



Research Paper

Associations between state-level policy liberalism, cannabis use, and cannabis use disorder from 2004 to 2012: Looking beyond medical cannabis law status

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ABSTRACT

Background: Medical cannabis laws (MCL) have received increased attention as potential drivers of cannabis use (CU), but little work has explored how the broader policy climate, independent of MCL, may impact CU outcomes. We explored the association between state-level policy liberalism and past-year cannabis use (CU) and cannabis use disorder (CUD).

Methods: We obtained state-level prevalence of past-year CU and CUD among past year cannabis users for ages 12–17, 18–25, and 26+ from the 2004–2006 and 2010–2012 National Surveys on Drug Use and Health. States were categorized as liberal, moderate, or conservative based on state-level policy liberalism rankings in 2005 and 2011. Linear models with random state effects examined the association between policy liberalism and past-year CU and CUD, adjusting for state-level social and economic covariates and medical cannabis laws.

Results: In adjusted models, liberal states had higher average past-year CU than conservative states for ages 12–17 (+1.58 percentage points; $p = 0.03$) and 18–25 (+2.96 percentage points; $p = 0.01$) but not for 26+ ($p = 0.19$). CUD prevalence among past year users was significantly lower in liberal compared to conservative states for ages 12–17 (–2.87 percentage points; $p = 0.045$) and marginally lower for ages 26+ (–2.45 percentage points; $p = 0.05$).

Conclusion: Liberal states had higher past-year CU, but lower CUD prevalence among users, compared to conservative states. Researchers and policy makers should consider how the broader policy environment, independent of MCL, may contribute to CU outcomes.

Introduction

Cannabis is the most frequently used substance in the United States (US) after alcohol and tobacco (Ahrnsbrak, Bose, Hedden, Lipari, & Park-Lee, 2017). Prevalence has increased since 2006–2007 (Carliner et al., 2017; Hasin et al., 2015; Mauro et al., 2018) and in 2014, 13.2% of individuals age 12 and older in the US reported past-year cannabis use (CU) (Center for Behavioral Health Statistics & Quality, 2015). This increasing prevalence has raised concerns about potential negative consequences associated with problematic CU, specifically cannabis use disorder (abuse or dependence). While little work has identified a direct

link between increasing prevalence of CU and an increase in cannabis use disorders (CUD), researchers have identified it as a potential concern (Mauro et al., 2017; Williams, Santaella-Tenorio, Mauro, Levin, & Martins, 2017) and noted a recent increase in the rate of CUD (Budney, Roffman, Stephens, & Walker, 2007; Hasin & Grant, 2016). CUD are associated with a risk of psychiatric comorbidities (Volkow, Baler, Compton, & Weiss, 2014), cognitive deficits (Volkow et al., 2014), respiratory problems (Owen, Sutter, & Albertson, 2014), and lower educational attainment (Fergusson, Horwood, & Beutrais, 2003). Factors that affect CU and related outcomes at the population-level are of public health interest, particularly modifiable factors, such as state-

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level policies.

As of January 2018, 29 states allowed medical cannabis use, 12 had legislation pending, and eight states plus Washington DC had legalized cannabis use (Legislatures, 2018). Based on these policy changes, state-level cannabis policies have received increased attention as potential drivers of CU prevalence, and research has increasingly studied the impact of cannabis-specific policies on CU (Martins et al., 2016). These policies have had differential impacts by age: while individuals ages 26+ living in states with medical cannabis laws (MCL) have higher past month prevalence of cannabis use, and have experienced an increase in use following enactment of MCL (Martins et al., 2016; Mauro et al., 2017; Mauro et al., 2018; Wen, Hockenberry, & Cummings, 2015), the majority of studies have found no causal relationship between MCL and CU among youth (Sarvet et al., 2018).

Much of the existing cannabis-focused policy work has taken a “one policy, one outcome” approach, focusing primarily on the effects of MCL on CU. However, a state’s broader policy climate can also impact health-related outcomes and disparities (Hatzenbuehler, 2011; Oldenburg et al., 2015). Indeed, public health policies in the aggregate—e.g., around sexual minority rights or state-level immigration policies—affect individual behaviors and thus population-level health (Hatzenbuehler et al., 2017).

One way to measure policy climate in the aggregate is through policy liberalism measures, which rank states on various policy indicators for which liberals and conservatives commonly differ. Gray (2012) developed a policy liberalism index that ranked states from ‘most liberal’ to ‘most conservative’ in 2005 and 2011 based on state-level policies such as gun control, abortion access, and tax structure. Studies have applied this more uniform comparison of policy context across states to assess the impact of policy climate on outcomes such as educational funding or mortality for racial/ethnic minorities (Kunitz, McKee, & Nolte, 2010; Tandberg, 2010). The impact that the broader policy climate has on CU outcomes, independent of MCL, remains unexplored.

Employing this policy liberalism index to study broader state-level policy climates and CU not only expands upon previous approaches, but also improves measurement in two distinct ways. First, it examines whether a group of policies in the aggregate impacts CU outcomes, which is more reflective of real-life policy exposure. Doing so can help provide new ways of thinking about the context in which CU outcomes, and policy implementation, occurs. Second, by controlling for MCL, this research explores whether the policy climate more broadly impacts CU outcomes beyond cannabis-specific policies, or whether more proximal CU policies are indeed responsible for any changes observed in CU, particularly among adults.

We therefore used US nationally-representative state-level data to 1) examine the associations between policy liberalism and CU and CUD among past year users; and 2) determine whether these associations remained after controlling for MCL and state-level demographic and economic characteristics. Findings from this study could help policymakers and public health practitioners consider the impact of policies on CU outcomes, and directly inform the degree to which other broader contextual factors also influence CU patterns in the US.

Methods

Study sample

The National Survey on Drug Use and Health (NSDUH) is sponsored by the Substance Abuse and Mental Health Services Administration (SAMHSA) and provides prevalence estimates of nonmedical use of legal and illegal drugs in a community-based population among individuals 12 years of age and older in the US. This annual cross-sectional survey employs a 50-state design with an independent multistage area probability sample for each state. Importantly, the survey design allows for weighted estimates to be representative of the non-

institutionalized US population aged 12 and older in each state. Response rates from 2004 to 2012 varied from 84%–91% for weighted screening response rates and 72%–77% for weighted interview response rates (SAMHSA, 2012). Individuals received \$30 for participating. The NSDUH used computer-assisted personal interviewing (CAPI), and substance use sections were administered using audio computer assisted self-interviewing (ACASI), to increase the accuracy of responses to potentially sensitive questions. The reliability and validity of the NSDUH measures are well-documented (Harrison, Martin, Enev, & Harrington, 2007). Additional NSDUH methodological descriptions can be found elsewhere (SAMHSA, 2015).

NSDUH study sample

We obtained annual cross-sectional survey data from the NSDUH restricted use data portal for years 2004–2006 to correspond to the 2005 policy liberalism index and for 2010–2012 to correspond to the 2011 index (individual-level data). Data were aggregated at the state level to derive state-representative estimates for three age categories: 12–17, 18–25, and 26 and older. More than 17,500 12–17 year-olds, 17,500 18–25 years-olds, and 18,800 adults 26 and older were interviewed each year (CBHSQ, 2015). This provided six years of data (2004–2006 and 2010–2012) across all 50 states for each of the three age categories; the unit of observation was the state in a particular year within each age category.

Measures

Primary exposure: policy liberalism index

The State Rank on Policy Liberalism Index ranked each state from 1 (most liberal) to 50 (most conservative) based on its policies regulating gun control, abortion access, Temporary Assistance to Needy Families, tax progressivity, and collective bargaining, weighing all policies equally (Gray, 2012). States were ranked according to their index value in 2005 and 2011, with ranking order increasing with higher levels of conservative policies (i.e., most conservative rankings were 41–50) (Gray, 2012). We categorized states based on policy index rank in 2005 and 2011 by creating a time-varying three-level categorical variable differentiating liberal states (ranks 1–20), moderate states (ranks 21–30) and conservative states (ranks 31–50). Doing so allowed us to incorporate all 50 states in order to maximize the use of the available data and to be best powered to conduct these analyses; it was also based on previous policy-related research (Fox, Feng, & Yumkham, 2017).

Primary outcome measures

Past year CU prevalence

We used aggregate measures of state-level prevalence of past-year CU from the NSDUH for ages 12–17, 18–25, and 26+ . Past year CU was calculated for each year from 2004 to 2006 to correspond to the 2005 policy liberalism index and for 2010–2012 to correspond to the 2011 index.

Past year CUD among past-year cannabis users

Aggregate measures of state-level prevalence of past year CUD from the NSDUH were obtained for each of the three age groups. The NSDUH variable for CUD was defined using the DSM IV (APA, 2000) criteria for cannabis abuse or dependence. Due to small sample sizes and low prevalence of CUD in some state/years, the state-level CUD prevalence for individuals aged 26+ was zero in 1.2% of all cells (i.e., state prevalence by year by age category). In these 1.2% of observations, we imputed state-level CUD prevalence by averaging the prevalence of the previous and subsequent year; no states had two or more consecutive years with zero prevalence (Leigh & Jencks, 2007).

Table 1
State, Policy Liberalism Classification and MCL status.

State	2005 Policy Liberalism classification	2005 MCL	2011 Policy Liberalism classification	2011 MCL	State	2005 Policy Liberalism classification	2005 MCL	2011 Policy Liberalism classification	2011 MCL
Alabama	Conservative		Conservative		Montana	Liberal	X	Liberal	X
Alaska	Liberal	X	Liberal	X	Nebraska	Moderate		Conservative	
Arizona	Conservative		Conservative	X	Nevada	Moderate	X	Conservative	X
Arkansas	Conservative		Conservative		New Hampshire	Moderate		Liberal	
California	Liberal	X	Liberal	X	New Jersey	Liberal		Liberal	X
Colorado	Moderate	X	Moderate	X	New Mexico	Liberal		Liberal	X
Connecticut	Liberal		Liberal		New York	Liberal		Liberal	
Delaware	Liberal		Moderate	X	North Carolina	Conservative		Moderate	
Florida	Conservative		Conservative		North Dakota	Conservative		Conservative	
Georgia	Conservative		Conservative		Ohio	Moderate		Moderate	
Hawaii	Liberal	X	Liberal	X	Oklahoma	Conservative		Conservative	
Idaho	Conservative		Conservative		Oregon	Liberal	X	Liberal	X
Illinois	Liberal		Liberal		Pennsylvania	Liberal		Moderate	
Indiana	Conservative		Conservative		Rhode Island	Liberal		Liberal	X
Iowa	Moderate		Moderate		South Carolina	Conservative		Conservative	
Kansas	Conservative		Moderate		South Dakota	Conservative		Conservative	
Kentucky	Moderate		Moderate		Tennessee	Conservative		Conservative	
Louisiana	Conservative		Conservative		Texas	Conservative		Conservative	
Maine	Liberal	X	Liberal	X	Utah	Conservative		Conservative	
Maryland	Liberal		Liberal		Vermont	Liberal	X	Liberal	X
Massachusetts	Liberal		Liberal		Virginia	Conservative		Conservative	
Michigan	Moderate		Moderate	X	Washington	Liberal	X	Liberal	X
Minnesota	Liberal		Liberal		West Virginia	Liberal		Liberal	
Mississippi	Conservative		Conservative		Wisconsin	Moderate		Liberal	
Missouri	Moderate		Moderate		Wyoming	Conservative		Conservative	

Other variables

Time period

Time period was categorized as 0 for years 2004–2006 and 1 for years 2010–2012 to coincide with the policy liberalism estimation in 2005 and 2011.

MCL enactment

State-level MCL was dichotomized as yes/no indicating whether the state had enacted a MCL by 2005 or 2011 (Table 1). MCL enactment was determined by a review of state policies by legal scholars, economists, and policy analysts at RAND Corporation (Pacula & Sevigny, 2014).

State-level covariates

State-level demographic covariates included the state's population total and percentage male, white non-Hispanic, and people aged 10–24. State-level economic covariates included the percentage of individuals 25 and over who completed high school, the state unemployment rate, and median household income. Data for these covariates were obtained from the U.S. Census Bureau in 2005 and 2010.

Statistical analysis

First, we examined survey-weighted prevalence of CU and CUD by state policy liberalism category by age at the state level, taking the average of these yearly estimates from 2004 to 2006 and 2010–2012. We also calculated the change in this average over the time period, and tested average differences over time using two-sample t-tests.

Second, we examined the association between state policy liberalism and CU outcomes using a linear model with state-level random effects. Separate models were fit for each of the outcomes stratified by age category (i.e., 12–17, 18–25, and 26+), so that each model included 300 observations (50 states by six years of observation). Model 1a regressed cannabis use outcomes on state-level policy liberalism, time period, and state-level demographic and economic covariates. Model 2a included all Model 1a variables, and added MCL. In each

model, we estimated the difference in prevalence between liberal, moderate and conservative states. We also calculated post-estimated adjusted prevalences (i.e., average predicted probabilities) of past-year CU and CUD for each one of the policy categories and periods from the models (Tables 3 and 4). The same analytic strategy was employed separately for CU and CUD. All analyses were conducted in STATA/SE version 14 (StataCorp, 2015).

Results

Prevalence of past year CU and CUD by time-varying policy liberalism and age (Table 2)

Average state-level prevalence of past-year CU by age from 2004 to 2006 to 2010–2012 was lowest for ages 26+ and highest for ages 18–25 (Table 2). Average prevalence increased for ages 18–25 in liberal states (33.13% to 36.46%; $p = 0.002$) and increased marginally in conservative states (24.48% to 25.84%; $p = 0.07$) from 2004 to 2006 to 2010–2012. The same pattern was observed for ages 26+ use in liberal (7.91% to 10.14%; $p < 0.001$) and conservative (5.74 to 6.83; $p = 0.002$) states. For ages 12–17, however, past year CU did not significantly change from 2004 to 2006 to 2010–2012 in liberal (15.76 to 16.31%) or conservative states (12.76 to 12.32%). In contrast, CUD among past-year cannabis users decreased significantly from 2004 to 2006 to 2010–2012 among ages 18–25 in conservative states (22.18% to 17.38%; $p < 0.001$) and liberal states (20.24% to 16.85%; $p < 0.001$); among individuals ages 26+, CUD among past-year cannabis users decreased in liberal states (10.62% to 8.23%; $p = 0.02$). For 12–17 year olds, CUD decreased in conservative states (27.69% to 24.89%; $p = 0.04$).

Adjusted differences in past year CU prevalence by state-level policy liberalism and age (Table 3)

In age-stratified analyses adjusting for state-level characteristics and time (Models 1a), liberal states had significantly higher past year CU prevalence than conservative states for ages 12–17 (+1.96 percentage

Table 2
State-representative prevalence of past year cannabis use and cannabis use disorder by state policy liberalism and age.

Age	State Policy Liberalism	Average State-level prevalence of past year CU		Change in CU prevalence	Average State-level prevalence of past year CUD among past year cannabis users		Change in CUD prevalence
		2004–2006	2010–2012		2004–2006	2010–2012	
		Est. (SE)	Est. (SE)	Diff. (SE)	Est. (SE)	Est. (SE)	Diff. (SE)
Ages 12–17	Conservative	12.76 (0.33)	12.32 (0.35)	−0.44 (0.48)	27.69 (0.99)	24.89 (0.89)	−2.80 [*] (1.33)
	Moderate	13.86 (0.50)	14.05 (0.47)	−1.18 (0.69)	25.26 (1.14)	23.86 (1.29)	−1.40 (1.72)
	Liberal	15.76 (0.39)	16.31 (0.47)	+0.55 (0.61)	25.75 (0.84)	23.82 (0.98)	−1.93 (1.30)
Ages 18–25	Conservative	24.48 (0.49)	25.84 (0.56)	+1.36 (0.75)	22.18 (0.61)	17.38 (0.60)	−4.80 ^{**} (0.86)
	Moderate	28.51 (1.02)	31.16 (1.02)	+0.29 (1.44)	18.30 (1.01)	17.54 (0.79)	−0.76 (1.28)
	Liberal	33.13 (0.73)	36.46 (0.79)	+3.33 ^{**} (1.07)	20.24 (0.61)	16.85 (0.52)	−3.39 ^{**} (0.80)
Ages 26+	Conservative	5.74 (0.19)	6.83 (0.28)	+1.09 ^{**} (0.34)	12.90 (0.91)	12.19 (1.04)	−0.71 (1.38)
	Moderate	6.99 (0.31)	7.66 (0.56)	+0.67 (0.64)	11.51 (1.20)	10.36 (0.89)	−1.15 (1.50)
	Liberal	7.91 (0.31)	10.14 (0.44)	+2.23 ^{**} (0.54)	10.62 (0.76)	8.23 (0.66)	−2.39 [*] (1.00)

Note: Est. = Estimate; Diff. = Difference; SE = Standard Error; CU = Cannabis Use; CUD = Cannabis Use Disorder. ^{*}p-value < 0.05; ^{**}p-value < 0.01. T-tests examined the association between time and CU (or CUD) from the National Survey on Drug use and Health within State Policy Liberalism and age. Policy liberalism categories (i.e., Conservative, Moderate, Liberal) derived from states' ranks in the 2005 and 2011 Policy Liberalism Index. Liberal₂₀₀₅ = CA, HI, NY, VT, NJ, CT, OR, MA, ME, RI, MD, MT, IL, MN, NM, DE, AK, WA, WV, PA; Moderate₂₀₀₅ = WI, MO, NH, IA, MI, OH, KY, CO, NE, NV; Conservative₂₀₀₅ = KS, SC, IN, TN, AZ, LA, NC, VA, UT, FL, TX, ID, AR, AL, OK, GA, MS, ND, SD, WY. Liberal₂₀₁₁ = CA, NY, NJ, VT, CT, HI, MD, RI, OR, ME, MA, MN, WI, MT, WA, NM, WV, IL, NH, AK; Moderate₂₀₁₁ = DE, MI, CO, PA, IA, KY, MO, OH, KS, NC; Conservative₂₀₁₁ = NV, GA, NE, SC, IN, VA, UT, AZ, TN ND, AL, ID, OK, SD, WY, FL, MS, TX, LA, AK.

Table 3
State-level policy liberalism, adjusted predicted probability of state-level past year CU, and differences in past year prevalence of cannabis use.

	Adjusted predicted probability of State-level past year CU ⁺		Adjusted differences in past year prevalence of CU by state policy liberalism	
	2004–2006	2010–2012	Model 1a [Policy liberalism + Time period + state-level covariates] Coef. [95% CI]	Model 2a [Model 1a + MCL] Coef. [95% CI]
	Est. [SE]	Est. [SE]		
AGES 12–17				
Policy Liberalism				
Conservative	13.72 [0.57]	12.91 [0.49]	Ref	Ref
Moderate	14.31 [0.58]	13.49 [0.58]	0.58 [−0.67, 1.82]	0.34 [−0.90, 1.59]
Liberal	15.69 [0.49]	14.87 [0.57]	1.96 ^{**} [0.59, 3.32]	1.58 [*] [0.19, 2.97]
Time Period				
2004–2006	–	–	Ref	Ref
2010–2012	–	–	−0.81 [−1.87, 0.24]	−0.62 [−1.66, 0.43]
MCL Enacted				
No	–	–	–	Ref
Yes	–	–	–	1.29 [*] [0.10, 2.47]
AGES 18–25				
Policy Liberalism				
Conservative	27.87 [0.98]	28.27 [0.90]	Ref	Ref
Moderate	29.89 [0.98]	30.29 [0.95]	2.02 [*] [0.06, 3.97]	1.38 [−0.54, 3.30]
Liberal	31.56 [0.90]	31.95 [1.00]	3.68 ^{**} [1.32, 6.04]	2.96 [*] [0.65, 5.27]
Time Period				
2004–2006	–	–	Ref	Ref
2010–2012	–	–	0.40 [−1.25, 2.04]	0.85 [−0.76, 2.46]
MCL Enacted				
No	–	–	–	Ref
Yes	–	–	–	3.56 ^{***} [1.81, 5.32]
AGES 26+				
Policy Liberalism				
Conservative	7.30 [0.45]	6.67 [0.39]	Ref	Ref
Moderate	7.68 [0.45]	7.04 [0.45]	0.37 [−0.59, 1.34]	−0.06 [−0.98, 0.87]
Liberal	8.62 [0.40]	7.99 [0.45]	1.32 [*] [0.24, 2.39]	0.70 [−0.35, 1.73]
Time Period				
2004–2006	–	–	Ref	Ref
2010–2012	–	–	−0.63 [1.45, 0.18]	−0.31 [−1.09, 0.47]
MCL Enacted				
No	–	–	–	Ref
Yes	–	–	–	2.15 ^{***} [1.27, 3.03]

State-level demographic covariates included the state's population total, percentage male, percentage white non-Hispanic individuals and percentage people ages 10–24. State-level economic covariates included the percentage of individuals 25 and over who completed high school, the state unemployment rate, and median household income. Data for these covariates were obtained from the U.S. Census Bureau in 2005 and 2010.

* p-value < 0.05.

** p-value < 0.01.

*** p-value < 0.001 ⁺From marginal.

Table 4
State-level policy liberalism, adjusted predicted probability of state-level past year CUD, and differences in past year prevalence of cannabis use disorder among past year cannabis users.

	Adjusted predicted probability of State-level past year CUD among users ⁺		Adjusted differences in past year prevalence of CUD by state policy liberalism	
	2004–2006	2010–2012	Model 1b [Policy liberalism + Time period + state-level covariates] Coef. [95% CI]	Model 2b [Model 1b + MCL] Coef. [95% CI]
	Est. [SE]	Est. [SE]		
AGES 12–17				
Policy Liberalism				
Conservative	28.03 [1.14]	25.24 [0.92]	Ref	Ref
Moderate	25.83 [1.17]	23.04 [1.23]	−2.20 [−4.82, 0.42]	−2.58 [−5.27, 0.12]
Liberal	25.90 [0.94]	23.10 [1.12]	−2.13 [−4.68, 0.41]	−2.87* [−5.68, −0.06]
Time Period				
2004–2006			Ref	Ref
2010–2012	–	–	−2.79 [−5.22, −0.37]	−2.49* [−4.97, −0.02]
MCL Enacted				
No				Ref
Yes	–	–	–	1.75 [−0.92, 4.43]
AGES 18–25				
Policy Liberalism				
Conservative	21.40 [0.69]	17.44 [0.56]	Ref	Ref
Moderate	19.87 [0.71]	15.92 [0.75]	−1.53 [−3.11, 0.05]	−1.48 [−3.10, 0.15]
Liberal	20.89 [0.56]	16.94 [0.67]	−0.51 [−2.02, 0.10]	−0.41 [−2.08, 1.26]
Time Period				
2004–2006			Ref	Ref
2010–2012	–	–	−3.96** [−5.48, −2.43]	−3.99*** [−5.54, −2.44]
MCL Enacted				
No				Ref
Yes	–	–	–	−0.23 [−1.85, 1.39]
AGES 26+				
Policy Liberalism				
Conservative	12.07 [1.01]	12.00 [0.81]	Ref	Ref
Moderate	10.75 [1.03]	10.68 [1.09]	−1.32 [−3.64, 0.97]	−1.55 [−3.93, 0.83]
Liberal	10.07 [0.82]	10.01 [0.99]	−1.99 [−4.22, 0.22]	−2.45 [−4.91, 0.01]
Time Period				
2004–2006			Ref	Ref
2010–2012	–	–	−0.07 [−2.25, 2.12]	1.07 [−2.12, 2.33]
MCL Enacted				
No				Ref
Yes	–	–	–	1.07 [−1.30, 3.44]

State-level demographic covariates included the state’s population total, percentage male, percentage white non-Hispanic individuals and percentage people ages 10–24. State-level economic covariates included the percentage of individuals 25 and over who completed high school, the state unemployment rate, and median household income. Data for these covariates were obtained from the U.S. Census Bureau in 2005 and 2010.

* p-value < 0.05.

** p-value < 0.01.

*** p-value < 0.001 ⁺From marginal.

points; 95% confidence interval (CI) 0.59, 3.32), 18–25 (+3.68 percentage points; 95%CI 1.32, 6.04), and 26+ (+1.32 percentage points; 95%CI 0.24, 2.39). This association remained statistically significant after controlling for MCL in Model 2a for ages 12–17 (+1.58 percentage points; 95%CI 0.19, 2.97) and 18–25 (+2.96 percentage points; p < 0.05), but not ages 26+ . While CU was higher among 18–25 year olds in moderate vs. conservative states (+2.02 percentage points; 95%CI 0.65, 5.27) states in Model 1a, the association was no longer significant after adjusting for MCL in Model 2a.

State-level policy liberalism and CUD among past year cannabis users, by age (Table 4)

In age-stratified analyses of state-level policy liberalism and CUD, adjusted for state-level characteristics and time, individuals ages 12-17 had marginally lower past year CUD in liberal (p = 0.10) and moderate (p = 0.10) states compared to conservative states. Moderate states had marginally lower CUD rates for ages 18–25 (p = 0.06), and liberal states had marginally lower CUD rates for ages 26+ (p = 0.08). In Model 2b, which included adjusting for MCL, liberal states had significantly lower past year CUD than conservative states for ages 12–17

(−2.87 percentage points; 95%CI -5.68, -0.06) and marginally lower CUD for ages 26+ (95% CI -4.91, 0.009). In Model 2b, moderate states had marginally lower CUD compared to conservative states for ages 18–25 (p = 0.08).

Discussion

This study examined the relationship between a state’s policy liberalism climate and CU and CUD using state- and nationally-representative data from the US. Specifically, we aimed to assess whether the broader policy climate—an index of five specific policies—was associated with CU and CUD beyond MCL. Results show that the prevalence of past year CU was consistently higher in liberal compared to conservative states, and remained significantly higher for ages 12–17 and 18–25 after adjusting for MCL. However, liberal states had lower CUD among past year cannabis users for 12–17 and 26+, though the latter was only marginally statistically significant. Findings also suggest a tension in how the overall policy climate impacted CU outcomes: liberal states had higher CU than conservative states, but lower CUD.

Liberal states had higher past year CU prevalence but lower past year CUD among users compared to conservative states, even after

accounting for MCL status. Previous studies have attributed changes in CU to states' adoption of MCL and resulting shifts in cannabis-related attitudes (Mason, Hanson, Fleming, Ringle, & Haggerty, 2015; Schuermeyer et al., 2014), access (Martins et al., 2016), and perceived risk (Palamar, Ompad, & Petkova, 2014). Finding differences across policy liberalism categories, even when controlling for MCL, suggests that there is unobserved heterogeneity across states that this focus on MCL is not fully capturing. Also, increases in CU are not translating to increases in CUD (C. Mauro et al., 2017), and future research needs to further explore this phenomenon to determine whether, for example, there is an increase in low frequency, non-disordered users or whether there is a potential delay in CUD development. In addition, future work should examine overall CUD (i.e., not just among users) to obtain a fuller picture of the potential population-level impact and potential burden on substance abuse treatment systems.

Findings also suggested a differential impact of policy liberalism climate by age. CU was higher in liberal states among those 12–17 and 18–25, and CUD was higher in conservative states for individuals 12–17, and 26+, even after controlling for MCL status. Importantly, we were not estimating the effect of MCL enactment on CU outcomes, as done previously. Instead, our study extends the literature on policy exposure measurement beyond MCL, and suggests that aspects of the policy climate other than MCL are related to CU prevalence, and that CUD among individuals 12–17 and 26+ remained lower in liberal (vs. conservative) states even after controlling for MCL. While MCL attenuated the relationship, policy liberalism remained significantly associated with CU in the fully adjusted models for ages 12–17 and 18–25. Including MCL in the model controlled for unobserved factors that may have made liberal states more likely to also have implemented MCL. Policy liberalism was not associated with CU among ages 26+ after MCL adjustment, indicating that substance use policies specific to cannabis use may be more proximally associated with CU in adults 26+. In addition, the prevalence of CU and CUD was lower among adults 26+, which may make it more difficult to discern a relationship between policy climate and CU outcomes.

This research does not suggest that being in a liberal state causes CU—instead, it highlights how states may differ beyond substance use policies, and how these differences merit attention. State-level policies can impact the public's health by changing the social context that constrains individual behavior (Blankenship, Friedman, Dworkin, & Mantell, 2006; Sommer & Parker, 2013) and make a healthier behavior the default. State-level policies also offer substantial promise in reducing health inequalities—for example with laws that regulate the use of tobacco (Hatzenbuehler, Keyes, Hamilton, & Hasin, 2014) and alcohol (Xuan et al., 2015).

Future research needs to increasingly focus on the broader policy climate whether at the county-, state-, or national-level. It is also important for future work to consider whether the five policies included in the policy liberalism index—gun control, abortion access, Temporary Assistance to Needy Families, tax progressivity, and collective bargaining—contribute to cannabis use and disorder at the population level, either individually or in aggregate. Future work should also consider how the relationship between policy liberalism, MCL, and CU outcomes changes over time. Lastly, liberal and conservative states are not distributed randomly throughout the U.S. and there may be important state differences around factors such as service availability which could impact cannabis-related knowledge, attitudes, and care access.

This study has numerous strengths. First, it is one of the first studies to assess the relationship between policy liberalism and health outcomes, specifically CU-related outcomes. Second, the analyses used state and nationally representative samples, which allows for generalization of findings to the US non-institutionalized population 12 years and older. Third, state-level demographics could be different in liberal compared to conservative states which could impact the relationship between state-level policy liberalism and cannabis use outcomes: we therefore controlled for demographic and economic state-level

covariates in the models. Fourth, we included time period in the model because the policy climate index was created at multiple time points. Including these two time periods allowed us to see trends over time—which suggests future avenues for exploration—and because it increased the power allowing us to more accurately answer our research question. Fifth, because of the economic downturn, we adjusted for state-level demographic and economic covariates in the models. It is important to note that the economic recession occurred in between the two time points in this analysis (i.e., 2005 and 2011) and had a profound impact on employment, education, and income; these, in turn, may impact CU outcomes (Carliner et al., 2017). Explicitly controlling for state-level economic covariates allowed us to account for state-level confounding. Future research therefore needs to explore how economic downturns impact substance use—and behavioral health more broadly—and how states impacted by the recession may have had differential changes in substance use.

Limitations are noted. While the NSDUH allows for inferences at the population level, these analyses used state-level prevalence of CU and CUD and could therefore not control for individual-level factors that might influence CU. However, because policy liberalism is a state-level exposure, state-level prevalence was the correct unit of analysis for this study. We are also unable to establish directionality in the relationship—i.e., whether cannabis users are more likely to move to liberal states or an increase in liberalism may increase CU/decrease CUD—though the ability to move across states is challenging for individuals 12–17. The adoption of MCL and resulting shifts in attitudes and discourse may also impact reporting of CU, which has implications for federal surveys such as the NSDUH. These analyses were unable to capture the potential impacts of policy spillover (e.g., in smaller states with liberal neighbors), but we will do so in future papers with individual-level data that are powered to address this issue with state-level indicators. Lastly, this is an exploratory study and we therefore did not adjust for multiple comparisons; future studies would need to confirm these findings.

The NSDUH is a household-based survey and does not capture people who are homeless, institutionalized, or in correctional facilities, though such individuals may have different patterns of substance use and would be systematically excluded from the survey. The NSDUH uses self-report to assess substance use, but studies have found these standardized measures to be reliable. In addition, while we used three age categories, these included broad age ranges (e.g., 26+), which could mask heterogeneity in CU outcomes. This state-level policy liberalism index is only created every five to ten years—the most recent year is 2011—and we were therefore unable to explore this relationship with more recent data. This liberalism index is a rank versus a score, which means that relationships between states are relative to each other. However, our findings provide an important first step in capturing how the broader policy environment beyond cannabis-specific policies can affect population-level CU and CUD.

These findings identified important relationships between state-level policy liberalism and CU outcomes. This was an important first step in this line of research, but additional work is required. First, CU outcomes are not evenly distributed among the population (Carliner et al., 2017; Martins et al., 2016) and future analyses should explore how the association between policy liberalism and CU may differ among, for example, racial/ethnic and sexual minority populations (Keyes et al., 2015). Second, the heterogeneity and clustering of different aspects of the policy index could be examined to determine if the liberalism of specific policies differentially impacts CU outcomes. Third, further investigation should explore potential associations between policy liberalism and CU as well as other substance use outcomes over time. Fourth, individual-level data with state identifiers was not available during analyses, and exploring this relationship at the individual-level is an important next step.

Public health implications

This study represents an important contribution to the literature on the structural determinants of CU outcomes, demonstrating that while liberal states had a higher prevalence of CU, they had lower rates of CUD among cannabis users; it also showed that these state-level policies differentially impact individuals based on age. We explored the effect of a *modifiable* structural factor—i.e., state-level policy—on specific health outcomes, which can inform points for future state-level interventions. This work also improves how we measure the overall environmental context by including both the state-level policy liberalism index and MCL. The majority of previous work has explored the relationship between one policy (i.e., MCL) and CU outcomes or how a specific type of policy (e.g., structural stigma toward LGB individuals) impacted substance use (Duncan, Hatzenbuehler, & Johnson, 2014). As MCL and recreational cannabis laws continue to change at the state level, it is increasingly important to understand the relationship between a state's policy climate and CU outcomes. Results help build evidence that policy change can differentially impact CU outcomes at a population level, particularly CU versus CUD. This highlights the need for researchers and public health professionals to distinguish between CU and CUD when interacting with patients at the individual-level and developing interventions at the population-level. This line of research can also help identify how state-level policies as a whole impact CU outcomes, ultimately promoting the development of more health-promoting policies.

Declarations of interest

None.

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