September 2023

# Initiative 502 and Cannabis-Related Public Health and Safety Outcomes:
## *Third Required Report*
### *Revised September 15, 2023 for technical corrections*

In November 2012, Washington State voters passed Initiative 502 (I-502), which legalized limited possession, private use, and commercial sales of cannabis for adults.[1] The law also directed the Washington State Institute for Public Policy (WSIPP) to conduct benefit-cost evaluations of the implementation of I-502 by examining outcomes related to public health, public safety, substance use, the criminal justice system, economic impacts, and administrative costs and revenues.[2]

WSIPP is required to produce reports for the legislature in 2015, 2017, 2022,[3] and 2032. In this third report, we evaluate the relationship between I-502 implementation and the following outcomes:

- reported adult and adolescent substance use,
- substance use disorder diagnoses,
- fatal traffic crashes, and
- cannabis-related convictions.

This report summarizes the key findings of several analyses we conducted to examine the relationship between non-medical cannabis legalization (NMC) or licensed retail operations and various outcomes. Comprehensive descriptions of each evaluation are published on our website.[4]

**Summary**

In this third legislatively mandated report, we build upon the preceding WSIPP I-502 evaluation by updating some of the previous findings with more years of data and exploring new outcomes related to public health and safety. Due to the potential coinciding impacts of the COVID-19 pandemic, our study period ends in 2019.

First, we find that cannabis possession conviction rates dropped to almost zero among adults of legal age immediately after I-502 went into effect. Rates also substantively dropped for underaged individuals after non-medical cannabis (NMC) legalization, but not as dramatically as for adults 21 and over.

Next, in a national comparison, we find no significant changes in overall reported cannabis use in Washington State after I-502 went into effect relative to comparable states.

However, in our analyses focusing on the impact of licensed NMC retail access within the state, evidence suggests that closer proximity to a retailer is related to a greater probability of reported past-month and heavy past-month cannabis use. Given this relationship, we last examine the relationship between retail access and subsequent cannabis-related outcomes. We find that increased retail access predicts:

- a greater probability of diagnosed cannabis, alcohol, and opioid use disorder and
- more drivers involved in fatal traffic collisions.

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[1] Initiative Measure No. 502.
[2] RCW 69.50.550.

[3] The initial 2022 report deadline was moved to 2023 by WSIPP's Board of Directors.
[4] See WSIPP's website for all cannabis-related publications.

In Section I, we describe our legislative assignment and summarize previous reports we have published in service of the assignment. In Section II, we briefly detail the implementation of I-502. In Section III, we summarize our findings from an examination of the evolution of cannabis possession conviction rates after the passage of I-502 and the advent of NMC retail operations in Washington State.

In Section IV, we summarize our findings from a national comparison of reported substance use. In Section V, we define our measure of NMC retail access and summarize our findings on the relationships between NMC retail access and reported cannabis use, substance use disorder, and fatal traffic collisions. In Section VI, we explain the limitations of our analysis and review key takeaways.

# I. WSIPP I-502 Report Series

This report is part of a series of reports WSIPP will release over a 20-year period to assess the effects of I-502, as directed by the initiative. The report series timeline and content details for individual reports are summarized in Exhibit 1. The legislative requirements for this assignment are displayed in Exhibit 2.
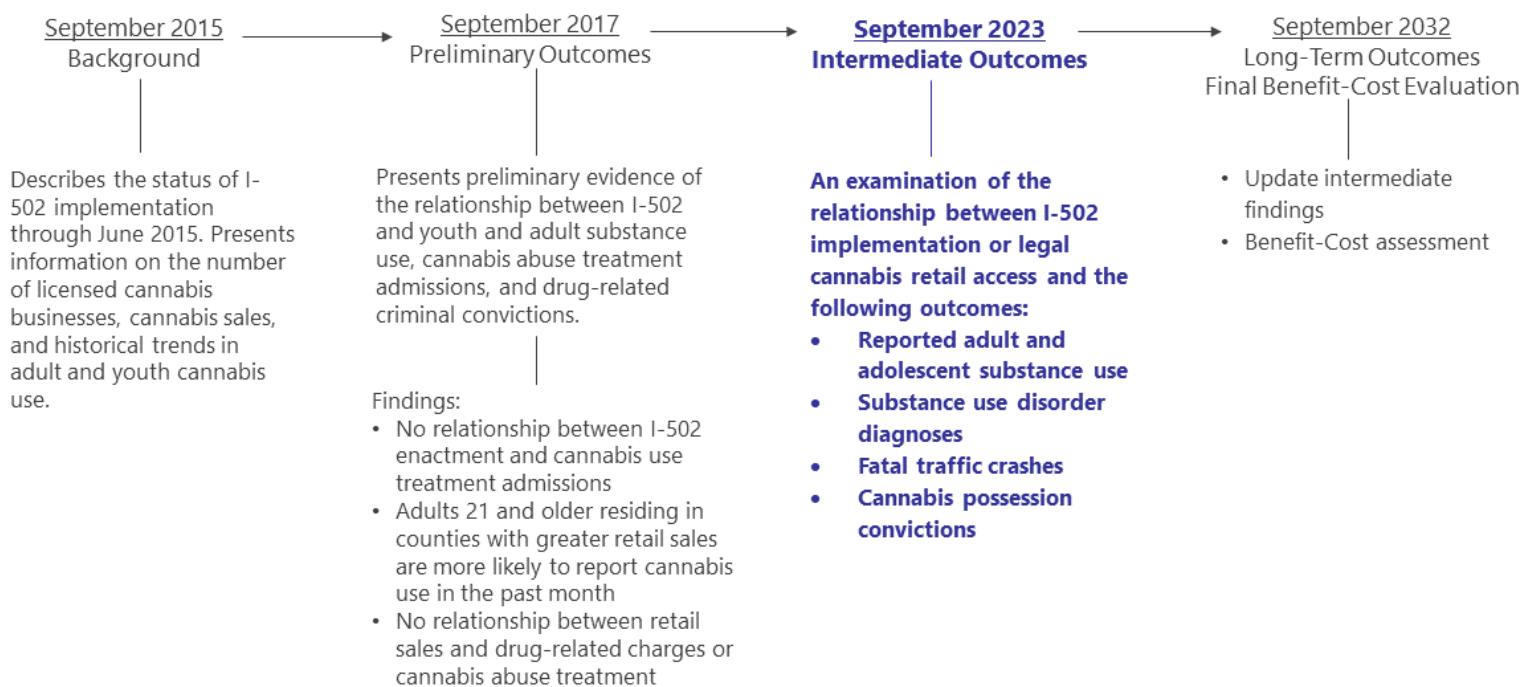
## Previous WSIPP I-502 Evaluation

The findings described in WSIPP's second report, published in 2017, suggest that in the years immediately after I-502, cannabis use treatment admissions did not increase in Washington relative to comparable states.[5]

When the authors focused on county-level outcomes within Washington State, they found evidence to suggest that in counties with higher legal cannabis retail sales, legal-aged adults are more likely to report heavy past-month cannabis use. They found no relationship between county-level retail sales and reported youth cannabis use, criminal justice outcomes, or cannabis abuse treatment admissions.

**Exhibit 1**
Report Series Plan for WSPP's I-502 Evaluation



September 2015
Background

Describes the status of I-502 implementation through June 2015. Presents information on the number of licensed cannabis businesses, cannabis sales, and historical trends in adult and youth cannabis use.

September 2017
Preliminary Outcomes

Presents preliminary evidence of the relationship between I-502 and youth and adult substance use, cannabis abuse treatment admissions, and drug-related criminal convictions.

Findings:
• No relationship between I-502 enactment and cannabis use treatment admissions
• Adults 21 and older residing in counties with greater retail sales are more likely to report cannabis use in the past month
• No relationship between retail sales and drug-related charges or cannabis abuse treatment

**September 2023**
**Intermediate Outcomes**

**An examination of the relationship between I-502 implementation or legal cannabis retail access and the following outcomes:**
• **Reported adult and adolescent substance use**
• **Substance use disorder diagnoses**
• **Fatal traffic crashes**
• **Cannabis possession convictions**

September 2032
Long-Term Outcomes
Final Benefit-Cost Evaluation

• Update intermediate findings
• Benefit-Cost assessment

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[5] Darnell, A.J. & Bitney, K. (2017). *I-502 evaluation and benefit-cost analysis: Second required report*. (Doc. No. 17- 09-3201). Olympia: Washington State Institute for Public Policy.

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## Exhibit 2
### Legislative Assignment

*(1) The Washington state institute for public policy shall conduct **cost-benefit evaluations** of the implementation of chapter 3, Laws of 2013. A preliminary report, and recommendations to appropriate committees of the legislature, shall be made by September 1, 2015, and the first final report with recommendations by September 1, 2017. Subsequent reports shall be due September 1, 2022, and September 1, 2032.*

*(2) The evaluation of the implementation of chapter 3, Laws of 2013 shall include, but not necessarily be limited to, consideration of the following factors:*

*(a) **Public health**, to include but not be limited to:*

> *(i) Health costs associated with marijuana use;*

> *(ii) Health costs associated with criminal prohibition of marijuana, including lack of product safety or quality control regulations and the relegation of marijuana to the same illegal market as potentially more dangerous substances; and*

> *(iii) The impact of increased investment in the research, evaluation, education, prevention and intervention programs, practices, and campaigns identified in RCW 69.50.363 on rates of marijuana-related maladaptive substance use and diagnosis of marijuana-related substance-use disorder, substance abuse, or substance dependence, as these terms are defined in the Diagnostic and Statistical Manual of Mental Disorders;*

*(b) **Public safety**, to include but not be limited to:*

> *(i) Public safety issues relating to marijuana use; and*

> *(ii) Public safety issues relating to criminal prohibition of marijuana;*

*(c) **Youth and adult rates** of the following:*

> *(i) Marijuana use;*

> *(ii) Maladaptive use of marijuana; and*

> *(iii) Diagnosis of marijuana-related substance-use disorder, substance abuse, or substance dependence, including primary, secondary, and tertiary choices of substance;*

*(d) **Economic impacts** in the private and public sectors, including but not limited to:*

> *(i) Jobs creation;*

> *(ii) Workplace safety;*

> *(iii) Revenues; and*

> *(iv)Taxes generated for state and local budgets;*

*(e) **Criminal justice impacts**, to include but not be limited to:*

> *(i) Use of public resources like law enforcement officers and equipment, prosecuting attorneys and public defenders, judges and court staff, the Washington state patrol crime lab and identification and criminal history section, jails and prisons, and misdemeanant and felon supervision officers to enforce state criminal laws regarding marijuana; and*

> *(ii) Short and long-term consequences of involvement in the criminal justice system for persons accused of crimes relating to marijuana, their families, and their communities; and*

*(f) **State and local** agency administrative costs and revenues*

## Current Report

In this report, we build upon the preceding WSIPP I-502 evaluation by updating some of the previous findings with more years of data and exploring new outcomes related to public health and safety. Exhibit 3 summarizes the outcomes evaluated for this report.

First, we examined how cannabis possession misdemeanor conviction rates evolved in Washington after the passage of I-502.

Second, we used national survey data to examine how reported cannabis use has changed in Washington after the passage of I-502 compared to non-legalizing states.

Last, we specifically focused on the impact of licensed NMC retail access. A focus on retail access is important because evidence suggests that supplying legal cannabis through retail is a major channel through which NMC legalization can increase cannabis use.[6] For these analyses, we used state administrative data to examine how NMC retail access relates to substance abuse and traffic safety outcomes within the state over time.

**Exhibit 3**
I-502 Report Three Outcome Evaluation Description

| Outcome | Data source | Full report |
|---------|-------------|-------------|
| Reported substance use (persons ages 12 and older) | National Survey on Drug Use and Health (NSDUH) | The Relationship Between Initiative 502 and Reported Substance Use |
| Cannabis possession conviction rates | WSIPP Criminal History Database | Initiative 502 and Cannabis-Related Convictions |
| Cannabis, alcohol, opioid use disorder diagnoses | Medicaid claims data | Licensed Cannabis Retail Access and Substance Use Disorder Diagnoses |
| Fatal traffic collisions | Washington Traffic Safety Commission Coded Fatal Crash files | Licensed Cannabis Retail Access and Traffic Fatalities |

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[6] Ambrose, C.A., Cowan, B.W., & Rosenman, R.E. (2021). Geographical access to recreational marijuana. *Contemporary Economic Policy*, *39*(4), 778-807 and Everson, E.M., Dilley, J.A., Maher, J.E., & Mack, C.E. (2019). Post-legalization opening of retail cannabis stores and adult cannabis use in Washington State, 2009–2016. *American Journal of Public Health*, *109*(9), 1294-1301.

## II. I-502 Implementation

Effective December 2012, I-502 legalized the possession, use, and commercial sales of non-medical cannabis for people ages 21 and older. The law also:

- Set a new threshold for driving under the influence of cannabis;[7]
- Gave the responsibility of regulation of cannabis retail licensure and sales to the existing Liquor Control Board—now known as the Liquor and Cannabis Board (LCB);
- Legalized the production, processing, and commercial sales of adult-use cannabis by licensed operators only;[8]
- Set excise taxes to 25% of sales at each level of the cannabis market, producers, processors, and retailers; and
- Established the Dedicated Cannabis Account (DCA) and required specific allocations of tax revenue funds to be spent on substance use prevention, treatment, and research.[9]

Initiative 502 charged the LCB with developing a licensing system and a regulatory structure to guide oversight of the cannabis market. Licensing rules were adopted in 2013, and non-medical retail sales began on July 8, 2014.

The cannabis sector in Washington primarily comprises three operations: production, processing, and retail sales. Production includes growing and harvesting the plant, processing converts the harvested plant into usable cannabis products, and retail sells cannabis products to end consumers.[10]

The LCB assigns a maximum number of cannabis retail sales license allowances in each town, city, or county area based on predicted local demand and the statewide retail cap. However, cities and counties can choose to prohibit or designate appropriate zones for licensed cannabis businesses, and they may file objections to granting a license at a particular location.[11]

For a more comprehensive description of cannabis-related policy and a summary of NMC revenues and expenditures over the last decade, refer to A 10-Year Review of Non-Medical Cannabis Policy, Revenues, and Expenditures.[12]

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[7] I-502 established a per se limit of 5.00 ng THC/ml blood, previously the threshold was 0.00 ng/ml.

[8] In Washington, qualifying patients who are entered into the medical cannabis database and hold a medical cannabis recognition card may legally purchase immature plants/clones/seeds for home cultivation from a licensed producer under RCW 69.50.325.

[9] I-502 required investments in substance use prevention, treatment, and research. Revenues collected from cannabis excise taxes, penalties, and fees are directed to public education campaigns, evidence-based prevention and

treatment programming, and cannabis-related research, all of which may mitigate potential harms resulting from increased access to cannabis.

[10] A licensed cannabis producer and/or processor is forbidden from owning, operating, or having any financial interest in a licensed cannabis retailer.

[11] RCW 69.50.331(10).

[12] Ingraham, B., & Rashid, A. (2023). *A 10-year review of non-medical cannabis policy, revenues, and expenditures* (Doc. No. 23-06-3201). Olympia: Washington State Institute for Public Policy.

# III. Cannabis-Possession Convictions

Previous studies have examined the relationship between I-502 and cannabis-related arrest rates. Our study extends this research by examining how rates of cannabis possession *convictions* have evolved in Washington since the enactment of I-502 and the advent of NMC retail operations.

## Data

Data on criminal justice outcomes come from WSIPP's Criminal History Database (CHD). WSIPP's CHD combines data from several Washington State agencies—court data from the Administrative Office of the Courts and incarceration in state prisons and community supervision data from the Department of Corrections—to provide detailed case-level information on all justice-involved youth and adults with criminal charges in Washington State.[13]

For our analyses, we looked at monthly statewide counts of convicted cannabis possession misdemeanor cases for individuals ages 12 to 85 between January 1, 2005, and December 31, 2019.[14] Over our study period, about 3,300,000 criminal cases occurred.[15] In roughly 1,800,000 cases, an individual was convicted, with about 3.6% of these convictions associated with a cannabis possession misdemeanor.

## Results

We explored how trends in cannabis possession misdemeanor conviction rates (per 100,000 population) evolved across different age groups after legalization.

### Ages 21 and Older
Panels A and B of Exhibit 4 depict monthly cannabis possession misdemeanor conviction rates for male and female populations ages 21 and older. The first vertical line marks the month I-502 went into effect (December 2012), and the second marks the first month of NMC retail sales (July 2014).

Although cannabis possession conviction rates have already been declining since 2008, we still observe a large decrease in monthly conviction rates immediately following I-502.[16] Specifically, conviction rates for both male and female legal-aged adult populations dropped to almost zero immediately after legalization.

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[13] WSIPP updates the CHD quarterly, and our analyses used information from the CHD as of February 2023.

[14] Cases with missing offense dates or demographic information (i.e., sex, race, and age) were excluded from our analysis. We count all cases with at least one cannabis possession misdemeanor that resulted in a conviction.

[15] Criminal cases are limited to cases where an individual is charged with a criminal offense; cases with traffic and non-traffic infractions are excluded.

[16] Several factors could contribute to declining rates in the years prior to I-502; for example, before legalization, Tacoma and Seattle publicly deprioritized cannabis arrests, and the provision of and legal supply for medicinal cannabis expanded (SSB 5798 and E2SSB 5073).
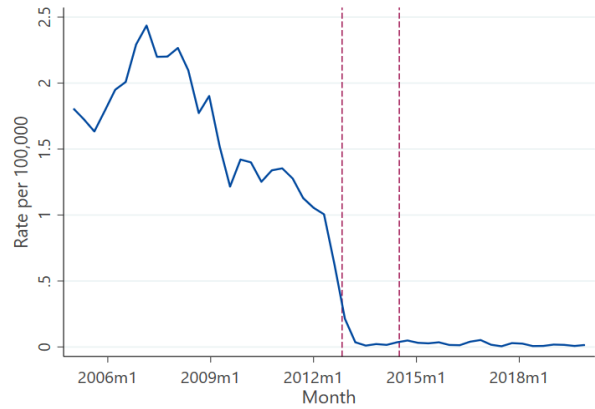
**Exhibit 4**

Population Rate (per 100,000) of Cannabis Possession Misdemeanor Convictions,
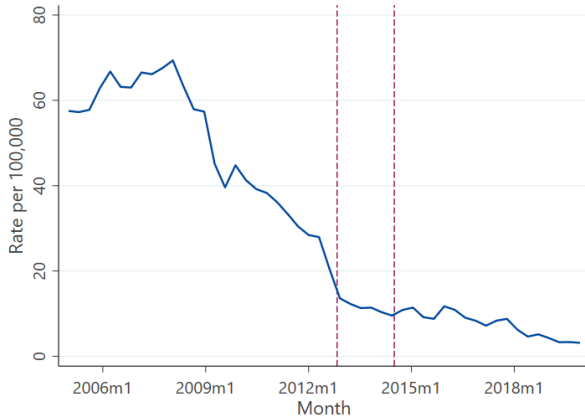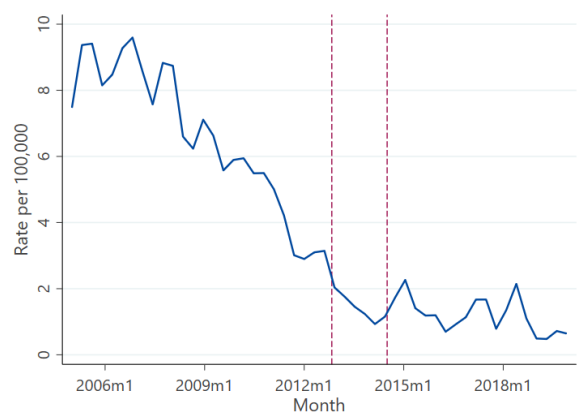by Age and Sex
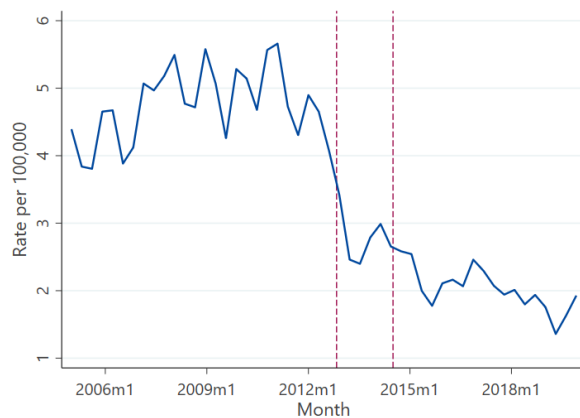
(A) Male—Ages 21 and Older
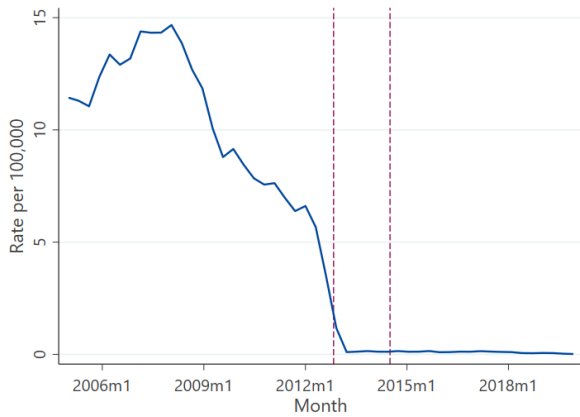
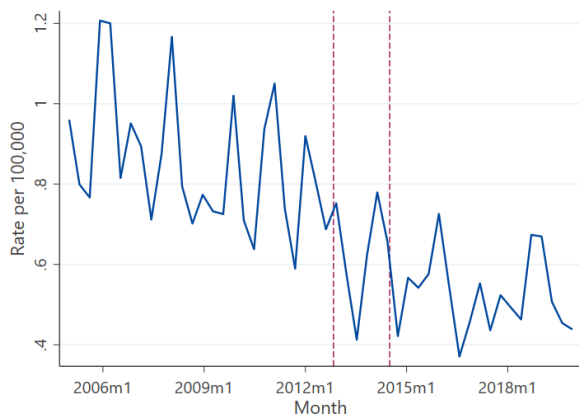(B) Female—Ages 21 and Older

(C) Male—Ages 18-20

(D) Female—Ages 18-20

(E) Male—Ages 12-17

(F) Female—Ages 12-17

Notes:
Data come from WSIPP's Criminal History Database, 2005-2019.
The first dashed line denotes the month I-502 went into effect (December 2012), and the second denotes the first month of NMC retail sales (July 2014).

While I-502 did not legalize cannabis possession for individuals under the age of 21, there was a general de-prioritization of cannabis crime by both police and prosecutors after I-502.[17] Therefore, we may still expect declines in cannabis possession misdemeanor convictions after I-502 among populations under 21.

Alternatively, licensed NMC sales may inadvertently provide an additional cannabis supply source for underage individuals, which could lead to increases in cannabis possession in the years after the advent of retail operations. This last consideration is of particular concern for school-aged youth; therefore, we examine trends separately for the population of those ages 18-20 and those ages 12-17.

### Ages 18-20
Panels C and D of Exhibit 4 depict monthly cannabis possession misdemeanor conviction rates for male and female populations ages 18-20. Among the male population, the average conviction rate went from roughly 50 convictions per 100,000 to 8 (an 84% reduction) after NMC legalization. Among the female population, the average conviction rate went from 6.6 to 1.2 (an 82% reduction) after NMC legalization.

### Ages 12-17
Panels E and F of Exhibit 4 depict conviction rates for male and female populations ages 12-17. Relative to adult populations, cannabis possession conviction rates were already low prior to NMC legalization.

Ultimately, we cannot confidently infer how much of the decline in female conviction rates after I-502 can be attributed to NMC legalization versus the pre-existing downward trend. Among males ages 12-17, we see a more pronounced decrease in the average conviction rate immediately after the enactment of I-502. For this male population, the average conviction rate roughly halved from about 4 to 2 (per 100,000). Notably, we do not detect significant increases in conviction rates in the years after the advent of retail operations.

### Discussion
Overall, we find that conviction rates dropped to almost zero among adults of legal age immediately after I-502 went into effect. Among those under 21, we generally find that conviction rates substantively dropped after NMC legalization, but not as dramatically as for adults ages 21 and over.

### Racial Groups
In analyses not presented here, we also examined trends separately across race and ethnicity (non-Hispanic White, non-Hispanic Black, non-Hispanic Indigenous, non-Hispanic Asian, Hispanic). We find that substantial declines in cannabis possession conviction rates after the passage of I-502 were largely shared across all racial groups. For a full description of the analysis and results, refer to WSIPP's Technical Report: Initiative 502 and Cannabis-Related Convictions.[18]

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[17] Stohr, M.K., Willits, D.W., Makin, D.A., Hemmens, C., Lovrich, N.P., Stanton Sr, D. L., & Meize, M. (2020). Effects of marijuana legalization on law enforcement and crime. *Final report. National Institute of Justice, Office of Justice Programs, US Department of Justice*.

[18] Rashid, A & Wanner, P. (2023). *Technical report—Initiative 502 and cannabis-related convictions* (Doc. No. 23-09-3203). Olympia: Washington State Institute for Public Policy.

## IV. Reported Substance Use: A National Comparison

For this analysis, we used national survey data from 2004 to 2019 to compare changes in the rates of reported cannabis, alcohol, and other substance use in Washington relative to comparable states after the enactment of I-502 and the advent of a licensed retail market.

### Data and Methods

Data come from the National Survey on Drug Use and Health (NSDUH). NSDUH is conducted annually and provides nationally representative information regarding cannabis and other substance use. For our analysis, we use data from the years 2004-2019. Our primary outcomes of interest measure self-reported past-month cannabis use, which reflects any days of cannabis use in the last 30 days.[19] The second reflects 20 or more days of cannabis use in the last 30. We refer to this as "heavy past-month use."

We used a method called *synthetic control* to examine if these outcomes changed differently in Washington compared to similar states that did not legalize NMC.[20] This method allows us to use information from comparable non-legalizing states to estimate what *would have* happened in Washington, all else being equal, had Washington not legalized NMC. This approach allows us to identify the effect of legalization, apart from any other trends that were occurring in the same time frame.

Because NMC was legalized only for adults 21 and over, we separately evaluated outcomes for the sample of individuals ages 12 to 20 and individuals 21 and older.

### Results

Largely, we did not find evidence that the enactment of I-502 *or* the advent of cannabis retail sales in Washington significantly changed reported adult cannabis use, alcohol use, or other substance use compared to non-legalizing states. When we examine trends after cannabis sales started in 2014, we do not see a large deviation in Washington's rate of reported past-month use. Although we see bigger gaps between outcomes in some of the years following retail allowance (e.g., 2017 and 2019), on average, the level and trend in reported past-month cannabis use for the "synthetic Washington" (i.e., a weighted average rate of past-month cannabis use among comparable non-legalizing states) still track relatively closely with Washington after 2014. This suggests that most, if not all, of the upward trend in reported past month use in Washington, would have likely persisted over this period even in the absence of legalized retail sales (given that trends were similarly increasing in comparable non-legalizing states).

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[19] Responses to the following survey question were used to construct the primary measures of reported cannabis use: "During the past 30 days, on how many days did you use marijuana or hashish?"

[20] We follow the approach described by Abadie, A., Diamond, A., & Hainmueller, J. (2010). Synthetic control methods for comparative case studies: Estimating the effect of California's tobacco control program. *Journal of the American Statistical Association*, *105*(490), 493-505.

Furthermore, we did not find a significant relationship between the advent of cannabis retail sales and reported youth and young adult cannabis or other substance use (Panel B of Exhibit 5). Therefore, we ultimately cannot attribute changes in cannabis use to the start of cannabis retail sales in Washington in July 2014.

The retail market has rolled out over several years, with varying accessibility to retailers across regions in the state. Therefore, it may be difficult to detect the impact of NMC retail using a comparison at a single point in time (i.e., before and after the advent of retail in July 2014). Furthermore, the impact of NMC retail on cannabis use and subsequent outcomes may differ depending on retail accessibility. That is, the impact of retail may disproportionately affect those with greater access to operational retailers. For a more comprehensive description of our research design and results, please refer to Technical Report: The Relationship Between Initiative 502 and Reported Substance Use.[21]
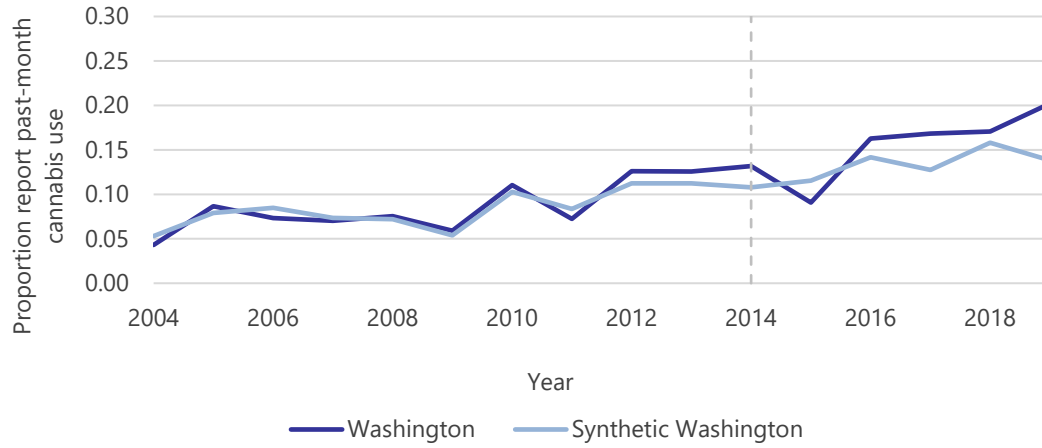
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[21] Ingraham, B., & Rashid, A. (2023). *Technical report—The relationship between Initiative 502 and reported substance use* (Doc. No. 23-09-3204). Olympia: Washington State Institute for Public Policy.

**Exhibit 5**

(A)     NSDUH Rates of Cannabis Use for Washington and the Synthetic Control Unit, Ages 21 and Older



(B)     NSDUH Rates of Cannabis Use for Washington and the Synthetic Control Unit, Ages 12-20
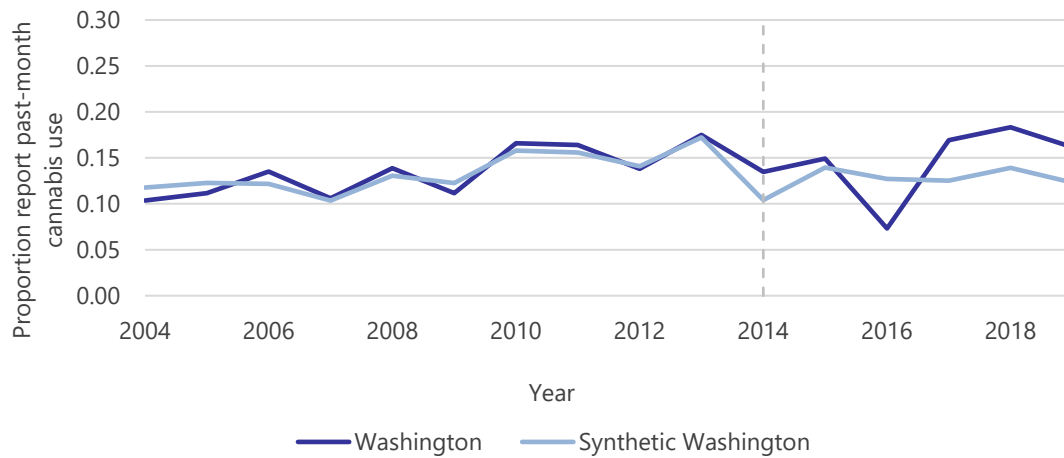


Note:
Restricted state identifiers were required for this analysis. Because the analyses required restricted-use data, the data were accessed through the Research Data Center.

# V. Licensed NMC Retail Access

The work detailed in the previous two sections provides an overall picture of how average outcomes have evolved statewide since I-502 and the start of retail sales. However, local differences in licensing created wide variation in geographical access to licensed cannabis retailers within Washington. Therefore, we further explore how increased access might differentially impact cannabis use and other related outcomes. In this section, we examine the relationship between access to licensed NMC retailers and reported cannabis use. We also evaluate the relationship between access and diagnosed substance use disorder and fatal traffic crashes.

## Licensed NMC Retailers

The first commercial sales of NMC started in July 2014. Exhibit 6 summarizes the number of NMC retailers at the close of each year between 2014 and 2021. Retailer licenses were initially capped at 334.[22] However, in 2016, to accommodate the needs of the medical cannabis market, the LCB increased the cap on the number of retail cannabis licenses to 556.[23] By December 2019, the end of our analysis sample, there were 438 NMC retailers operating in the state.

**Exhibit 6**

Number of Licensed NMC Retailers in Operation, by Year



Notes:
Data come from the Liquor and Cannabis Board (LCB).
Counts denote the number of operational retailers in December of each calendar year.

### Measuring Access

Our primary definition of *access* is the average drive time to the nearest operational NMC retailer from a specified geographical unit (i.e., ZIP code or census tract).[24] Exhibit 7 displays the average drive time (in minutes) to the nearest retailer by year.[25] The average drive time to the nearest NMC retailer has decreased as the number of operational retailers has increased.

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[22] Retailer licenses were allotted for each city and county based on estimates of cannabis demand and incorporated random selection when the number of applicants exceeded the allotment.
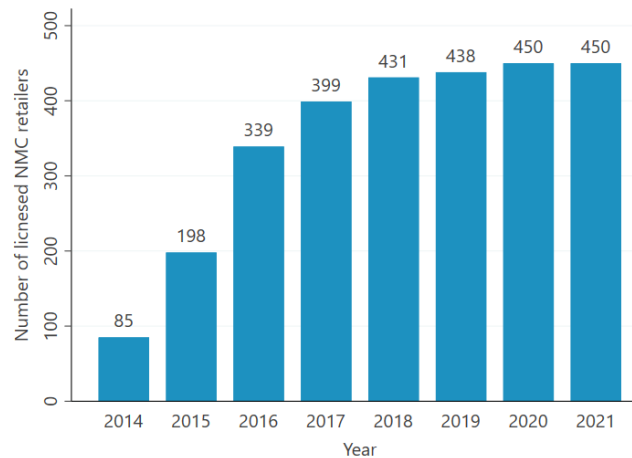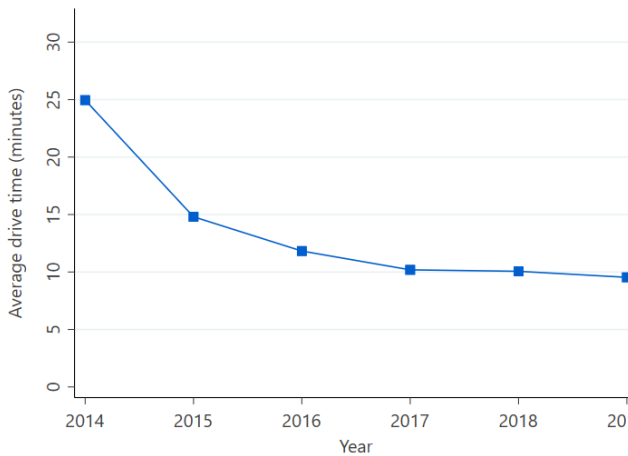
[23] Second Substitute Senate Bill 5052, Chapter 70, Laws of 2015, partial veto.

[24] Our access measure does not include tribal NMC retailers, out-of-state NMC retailers that border WA, and unregulated market sales. Therefore, our measure likely underestimates true access to cannabis product.

[25] We use 2019 census block-group data to approximate household locations throughout the state. For computational

feasibility, we produce a 0.5% population sample of synthetic households to approximate the spatial distribution of household residential locations. The exact location assigned to any synthetic household within a block-group is random assuming a uniform distribution of families within the livable areas of census block-group boundaries—we include census block-group boundaries that are on a tax parcel with a building on it or a military base. The travel time between each household and each operational NMC retailer (within 120 minutes) is then estimated. The synthetic household sample and drive times were generated using ArcGIS Pro.

## Exhibit 7
### Average Drive Time to Nearest NMC Retailer in Minutes

Exhibit 8 is a map of Washington State ZIP codes. The red points on the graph denote the location of operational NMC retailers at the close of 2019. The darker the shading of a ZIP code, the longer the average drive time to the nearest retailer (in minutes) for the average resident of that ZIP code. We observe considerable geographical variation in access across the state, with more populated regions generally facing shorter drive times.

There are reasons why cannabis retailers might be more concentrated in certain areas. For example, the regulation mandates that cannabis storefronts be a minimum distance from schools, public parks, and public transit centers.

## Exhibit 8
### Average Drive Time to Nearest NMC Retailer in Minutes



Average drive time (minutes)

1.5 - 11.2   11.2 - 24.9   24.9 - 45.8   45.8 - 113.6
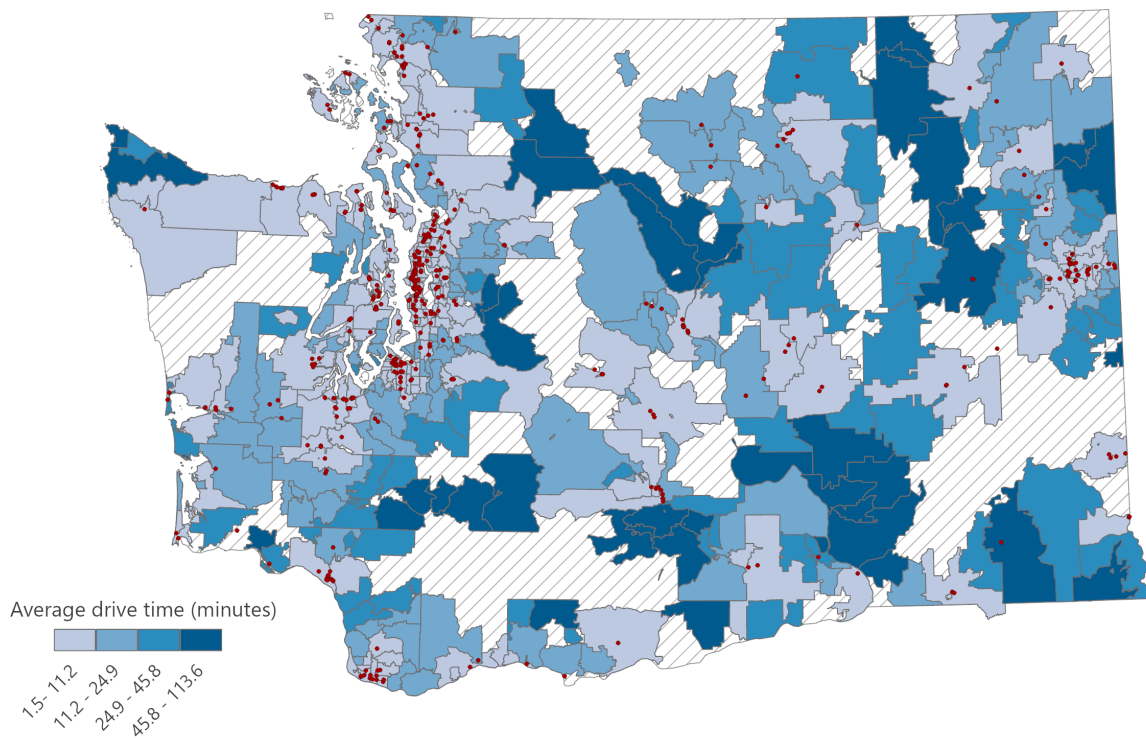
Note:
Hatched lines indicate tracts which are either missing information about tax parcels (most of Whitman County) or have no tax parcel with a building on it or a military base.

Furthermore, retailers consider factors such as rental prices and anticipated demand when choosing where to locate. Last, some locales choose to ban retail operations altogether. Exhibit 9 compares the demographic and economic characteristics of ZIP codes with an operational retailer versus those without one in 2019.

Notably, ZIP codes with operational licensed NMC retailers have smaller White and American Indian/Alaskan Native (AIAN) populations and larger Black and Asian populations. ZIP codes with licensed retailers also have a larger percentage with at least a bachelor's degree, a larger percentage of rental housing, and a higher median household income.

### Exhibit 9
ZIP Code Characteristics, 2019

| | Operational NMC retailers | No operational NMC retailers | Difference |
|---|---|---|---|
| Percent population White | 73.15 (1.15) | 76.1 (1.59) | -2.95* |
| Percent population Hispanic | 11.48 (0.81) | 11.7 (0.95) | -0.216 |
| Percent population Asian | 6.24 (0.57) | 3.14 (0.32) | 3.10*** |
| Percent population Black | 2.87 (0.3) | 1.59 (0.18) | 1.275*** |
| Percent population American Indian/Alaskan Native | 1.192 (0.13) | 3.35 (0.58) | -2.16*** |
| Percent population other race/ethnicity | 5.07 (0.2) | 4.117 (0.24) | 0.95*** |
| Percent population age 25+, less than HS diploma | 9.26 (0.47) | 11.29 (0.61) | -2.03*** |
| Percent population age 25+, at least a bachelor's degree | 32.25 (1.18) | 26.44 (0.91) | 5.81*** |
| Percent households below FPL | 11.6 (0.4) | 12.19 (0.51) | -0.59 |
| Percent households receiving cash assistance/SNAP | 13.96 (0.53) | 14.02 (0.57) | -0.06 |
| Percent households renting | 35.65 (1.06) | 27.78 -0.98 | 7.86*** |
| Median household income | 70,007 (1,588) | 65,766 -1424 | 4,241** |
| Unemployment rate | 5 (0.16) | 5.86 (0.31) | -0.86** |
| Observations | 204 | 385 | |

Notes:
ZIP code characteristics come from 2019 American Community Survey.
Differences estimated using a standard difference in means t-test.
***Significant at the 0.001-level, **significant at the 0.05-level, *significant at the 0.01-level.

## NMC Retail Access and Reported Cannabis Use

Previous studies have found that greater NMC retail access in a ZIP code—measured as the minimum average drive time or distance to the nearest retailer—predicts a higher likelihood of reported cannabis use over the years 2014-2016.[26] Here, we extended these studies by examining reported cannabis use outcomes through 2019 among respondents 21 and older.

### Data and Methods

For these analyses, we focused on two measures of cannabis use: 1) any past-month cannabis use and 2) heavy past-month cannabis use (i.e., reporting 20 or more days within the last 30).[27] Exhibit 10 depicts the average annual proportion of respondents who report any past-month or heavy past-month cannabis use. Over our sample period, roughly 10% of adult respondents report past-month cannabis use, and about 4% report heavy past-month cannabis use.

Using data from 2014, the advent of NMC retail, through 2019, we estimated the impact of drive time on our measures of reported cannabis use.[28]

### Results

Consistent with previous research, we found that residing in a ZIP code with greater proximity to an NMC retailer predicts a higher probability of reported cannabis use. For example, we estimated that *a 50% reduction in the average drive time to the nearest NMC retailer is associated with a 6.1% increase in the probability of reporting past-month cannabis use and an 8.3% increase in reporting heavy past-month cannabis use.* Furthermore, our findings suggest the relationship between access and heavy past-month cannabis use is driven by respondents residing in rural ZIP codes.[29]

### Exhibit 10
Proportion Reporting Past-Month Cannabis Use

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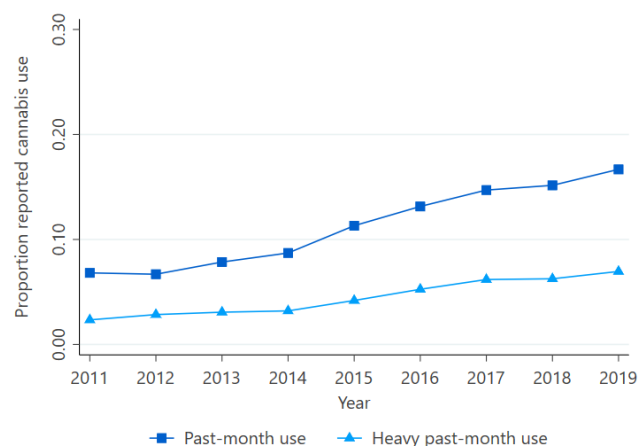
[26] Ambrose et al. (2021) and Everson et al. (2019)
[27] Data on reported cannabis use come from the Washington State Behavioral Risk and Surveillance System (BRFSS) provided by the Department of Health.
[28] We estimate the relationship between *the natural log* of the average drive time (in minutes) to the nearest retailer in a given ZIP code and the probability of reported cannabis use. We used the natural log of drive time to account for the fact that the impact of a reduction in drive time will differ depending on the initial distance. For example, the impact of a 10-minute reduction in drive time may differ depending on whether we are moving from 60 to 50 minutes versus 15 to 5 minutes. We estimate an OLS regression model, controlling for individual-level demographic characteristics, time-varying ZIP code demographic and economic characteristics, and ZIP-code and year fixed effects.
[29] Full results from our estimated models are available upon request.

## NMC Retail Access and Substance Use Disorder

Given that greater NMC retail access predicts greater cannabis use, we examined whether access relates to disordered substance use diagnoses.
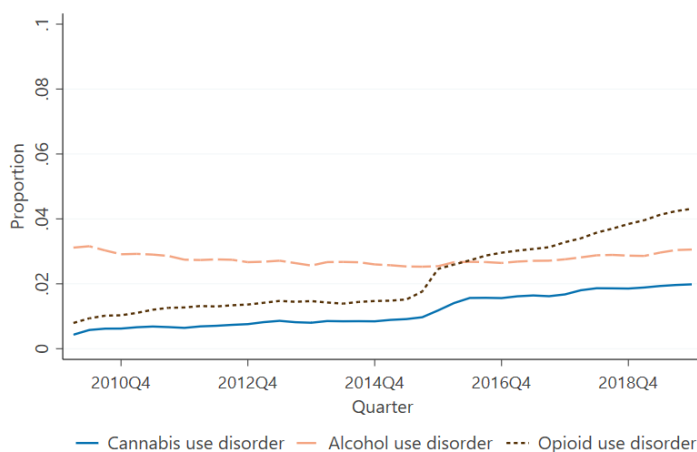
### Data

For these analyses, we used person-level administrative monthly records of relevant health care received by Medicaid enrollees in Washington State.[30] Specifically, we have information about the population of individuals ages 12 and older who were enrolled in Medicaid at any time between January 1, 2010, and December 31, 2019.

Our primary outcome measures indicate if a beneficiary has had any Medicaid claim or encounter records that included a diagnosis code for cannabis use disorder (CUD), alcohol use disorder (AUD), or opioid use disorder (OUD). These diagnostic categories can arise from several healthcare uses, including a hospitalization, an office visit, an emergency department visit, or a stay at a substance use disorder (SUD) residential treatment facility.[31] Exhibit 11 depicts the average quarterly proportion of beneficiaries diagnosed with a SUD between 2010 and 2019. During this period, roughly 900,000 individuals ages 21 and older enrolled in Medicaid each quarter.

**Exhibit 11**

Average Quarterly Proportion of Medicaid Enrollees with Substance Use Disorder Diagnosis, Ages 21 and Older



Note:
Data come from administrative Medicaid enrollee records between 2010-2019.

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[30] Medicaid claims data are provided by Department of Social and Health Services, Research and Data Analysis Division from its Integrated Client Databases (ICDB). ICDB contains administrative data from several state data systems, including the ProviderOne Medicaid data system and the

Behavioral Health Data System (BHDS). See Mancuso & Huber (2021).
[31] Our outcome variables do not necessarily capture disease onset or initial diagnosis.

We also examined co-occurring diagnoses between CUD and other substance use disorders. Exhibit 12 depicts the average quarterly proportion of beneficiaries diagnosed with both CUD and AUD and the proportion of beneficiaries diagnosed with both CUD and OUD in the same quarter. On average, about 50% of quarterly CUD claims are co-occurring with AUD *or* OUD, and roughly 10% are co-occurring with AUD *and* OUD.

**Exhibit 12**

Average Quarterly Proportion of Medicaid Enrollees with Cannabis Use and Other Co-Diagnoses, Ages 21 and Older
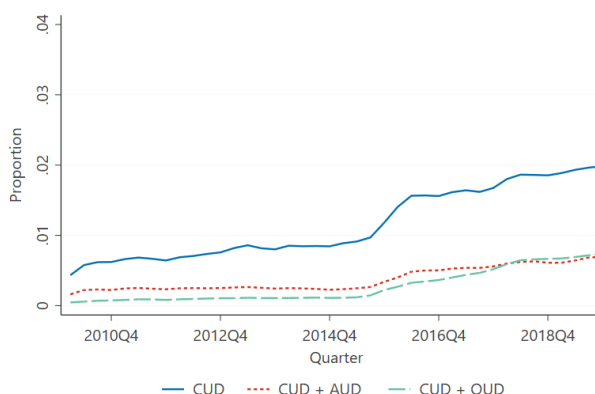


Note:
Data come from administrative Medicaid enrollee records between 2010-2019.

## Results—Average Drive Time to Nearest NMC Retailer

*Ages 21 and Older*. We first examined how the average minimum drive time to the nearest operational retailer in a census tract relates to the probability of receiving a CUD,

AUD, or OUD diagnosis among Medicaid beneficiaries 21 and older in a given year (between 2014 and 2019).[32] Over the study period, 3.1% of adult claimants had any CUD diagnosis in a given year, 4.9% had AUD, and 4.5% had OUD.

Results from these analyses are summarized in Exhibit 13. Across all three outcomes, we found that as local NMC retail becomes more accessible, the probability of a SUD diagnosis within the year significantly increases.[33] For example, a *50% reduction in drive time to the nearest retailer is associated with a 2.3% higher likelihood of any CUD diagnosis annually (roughly 850 more claimants with a CUD diagnosis in a given year).* [34]

**Exhibit 13**

Travel Time to the Nearest NMC Retailer and Changes in the Probability of SUD Diagnosis, Ages 21 and Older

| | CUD | AUD | OUD |
|---|---|---|---|
| 25% reduction in average drive time | 1.00%*** | 0.81%*** | 1.30%*** |
| 50% reduction in average drive time | 2.30%*** | 1.80%*** | 3.30%*** |
| 75% reduction in average drive time | 4.70%*** | 3.80%*** | 6.70%*** |

Note:
*\*\*\*Significant at the 0.001-level, \*\*significant at the 0.05-level, and \*significant at the 0.10-level.*

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[32] We estimated OLS models which regress SUD indicators on the natural log of minimum average tract drive time. Our models account for race/ethnicity, sex, age, and the reason for Medicaid eligibility. We also account for annual census tract population, racial makeup, unemployment rate, high school and college graduation rates, median household income, and the proportion of the population that works in a major metropolitan city. We additionally account for county-level fixed effects and year fixed effects. Standard errors are estimated to adjust for clustering at the census tract level.

[33] For these analyses, NMC retail access is measured as the average drive time to the nearest NMC retailer in a given census tract.

[34] This estimate comes from first computing a change in the probability of CUD $\beta_1 * \ln\left(\frac{[100+p\%]}{100}\right) = 0.0010 \times \ln\left(\frac{[100-50]}{100}\right)$. This calculation implies that a 50% reduction ($p$ = -50) in drive time increases the probability of CUD by 0.07 percentage points. Given that the average probability of past-year CUD is 0.031, this result implies a 2.3% increase in the likelihood.

We next examined the relationship between access and the probability of co-occurring CUD and AUD diagnoses and co-occurring CUD and OUD diagnoses (within the last year). These analyses allow us to examine better the relationship between CUD and other disordered substance use. The results from these analyses are presented in Exhibit 14. Our results imply that *a 50% reduction in the average drive time to the nearest retailer is related to a 2% higher likelihood of co-occurring CUD and AUD diagnoses and a 3.8% higher likelihood of co-occurring CUD and OUD diagnoses within the year.*

**Exhibit 14**

Travel Time to the Nearest NMC Retailer and Changes in the Probability of Co-Occurring Diagnosis, Ages 21 and Older

|  | CUD & AUD | CUD & OUD |
|---|---|---|
| 25% reduction in average drive time | 1.00%** | 1.75%*** |
| 50% reduction in average drive time | 2.00%** | 3.80%*** |
| 75% reduction in average drive time | 5.10%** | 8.60%*** |

Note:
 ***Significant at the 0.001-level, **significant at the 0.05-level, and *significant at the 0.10-level.

*Ages 12-20.* We also explored the relationship between drive time to the nearest retailer and past-year SUD diagnoses among enrollees ages 12-20. Relative to legal-aged adults, CUD diagnoses are less common among younger age groups: about 1.5% of youth ages 12-17 are diagnosed with CUD annually, compared to about 2.6% of young adults ages 18-20 and about 3.1% of adults ages 21 and older. Exhibit 15 summarizes the relationship between the average local drive time to the nearest retailer and the probability of past-year CUD.

Our findings suggest that greater access does not significantly correlate with changes in the probability of CUD for enrollees ages 18-20. However, we did find a significant relationship among adolescents ages 12-17. This evidence suggests that a potential unintended consequence of legal cannabis retail is more severe youth cannabis use.

**Exhibit 15**

Travel Time to the Nearest NMC Retailer and Changes in the Probability of SUD Diagnosis

|  | Ages 12-17 CUD | Ages 18-20 CUD |
|---|---|---|
| 25% reduction in average drive time | 2.00%*** | 0.33% |
| 50% reduction in average drive time | 4.70%*** | 0.77% |
| 75% reduction in average drive time | 10.00%*** | 1.50% |

Note:
 ***Significant at the 0.001-level, **significant at the 0.05-level, and *significant at the 0.10-level.

*Discussion.* Overall, our findings suggest that less travel time to an NMC retailer predicts a small increase in the probability of a CUD, AUD, or OUD diagnosis within the year among Medicaid enrollees ages 21 and older and enrollees ages 12-17. These findings suggest that greater access is related to not only higher general cannabis use but also more cannabis-related healthcare utilization and potentially more severe cannabis use. Our findings also suggest a complementary relationship between cannabis misuse and alcohol or opioid misuse, that is, cannabis use occurs with opioid and alcohol use. These findings are supported by other studies which have linked cannabis use to binge drinking and opioid use disorder.

Note, our study period coincides with increased opioid misuse in Washington State. Therefore, if other factors increasing opioid misuse over this period disproportionately impact neighborhoods that simultaneously experienced large increases in NMC retail, this could alternatively explain estimated increases in OUD.[35]

More generally, we cannot account for health care provision, access, or SUD treatment changes. Therefore, if relevant health care or treatment access systematically increases with retail access, this could alternatively explain increases in any of our SUD diagnoses (especially AUD and OUD) independent of cannabis use. Our outcome measures do not directly capture healthcare *needs*. Instead, they are measures of healthcare *utilization* that are influenced by needs as well as healthcare access, types of healthcare providers, and attitudes toward treatment.

### Results—NMC Retail Density
In addition to retailer proximity, we examined the relationship between measures of NMC retailer density and CUD diagnoses. Here, we defined density in three ways: the average number of retailers within 5 minutes (in a given census tract), within 10 minutes, and 15 minutes.[36] Density is important to consider because a greater concentration of local retailers will increase customer competition through advertising, product pricing, or product selection, which could ultimately drive greater cannabis use.

Exhibit 16 summarizes the estimated relationship between retail density and the probability of past=year CUD diagnosis for adults 21 and over. Our findings suggest that *one more operational NMC retailer within 5 minutes predicts a 4.2% higher likelihood of CUD annually, and one more retailer within 10 minutes predicts a 1.3% higher likelihood of CUD annually*.

A change in the number of retailers within 15 minutes does not significantly predict a change in the likelihood of CUD.

**Exhibit 16**
NMC Retailer Density and Changes in the Probability of Past-Year SUD diagnosis, Ages 21 and Older

|  | CUD |
| --- | --- |
| Number of retailers within 5 minutes | 4.20%*** |
| Number of retailers within 10 minutes | 1.33%*** |
| Number of retailers within 15 minutes | 0.00% |

Note:
***Significant at the 0.001-level, **significant at the 0.05-level, and *significant at the 0.10-level.

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[35] University of Washington Addictions, Drug & Alcohol Institute. *Opioid trends across Washington State.*

[36] We use measures of density like Ambrose et al. (2021).

*Discussion.* Our findings suggest that density is more predictive of a CUD diagnosis than travel time in neighborhoods with multiple retailers within very close proximity. This is likely because in relatively more competitive NMC retail markets, cannabis products may be more potent, advertised more heavily, or consumers may face lower prices. These factors could explain more frequent and severe cannabis use.[37] However, only 10% of our sample reside in a census tract with an average of more than one operational retailer located within five minutes; further examination of the characteristics of these unique neighborhoods and their local policies is required to understand better the relationship between retail density and cannabis use diagnoses.

For a more comprehensive description of the related literature, research design, and results, please refer to Technical Report: Licensed Cannabis Retail Access and Substance Use Disorder Diagnoses.[38]

## NMC Retail Access and Fatal Traffic Crashes

Last, we explored the relationship between NMC retail access and fatal traffic collisions. We found that greater access to legal cannabis predicts greater reported cannabis use. Therefore, we would expect greater access to legal cannabis to impact traffic safety outcomes if subsequent cannabis-impaired driving also increases with access. Specifically, we examined if greater local access to licensed NMC retailers predicts differences in the number of drivers involved in a fatal traffic crash. We also examined how NMC retail access predicts the prevalence of drivers involved in fatal crashes who test positive for THC.

### Data
Data on traffic fatalities came from the Washington Coded Fatal Crash (CFC).[39] These data comprise all recorded individuals and vehicles involved in motor vehicle crashes that occur on a public road in Washington State and result in death within 30 days. These data also include blood test results for intoxicants, including THC, from the state's centralized toxicology laboratory.

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[37] Note, since NMC retail licenses are not randomly allocated across the state, there may be other relevant characteristics of locales that allow for multiple license allotments that are not captured by our model but separately impact cannabis use. However, since we are exploiting variation within county over time it is unlikely that our results are solely driven by omitted considerations.

[38] Rashid, A & Adams, N. (2023). *Technical report—Licensed Cannabis retail access and substance use disorder diagnosis* (Doc. No. 23-09-3205). Olympia: Washington State Institute for Public Policy.
[39] This database is maintained and distributed by the Washington State Traffic Safety Commission.

Exhibit 17 depicts the statewide quarterly number of drivers (ages 21 and older) involved in a traffic fatality over time—on average, 172 drivers are involved in a fatal incident per quarter. We only observe THC content for drivers who receive a blood test—only 48% of drivers involved in a fatal crash received a blood test (light blue line).[40] As indicated by the dashed line, among blood-tested drivers, about 12 drivers per quarter test positive for delta-9-tetrahydrocannabinol (THC).[41]

**Exhibit 17**

Quarterly Number of Drivers Involved in Fatal Traffic Accidents, 2008-2019



— All drivers   — Blood tested   - - THC positive
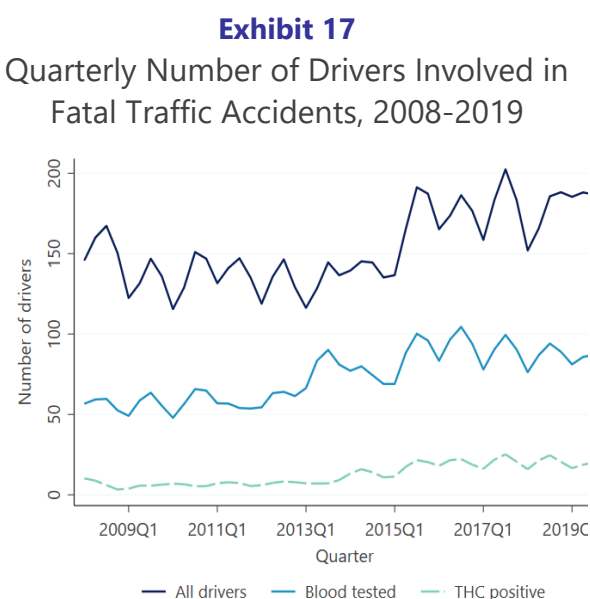
<u>Note</u>:
Data come from the Coded Fatal Crash (CFC) data files, 2008-2019.

## Results

We first examined how the average minimum drive time to the nearest operational licensed NMC retailer relates to the total number of drivers involved in a fatal crash annually.

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[40] Roughly 75% of drivers that have received a blood test are deceased because of the collision. State law dictates that drivers and pedestrians killed within four hours of a fatal crash shall have their blood sample analyzed by the state toxicologist (RCW 46.52.065). Generally, a police officer needs a warrant to compel a blood test from a surviving driver (RCW 46.20.308).

[41] A driver is classified as THC-positive if there is at least 1.0 nanogram of THC per milliliter of blood drawn.

Here, an increase in the number of drivers necessarily implies an increase in the number of cars involved in fatal crashes. A driver's involvement in a fatal crash does not necessarily imply the driver is deceased, just that someone is deceased because of the collision; for example, it could be a passenger, pedestrian, or another driver.

The results from this analysis are presented in Column 1 of Exhibit 18. Specifically, we approximate the increase in the statewide annual number of drivers involved in fatal crashes for a given change in the average drive time to the nearest retailer for the average resident in a given ZIP code. For example, our results imply that a *50% reduction in the average drive time to the nearest retailer predicts about 46 more drivers involved in a fatal crash annually in Washington State (a 5.9% increase)*.[42]

**Exhibit 18**

Travel Time to the Nearest NMC Retailer and Changes in the Number of Drivers (Ages 21 and Older) Statewide

| | Total number of drivers | Number of THC-positive drivers |
|---|---|---|
| 25% reduction in average drive time | 19*** | 5** |
| 50% reduction in average drive time | 46*** | 13** |
| 75% reduction in average drive time | 92*** | 25** |

<u>Note</u>:
***Significant at the 0.001-level, **significant at the 0.05-level, and *significant at the 0.10-level.

[42] This estimate comes from first computing a change in the number of drivers using $\beta_1 * \ln\left(\frac{[100+p\%]}{100}\right) = 0.1115 \times \ln\left(\frac{[100-50]}{100}\right)$. This calculation implies that a 50% reduction ($p = -50$) in drive time increases the number of drivers involved in fatal crashes by 0.077 in a ZIP code each year. Given that there are 596 ZIP codes in our analysis, that is roughly 0.077 × 596 = 46 more drivers statewide.

We next examined how NMC retail access predicts changes in the prevalence of THC-positive drivers. The results from our examination of THC-positive drivers are presented in Column 2 of Exhibit 18.[43] The estimates presented in Column 2 indicate a significant relationship between NMC retail access and the prevalence of THC-positive drivers (at least 1.0 ng/mL blood content). For example, *a 50% reduction in average drive time to the nearest retailer predicts 13 more drivers involved in a fatal crash annually who test positive for THC—this corresponds to a 14% increase in the average number of THC-positive drivers*.

*Discussion*.

Our findings suggest that in areas with more cannabis use (as measured by easier access to NMC retail), there are more drivers involved in fatal traffic collisions. Furthermore, in areas with greater NMC retail access there is a greater prevalence of THC-positve drivers which may indicate a greater prevalence of driving after relatively recent cannabis use. However, we cannot establish if this evidence ultimately implies an increase in cannabis-impaired driving, because the onset, intensity, and duration of cannabis-impairment can vary depending on the type of product consumed, the frequency and method of use, and user characteristics.

For a more comprehensive description of the related literature, research design, and results, please refer to Technical Report: Licensed Cannabis Retail Access Traffic Fatalities.[44]

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[43] To account for potential unrelated changes in the prevalence of blood testing, the models estimated for these analyses additionally control for the total number of drivers who received a blood test.

[44] Rashid, A. (2023). *Technical report—Licensed cannabis retail access and traffic fatalities* (Doc. No. 23-09-3202). Olympia: Washington State Institute for Public Policy.

# VI. Conclusion

We found that cannabis possession conviction rates dropped to essentially zero among adults of legal age immediately after I-502 went into effect. Rates also substantively dropped for underaged individuals after NMC legalization, but not as dramatically as for adults 21 and older. Across all age groups, we find no significant changes in conviction rates after the advent of NMC retail operations.

We did not find evidence that the enactment of I-502 *or* the advent of cannabis retail sales, a major component of I-502, significantly changed average reported cannabis use, alcohol use, or other substance use in Washington compared to non-legalizing states. While we may not be able to detect an average effect of NMC retail in Washington as a whole, it may be that the impact of NMC retail on cannabis use and subsequent outcomes is different depending on retail accessibility. That is, the impact of retail may disproportionately affect those with greater access to operational retailers, and we know that licensed cannabis retail access has varied greatly across the state over the years.

Our analyses focusing on the relationship between licensed NMC retail access across the state and relevant health and safety outcomes suggest that lower average local drive times to a retailer predict a greater probability of past-month and heavy past-month cannabis use. Given that residence in a neighborhood with greater proximity to a retailer predicts a greater probability of cannabis use, we also examined the relationship between local retail access and subsequent cannabis-related outcomes.

Our findings suggest that increased licensed NMC access predicts:

- a greater probability of diagnosed CUD, AUD, and OUD; and
- more drivers involved in fatal traffic collisions.

While these analyses provide evidence of a robust association between retail access and both greater cannabis use and potential cannabis misuse, several study limitations inhibit our ability to ultimately establish a *causal* link between retail access and relevant outcomes. The unique limitations for each outcome evaluation are highlighted in the accompanying technical report, but here, we highlight some overarching limitations to conducting a comprehensive evaluation of the overall public health, safety, and economic impacts of I-502.

More demographic, economic, and health information about the locales where retailers operate will allow us to disentangle better retail operations' impact from other relevant factors that independently impact cannabis-related outcomes. Furthermore, more neighborhood-level information on relevant outcomes is required to evaluate the relationship between NMC retail access and a more comprehensive set of outcomes.

We explain the relationship between NMC retail availability and outcomes through a measure of *accessibility*. Although accessibility to a legal cannabis supply source is an important consequence of legalized retail, to understand other mechanisms through which cannabis retail markets may impact the severity of cannabis use and subsequent outcomes, we need more information about the prices, potency, and types of products used.

More generally, our analyses speak to outcomes through 2019, before the COVID-19 pandemic. The pandemic substantially impacted both retail access and public health and safety outcomes across the state. Future research will need to re-evaluate how these outcomes evolved over this period.

Last, other components of I-502 may also impact relevant outcomes in unique ways. Namely, ongoing prevention work is both mandated by I-502 and funded through the Dedicated Cannabis Account. Future work may consider avenues to empirically evaluate the relationship between prevention programming and cannabis-related health outcomes.

The analyses presented in this report represent an intermediate step towards the ultimate legislatively mandated benefit-cost evaluation of I-502. In service of supporting a comprehensive evaluation of I-502, we will continue to examine how I-502 relates to relevant outcomes in the intervening years. For example, a forthcoming report will explore how I-502 and access to NMC retail associates with reported adolescent cannabis use and high school outcomes.

## Acknowledgments

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### Washington State Institute for Public Policy

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