State recreational cannabis laws and racial disparities in the criminal justice system

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1. Introduction

The prohibition of cannabis is often considered one of the most costly and destructive aspects of America's failed war on drugs. The toll comprises street violence from the creation of an illegal drug market, years of life lost behind bars, children growing up without a parent, criminal records crippling access to jobs, loans, housing and government benefits, and billions of dollars wasted in law enforcement (Shultz and Aspe, 2017; Hudak, 2021; Earp et al., 2021). In 2018, police officers made about 663,000 cannabis arrests, 92% for possession and 8% for sales, which accounted for 40% of all drug arrests and exceeded arrests for all violent crimes combined (Gramlich, 2020). Incarceration statistics are also striking. In 2019, drug possession or trafficking was the most serious offense for serving time among 46% of sentenced federal prisoners and among 14% of sentenced state prisoners (Carson, 2020).

Racial and ethnic disparities in law enforcement of cannabis and other drugs are widespread and longstanding, with Black communities being disproportionately affected. Even though White and Black persons use cannabis at roughly the same rate, Black persons are over 3.64 times more likely to be arrested for cannabis possession (Edwards et al., 2020). Black persons are also incarcerated at dramatically higher rates than White persons for drug-related offenses. Despite representing 13.4% of the total U.S. population (U.S. Census Bureau, 2022), Black persons account for 28% of state prisoners and 33% of federal prisoners with a sentence of more than one year for a drug-related offense (Carson, 2021; Motivans, 2022). Additionally, over 50% of homicide victims are Black (Federal Bureau of Investigation, 2018), and the 2020 firearm death rate among Black persons was 31.8 per 100,000: nearly three times the firearm death rate (11.6 per 100,000) among White persons (Kaiser, 2022).

The legalization of cannabis may be an effective step toward correcting the damage of cannabis prohibition on racial disparities in the criminal justice system and other consequences related to street violence. As of 2021, 19 states have passed recreational cannabis laws (RCLs), allowing individuals ages 21+ to possess, use, and supply limited amounts of cannabis for recreational purposes (ProCon, 2022). Supporters of cannabis legalization believe that RCLs will achieve public policy goals such as create hundreds of thousands of jobs, generate tax revenue, take business away from illegal markets, lower street crime and violence, reduce law enforcement costs, and reduce racial and ethnic disparities in criminal justice outcomes (Gettman and Kennedy, 2014).

Previous studies on the impacts of RCLs are scarce and focus primarily on measures of cannabis utilization in the overall population and by age group, documenting increases for adults and mixed evidence for teenagers (Cerdá et al., 2017; Aydelotte et al., 2019; Cerdá et al., 2020; Hansen et al., 2018; Meinhofer et al., 2021). One recent RCL study considered self-reported cannabis use across racial and ethnic groups, finding statistically significant increases among adults who were Hispanic, Non-Hispanic White, and non-Hispanic Other Race, but no statistically significant changes for Non-Hispanic Black adults (Martins et al., 2021). Several RCL studies have considered criminal justice outcomes in the general population, including property and violent crimes, arrests, and drug seizures (National Criminal Justice Reference Service, 2020; Lu et al., 2021; Wu et al., 2020; Brinkman & Mok-Lamme, 2019; Plunk et al. 2019; Meinhofer & Rubli, 2021). There are somewhat mixed results regarding the impact of RCLs on crime, with studies documenting no changes (Lu et al., 2021; Stohr et al., 2020) or reductions (Dragone et al., 2019; Brinkman & Mok-Lamme, 2019; Wu et al., 2020) in crime. There is consensus, however, that cannabis legalization did reduce cannabis-possession arrests among adults in RCL states compared to non-RCL states (Plunk et al., 2019; Stohr et al., 2020). There is also evidence that cannabis legalization reduced law enforcement seizures of cannabis (Stohr et al., 2020) and other drugs, and potentially reduced the size of the illegal drug market (Meinhofer and Rubli, 2021).

The majority of previous RCL studies have not considered the role of legalization on racial disparities in the criminal justice system; the handful that have, documented large reductions in cannabis-possession arrests for Black and White adults (Edwards et al., 2020; Firth et al., 2019; Sheehan et al., 2021). One study documented reductions in police traffic stops resulting in searches among Black, White, and Hispanic persons (Pierson et al., 2020). These studies, however, were either descriptive or based on pre-post analyses (Edwards et al., 2020; Firth et al., 2019; Pierson et al., 2020), used data from a single state or few states (Firth et al., 2019; Pierson et al., 2020), generated separate estimates for Black and White groups but did not formally test for changes in relative and absolute disparities (Edwards et al., 2020; Sheehan et al., 2021; Pierson et al., 2020); and/or did not consider other racial or ethnic groups (Edwards et al., 2020; Firth et al., 2019; Sheehan et al., 2021). Except for Pierson et al., 2020, these studies analyzed cannabis-possession arrests exclusively (Edwards et al., 2020; Firth et al., 2019; Sheehan et al., 2021), an outcome that may only reflect partial equilibrium effects. Researchers have highlighted

that it may be equally or more important to evaluate other cannabis offenses, such as sales and public intoxication, as well as other drug and non-drug offenses (Smart & Kleiman, 2019). Importantly, no studies have elucidated the net effects of RCLs, that is, whether legalization narrowed longstanding racial and ethnic disparities in overall arrests or other aggregate criminal justice outcomes. Understanding these general equilibrium effects is crucial because RCLs may lead to spillovers such as police reallocating resources away from cannabis-possession arrests to the prevention of other crimes (Makin, 2019). Moreover, RCLs may lead to changes in the size and nature of the illegal drug market more broadly (Meinhofer and Rubli, 2021), thus, affecting drug-related crimes and associated criminal justice outcomes.

This study addressed these gaps in the literature and generated the most comprehensive estimates to date of the effects of RCLs on racial and ethnic disparities in the criminal justice system. The outcomes of interest included measures of law enforcement and street violence associated with illegal drug markets, both of which reflect important consequences of drug prohibition. Specific measures included the rate of arrests, prisoners, homicides, assaults, and gun injuries per 10,000 persons, overall and by racial and ethnic groups. Rate ratios and rate differences relative to the White group, which represents the largest proportion of the U.S. population, were also considered. Rate ratios and rate differences measure relative and absolute disparities, respectively. Although both correlate perfectly in the cross-section, they may provide contradictory results when considering changes over time and space. As such, both measures provide distinct information and are important for understanding the nature of changes in disparities (Keppel et al., 2005). We analyzed a variety of administrative datasets spanning 2007-2019, each providing complementary strengths and allowing for a validation check of findings, which is necessary given the inherent challenges in measuring criminal justice outcomes. Our research design relied on a difference-in-difference framework that exploited the staggered implementation of RCLs across states using effective dates.

Elucidating the impact of RCLs on racial and ethnic disparities in the criminal justice system is important for designing successful regulation that works in reparative ways. This timely study is of critical importance as it can inform the cannabis legalization debate, guide federal and state governments regulating cannabis possession and distribution, identify unintended consequences, and generate knowledge that can guide policy approaches for

implementing cannabis legalization policies that seek to repair unequal criminal justice outcomes caused by the war on drugs.

2. Background

2.1. Cannabis liberalization

The U.S. Federal government classifies marijuana as a controlled substance in Schedule I. Substances in this schedule have no accepted medical use, a lack of accepted safety, and a high potential for abuse (Drug Enforcement Administration, 2019). At the state level, however, 19 states have enacted recreational cannabis laws as of 2021, legalizing cannabis use among adults aged 21 or older, subject to amount limits and other restrictions (ProCon, 2022). There is state variation in RCL provisions. Some RCL states legalize the use of cannabis in public, create licenses to legally sell cannabis, and permit home cultivation (ProCon, 2022). Allowed possession amounts in RCL states range from 1-3 ounces in public and up to 10 ounces in a private residence (ProCon, 2022). Nearly all RCLs were predated by medical cannabis laws (MCLs) and some by cannabis decriminalization laws (CDLs). MCLs allow authorized physicians to recommend cannabis use for patients with eligible health conditions, while CDLs remove criminal sanctions for certain small cannabis possession offenses. Instead, the penalties for possession can range from no penalties, civil fines, drug education, or drug treatment (Svrakic et al., 2012).

While decriminalization may offer some relief from mass incarceration, it preserves many of the punitive features and consequences of the criminal misdemeanor experience (Natapoff, 2015). In particular, it makes easier to impose fines and supervision on populations that will often face punitive consequences when they cannot afford these fines or comply with supervisory conditions. An unpaid penalty can turn into a court judgment (and an arrest warrant in some states), and that judgment can follow the individual for years after the penalty, when applying for a driver's license, registering an automobile, or establishing credit (Smart & Kleiman, 2019). These consequences are likely to have distributive implications, affecting poor, drug-dependent, and otherwise disadvantaged defendants, the majority of which are persons of color, while permitting well-resourced offenders to exit the process quickly and relatively unscathed (Smart & Kleiman, 2019).

2.2. Previous literature

Previous studies of the impact of cannabis liberalization on criminal justice outcomes primarily focus on MCLs and its effects in the general population (Morris et al. 2014; Huber III et al. 2016; Chu and Townsend 2019; Gavrilova et al. 2019; Dragone et al. 2019; Anderson and Rees, 2021). None of these studies have found evidence suggesting that MCLs increased crime; if anything, most of the evidence suggests that MCL implementation was followed by crime reductions. CDL studies of criminal justice outcomes in the general population have documented reductions in drug-related arrests (Grucza et al., 2018; Plunk et al., 2019). Several RCL studies have also considered criminal justice outcomes in the general population, including property and violent crimes, arrests, and drug seizures. There are somewhat mixed results regarding the impact of RCLs on crime, with studies documenting no changes (Lu et al., 2021; Stohr et al., 2020) or reductions (Dragone et al., 2019; Brinkman et al., 2019; Wu et al., 2020) in crime. There is consensus, however, that cannabis legalization did reduce cannabis-possession arrests among adults in RCL states compared to non-RCL states (Plunk et al., 2019; Stohr et al., 2020). Indeed, a study found that cannabis-possession arrests dropped by 168.50 per 100,000 persons following RCL implementation in four states (Plunk et al., 2019). There is also consensus that cannabis legalization reduced law enforcement seizures of cannabis (Stohr et al., 2020) and other drugs, and possibly reduced the size of the illegal drug market (Meinhofer & Rubli, 2021).

Previous studies of the impact of cannabis liberalization policies on criminal justice outcomes have also considered racial and ethnic disparities. One recent study analyzed the impact of CDLs on cannabis-possession arrests among Black and White youth and adults using an event study approach (Sheehan et al., 2021). It found that decriminalization was associated with reductions in cannabis possession arrests among Black and White youth and adults. Another study focusing on CDLs found similar results: decriminalization was associated with a 17% decrease in racial disparity in cannabis possession arrests rates between Black and White adults (Gunadi and Yuyan, 2022).

The handful of previous RCL studies that considered racial and ethnic disparities in the criminal justice system were descriptive or based on single-state data (Edwards et al., 2020; Firth et al., 2019; Firth et al., 2020). An exception is a recent study that employed an event study approach and documented large reductions in cannabis possession arrests for Black and White adults in the first three years following RCL implementation (Sheehan et al., 2021). The parallel

trends assumption, however, did not hold for most of these estimates, and it was unclear if and which reference period was excluded or if authors controlled for lags and leads beyond those reported in the figures. Moreover, this study did not account for the well-documented variation across states and over time in the number of reporting agencies (Kaplan, 2021). A descriptive report by the American Civil Liberties Union documented that RCL states had lower racial disparities in cannabis possession arrests in 2018 than states where cannabis remained fully illegal, as well as states that decriminalized (Edwards et al., 2020). However, it was not clear that these lower racial disparities resulted from legalization as RCL states also had lower racial disparities in the years prior to legalization. A single-state study focusing on Washington found that cannabis-possession arrest rates decreased significantly among both Black and White adults but relative disparities grew from 2.5 to 5 following RCL implementation (Firth et al., 2019). As previously noted, these studies analyzed cannabis-possession arrests exclusively, an outcome that only reflects partial equilibrium effects. Elucidating the impact of RCLs on racial and ethnic disparities in the criminal justice system requires examination of non-cannabis arrests and other outcomes to assess potential spillovers and general equilibrium effects.

2.3. Conceptual framework

The net effect of cannabis legalization on overall criminal activity and associated law enforcement efforts is theoretically ambiguous, and will be largely influenced by the effect of RCLs on consumers and producers of cannabis and other drugs, as well as on law enforcement efforts. Most directly, it is a crime to use, possess, manufacture, or distribute drugs. Drugs are also related to criminal activity and associated law enforcement efforts through their effects on user's behavior and by generating street violence and other illegal activity in connection with drug trafficking.

The legalization of cannabis may *reduce* criminal activity and associated law enforcement efforts through various pathways. The effect on cannabis arrests is mostly mechanical, since police cannot make arrests for legal cannabis possession or sales. In general, legalization should reduce the illegal market for cannabis, both producer and consumer activities, therefore reducing law enforcement efforts targeting cannabis use, possession, manufacture, or distribution such as arrests and incarceration. Indeed, previous studies suggest that the street price of cannabis declined following RCL implementation (Meinhofer and Rubli, 2021).

Consumers and producers of cannabis may also be consumers and producers of other illegal drugs. To the extent RCLs reduce the illegal market for other drugs or the use of other drugs that are substitutes of cannabis, legalization may also reduce criminal activity and associated law enforcement efforts involving other drugs. Law enforcement agencies may also reduce resources allocated to drug prohibition efforts following RCL implementation, further reducing arrests and incarcerations associated with cannabis and other drugs. Previous research has found that law enforcement seizures of other illegal drugs declined following RCL implementation (Meinhofer and Rubli, 2021). These reductions should be observed across all races/ethnicities. As people of color are more likely to be targeted by police efforts and booked for relatively small offenses such as cannabis possession, reductions should be strongest for persons of color.

In contrast, the legalization of cannabis may *increase* criminal activity and associated law enforcement efforts through various pathways. In particular, RCLs may increase aggregate demand for cannabis, which may lead to increases in traffic offenses related to cannabis (i.e. driving under the influence), public nuisances such as disorderly conduct, or crimes committed by individuals to finance their cannabis consumption. Moreover, if greater cannabis use increases consumption of complement drugs, legalization could lead to more drug-related offenses. Increased competition from the creation of a legal market may increase street violence associated with drug trafficking. Lastly, law enforcement may decide to reallocate resources towards pursuing other drug or non-drug offenses, increasing arrests and incarcerations for other offenses (Makin, 2019). To the extent that arrest rates are higher for people of color, these impacts may disproportionately affect them.

3. Methods

3.1. Data

Arrests. We analyzed arrest data from the Federal Bureau of Investigation's (FBI) Uniform Crime Reporting Program: Arrests by Age, Sex, and Race (UCR-ASR). Data captured monthly arrest counts for each agency that reported to the UCR Program, disaggregated by offense type, race, age, and sex. We retrieved arrest data dating back from 2007 to 2019 and excluded U.S. territories (American Samoa, Canal Zone, Guam, Puerto Rico and Virgin Islands) from our analysis. All arrest records corresponded to the highest charge, according to an FBI hierarchy, for each individual arrested (Kaplan, 2021). For instance, any cannabis arrest recorded was one

in which cannabis possession/sale was the highest charge for which that individual was arrested during that police interaction. For each arrest, police officers register the offender's race, based on their own perceptions, as either White, Black, Asian, or American Indian. We aggregated the last two into an "Other Race" category. Although ethnicity is also technically reported, the vast majority of agencies did not include Hispanic counts during most of our sample period, which is why we do not consider this dimension. We analyzed "Cannabis arrests" and "Other drug arrests" (heroin/cocaine, synthetic narcotics, and other drugs), each of which combined arrests for possession and sales. We also aggregated all "Non-drug arrests" and "Total drug arrests". Lastly, to explore potential spillover effects, we followed the FBI's classification to aggregate arrests into Part I (made up of property crimes corresponding to arson, burglary, motor vehicle theft, and theft, and violent crimes comprising aggravated assault, manslaughter, murder, rape, and robbery) and Part II offenses (everything else, excluding drug offenses). Finally, to account for differences in when agencies report to the FBI, we aggregated arrests up to the county-year level, overall and for each race category. A notable limitation of UCR-ASR is that reporting is voluntary, and some counties have a low number of reporting agencies (Kaplan, 2021). We addressed this limitation by using the coverage indicator sample criterion, which has been used in previous studies (Freedman & Owens, 2011), and by controlling in our specifications for the number of reporting agencies. Specifically, we constructed a county-level index of the share of reporting months each year multiplied by the fraction of the total county population that is covered by reporting agencies in that county. In our main analysis, we restricted to an agency reporting coverage threshold of at least 65%. This effectively completely dropped all data for Florida, Illinois, and Washington, DC, consistent with previous studies (Sheehan et al., 2021).

Homicides. Homicides were obtained from restricted use 2007-2019 National Vital Statistics System (NVSS) Mortality Files. Mortality Files are based on information abstracted from death certificates and provide underlying cause of death and multiple cause of death for nearly all deaths occurring within the United States. We selected homicide deaths from persons aged 12 years or older at the time of death. Homicides as the underlying cause of death were identified using International Classification of Diseases (ICD), Tenth Revision codes (U01, U02, X85-X99, Y00-Y09, Y87.1) previously established (Center for Disease Control and Prevention, 2007). We also relied in a NVSS data variable identifying homicide as a manner of death. We aggregated

homicides at the state-year-quarter level, overall and by race and ethnicity. Racial and ethnic groups included White Non-Hispanic, Black Non-Hispanic, Other Race Non-Hispanic (Asian, American Indian/Alaska Native, Pacific Islander), and Hispanic.

Gun Injuries and Assault. Hospitalizations involving gun injuries and assault were drawn from the Healthcare Cost and Utilization Project (HCUP). HCUP is the largest collection of longitudinal hospital data in the US, with all-payer, encounter-level information. We specifically relied on the 2007-2019 HCUP State Inpatient Databases (HCUP-SID) for select states, although our panel of states was unbalanced since we could not obtain all data years for some states. HCUP-SID contains a near census of inpatient care discharge records in participating states, and provide demographic and healthcare information for patients. Demographic information included age, race and ethnicity, sex, and geographic area. Healthcare information includes primary expected payer (Medicaid, private insurance, other) and ICD-9/ICD-10 diagnostic and procedure codes associated with the discharge. We identified hospitalizations involving gun injuries and assault using standard ICD-9/ICD-10 codes previously established (Smart et al., 2021; Centers for Disease Control and Prevention, 2021). Some states participating or not participating in HCUP directly provide researchers with access to their inpatient discharge records for a lower fee, or can directly generate assault and gun injury state-year counts for a lower fee. We combined HCUP-SID with hospital discharge data directly shared by other states, for a total of 31 states including 10 switching RML states. We aggregated hospitalizations at the state-year level, overall and by race and ethnicity. Racial and ethnic groups included White Non-Hispanic, Black Non-Hispanic, Other Race Non-Hispanic (Asian, American Indian/Alaska Native, Pacific Islander), and Hispanic.

Incarcerations. Incarceration data were obtained from the Bureau of Justice Statistics' 2007-2019 National Prisoner Statistics Program (NPS). NPS provides an enumeration of persons in state and federal prisons on December 31 of the reporting year by race and ethnicity. An individual person may have more than one record if they stayed in prison longer than one year. Counts are at the state level and include all state and federal inmates held in a prison (custody) and those held in jail facilities either physically located inside or outside of the state of legal responsibility, and other inmates who may not be physically located in a facility at yearend but

are under a state's jurisdiction. NPS data are subject to limitations. Since 2001, the District of Columbia no longer operated a prison system, thus, we dropped it from our analysis of NPS data. No other states were dropped, but some imputations were done to correct for obvious reporting errors in some states. For example, in 2013 Alaska reported zero prisoners for each racial and ethnic group, but reported a jurisdiction total of 5,081 prisoners. To correct for this reporting error, an average incarceration count was calculated using 2012 and 2014 counts to replace the zero value for the racial and ethnic groups in 2013. Another reporting change occurred in California in October of 2011, where there was a realignment of the prison system which shifted the management of lower-level felons from state prisons and parole systems to county jails and probation systems. As this mechanically reduced the number of state prisoners observed in the data (now placed in county jails), we dropped observations corresponding to California in 2007-2011. Another limitation included the underrepresentation of Hispanic inmates due to differences in reporting of ethnicity across states. We generated year-end prisoner counts at the state-year level, overall and by race and ethnicity. Racial and ethnic groups included White Non-Hispanic, Black Non-Hispanic, Other Race Non-Hispanic (Asian, American Indian/Alaska Native, Native Hawaiian/ other Pacific Islander), and Hispanic.

3.2. Analysis

Our identification strategy exploited variation in the staggered implementation of recreational cannabis laws across states and time using the effective dates in Appendix Table A1. Equations (1), (2), and (3) represented the two-way fixed effects (TWFE) difference-in-differences (DID) regression models, indexed by geographic area *s* and time period *t*. Separate DID models were estimated for the overall population and for each racial/ethnic group *r*, including White Non-Hispanic, Black Non-Hispanic, Other Race Non-Hispanic, and Hispanic. As UCR-ASR data did not identify ethnicity, racial/ethnic groups *r* included White, Black, and Other Race in this case. The unit of observation for UCR-ASR was a county-year, for NPS and HCUP a state-year, and for NVSS Mortality a state-year-quarter.

Equation (1) estimated the static effect of RCLs on the per capita rate of arrests, prisoners, homicides, assaults, and gun injuries per 10,000 persons, generated using outcome counts $Y_{r,s,t}$ for racial/ethnic group *r* divided by U.S. Census population estimates $Population_{r,s,t}$ corresponding to racial/ethnic group *r*. Equation (2) estimated the static effect of

RCLs on the rate ratio, generated by dividing the $Rate_{r,s,t}$ for racial group *r* by the $Rate_{White,s,t}$ for the White group. Equation (3) estimated the static effect of RCLs on the rate differences, generated by subtracting the rate $Rate_{White,s,t}$ for the White group from the rate $Rate_{r,s,t}$ for racial group *r*. Rate differences measure absolute disparities while rate ratios measure relative disparities, both of which provide distinct information and are necessary for understanding the nature of changes in disparities across geographic areas and over time (Keppel et al., 2005).

The main independent variable was the RCL indicator $RCL_{s,t}$. $RCL_{s,t}$ was equal to one if a recreational cannabis law was effective in geographic area *s* and time period *t*, and zero otherwise. Each model controlled for area fixed effects θ_s (e.g. state, county) to account for time invariant differences between geographies and for time period fixed effects δ_t (e.g. year, year-quarter) to account for nationwide trends in outcomes. Despite these controls, estimates may be subject to bias if we fail to account for other variables affecting outcomes and changing differentially over time in RCL states relative to control states. To minimize any such bias, all models controlled for state differences in unemployment rates to account for differences in economic conditions, and for MCLs and CDLs, reflected in vector $X_{s,t}$.

Regressions for racial/ethnic group *r* were weighted with U.S. Census population estimates corresponding to racial/ethnic group r. Standard errors were clustered at the state level using the cluster-robust variance matrix estimator (Bertrand et al., 2004).

(1) $Rate_{r,s,t} = \beta_0 + \beta_1 RCL_{s,t} + \beta_2 X_{s,t} + \theta_s + \delta_t + e_{r,s,t}$, where $Rate_{r,s,t} = (Y_{r,s,t}/Population_{r,s,t}) \times 10{,}000$

(2) $RateRatio_{r,s,t} = \alpha_0 + \alpha_1 RCL_{s,t} + \alpha_2 X_{s,t} + \theta_s + \delta_t + e_{r,s,t}$, where $RateRatio_{r,s,t} = Rate_{r,s,t}/Rate_{White,s,t}$

(3) $RateDiff_{r,s,t} = \gamma_0 + \gamma_1 RCL_{s,t} + \gamma_2 X_{s,t} + \theta_s + \delta_t + e_{r,s,t}$, where $RateDiff_{r,s,t} = Rate_{r,s,t} - Rate_{White,s,t}$

We assessed the validity, credibility, and robustness of our findings in a variety of ways. First, difference-in-differences models are only valid under the assumption of parallel trends between treatment and control groups (e.g. in the absence of RCL implementation, the difference in outcomes between states with RCLs and states without RCLs would have been constant over time). To assess whether this assumption was reasonable and examine if the strength of the association between RCLs and outcomes changed over time, we presented graphical evidence based on an event study approach that controlled for indicators of leads and lags of RCL. A test

validating the parallel trends assumption estimates if the indicators were statistically not different from zero during the pre-RCL period. Second, we generated graphical evidence plotting main outcomes using the raw data. Third, we generated main estimates but dropping control variables. Fourth, we generated main estimates but dropping each RCL state one at a time to examine whether a given outlier RCL state was driving the results. Fifth, one might be concerned that the number of switching RCL states was not sufficiently large, in which case standard methods of statistical inference can over-reject the null (Roodman et al., 2019; Cameron et al. 2015; Conley et al., 2011). We reported p-values using the wild cluster bootstrap approach, which improves statistical inference when the number of treated clusters is small (Roodman et al., 2019; Meinhofer et al., 2021).

Sixth, we applied the diagnostic test *twowayfeweights* described in Chaisemartin et al., (2020) to verify whether our TWFE estimates were robust to treatment effect heterogeneity. When using a TWFE estimator in staggered implementation designs such as ours, early "treated" groups join the "comparison" group of later "treated" groups, generating negative weights. The negative weights can lead to misleading estimates when treatment effects are heterogeneous across states or time, even when the parallel trends assumption holds (Chaisemartin et al., 2020). TWFE is more likely to assign negative weights to periods with a large fraction of treated states and to states treated for many periods (Chaisemartin et al., 2020). The diagnostic test found that the percentage of negative weights attached to $RCL_{s,t}$ was zero across our samples, likely because RMLs are more recent and the share of treated states is low. This strengthens the validity of our TWFE estimator.

Lastly, we considered additional sample restrictions to the UCR data by imposing stricter thresholds for the reporting agency coverage indicator and by excluding outliers from the estimation, defined as arrest counts that are larger than the county-level mean plus two times its standard deviation.

4. Results

4.1 Descriptive results

Tables 1 to 4 report summary statistics for RCL and non-RCL states. The rate of arrests, prisoners, homicides, gun injuries, and assaults was substantially larger for Black persons, regardless of RCL status. Figures 1 to 4 use the raw data to plot outcomes before and after RCL

implementation in RCL states, by race and ethnicity. Following RCL implementation, the rate of cannabis arrests, homicides, assaults, and gun injuries declined among Black persons. The rate of prisoners, however, did not seem to change discontinuously in the post RCL period.

4.2 Law enforcement

Table 5 reports difference-in-differences estimates of the impact of RCLs on cannabis arrests, other drug arrests, non-drug arrests, and total arrests per 10,000 persons. We found that cannabis arrest rates declined significantly across the board in RCL states after the implementation of RCLs relative to non-RCL states. Moreover, we obtained significant and sizable declines in disparities between Black and White persons, both in relative and absolute terms, of around 13 and 54% of the baseline disparity. For Other Race populations, we observed a significant increase in disparities, perhaps driven by the fact that cannabis arrest rates among those groups were already low at baseline and the scope for additional declines were limited. Point estimates for other drug arrests were all negative although insignificant at conventional levels. Arrest rates for other drugs for Black populations declined six times as much as for White (-9.10 vs -1.54), with the latter effect statistically significant at the 90% level. We did not find significant impacts for disparities, except an increase in the rate ratio between Black and White persons of around 10%. However, the rate difference is negative and statistically insignificant.

For total non-drug arrests, we found positive coefficients for all race groups, though only the effect for Black populations was significant at the 95% level. Moreover, this point estimate was eight times larger than the one for White persons. Hence, we obtained positive and significant effects on disparities between Black and White population groups, showing an increase in both the relative and absolute measures of arrest rate disparities of 6 and 16%, respectively. Lastly, we found no significant effects on total arrest rates, though the point estimate for Black persons was positive and large and the one for White persons was negative and small. We obtained positive estimates for disparities in total arrest rates, though only the rate difference between Black and White populations was significant at the 90% level.

Overall, Table 5 shows that cannabis arrest rates declined with RCLs, decreasing disparities between Black and White populations. Arrest rates for other drugs may have declined although effects were mostly not significant at conventional levels. However, we found strong increases in non-drug arrest rates for Black persons, which increased disparities relative to White. Lastly, we

did not observe significant changes in arrest rates and disparities for total arrests, suggesting that the total rates and disparities were unaffected by RCLs. Figure 5 shows event studies that lend credibility to our empirical strategy and support the results in Table 5.

Table 6 reports difference-in-differences estimates of the impact of RCLs on cannabis arrests and other drug arrests stratified by possession and sale offenses, as well as non-drug arrests stratified Part 1 and Part 2 offenses. We found that the cannabis arrest rate results are strong across both the possession and sales categories. However, we obtained negative and insignificant estimates for possession of other drugs across all race groups, while estimates were negative and significant for sales of other drugs. Since sales of other drugs only make up about a third of all other drug arrests, this explains the mostly insignificant impacts for arrest rates in this category in Table 5. We further obtained mostly statistically insignificant estimates for Part 1 offenses, distinguishing by violent crime and property crime. However, we found large and significant increases in arrest rates for Part 2 offenses among Black populations, with a much smaller and insignificant point estimate for White populations. Overall, these results suggest that there were declines in arrest rates for other drugs but only for sales, not possession, and that the increase in non-drug arrests for Black persons was driven by Part 2 offenses.

Table 7 reports difference-in-differences estimates of the impact of RCLs on the rate, rate ratio, and rate difference of prisoners per 10,000 persons. We found no statistically significant changes in prisoner outcomes, regardless of race and ethnicity. Corresponding event study plots are in Figure 6.

4.3 Street violence

Table 8 reports difference-in-differences estimates of the impact of RCLs on the rate ratio, and rate difference of homicides, assault hospitalizations, and gun injury hospitalizations per 10,000 persons. Corresponding event study plots are in Figures 7 and 8. We found no evidence of statistically significant changes in outcomes following RCL implementation among Non-Hispanic White persons and estimated coefficients were small. However, among Non-Hispanic Black persons, there were statistically significant and sizable declines in the rate (-0.131), rate ratio (-1.421), and rate differences (-0.130) of homicides. Relative to the mean in RCL states, these represented a respective decline of 25% (-0.131/.52 *100), 16% (-1.421/8.68*100), and 29% (-0.130/0.45*100). Similarly, there were statistically significant declines in the rate (-

0.747), rate ratio (-2.133), and rate difference (-0.756) of gun injury hospitalizations among Non-Hispanic Black persons. Relative to the baseline mean in RCL states, these represented a respective decline of about 19% (-0.747/4.01*100), 17% (-2.133/12.19*100), and 21% (-0.756/3.64*100). Estimates of assault hospitalizations were negative but not statistically significant among Non-Hispanic Black persons. As for Hispanic persons, we found statistically significant declines in the rate (-0.127) and rate difference (-0.135) of gun injury hospitalizations. These represented a respective decline of about 14% (-0.127/0.90*100) and 25% (-0.135/0.53*100) relative to the baseline mean among Hispanic persons in RCL states. All other estimates were negative but not statistically significant among Hispanic persons.

5. Discussion

Racial and ethnic disparities in law enforcement of drug prohibition are widespread and longstanding, with Black communities being disproportionately affected. Understanding the effect of cannabis legalization on these disparities is crucial for designing successful policies that work in reparative ways. This study provides the most comprehensive evidence to date of the partial and general equilibrium effects of recreational cannabis laws on racial and ethnic disparities in the criminal justice system and other consequences related to street violence. Using a comprehensive collection of administrative datasets and a rigorous difference-in-differences framework, we documented several key findings.

First, RCL implementation was associated with declines in cannabis arrest rates among all racial groups, and declines in relative and absolute disparities in arrest rates between Black and White populations. These findings are consistent with the mechanical aspect of RCLs that legalize cannabis, while the decline in Black-White disparities likely follows from the higher arrest rates among Black persons prior to RCLs.

Second, RCL implementation was associated with an increase in arrest rates for non-drug crimes but only among Black populations. Moreover, these effects are driven by an increase in arrests for less serious crimes (Part 2 offenses). These alarming findings cannot be explained by a purely mechanical effect in how arrests are recorded in the UCR-ASR data, since estimates are only large and significant for Black persons. This suggests a potential change in policing efforts in jurisdictions with RCLs, which may be driven by profiling or by shuffling police resources to other crimes that are more prevalent or easier to detect among Black populations. From a policy

perspective, this result raises the question of whether incentives in law enforcement are such that RCLs unintentionally increase disparities in arrest rates for Part 2 offenses, and suggests that additional policies that curtail this effect may be necessary.

Third, we did not find any significant changes in both total arrest and incarceration rates, as well as race disparities in these outcomes. This suggests that our previous results are a reshuffling of arrests across categories by race groups, but that RCLs are not associated with any overall changes in total arrests made, or in the rate at which arrests lead to incarceration. Moreover, we see no evidence that cannabis liberalization may address disparities in the rate at which different populations are incarcerated.

Lastly, RCL implementation was associated with reductions in street violence among Black populations, as measured by reductions in homicides and hospitalizations due to gun injury. This suggests that legal cannabis is leading to improvements in safety, possibly because of reductions in illegal drug markets. However, it is interesting that effects are only present for Black populations, and that we do not find declines in arrest rates among Black persons for violent crime although this may be due to the relatively small arrest rates for violent crimes at around just 3% of total arrests.

While our results are robust across specifications, a few key limitations and open questions remain. First, we observe the outcomes from policing efforts in the form of arrest rates for various categories of crime, but we cannot directly observe how resources are allocated by law enforcement agencies nor the incentives that police may face. For instance, we do not know whether their objective is to decrease criminal activity or to comply with a fixed number of arrests per year. As such, we only estimate the impacts of RCLs on arrest rates but cannot pin down the mechanisms in terms of potential changes in policing strategies. Second, we only observe counts of incarcerated persons, but cannot observe the length of sentence, types of crime that led to conviction, or other outcomes like eligibility for parole. Hence, we might be missing important ways in which incarcerations are changing after RCL implementation. Lastly, we only observe instances of street violence that led to hospitalization or death. Both are relatively extreme outcomes, such that violence may be changing with RCLs in ways unobservable in the data.

Taken together, our study documented that RCL implementation led to important shifts in arrest rates across categories of crime. The declines in cannabis arrest rates and disparities

between Black and White populations were compensated by large and significant increases in non-drug arrest rates for Black persons, resulting in a zero net change in total arrest rates and disparities. However, we did find evidence that measures of street violence declined among Black persons.

References

1) Shultz, G., and Aspe, P. (2017). The Failed War on Drugs. *The New York Times*. https://www.nytimes.com/2017/12/31/opinion/failed-war-on-drugs.html
2) Hudak, J. (2021). Biden should end America's longest war: The War on Drugs. *Brookings*. https://www.brookings.edu/blog/how-we-rise/2021/09/24/biden-should-end-americas-longest-war-the-war-on-drugs/
3) Earp, B. D., Lewis, J., Hart, C. L., with, B., & Allied Professionals for Drug Policy, R. (2021). Racial Justice Requires Ending the War on Drugs. *Am J Bioeth*, 21(4), 4-19. https://doi.org/10.1080/15265161.2020.1861364
4) Gramlich, J. (2020). *Four-in-ten U.S. drug arrests in 2018 were for marijuana offenses–mostly possession.* Paw Research Center. https://www.pewresearch.org/fact-tank/2020/01/22/four-in-ten-u-s-drug-arrests-in-2018-were-for-marijuana-offenses-mostly-possession/
5) Carson, E. A. (2020). *Prisoners in 2019*. U.S. Department of Justice. https://bjs.ojp.gov/content/pub/pdf/p19.pdf
6) American Civil Liberties Union. (2020*). A Tale of Two Countries: Racially Targeted Arrests In The Era Of Marijuana Reform*. https://www.aclu.org/report/tale-two-countries-racially-targeted-arrests-era-marijuana-reform
7) U.S. Census Bureau (2022). Population Estimates. July 1, 2021. https://www.census.gov/quickfacts/fact/table/US/PST045221
8) Carson, E. A. (2021). *Prisoners in 2020*. U.S. Department of Justice. https://bjs.ojp.gov/content/pub/pdf/p20st.pdf
9) Motivans, M. (2022). *Federal Justice Statistics, 2020.* U.S. Department of Justice. https://bjs.ojp.gov/content/pub/pdf/fjs20.pdf
10) Federal Bureau of Investigation. (2018). *2018 Crime in the United States.* https://ucr.fbi.gov/crime-in-the-u.s/2018/crime-in-the-u.s.-2018/topic-pages/tables/expanded-homicide-data-table-1.xls
11) Kaiser Family Foundation. (2022). Deaths Due to Firearms per 100,000 Population by Race/Ethnicity. https://www.kff.org/other/state-indicator/firearms-death-rate-by-raceethnicity/?currentTimeframe=0&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D
12) ProCon.org. (2022). *State-by-State Recreational Marijuana Laws.* https://marijuana.procon.org/legal-recreational-marijuana-states-and-dc/
13) Gettman, J., & Kennedy, M. (2014). Let it grow-the open market solution to marijuana control. *Harm Reduct J*, *11*(1), 32. https://doi.org/10.1186/1477-7517-11-32

14) Cerda, M., Wall, M., Feng, T., Keyes, K. M., Sarvet, A., Schulenberg, J., O'Malley, P. M., Pacula, R. L., Galea, S., & Hasin, D. S. (2017). Association of State Recreational Marijuana Laws With Adolescent Marijuana Use. *JAMA Pediatr*, *171*(2), 142-149. https://doi.org/10.1001/jamapediatrics.2016.3624
15) Aydelotte, J. D., Mardock, A. L., Mancheski, C. A., Quamar, S. M., Teixeira, P. G., Brown, C. V. R., & Brown, L. H. (2019). Fatal crashes in the 5 years after recreational marijuana legalization in Colorado and Washington. *Accid Anal Prev*, *132*, 105284. https://doi.org/10.1016/j.aap.2019.105284
16) Cerda, M., Mauro, C., Hamilton, A., Levy, N. S., Santaella-Tenorio, J., Hasin, D., Wall, M. M., Keyes, K. M., & Martins, S. S. (2020). Association Between Recreational Marijuana Legalization in the United States and Changes in Marijuana Use and Cannabis Use Disorder From 2008 to 2016. *JAMA Psychiatry*, *77*(2), 165-171. https://doi.org/10.1001/jamapsychiatry.2019.3254
17) Hansen, B., Miller, K. S., Weber, C., & National Bureau of Economic, R. (2018). *Early evidence on recreational marijuana legalization and traffic fatalities*. National Bureau of Economic Research. http://www.uky.edu/~cwki230/HMW_marijuana_traffic.pdf
18) Meinhofer, A. l., Witman, A., Hinde, J. M., Simon, K. I., & National Bureau of Economic, R. (2021). *Marijuana liberalization policies and perinatal health*. National Bureau of Economic Research.
19) Martins, S. S., Segura, L. E., Levy, N. S., Mauro, P. M., Mauro, C. M., Philbin, M. M., & Hasin, D. S. (2021). Racial and Ethnic Differences in Cannabis Use Following Legalization in US States With Medical Cannabis Laws. *JAMA Netw Open*, *4*(9), e2127002. https://doi.org/10.1001/jamanetworkopen.2021.27002
20) National Criminal Justice Reference Service. (2020). *Effects of Marijuana Legalization on Law Enforcement and Crime: Final Report.* https://www.ojp.gov/pdffiles1/nij/grants/255060.pdf
21) Lu, R., Willits, D., Stohr, M. K., Makin, D., Snyder, J., Lovrich, N., Meize, M., Stanton, D., Wu, G., & Hemmens, C. (2021). The Cannabis Effect on Crime: Time-Series Analysis of Crime in Colorado and Washington State. *Justice Quarterly*, *38*(4), 565-595. https://doi.org/10.1080/07418825.2019.1666903
22) Wu, G., Boateng, F., & Lang, X. (2020). The Spillover Effect of Recreational Marijuana Legalization on Crime: Evidence From Neighboring States of Colorado and Washington State. *Journal of drug issues*, *50*. https://doi.org/10.1177/0022042620921359
23) Brinkman, J., & Mok-Lamme, D. (2019). Not in my backyard? Not so fast. The effect of marijuana legalization on neighborhood crime. *Regional Science and Urban Economics*, *78*, 103460. https://doi.org/https://doi.org/10.1016/j.regsciurbeco.2019.103460
24) Plunk, A. D., Peglow, S. L., Harrell, P. T., & Grucza, R. A. (2019). Youth and Adult Arrests for Cannabis Possession After Decriminalization and Legalization of Cannabis. *JAMA Pediatr*, *173*(8), 763-769. https://doi.org/10.1001/jamapediatrics.2019.1539
25) Meinhofer, A., & Rubli, A. (2021). Illegal drug market responses to state recreational cannabis laws. Addiction, 116(12), 3433-3443.
26) Stohr, M., Willits, D., Makin, D., Hemmens, C., Lovrich, N., Stanton, D., & Meize, M. (2021). *Effects of Marijuana Legalization on Law Enforcement and Crime, Washington, 2004-2018* Inter-university Consortium for Political and Social Research [distributor]. https://doi.org/10.3886/ICPSR37661.v1

27) Dragone, D., Prarolo, G., Vanin, P., & Zanella, G. (2019). Crime and the legalization of recreational marijuana. *Journal of Economic Behavior & Organization*, *159*, 488-501. https://doi.org/https://doi.org/10.1016/j.jebo.2018.02.005
28) Edwards, E., Greytak, E., Madubuonwu, B., Sanchez, T., Beiers, S., Fernandez, P., & Galai, S. (2020). A Tale of Two Countries Racially Targeted Arrests in the Era of Cannabis Reform. American Civil Liberties Union. https://www.aclu.org/sites/default/files/field_document/cannabisreport_03232021.pdf
29) Firth, C. L., Maher, J. E., Dilley, J. A., Darnell, A., & Lovrich, N. P. (2019). Did cannabis legalization in Washington State reduce racial disparities in adult cannabis arrests?. Substance use & misuse, 54(9), 1582-1587.
30) Firth, C. L., Hajat, A., Dilley, J. A., Braun, M., & Maher, J. E. (2020). Implications of cannabis legalization on juvenile justice outcomes and racial disparities. American journal of preventive medicine, 58(4), 562-569.
31) Sheehan, Brynn E., et al. "Association of Racial Disparity of Cannabis Possession Arrests Among Adults and Youths With Statewide Cannabis Decriminalization and Legalization." *JAMA Health Forum*, vol. 2, no. 10, Oct. 2021, p. e213435. *Silverchair*, https://doi.org/10.1001/jamahealthforum.2021.3435.
32) Pierson, E., Simoiu, C., Overgoor, J., Corbett-Davies, S., Jenson, D., Shoemaker, A., ... & Goel, S. (2020). A large-scale analysis of racial disparities in police stops across the United States. Nature human behaviour, 4(7), 736-745.
33) Smart, R., & Kleiman, M. A. (2019). Association of cannabis legalization and decriminalization with arrest rates of youths. JAMA Pediatrics, 173(8), 725-727.
34) Makin, D., Willits, D., Wu, G., DuBois, K., Lu, R., Stohr, M., Koslicki, W., Stanton, D., Hemmens, C., Snyder, J., & Lovrich, N. (2019). Marijuana Legalization and Crime Clearance Rates: Testing Proponent Assertions in Colorado and Washington State. *Police Quarterly*, *22*, 31-55. https://doi.org/10.1177/1098611118786255
35) Keppel, K., Pamuk, E., Lynch, J., Carter-Pokras, O., Kim, I., Mays, V., Pearcy, J., Schoenbach, V., & Weissman, J. S. (2005). Methodological issues in measuring health disparities. *Vital Health Stat 2*(141), 1-16.
36) Drug Enforcement Administration. (2019). List of controlled substances. https://www.deadiversion.usdoj.gov/schedules/orangebook/c_cs_alpha.pdf
37) ProCon.org. "States Where Recreational Marijuana Is Legal." Recreational Marijuana, https://marijuana.procon.org/legal-recreational-marijuana-states-and-dc/. Accessed 25 Apr. 2022.
38) Svrakic, D. M., Lustman, P. J., Mallya, A., Lynn, T. A., Finney, R., & Svrakic, N. M. (2012). Legalization, decriminalization & medicinal use of cannabis: a scientific and public health perspective. *Mo Med*, *109*(2), 90-98.
39) Natapoff, A. (2015). Misdemeanor decriminalization. Vand. L. Rev., 68, 1055.
40) Morris, R. G., TenEyck, M., Barnes, J. C., & Kovandzic, T. V. (2014). The effect of medical marijuana laws on crime: evidence from state panel data, 1990-2006. PloS one, 9(3), e92816.
41) Huber III, A., Newman, R., & LaFave, D. (2016). Cannabis control and crime: Medicinal use, depenalization and the war on drugs. The BE journal of economic analysis & policy, 16(4).
42) Chu, Y. W. L., & Townsend, W. (2019). Joint culpability: The effects of medical marijuana laws on crime. Journal of Economic Behavior & Organization, 159, 502-525.

43) Gavrilova, E., Kamada, T., & Zoutman, F. (2019). Is legal pot crippling Mexican drug trafficking organisations? The effect of medical marijuana laws on US crime. The Economic Journal, 129(617), 375-407.
44) Anderson, D. M., & Rees, D. I. (2021). The public health effects of legalizing marijuana (No. w28647). National Bureau of Economic Research.
45) Grucza, R. A., Vuolo, M., Krauss, M. J., Plunk, A. D., Agrawal, A., Chaloupka, F. J., & Bierut, L. J. (2018). Cannabis decriminalization: a study of recent policy change in five US states. International Journal of Drug Policy, 59, 67-75.
46) Gunadi, Christian, and Yuyan Shi. "Cannabis Decriminalization and Racial Disparity in Arrests for Cannabis Possession." *Social Science & Medicine*, vol. 293, Jan. 2022, p. 114672. *ScienceDirect*, https://doi.org/10.1016/j.socscimed.2021.114672.
47) Kaplan, Jacob. "Uniform Crime Reporting (UCR) program data: A practitioner's guide." CrimRxiv (2021).
48) Freedman, Matthew, and Emily G. Owens. "Low-income housing development and crime." Journal of Urban Economics70, no. 2-3 (2011): 115-131.
49) Center for Disease Control and Prevention. (2007). ICD–10 and ICD–9 comparability ratios according to mechanism of injury and intent of death. https://www.cdc.gov/nchs/data/injury/icd9_icd10_comparability_ratios.pdf
50) Smart, R., Peterson, S., Schell, T. L., Kerber, R., & Morral, A. R. (2021). Inpatient Hospitalizations for Firearm Injury: Estimating State-Level Rates From 2000 to 2016. RAND.
51) Center for Disease Control and Prevention. (2021). ICD Injury Codes and Matrices. https://www.cdc.gov/nchs/injury/injury_matrices.htm
52) Bertrand, M., Duflo, E., Mullainathan, S., & National Bureau of Economic, R. (2002). *How Much Should We Trust Differences-in-Differences Estimates?* National Bureau of Economic Research. http://ed-primo.hosted.exlibrisgroup.com/openurl/44UOE/44UOE_services_page?
53) David Roodman, Morten Orregaard Nielsen, James G MacKinnon, and Matthew D Webb. Fast and wild: Bootstrap inference in Stata using boottest. The Stata Journal, 19(1):4-60, 2019.
54) A Colin Cameron and Douglas L Miller. A practitioner's guide to cluster-robust inference. Journal of human resources, 50(2):317-372, 2015.
55) Timothy G Conley and Christopher R Taber. Inference with difference in differences with a small number of policy changes. The Review of Economics and Statistics, 93(1):113-125, 2011.
56) A Colin Cameron, Jonah B Gelbach, and Douglas L Miller. Bootstrap-based improvements for inference with clustered errors. The Review of Economics and Statistics, 90(3):414-427, 2008.
57) Chaisemartin, C. d., Haultfoeuille, X. d., & National Bureau of Economic, R. (2019). *Two-way fixed effects estimators with heterogeneous treatment effects*. National Bureau of Economic Research. http://imp-primo.hosted.exlibrisgroup.com/openurl/44IMP/44IMP_services_page?

Tables and Figures

Raw plots

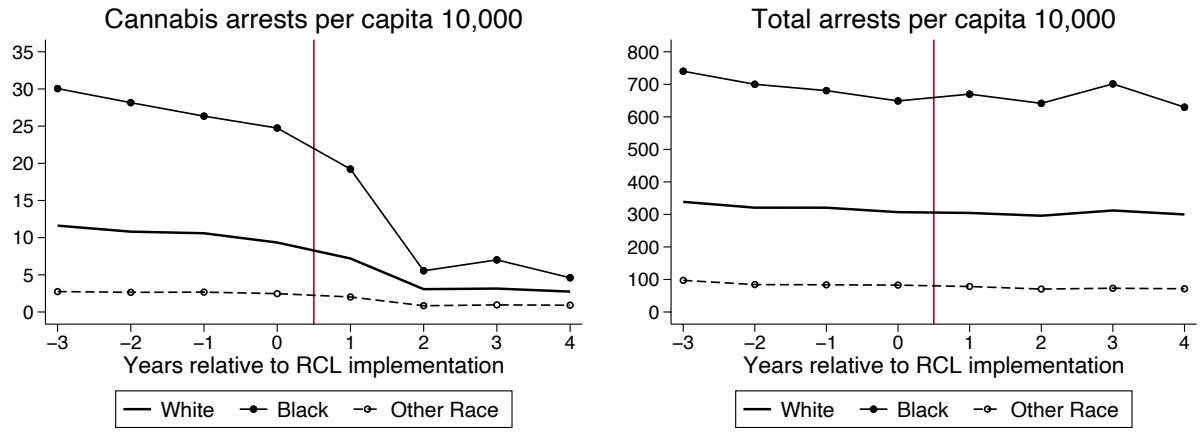


Figure 1. Arrests per 10,000 persons, by time since RCL implementation

Notes: Data are from the 2007-2019 Uniform Crime Reports Arrests by Age, Sex, and Race. The unit of analysis is a county-year. Counts for a given are divided by county-year population estimates corresponding to that race and multiplied by 10,000. Sample restricted to counties with an agency reporting coverage threshold above or equal to 65%. Race-specific population-weighted averages calculated for years relative to RCL implementation. The year t = 0 corresponds to the period immediately before RCL implementation. RCL=Recreational cannabis laws.

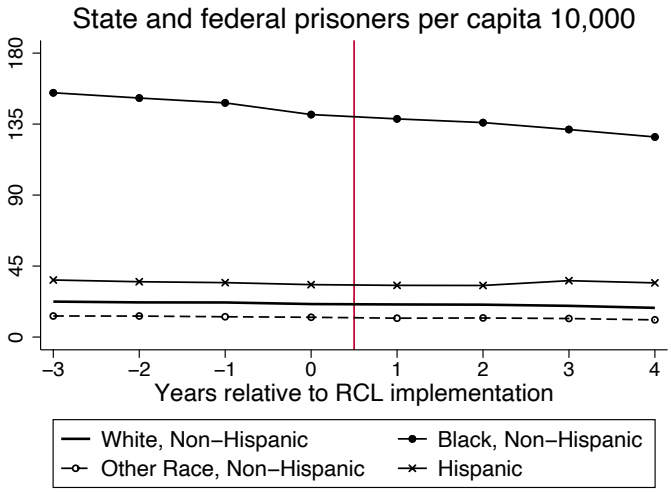


Figure 2. Prisoners per 10,000 persons, by time since RCL implementation

Notes: Data are from the 2007-2019 National Prisoner Statistics. The unit of analysis is a state-year. Counts for a given race/ethnicity are divided by state-year population estimates corresponding to that race/ethnicity, and multiplied by 10,000. RCL=Recreational cannabis laws.

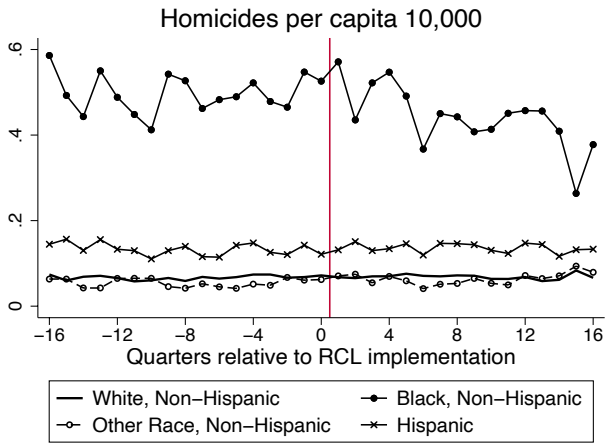


Figure 3. Homicides per 10,000 persons, by time since RCL implementation

Notes: Data are from the 2007-2019 NVSS Mortality Files. The unit of analysis is a state-year-quarter. Counts for a given race or ethnicity are divided by state-year population estimates corresponding to that race or ethnicity, and multiplied by 10,000. RCL=Recreational cannabis laws.

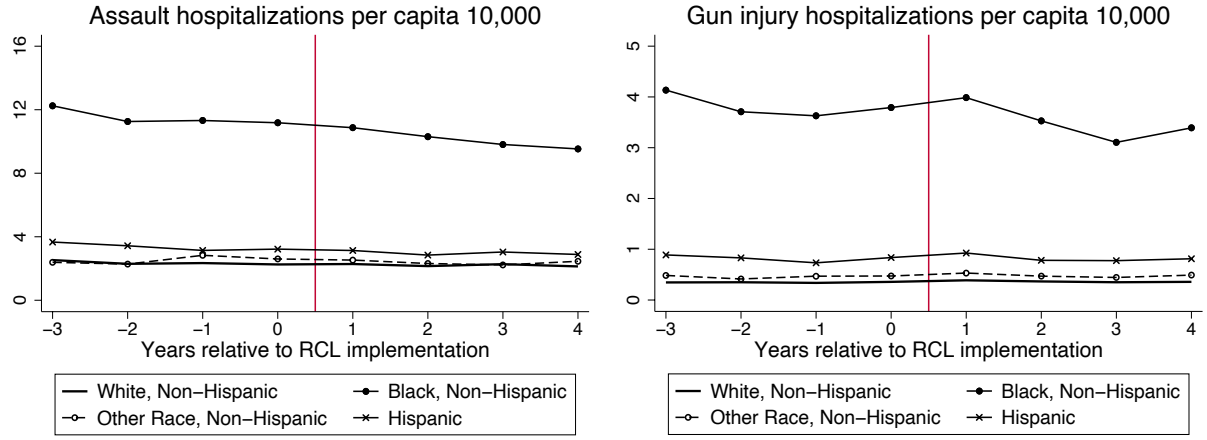


Figure 4. Hospitalizations involving assault and gun injury per 10,000 persons, by time since RCL implementation

Notes: Data are from the 2007-2019 HCUP-SID. The unit of analysis is a state-year. Counts for a given race or ethnicity are divided by state-year population estimates corresponding to that race or ethnicity, and multiplied by 10,000. RCL=Recreational cannabis laws.

Event Study Plots

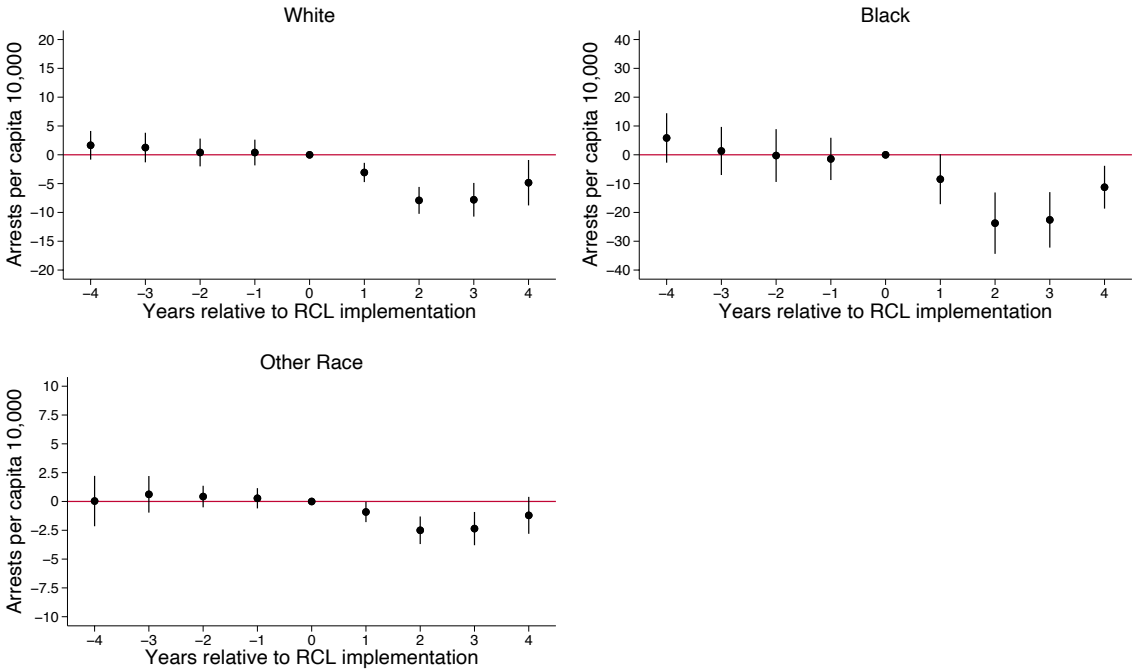


Figure 5. Effect of recreational cannabis laws on cannabis arrests per 10,000 persons, by time since RCL implementation

Notes: Data are from the 2007-2019 Uniform Crime Reports Arrests by Age, Sex, and Race. The unit of analysis is a county-year. Counts for a given outcome are divided by county-year population estimates corresponding to that race and multiplied by 10,000. Sample is restricted to counties with an agency reporting coverage threshold above or equal to 65%. Coefficients and 95% confidence intervals clustered at the state level are based on an event study approach that estimates leads and lags of the intervention and that accounts for controls. Regressions are weighted by race-specific population. Controls include the number of reporting agencies, unemployment rates, medical cannabis laws, and cannabis decriminalization laws. The reference year is t = 0, the year immediately before RCL implementation. RCL=Recreational cannabis laws.

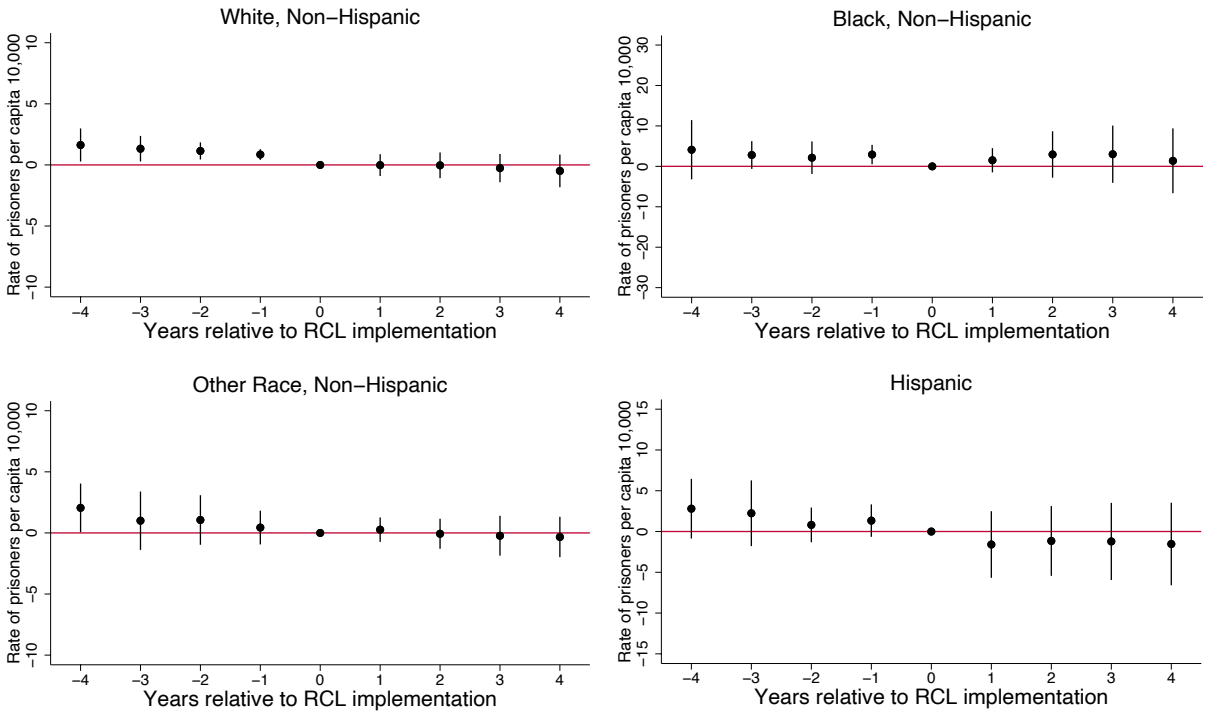


Figure 6. Effect of recreational cannabis laws on state and federal prisoners per 10,000 persons, by time since RCL implementation

Notes: Data are from the 2007-2019 National Prisoner Statistics. The unit of analysis is a state-year. Counts for a given racial/ethnic group are divided by state-year population estimates corresponding to that racial/ethnic group and multiplied by 10,000. Coefficients and 95% confidence intervals clustered at the state level are based on an event study approach that estimates leads and lags of the intervention and that accounts for controls. Regressions are weighted by race/ethnicity-specific population. Controls include unemployment rates, medical cannabis laws, and cannabis decriminalization laws. The reference year is t = 0, the year immediately before RCL implementation. RCL=Recreational cannabis laws.

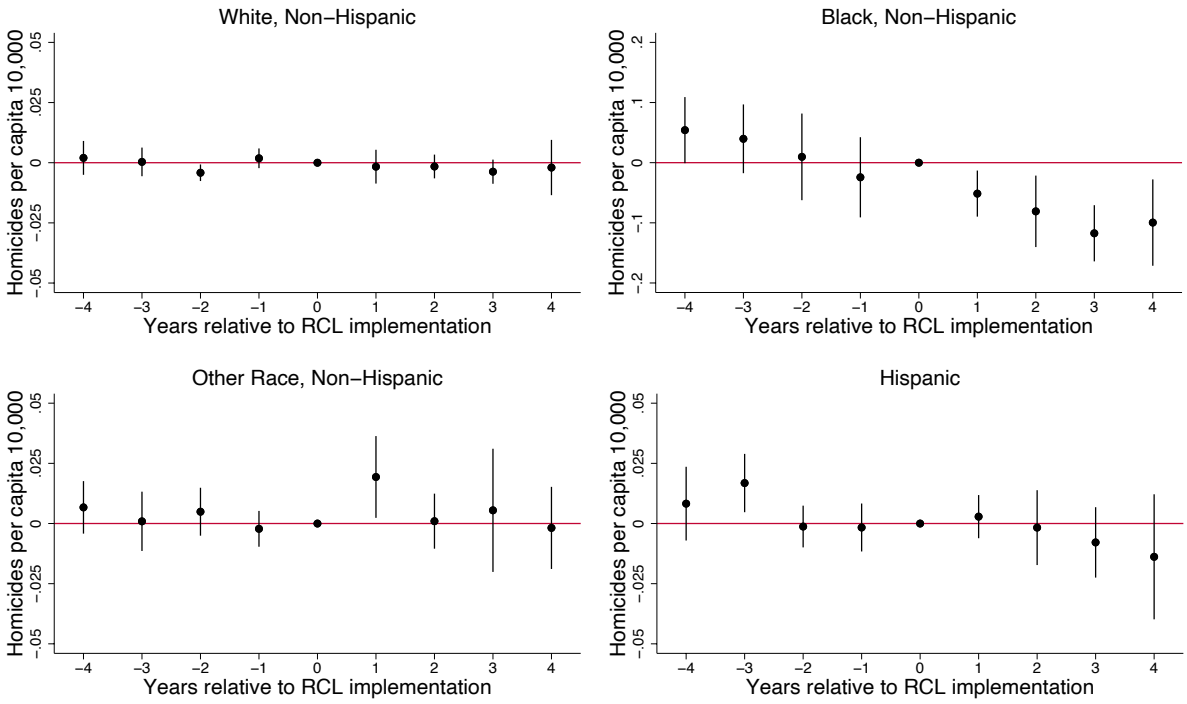


Figure 7. Effect of recreational cannabis laws on homicides per 10,000 persons, by time since RCL implementation

Notes: Data are from the 2007-2019 NVSS Mortality Files. The unit of analysis is a state-year-quarter. Counts for a given racial/ethnic group are divided by state-year population estimates corresponding to that racial/ethnic group, and multiplied by 10,000. Coefficients and 95% confidence intervals clustered at the state level are based on an event study approach that estimates leads and lags of the intervention and that accounts for controls. Regressions are weighted by race-specific population. Controls include unemployment rates, medical cannabis laws, and cannabis decriminalization laws. The reference year is t = 0, the year (four quarters) immediately before RCL implementation. RCL=Recreational cannabis laws.

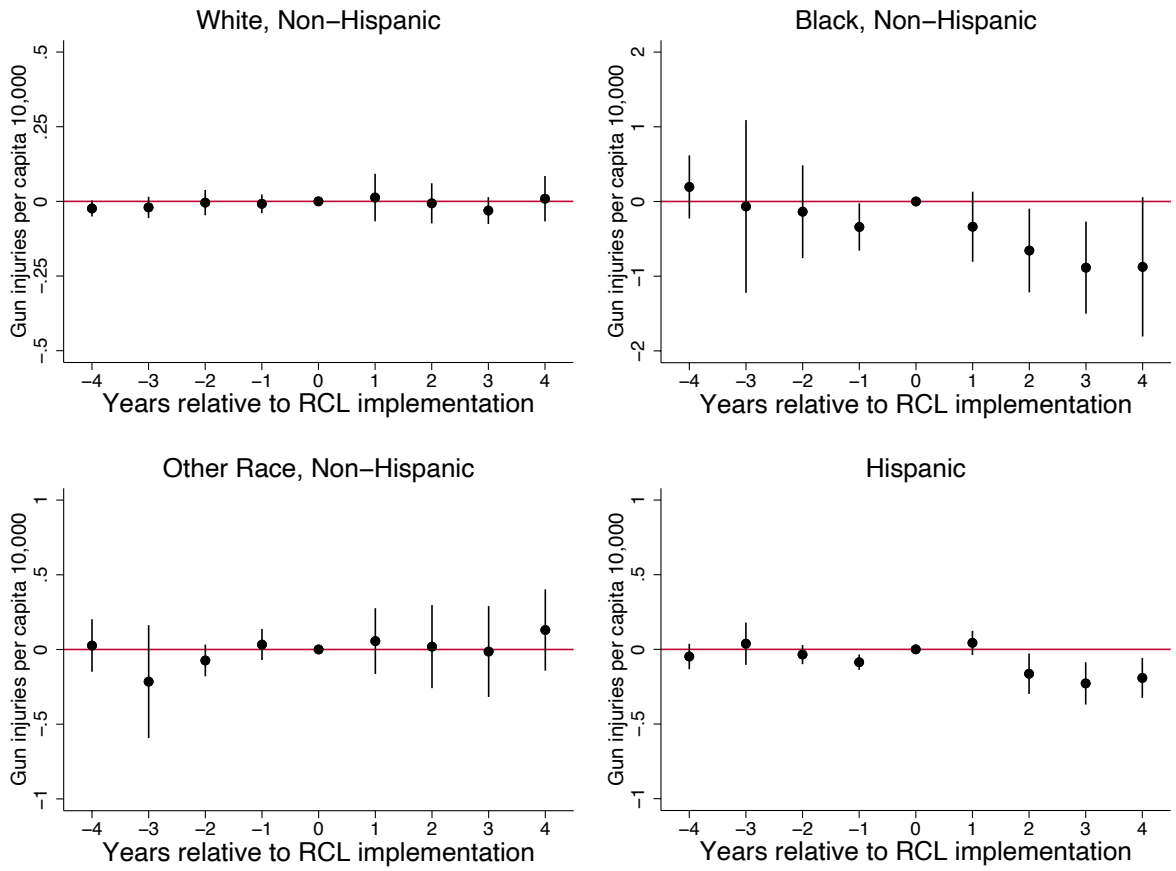


Figure 8. Effect of recreational cannabis laws on gun injuries per 10,000 persons, by time since RCL implementation

Notes: Data are from the 2007-2019 HCUP-SID. The unit of analysis is a state-year. Counts for a given racial/ethnic group are divided by state-year population estimates corresponding to that racial/ethnic group, and multiplied by 10,000. Coefficients and 95% confidence intervals clustered at the state level are based on an event study approach that estimates leads and lags of the intervention and that accounts for controls. Regressions are weighted by race-specific population. Controls include unemployment rates, medical cannabis laws, and cannabis decriminalization laws. The reference year is t = 0, the year immediately before RCL implementation. RCL=Recreational cannabis laws.

Table 1. Summary statistics for arrests, 2007-2019

	RCL States		Non-RCL States		All states	
	Mean	N	Mean	N	Mean	N
Rate of arrests per 10,000 persons						
Population						
Cannabis arrests	18.78	2816	30.95	18000	29.31	20816
Other drug arrests	29.35	2816	26.04	18000	26.48	20816
Total non-drug arrests	337.14	2816	363.87	18000	360.25	20816
Total arrests	385.27	2816	420.94	18000	416.12	20816
White						
Cannabis arrests	17.89	2816	25.25	18000	24.25	20816
Other drug arrests	29.58	2816	23.43	18000	24.26	20816
Total non-drug arrests	318.40	2816	312.13	18000	312.98	20816
Total arrests	365.86	2816	360.88	18000	361.55	20816
Black						
Cannabis arrests	43.72	2816	106.35	18000	97.88	20816
Other drug arrests	61.10	2816	59.34	18000	59.58	20816
Total non-drug arrests	738.13	2816	831.87	18000	819.19	20816
Total arrests	843.10	2816	997.88	18000	976.94	20816
Other Race						
Cannabis arrests	9.62	2816	15.75	18000	14.92	20816
Other drug arrests	12.59	2816	10.36	18000	10.66	20816
Total non-drug arrests	212.65	2816	206.67	18000	207.48	20816
Total arrests	234.86	2816	232.82	18000	233.09	20816
Ratio of arrest rates (relative to White)						
Black						
Cannabis arrests	2.76	2724	4.26	17889	4.06	20613
Other drug arrests	2.97	2743	3.15	17927	3.12	20670
Total non-drug arrests	2.49	2788	2.75	17964	2.71	20752
Total arrests	2.50	2788	2.85	17964	2.80	20752
Other Race						
Cannabis arrests	0.73	2724	0.61	17889	0.63	20613
Other drug arrests	0.47	2743	0.58	17927	0.57	20670
Total non-drug arrests	0.77	2788	0.68	17964	0.69	20752
Total arrests	0.75	2788	0.66	17964	0.68	20752
Differences in arrest rates (relative to White)						
Black						
Cannabis arrests	25.83	2816	81.10	18000	73.62	20816
Other drug arrests	31.53	2816	35.92	18000	35.32	20816
Total non-drug arrests	419.74	2816	637.00	18000	615.39	20816
Total arrests	477.24	2816	637.00	18000	615.39	20816
Other Race						
Cannabis arrests	-8.26	2816	-9.50	18000	-9.33	20816
Other drug arrests	-16.99	2816	-13.06	18000	-13.59	20816
Total non-drug arrests	-105.75	2816	-105.45	18000	-105.49	20816
Total arrests	-131.00	2816	-128.06	18000	-128.46	20816

Notes: Data are from the 2007-2019 Uniform Crime Reports Arrests by Age, Sex, and Race. The unit of analysis is a county-year. Averages and sample size shown. Averages are weighted by race-specific population. Sample restricted to counties with an agency reporting coverage threshold above or equal to 65%. RCL=Recreational cannabis laws.

Table 2. Summary statistics for prisoners, 2007-2019

	RCL States		Non-RCL States		All states	
	Mean	N	Mean	N	Mean	N
Rate of prisoners per 10,000 persons						
Population	33.88	125	45.09	520	42.77	645
White, Non-Hispanic	21.95	125	28.67	520	27.28	645
Black, Non-Hispanic	140.52	125	143.06	520	142.54	645
Other Race, Non-Hispanic	14.57	125	12.65	520	13.05	645
Hispanic	33.35	99	34.82	481	34.51	580
Ratio of prisoner rates (relative to White, Non-Hispanic)						
Black, Non-Hispanic	6.73	125	5.83	520	6.01	645
Other Race, Non-Hispanic	0.61	125	0.52	520	0.54	645
Hispanic	1.79	99	1.52	481	1.58	580
Differences in prisoner rates (relative to White, Non-Hispanic)						
Black, Non-Hispanic	118.57	125	114.39	520	115.26	645
Other Race, Non-Hispanic	-7.38	125	-16.02	520	-14.23	645
Hispanic	11.31	99	6.10	481	7.19	580

Notes: Data are from the 2007-2019 National Prisoner Statistics. The unit of analysis is a state-year. Averages and sample size shown. Averages are weighted by race/ethnicity-specific population. RCL=Recreational cannabis laws.

Table 3. Summary statistics for homicides, 2007-2019

	RCL States		Non-RCL States		All states	
	Mean	N	Mean	N	Mean	N
Rate of homicides per 10,000 persons						
Population	0.12	572	0.15	2080	0.14	2652
White, Non-Hispanic	0.07	572	0.07	2080	0.07	2652
Black, Non-Hispanic	0.52	572	0.51	2080	0.51	2652
Other Race, Non-Hispanic	0.06	572	0.08	2080	0.07	2652
Hispanic	0.15	572	0.13	2080	0.14	2652
Ratio of homicide rates (relative to White, Non-Hispanic)						
Black, Non-Hispanic	8.68	537	8.6	2055	8.62	2592
Other Race, Non-Hispanic	0.98	537	1.18	2055	1.13	2592
Hispanic	2.51	537	2.21	2055	2.28	2592
Differences in homicide rates (relative to White, Non-Hispanic)						
Black, Non-Hispanic	0.45	572	0.44	2080	0.44	2652
Other Race, Non-Hispanic	-0.00	572	0.00	2080	0.00	2652
Hispanic	0.08	572	0.06	2080	0.07	2652

Notes: Data are from 2007-2019 NVSS Mortality Files. The unit of analysis is a state-year-quarter. Averages and sample size shown. Averages are weighted by race/ethnicity-specific population. RCL=Recreational cannabis laws.

Table 4. Summary statistics for hospitalizations, 2007-2019

	RCL States		Non-RCL		All states	
	Mean	N	Mean	N	Mean	N
Rate of hospitalizations per 10,000 persons						
Population						
Assault	3.43	102	3.5	260	3.48	362
Gun injuries	0.85	102	1.04	260	0.98	362
White, Non-Hispanic						
Assault	2.37	92	2.11	243	2.2	335
Gun injuries	0.37	92	0.5	243	0.45	335
Black, Non-Hispanic						
Assault	11.57	92	9.2	243	9.98	335
Gun injuries	4.01	92	3.64	243	3.76	335
Other Race, Non-Hispanic						
Assault	2.37	92	4.97	243	4.12	335
Gun injuries	0.52	92	1.12	243	0.92	335
Hispanic						
Assault	3.45	92	3.06	243	3.19	335
Gun injuries	0.90	92	0.72	243	0.78	335
Ratio of hospitalizations rates (relative to White)						
Black, Non-Hispanic						
Assault	5.12	92	4.61	243	4.77	335
Gun injuries	12.19	92	10.5	243	11.05	335
Other Race, Non-Hispanic						
Assault	1.14	92	2.45	243	2.02	335
Gun injuries	1.57	92	2.77	243	2.37	335
Hispanic						
Assault	1.46	92	1.53	243	1.51	335
Gun injuries	2.81	92	1.9	243	2.2	335
Differences in hospitalizations rates (relative to White)						
Black, Non-Hispanic						
Assault	9.21	92	7.09	243	7.78	335
Gun injuries	3.64	92	3.14	243	3.31	335
Other Race, Non-Hispanic						
Assault	0.01	92	2.86	243	1.92	335
Gun injuries	0.15	92	0.62	243	0.47	335
Hispanic						
Assault	1.08	92	0.95	243	0.99	335
Gun injuries	0.53	92	0.22	243	0.32	335

Notes: Data are from the 2007-2019 HCUP-SID. The unit of analysis is a state-year. Counts for a given racial/ethnic group are divided by state-year population estimates corresponding to that racial/ethnic group, and multiplied by 10,000.

Table 5. Effect of recreational cannabis laws on arrests per 10,000 persons, 2007-2019

	Cannabis Arrests			Other Drug Arrests			Total Non-Drug Arrests			Total Arrests		
	Rate	Rate Ratio	Rate Difference	Rate	Rate Ratio	Rate Difference	Rate	Rate Ratio	Rate Difference	Rate	Rate Ratio	Rate Difference
Population	-8.79***	n.a.	n.a.	-1.55	n.a.	n.a.	23.68**	n.a.	n.a.	13.58	n.a.	n.a.
	(1.38)			(1.00)			(11.54)			(11.37)		
White	-8.50***	n.a.	n.a.	-1.54	n.a.	n.a.	8.56	n.a.	n.a.	-1.26	n.a.	n.a.
	(1.12)			(0.94)			(11.34)			(11.03)		
Black	-24.97***	-0.38***	-18.31***	-9.10*	0.33**	-6.87	68.96**	0.14***	63.20***	42.73	0.10	45.73*
	(4.01)	(0.14)	(3.34)	(5.14)	(0.15)	(4.86)	(27.82)	(0.05)	(20.30)	(32.97)	(0.06)	(24.60)
Other Race	-2.02**	0.14***	5.14***	-0.72	0.03	-0.25	9.18	0.03	-0.51	6.48	0.05	4.27
	(0.87)	(0.04)	(1.23)	(0.80)	(0.04)	(0.91)	(20.32)	(0.07)	(17.95)	(21.21)	(0.07)	(18.87)
County F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Effect of recreational cannabis laws on arrest rates, rate ratios, and rate differences, by race. Ethnicity is not available. Data are from the 2007-2019 Uniform Crime Reports Arrests by Age, Sex, and Race, where the unit of analysis is a county-year. Counts for a given race are divided by county-year population estimates corresponding to that race and multiplied by 10,000. Sample restricted to counties with an agency reporting coverage threshold above or equal to 65%. Each coefficient is based on separate two-way fixed effects regressions described in Equations (1), (2) and (3). Regressions are weighted by race-specific population. Control variables include unemployment rates, medical cannabis laws, and cannabis decriminalization laws. State clustered standard errors are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 6. Effect of recreational cannabis laws on arrests per 10,000 persons by different categories

	Drug Possession		Drug Sales		Part 1 Offenses		Part 2 Offenses
	Cannabis	Other Drugs	Cannabis	Other Drugs	Violent	Property	
Population	-7.602***	-0.425	-1.189***	-1.125***	-0.301	1.625	22.352**
	(1.412)	(0.860)	(0.233)	(0.310)	(0.604)	(1.554)	(10.656)
White	-7.306***	-0.225	-1.193***	-1.311***	-0.719*	-1.058	10.336
	(1.200)	(0.902)	(0.214)	(0.235)	(0.380)	(1.618)	(10.419)
Black	-19.873***	-4.217	-5.099***	-4.885***	-0.621	4.472	65.106***
	(4.068)	(3.731)	(0.959)	(1.642)	(2.669)	(4.649)	(24.138)
Other Race	-1.721**	-0.443	-0.301**	-0.281**	-0.491	1.837	7.837
	(0.812)	(0.736)	(0.112)	(0.138)	(1.099)	(1.456)	(18.699)
County F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Effect of recreational cannabis laws on arrest rates, rate ratios, and rate differences, by race. Ethnicity is not available. Data are from the 2007-2019 Uniform Crime Reports Arrests by Age, Sex, and Race, where the unit of analysis is a county-year. Counts for a given race are divided by county-year population estimates corresponding to that race and multiplied by 10,000. Sample restricted to counties with an agency reporting coverage threshold above or equal to 65%. Each coefficient is based on separate two-way fixed effects regressions described in Equations (1), (2) and (3). Regressions are weighted by race-specific population. Control variables include unemployment rates, medical cannabis laws, and cannabis decriminalization laws. State clustered standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 7. Effect of recreational cannabis laws on state and federal prisoners per 10,000 persons, 2007-2019

	National Prisoner Statistics (Federal and State Prisoners)		
	Rate	Rate Ratio	Rate Difference
Population	0.503	n.a.	n.a.
	(1.039)		
White, Non-Hispanic	-1.363	n.a.	n.a.
	(0.824)		
Black, Non-Hispanic	0.115	0.113	0.968
	(3.811)	(0.14)	(3.341)
Other Race, Non-Hispanic	-0.714	0.02	0.131
	(1.095)	(0.02)	(0.677)
Hispanic	-2.524	-0.068	-2.963
	(3.229)	(0.121)	(4.088)
State F.E.	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Notes: Effect of recreational cannabis laws on incarceration rates, rate ratios, and rate differences, by race and ethnicity. Data are from the 2007-2019 National Prisoner Statistics, where the unit of analysis is a state-year. Counts for a given race/ethnicity are divided by state-year population estimates corresponding to that race/ethnicity and multiplied by 10,000. Rate ratios and rate differences are relative to the White, Non-Hispanic group. Each coefficient is based on separate two-way fixed effects regressions described in Equations (1), (2) and (3). Regressions are weighted by race-specific population. Control variables include unemployment rates, medical cannabis laws, and cannabis decriminalization laws. State clustered standard errors are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 8. Effect of recreational cannabis laws on street violence

	Homicides			Assault Hospitalizations			Gun Injury Hospitalizations		
	Rate	Rate Ratio	Rate Difference	Rate	Rate Ratio	Rate Difference	Rate	Rate Ratio	Rate Difference
Population	-0.020***	n.a.	n.a.	0.005	n.a.	n.a.	-0.091	n.a.	n.a.
	(0.007)			(0.146)			(0.057)		
White, Non-Hispanic	0.000	n.a.	n.a.	-0.035	n.a.	n.a.	0.004	n.a.	n.a.
	(0.003)			(0.087)			(0.023)		
Black, Non-Hispanic	-0.131***	-1.421***	-0.130***	-0.679	-0.100	-0.615	-0.747**	-2.133*	-0.756**
	(0.032)	(0.406)	(0.030)	(0.597)	(0.314)	(0.563)	(0.297)	(1.127)	(0.282)
Other Race, Non-Hispanic	0.008	0.069	0.007	1.042*	0.334	1.048**	0.091	0.24	0.086
	(0.009)	(0.061)	(0.007)	(0.512)	(0.198)	(0.490)	(0.118)	(0.288)	(0.117)
Hispanic	-0.007	-0.047	-0.012	-0.275	0.004	-0.204	-0.127*	-0.172	-0.135**
	(0.008)	(0.144)	(0.011)	(0.258)	(0.098)	(0.214)	(0.065)	(0.176)	(0.062)
State F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Effect of recreational cannabis laws on rates, rate ratios, and rate differences, by race and ethnicity. Homicide data are from 2007-2019 NVSS Mortality Files, where the unit of analysis is a state-year-quarter. Hospital discharge data are from 2007-2019 HCUP-SID, where the unit of analysis is a state-year. Counts for a given race or ethnicity are divided by state-year population estimates corresponding to that race or ethnicity, and multiplied by 10,000. Rate ratios and rate differences are relative to the White, Non-Hispanic group. Each coefficient is based on separate two-way fixed effects regressions described in Equations (1), (2) and (3). Regressions are weighted by race-specific population. Control variables include unemployment rates, medical cannabis laws, and cannabis decriminalization laws. State clustered standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.