0.49	0.61	0.49
Homeless at admission	0.18	0.39	0.26	0.44
Age at admission	33.7	13.0	36.7	12.1
Medi-Cal beneficiary	0.47	0.50	0.79	0.41
Mental illness diagnosis	0.29	0.45	0.38	0.49
Number of prior treatment episodes	1.50	3.05	0.81	2.50
Veteran status	0.03	0.17	0.02	0.16
Referral source				
Alcohol/drug program	0.05	0.22	0.08	0.27
Criminal justice	0.35	0.48	0.24	0.42
CPS	0.06	0.24	0.05	0.22
Individual/self referral	0.38	0.48	0.51	0.50
Other	0.12	0.32	0.12	0.32
School	0.04	0.20	0.01	0.10
Race				
White	0.42	0.49	0.43	0.49
Black	0.12	0.33	0.10	0.30
Hispanic	0.38	0.49	0.39	0.49
Other	0.08	0.27	0.08	0.27
County-level covariates				
Poverty rate	0.16	0.05	0.13	0.04
Unemployment rate	0.09	0.03	0.06	0.03
Adult drug court	0.94	0.24	0.92	0.27
Juvenile drug court	0.48	0.50	0.41	0.49
# Adult arrests	95,641.1	107,596.3	69,842.5	75,530.2
# Juvenile arrests	9120.7	10,969.5	2627.9	2670.7
DMC-ODS waiver	0	0	0.66	0.47
Stay at home order	0	0	0.12	0.32
Prop 36	0.57	0.49	1	0
Prop 47	0.28	0.45	1	0
AB 109	0.73	0.44	1	0
Observations	898,649		561,417	

We also include several county-level covariates at the month-year level, including the poverty rate and the unemployment rate (obtained from the American Community Survey for 2010–2021), indicators for whether a county had an adult or juvenile drug court operating in it (requested and obtained from the Judicial Council of California), the log number of adult and juvenile arrests (obtained from the Department of Justice's Open Justice website), an indicator for participation in the Drug Medi-Cal Organized Delivery System waiver (available from the CA Department of Health Care Services), a stay-at-home order indicator to capture impacts of COVID-19 (obtained from the University of Arizona's Research on COVID-19 Interventions and Impacts Group), and indicators for criminal justice-related reform in California, including Proposition 36 (Changes to Three Strikes Sentencing Initiative, November 2012), Proposition 47 (also known as "The Safe Neighborhoods and Schools Act", November 2014), and AB 109 (also known as the "California Public Safety Realignment Act", October 2011).

Table 2
Associations between Proposition 64 and CUD treatment admissions.

	Overall CUD admissions	Male	Medi-Cal beneficiary	Adult 21+	CJ referral	White	Black	Hispanic
	(1)	(2)	(4)	(5)	(6)	(7)	(8)	(9)
Proposition 64 (adjusted odds ratio)	0.951**	0.761***	0.760***	0.879***	1.205***	0.874***	1.040**	1.096***
	(0.023)	(0.010)	(0.010)	(0.014)	(0.015)	(0.012)	(0.018)	(0.013)
	[0.906,0.998]	[0.742,0.780]	[0.740,0.781]	[0.853,0.906]	[1.175,1.236]	[0.851,0.898]	[1.004,1.076]	[1.071,1.122]
Avg. marginal effect	−0.005**	−0.025***	−0.025***	−0.011***	0.017***	−0.012***	0.004**	0.009***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
	[−0.009,−0.000]	[−0.027,−0.023]	[−0.027,−0.023]	[−0.014,−0.009]	[0.015,0.020]	[−0.015,−0.010]	[0.000,0.007]	[0.006,0.011]
Observations	1,460,066	1,460,066	1,460,066	1,460,066	1,460,080	1,460,080	1,460,080	1,460,080

Notes: Adjusted odds ratios and average marginal effects from logistic regressions are presented. Standard errors are reported in parentheses, and 95 % confidence intervals are reported in brackets. Each column presents a separate regression. All regressions control from all individual-level and county-level covariates, and county and year fixed effects, as discussed in the text. Regressions in columns (2)–(9) present subgroup analyses, and each regression includes an interaction term between the characteristic and Proposition 64, plus the main effects for both variables.
*** Represents statistical significance at the 1 % level.
** Represents statistical significance at the 5 % level.

2.2. Statistical methods

To determine the impact of Proposition 64 on CUD admissions, we estimate an individual-level pre-post time series model, including individual and county-level characteristics and county and year fixed effects via logistic regression. We can interpret the coefficients reported in Table 2 as the expected change in the probability of admission to CUD treatment after Proposition 64, compared to before the passage of Proposition 64. Analyses were conducted using Stata version 17.

2.3. Human subjects protections

Our Office of Human Research Protection Program reviewed this project and determined that it did not need institutional review board review or certification of exemption.

3. Results

See Table 1 for an overview of the study sample, by pre- and post-Proposition 64 passage. Among treatment admissions, pre-Proposition 64, 19 % of SUD admissions were CUD (or 170,743 CUD admissions), compared to only 9 % post-Proposition 64 (or 50,527 CUD admissions). The distributions among individual and county-level covariates remain stable across both periods.

Table 2 shows the adjusted odds ratios and average marginal effects from logistic regressions of Proposition 64's association with CUD treatment admissions. Each column presents a separate regression. Column (1) of Table 2 suggests that after the passage of Proposition 64, the probability of admission to CUD treatment significantly decreased (AME: −0.005, 95 % CI: −0.009, 0.000). That is, the 0.5 percentage point decrease translates to a decrease in CUD admissions post-Proposition 64 of roughly 7300 patients.

We next explore the association between the passage of Proposition 64 and CUD treatment admissions among population subgroups. We find that Proposition 64 is associated with a decrease in the probability of admission to CUD treatment for males (AME: −0.025, 95 % CI: −0.027, −0.023) Medi-Cal beneficiaries (AME: −0.025, 95 % CI: −0.027, −0.023) adults ages 21+ (AME: −0.011, 95 % CI: −0.014, −0.009) and Whites (AME: −0.012, 95 % CI: −0.015, −0.010). We also find that Proposition 64 is associated with an increase in the probability of admission to CUD treatment for patients referred from the criminal justice system (AME: 0.017, 95 % CI: 0.015, 0.020) and Blacks (AME: 0.004, 95 % CI: 0.000, 0.007) and Hispanics (AME: 0.009, 95 % CI: 0.006, 0.011).

4. Discussion

The main finding that Proposition 64's implementation was associated with a decrease in the overall probability of CUD admissions accords with other research showing that adult-use legalization was associated with decreased CUD treatment utilization (Maxwell & Mendelson, 2016; Rhee & Rosenheck, 2022). There are a couple of reasons why adult-use legalization could decrease CUD treatment admissions. First, adult use legalization could decrease the perceived harms of cannabis use and increase its social acceptability (Hall & Lynskey, 2016), thus reducing the likelihood that individuals who use cannabis would become motivated to change their cannabis consumption or that others would encourage or legally mandate them to seek treatment. Second, increased availability of cannabis from legal sources decreases the time, effort, and resources that cannabis consumers need to devote to procuring the drug (Wadsworth et al., 2022). Consequently, cannabis use may become less disruptive to users' daily lives, thus decreasing the likelihood that they will feel a need to seek treatment under legalization. The fact that California's regulated cannabis market has generated approximately $4.9 billion in revenue since commercial sales began (California Department of Tax and Fee Administration, 2023) underscores the degree to which cannabis users have been utilizing the legalized market.

We also find suggestive evidence that adult-use legalization was associated with increases in the probability of CUD admissions for criminal justice referrals, Blacks, and Hispanics. There are also reasons why adult-use legalization may increase CUD admissions for certain subgroups. First, since adult-use legalization may increase cannabis use (Smart & Pacula, 2019), time spent intoxicated may also increase, thus allowing cannabis use to become more disruptive to users' daily lives. Increased admissions for Blacks and Hispanics could be a result of the fact that among cannabis users, Blacks and Hispanics are at particularly high risk for developing CUD (Wu et al., 2016), so increases in cannabis use following legalization could be leading to increased CUD treatment need for these populations in particular. Second, even after legalization, arrests are still being made for driving under the influence of cannabis, public consumption, and illicit growing (Gunadi & Shi, 2022; Kilmer, 2019), thus potentially facilitating criminal justice referrals to treatment. More research is needed to fully understand the mechanisms driving the increase in CUD admissions among these subgroups, and will be a next line of work for the authors of this study.

5. Conclusions

Our findings show that when incorporating recent data that includes a timeframe since the COVID-19 pandemic began and cannabis potency levels have increased, adult-use legalization in California has been

associated with an overall decrease in CUD admissions. Since this study was limited to one state (California) and left without a proper control group for generating a more causal link, further research on adult-use legalization's recent impacts on CUD treatment and its effectiveness is needed to inform public health policy and practice in the age of legalization.

Declaration of generative AI

No AI or AI-assisted technologies were used in the writing process of this manuscript.

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CRediT authorship contribution statement

Brittany Bass: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Howard Padwa:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization. **Dhruv Khurana:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Data curation. **Darren Urada:** Writing – review & editing, Methodology, Funding acquisition, Data curation. **Anne Boustead:** Writing – review & editing, Methodology, Data curation.

Declaration of competing interest

We have no competing interests to declare.

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