The delayed impact of school closure during COVID-19 on substance use

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Outline

- Introduction
- Motivation
- Data
- Methodology
- Primary Results
- Conclusion

Introduction and Motivation

Introduction

- In April 2020, COVID-19 spread quickly across the U.S.

- 48 states and Washington, D.C. close schools for the academic year
  - Jan 29: First U.S. cases emerge
  - Mid-Feb: Temporary school closures
  - March 11: Pandemic declared
  - March 25: All U.S. public school buildings are closed
  - May 6: Nearly all states (except WY and MT) close schools for the academic year

- Starting September 2020, at the beginning of the new school year
  - States and local authorities implemented varying approaches to virtual learning
  - School closures were more evenly distributed across the U.S.

Introduction
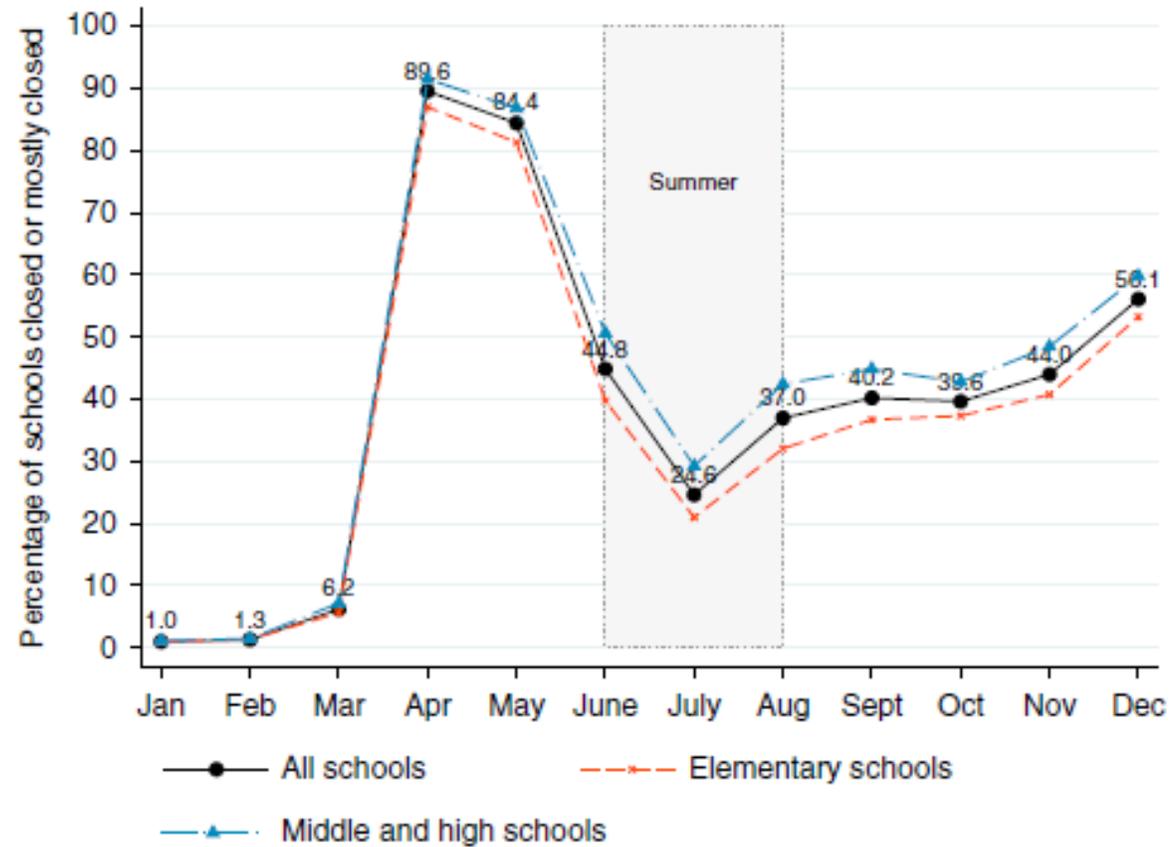
Source: Parolin et. al., 2021

Presentation in One Slide

- **Question:** The delayed impact of school closure (change in in-person visits) on youth substance use

- **Data:** Foot traffic data from SafeGraph and YRBSS

- **Identifying Variation:** State-level variation in school-closure intensity

- **Estimation Strategy:** TWFE

- **Results:** Compared to students in states with no school closures, those in states with average 2020 closure intensity led to :
  - a 42.8% and 66.6% decrease in frequent and daily alcohol use **in 2021 and 2023**
  - a 19.3% and 36.8% decrease in current and frequent marijuana use **in 2021 and 2023**

Motivation: Risky behavior around peers

- Adolescents around peers (Gardner & Steinberg, 2005)

  - Randomized experiment across three groups

  - Take far more risks around peers

  - Peer effect is much stronger for teens than adults

- Peers enhance risky decisions (Chein et al., 2011)

  - Neuroimaging confirms that peers enhance reward circuitry activation during risky decisions specifically in adolescents

Motivation: Peer effect and substance use

- Meta-analysis of 27 longitudinal studies (Watts et al., 2024)

  - Peer influence is associated with adolescent substance use

- Best-friend vs family (Schuler et al., 2019)

  - Best-friend substance use predicts youths' own use more strongly than sibling/adult use

  - Peer concordance intensifies through high school

- Causal evidence:

  – Peer influence amplifies substance use and leaves long-lasting effects (Powell et al., 2005; Clark & Lohéac, 2007; Robalino & Macy, 2018)

Motivation: Supportive social connectedness

- Attachment to caring adults and institutions raises the cost of risky behavior (Hirschi, 1969)

- Supportive school connectedness helps (Dudovitz et al., 2017)
  - Results from school-based surveys
  - Teachers, coaches, and counselors provide a distinct non-family adult connection
  - Youth with supportive school adults report lower substance use

- Family and school connectedness protect teens across major risk behavior (Resnick et al., 1997; Wilkins et al., 2023)

Contribution

- In sum:
  - Peer effects matter and have long-term impacts
  - Supportive social connections improve outcomes
  - COVID-19 school closures disrupted negative peer channels and increased family monitoring

- In this study, we exploit variation in school-closure intensity (changes in in-person visits) as plausibly exogenous to estimate delayed effects on youth substance use

Data

Data: School closure data

- **School closure data:** Parolin, Z., Lee, E.K. (2021)

  - Estimated using aggregated, anonymized SafeGraph cellphone data

  - SafeGraph sample closely corresponds to U.S. Census counts (r = 0.98)

  - Provides monthly foot-traffic visits to school locations

  - Manual checks in selected schools

  - Consistent with Education Week's (EW) manually coded school closure status of more than 907 school districts

Data: School closure data

- **School closure data:** Parolin, Z., Lee, E.K. (2021)

    - State-level intensity of closure: changes in yearly visits in 2020 compared to 2019

    - Continuous treatment captures severity, not just binary open/closed

    - We rescale intensity of closure by its mean

Data: School closure data

Table 1. Distribution of intensity of closure measure

	Mean	SD	Min	Max	Median
Intensity of closure					
States in the sample panel (39 states)	0.35	0.08	0.18	0.53	0.35
Rescaled (39 states)	**1.0**	**0.28**	**0.52**	**1.55**	**1.0**

Data: Intensity of school closure
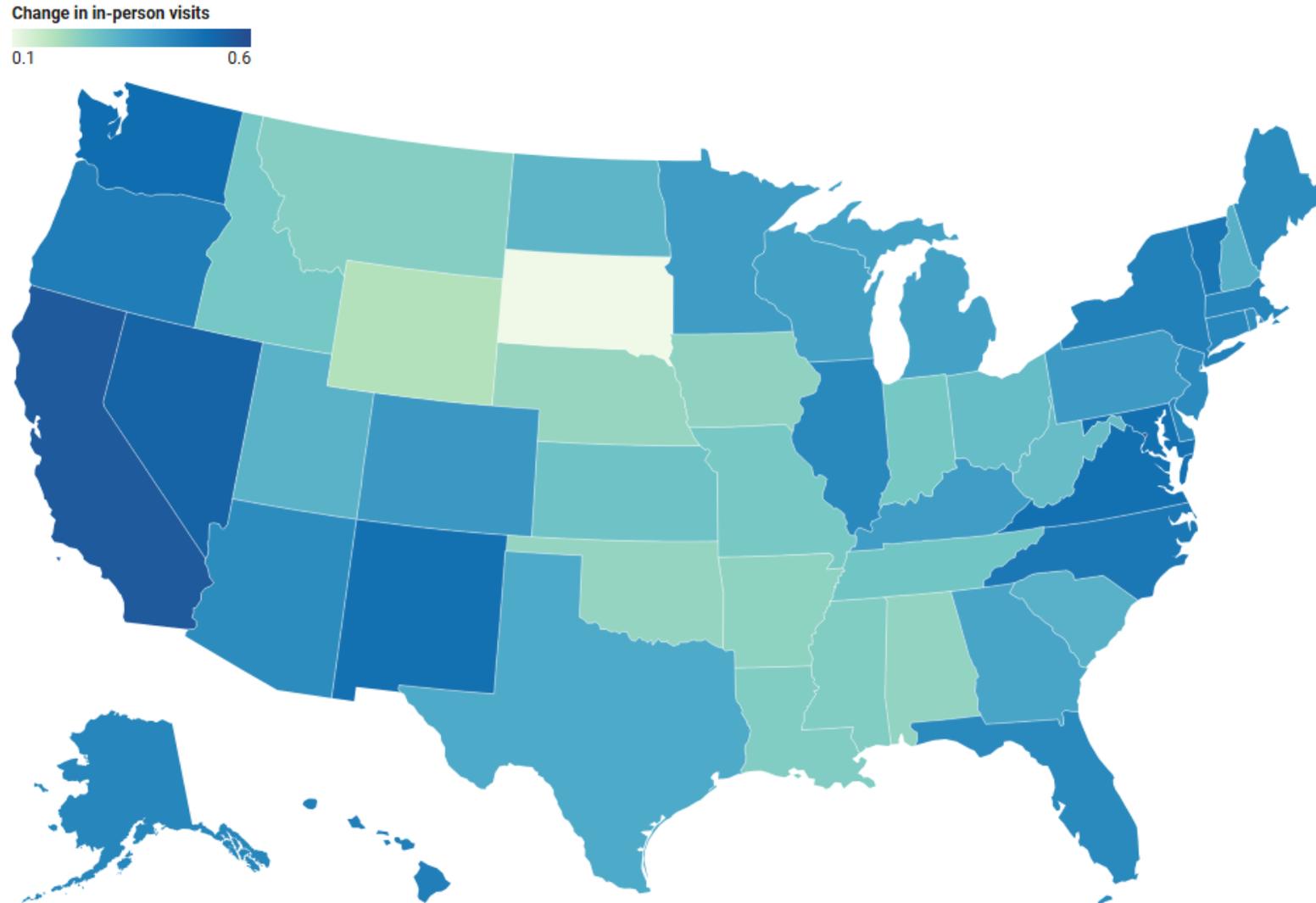
Data: Substance use data

- **Substance use data:** Youth Risk Behavior Surveillance System (YRBSS) - CDC

  - Monitors youth risk behaviors such as tobacco, alcohol, marijuana and others

  - We use state YRBSS: biennial repeated cross-section of high school students (grades 9–12)

  - Typically administered in spring; 2021 in fall for many states due to COVID-19

  - Conducted by state health/education departments in collaboration with CDC

  - Representative of public high school students within each state

  - Anonymous, self-administered survey (~one class period)

  - Standard CDC questionnaire; states may add/remove non-mandatory items

  - Overall response rate: ~35%–70%; student response rate: 71%–88% (2023–2013)

Data: Substance use data

- **Substance use data:**

  - Outcome variables are cigarettes, e-cigarettes, alcohol, and marijuana

  - Three measures of intensity based on how many days a student smoked or drank in the 30 days prior to the survey:
    - **Current**: at least 1 day
    - **Frequent**: 20 or more days
    - **Daily**: all 30 days

  - Student demographics: age, race, sex, and grade

Data: Substance use data

- **Substance use data:**

  - Panel covers odd years, 2011–2023, across 39 states

  - Unbalanced panel due to missing states in some waves

    - Some states did not permit the CDC to include their data in the combined datasets

    - The survey was not administered in that year

    - The survey was conducted, but response rates were too low to support weighting

    - The survey was conducted, but response rates fell below 60%, and nonresponse bias analysis indicated the data were not representative of the population

Data: Substance use data

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Table 2. Descriptive statistics

	Mean	SD
Female	0.49	0.50
Grade: 9th	0.27	0.44
10th	0.25	0.44
11th	0.24	0.43
12th	0.23	0.42
Race: White	0.50	0.50
Black	0.15	0.36
Native American	0.01	0.11
Asian or Pacific Islander	0.04	0.20
Hispanic	0.23	0.42
Other	0.07	0.22
Age: $\leq$ 12 years	< 0.01	0.06
13 years	< 0.01	0.05
14 years	0.12	0.33
15 years	0.25	0.43
16 years	0.25	0.44
17 years	0.24	0.42
$\geq$ 18 years	0.13	0.33
N	*975464*	

</div>

Data

- **State policy controls:**

  - Cigarette, cigar, e-cigarette, and beer tax rates by state-year

  - Medical and recreational marijuana laws

  - State e-cigarette restrictions, flavor bans, and e-cigarette MSLA

Methodology

Methodology

- Specification (TWFE):

$$Y_{ist} = \alpha + ClosureIntensity_{s2020} \times Post_t\beta + X_{ist}\gamma + C_{st}\theta + \delta_s + \tau_t + \varepsilon_{ist}$$

- Y_{ist} : binary substance use indicator for a student i, in state s, and survey year t

- $ClosureIntensity_{s2020}$: intensity of closure defined earlier

- X_{ist} : vector of student demographics

- C_{st} : time-varying state-level policies: cigarette, cigar, e-cigarette, and beer taxes, medical and recreational marijuana laws, e-cigarette restrictions, flavor bans and MLSA

- δ_s and μ_t are state- and survey year-fixed effect, respectively

- ε_{ist} error terms that are clustered at the state level

Methodology

- Specification (TWFE):

$$Y_{ist} = \alpha + ClosureIntensity_{s2020} \times Post_t\beta + X_{ist}\gamma + C_{st}\theta + \delta_s + \tau_t + \varepsilon_{ist}$$

  - Regressions are survey weighted

  - β has a causal interpretation provided parallel trends are met and in the absence of concurrent policy changes correlated with our treatment variable.

  - We capture both short-term effects (2021) and longer-term effects (2023) from 2020 school closures
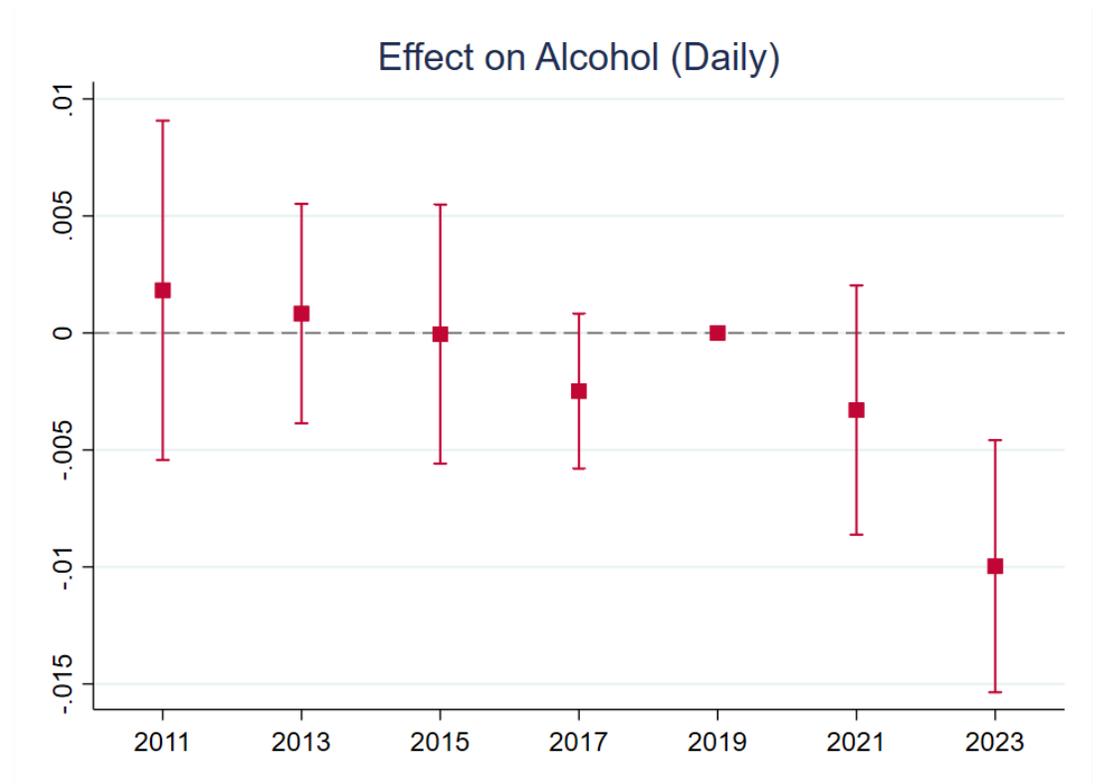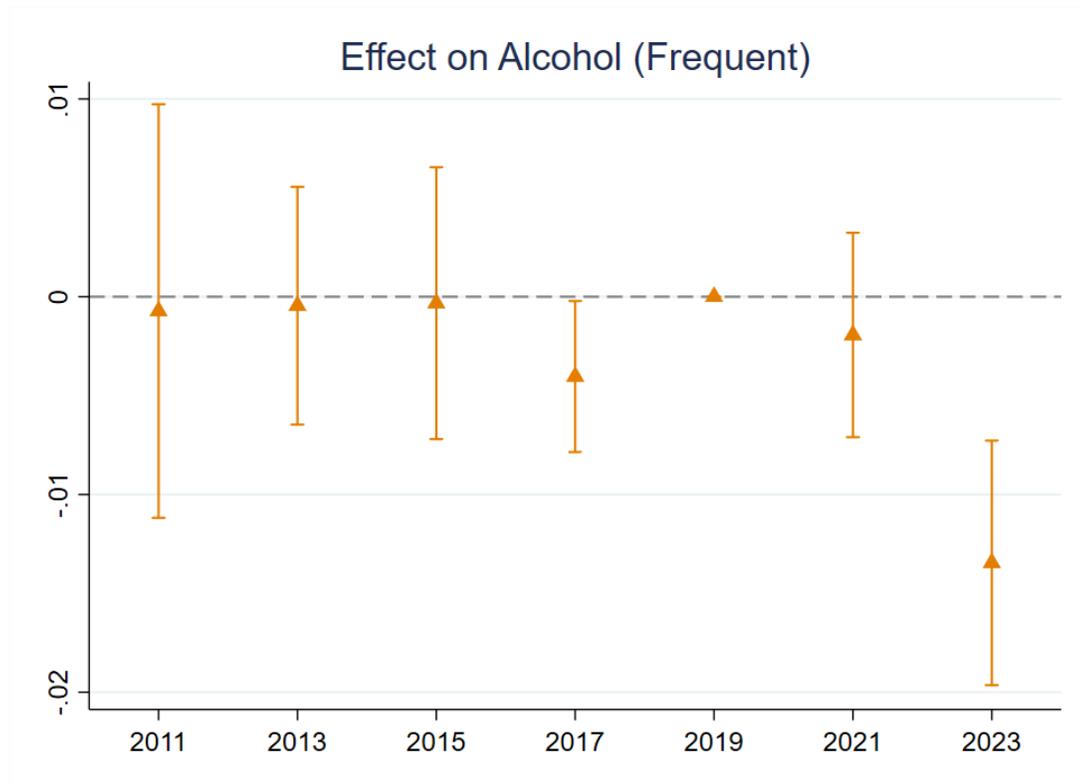
Primary Results

Simple illustration: trend
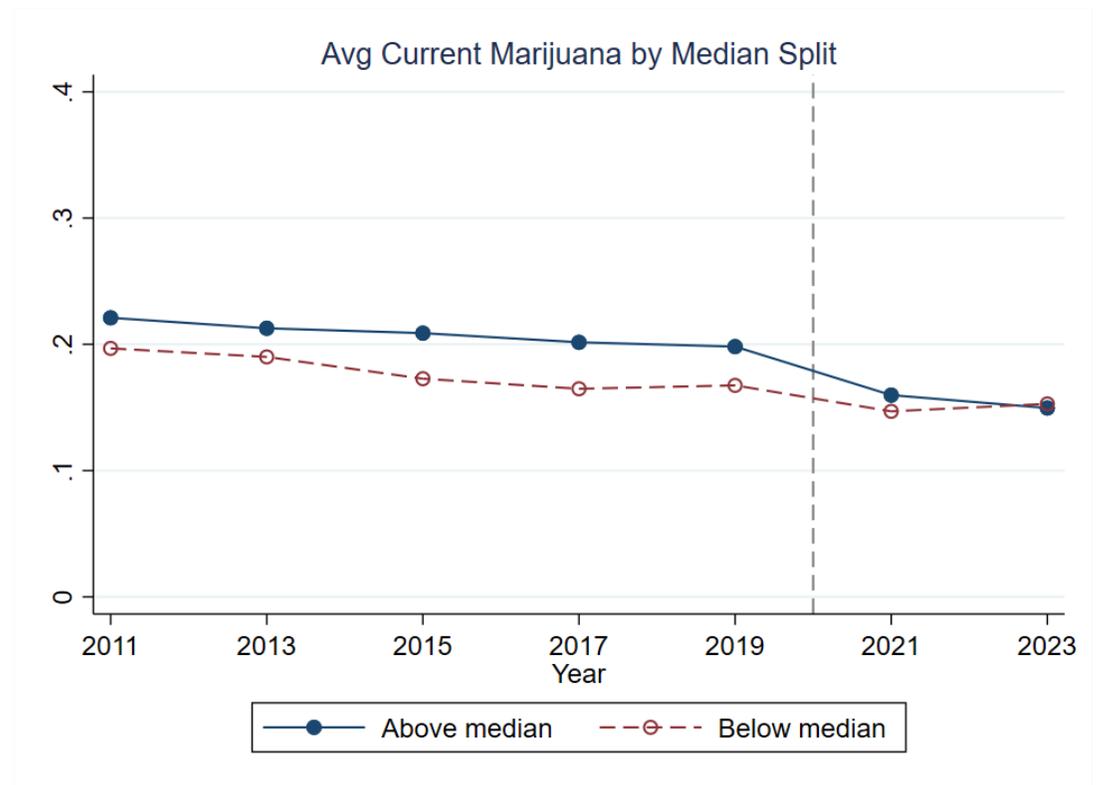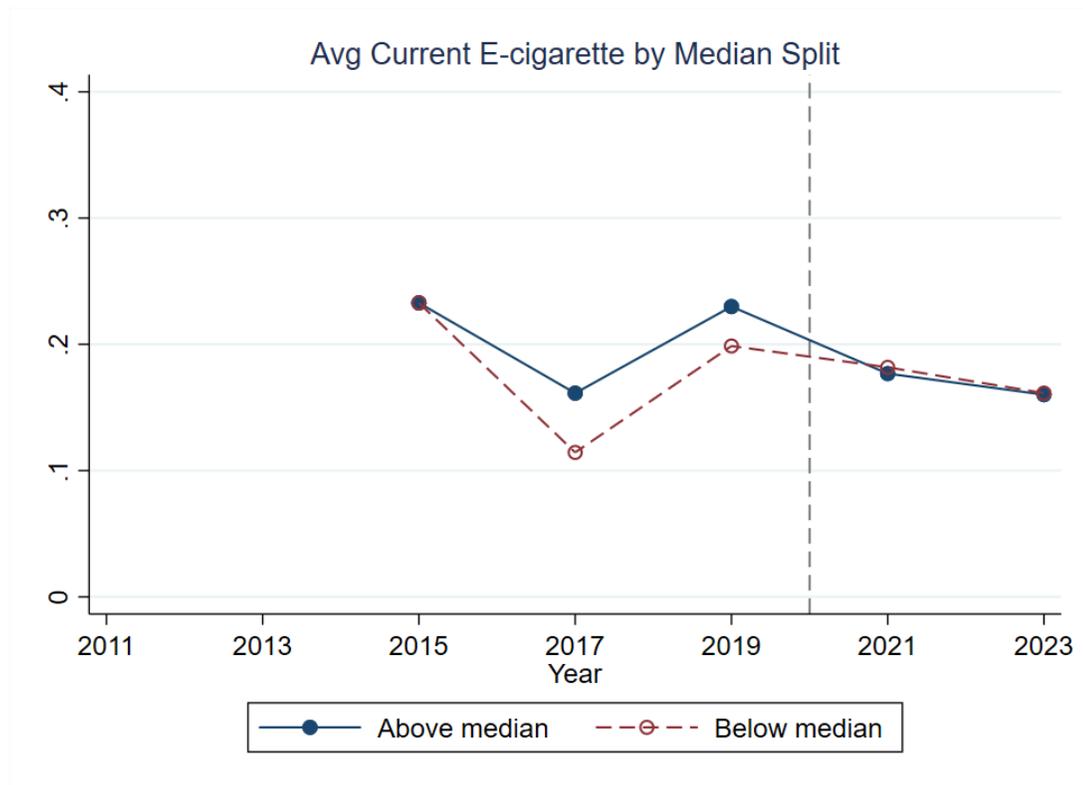
Parallel pre-trends for alcohol and marijuana outcomes
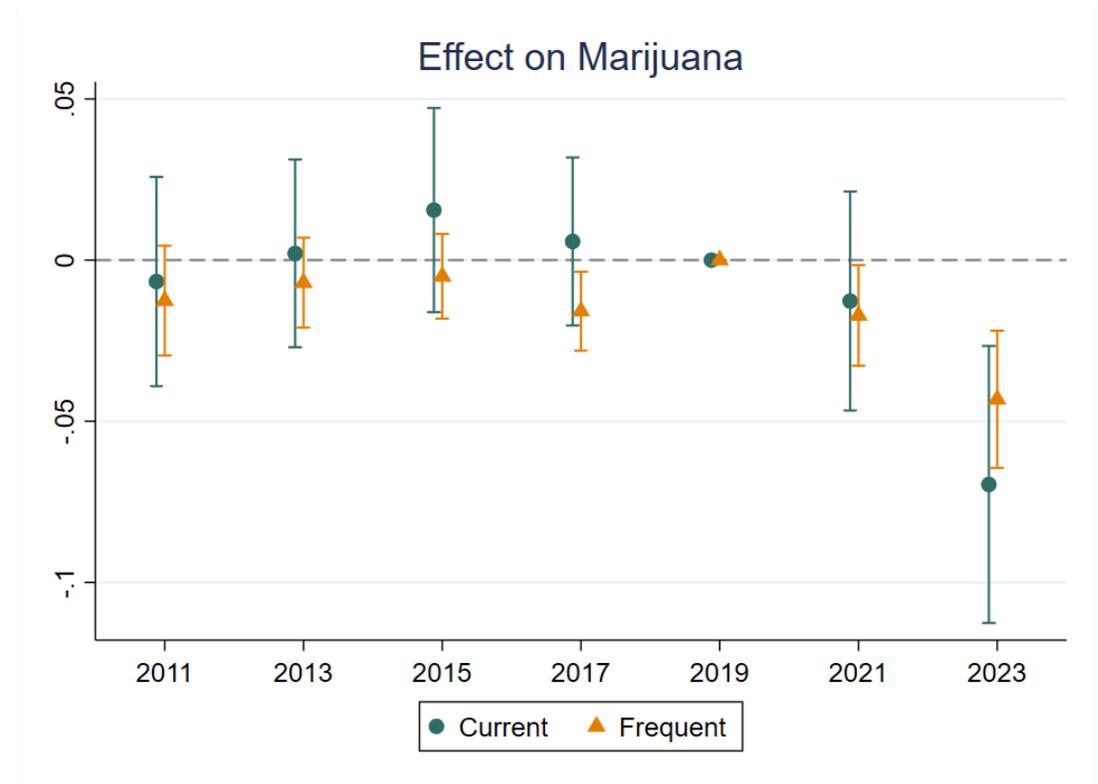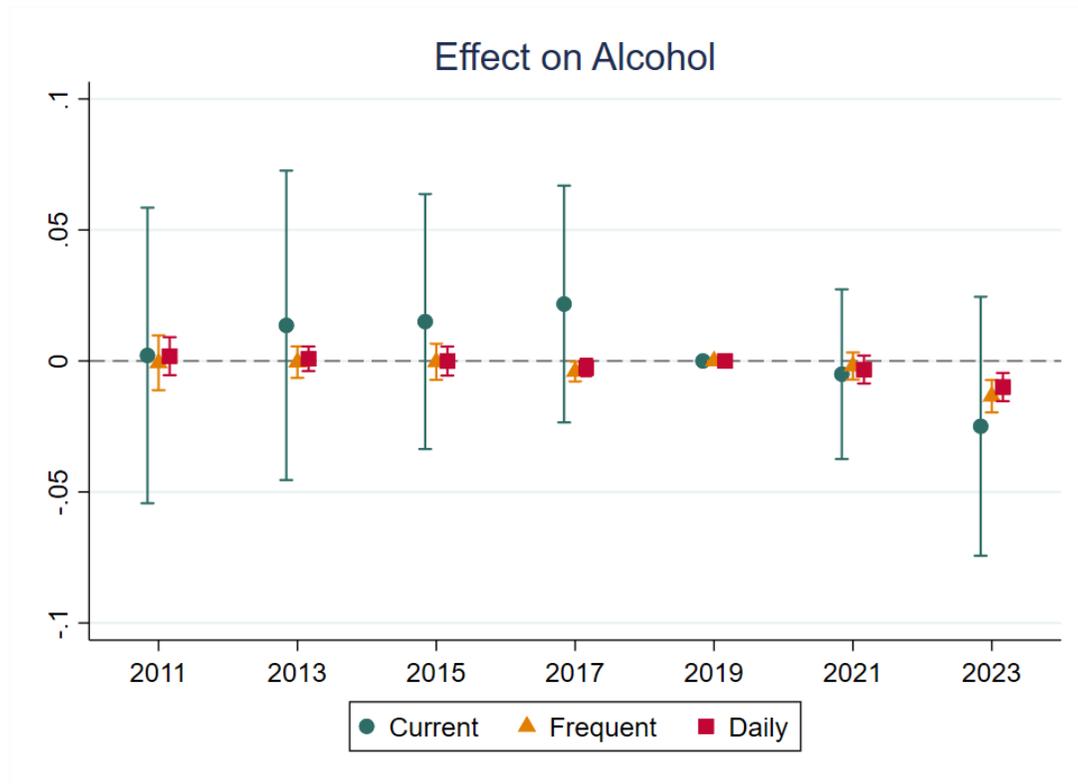
Primary Results : Alcohol

Event-study: Alcohol

Effect on Alcohol (Frequent)

Effect on Alcohol (Daily)

Primary Results: Alcohol

Table 3a. Alcohol use and intensity of school closure

	(Frequent)		(Daily)	
2020 closure intensity × Post	-0.006**	-0.006*	-0.005***	-0.006**
	(0.002)	(0.002)	(0.001)	(0.002)
Pre-mean of DV	[0.014]	[0.014]	[0.009]	[0.009]
% of mean	-42.8	-42.8	-55.5	-66.6
Observations	892978	892978	892978	892978
Controls		Y		Y
State FE + Year FE	Y	Y	Y	Y

*p < 0.1, ** p < 0.05, *** p < 0.01

- A **one-unit** increase corresponds to moving from **zero** closure to **sample mean** level closure
- A student living in a state with the average 2020 school closure rate was **42.8%** (0.6pp) less likely to use alcohol frequently compared to a student that lived in a state without any school closures
- These are delayed effects (short-term effects in 2021, and longer-term effects in 2023)

Primary Results : Marijuana

Event-study: Marijuana
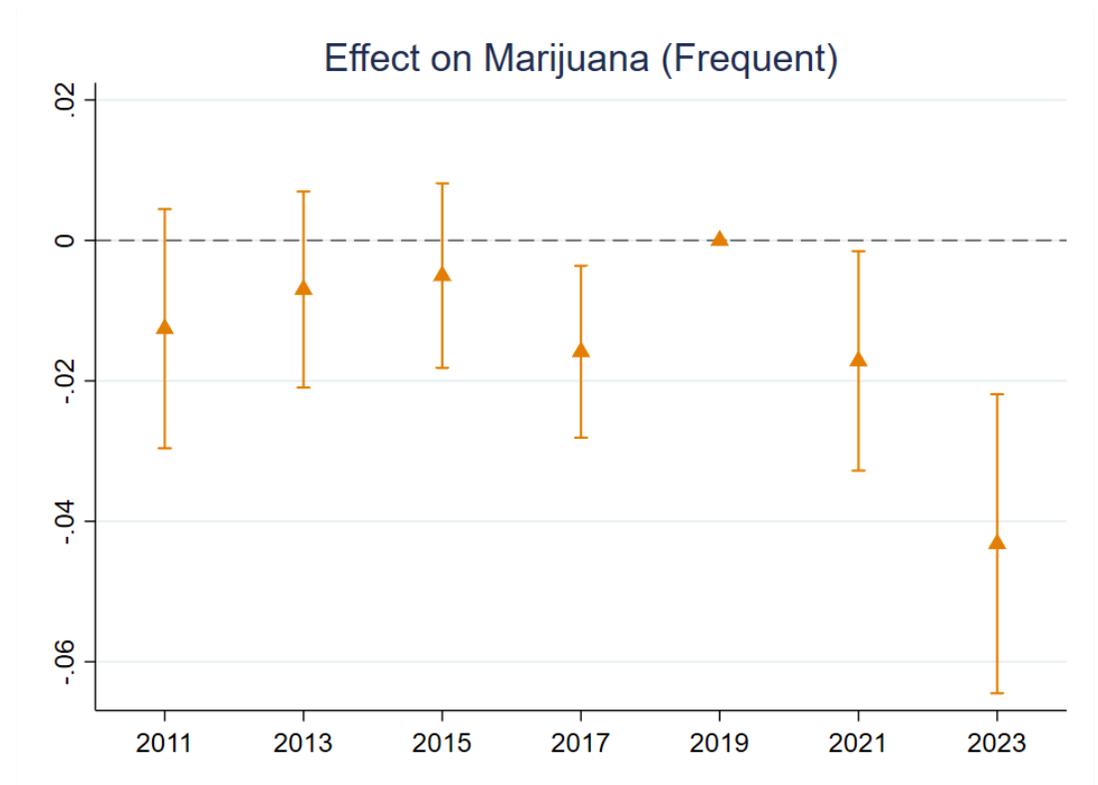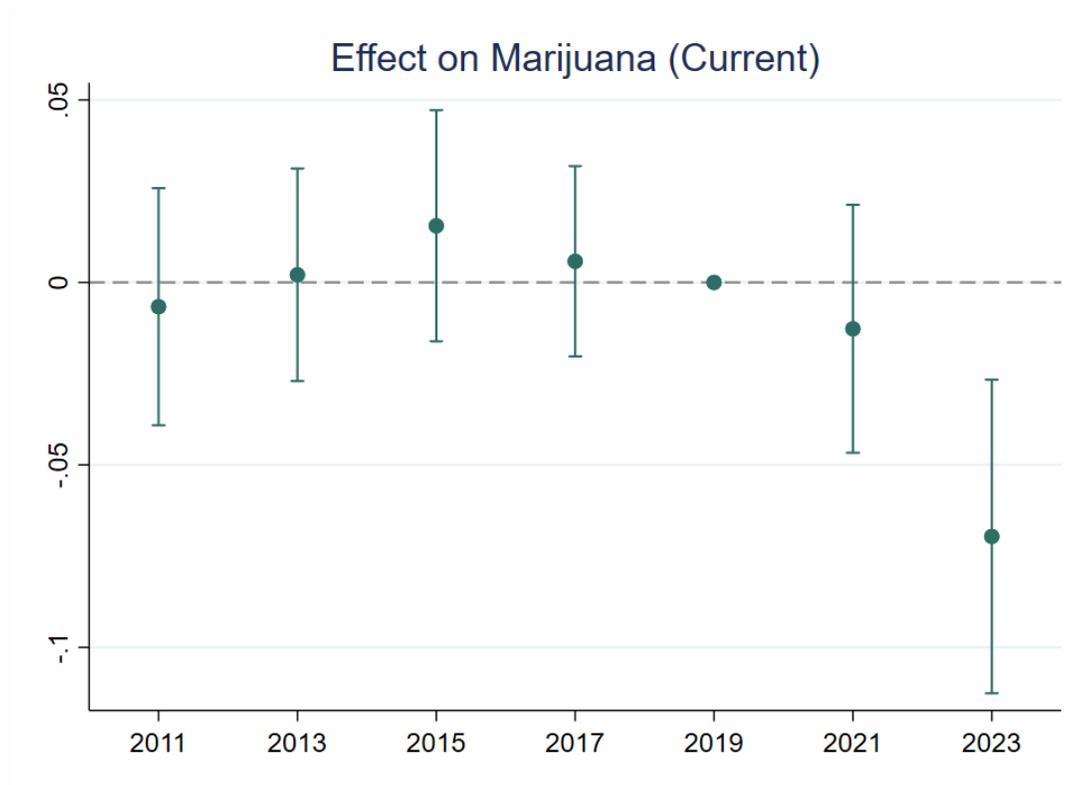
Primary Results: Marijuana

Table 3b. Marijuana use and intensity of school closure

	(Current)		(Frequent)	
2020 closure intensity × Post	-0.051***	-0.039*	-0.018**	-0.021**
	(0.011)	(0.015)	(0.006)	(0.007)
Pre-mean of DV	[0.202]	[0.202]	[0.057]	[0.057]
% of mean	-25.2	-19.3	-31.6	-36.8
Observations	937677	937677	937677	937677
Controls		Y		Y
State FE + Year FE	Y	Y	Y	Y

*p < 0.1, ** p < 0.05, *** p < 0.01

- A student living in a state with the average 2020 school closure rate was **19.3%** (4pp) and **36.8%** less likely to use marijuana currently and frequently, respectively, compared to a student that lived in a state without any school closures

Possible mechanism: Initiation effect

We split the sample based on who experienced the 2020 closure

- **High exposure (junior high: new to school after 2020 closure)**
  - Grade 9 and 10 in 2021 (Fall)
  - And the same cohort as Grade 10 and 11 in 2023 (Spring)

- **Low exposure (more likely to have already initiated)**
  - Grade 11 and 12 in 2021 (Fall)
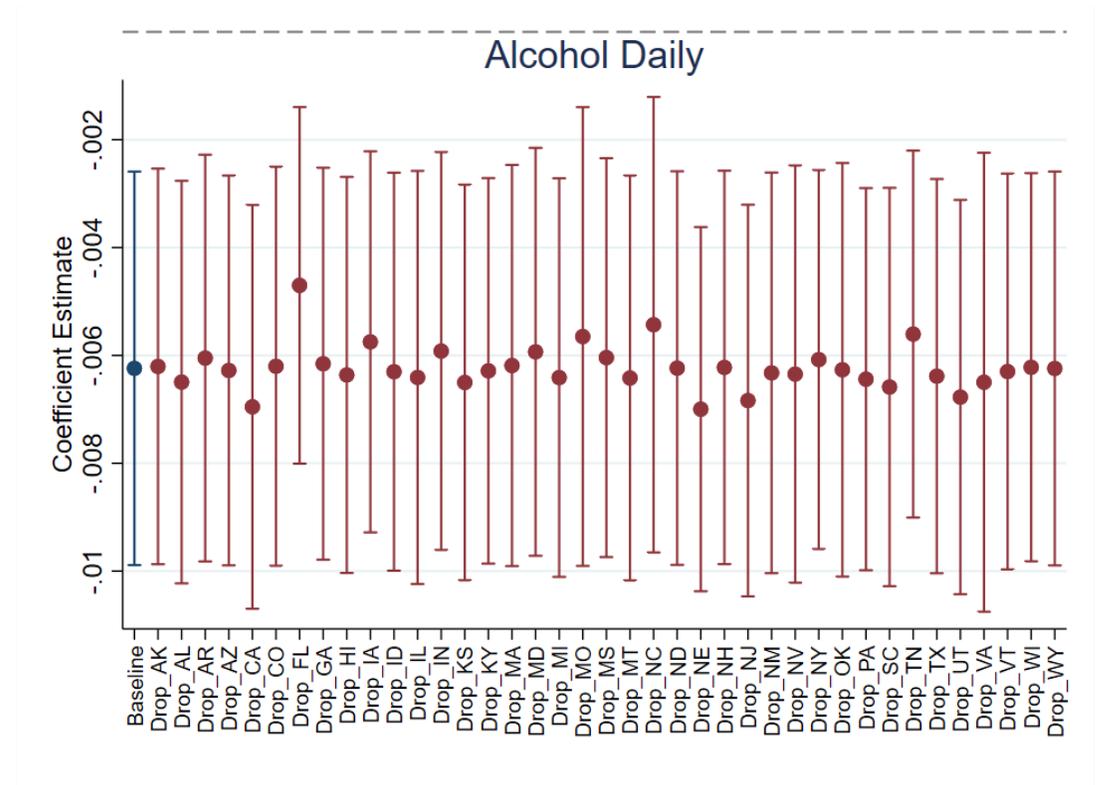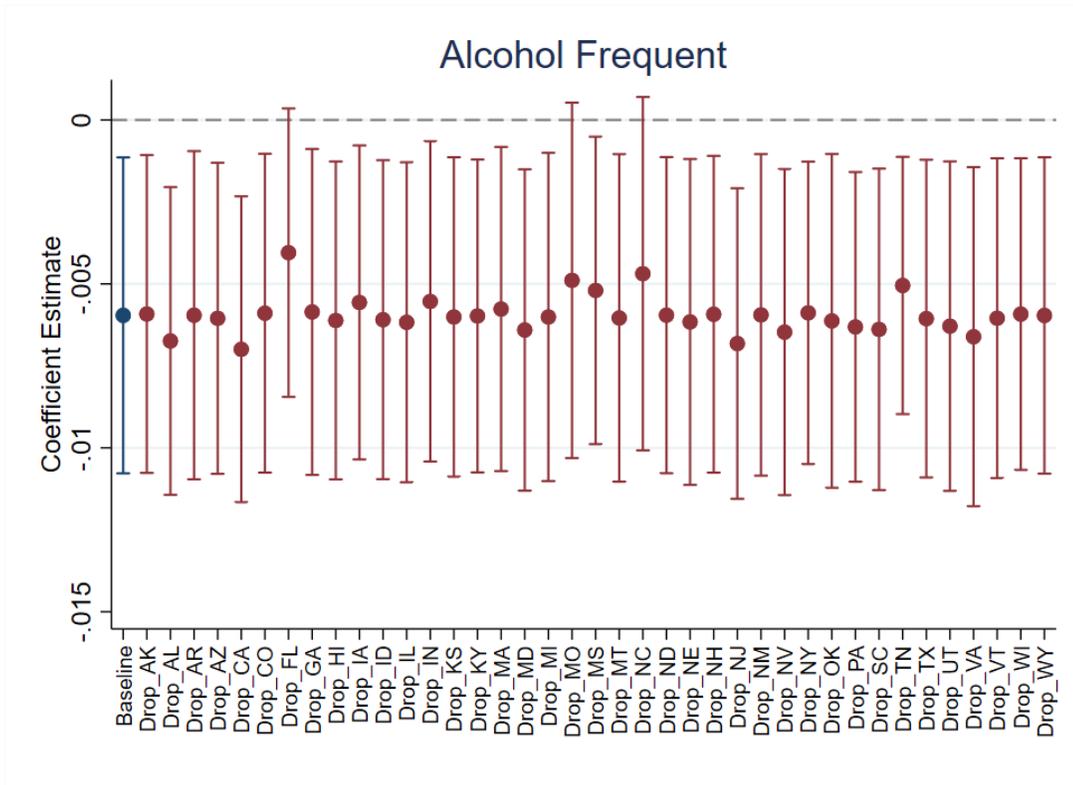 - And the same cohort as Grade 12 in 2023 (Spring)
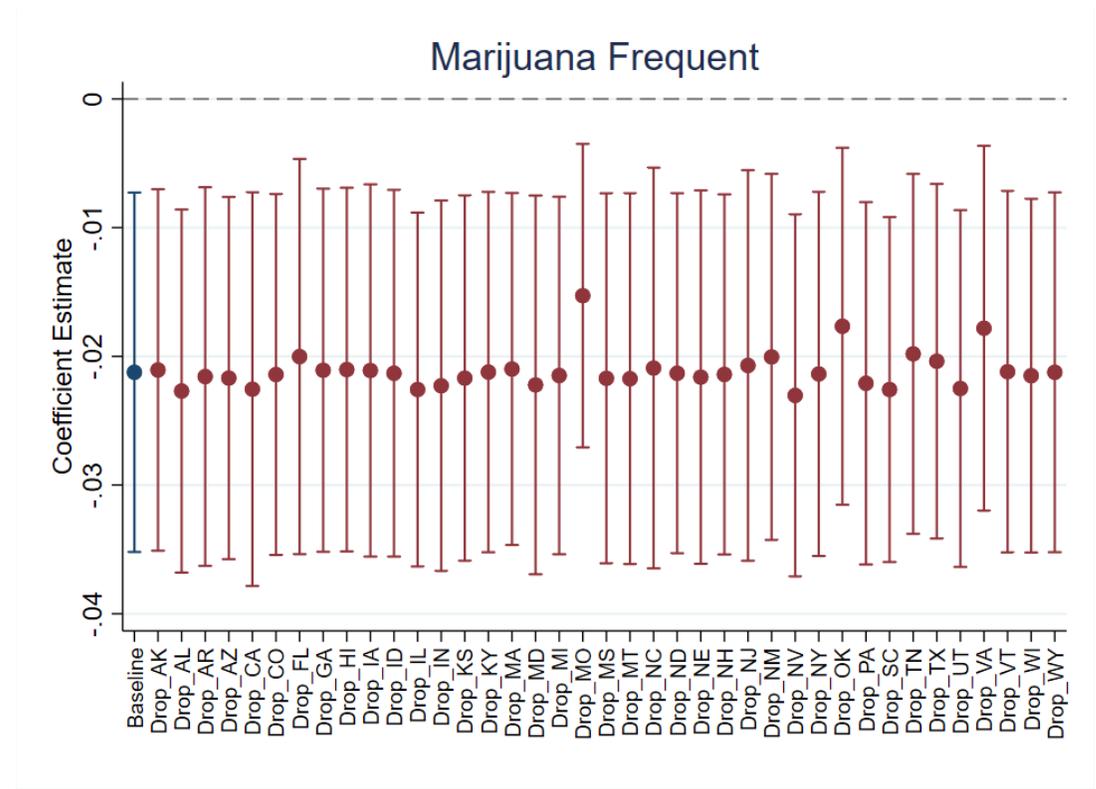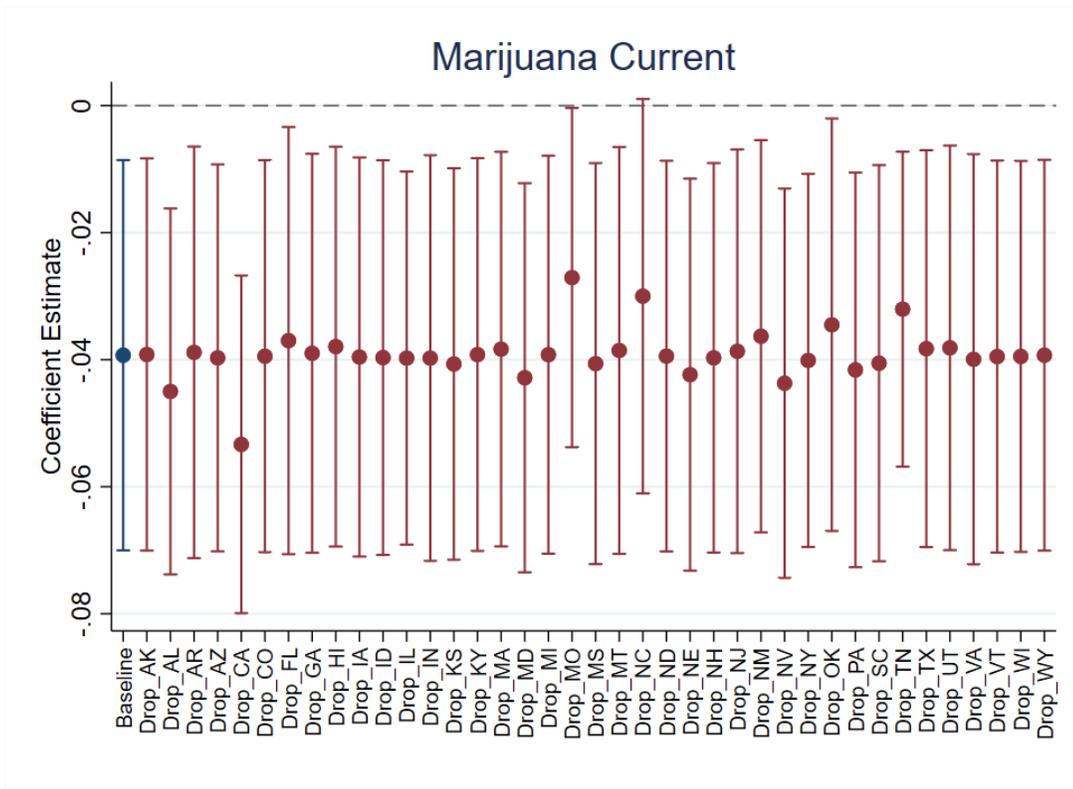
Initiation effect: Marijuana
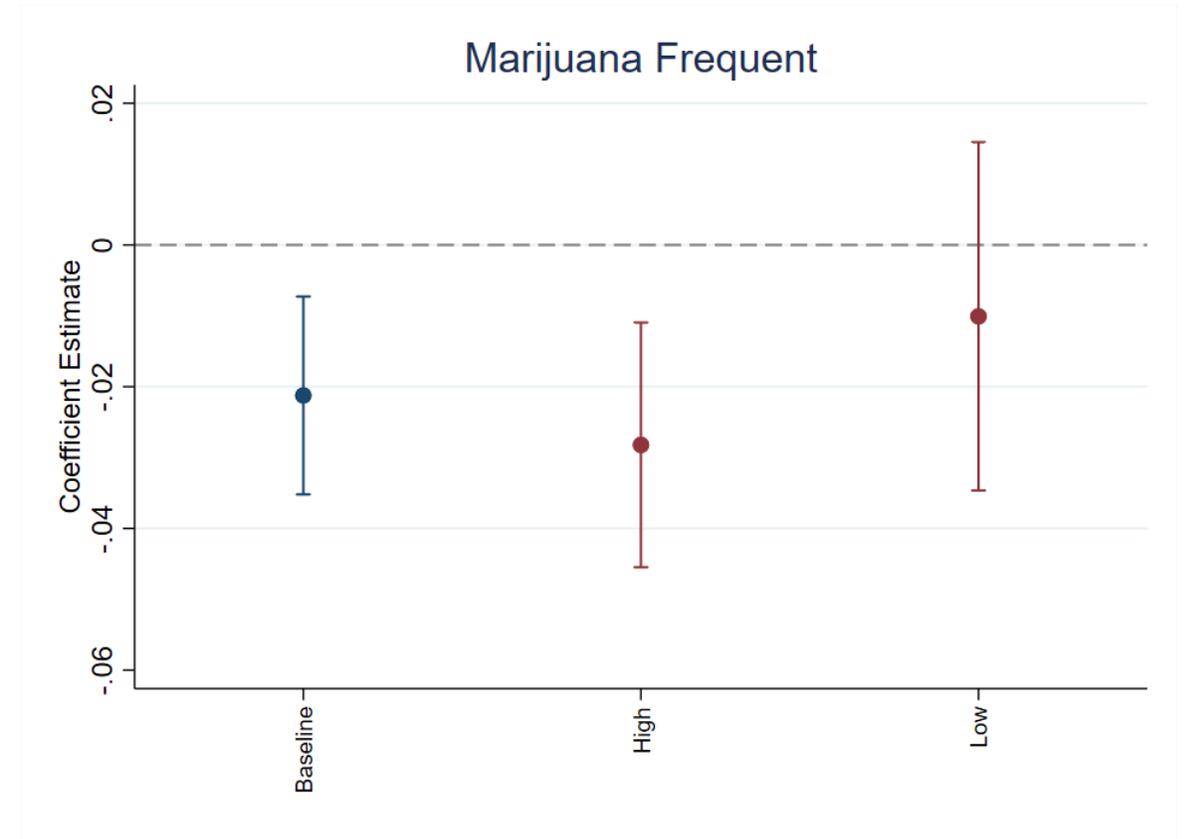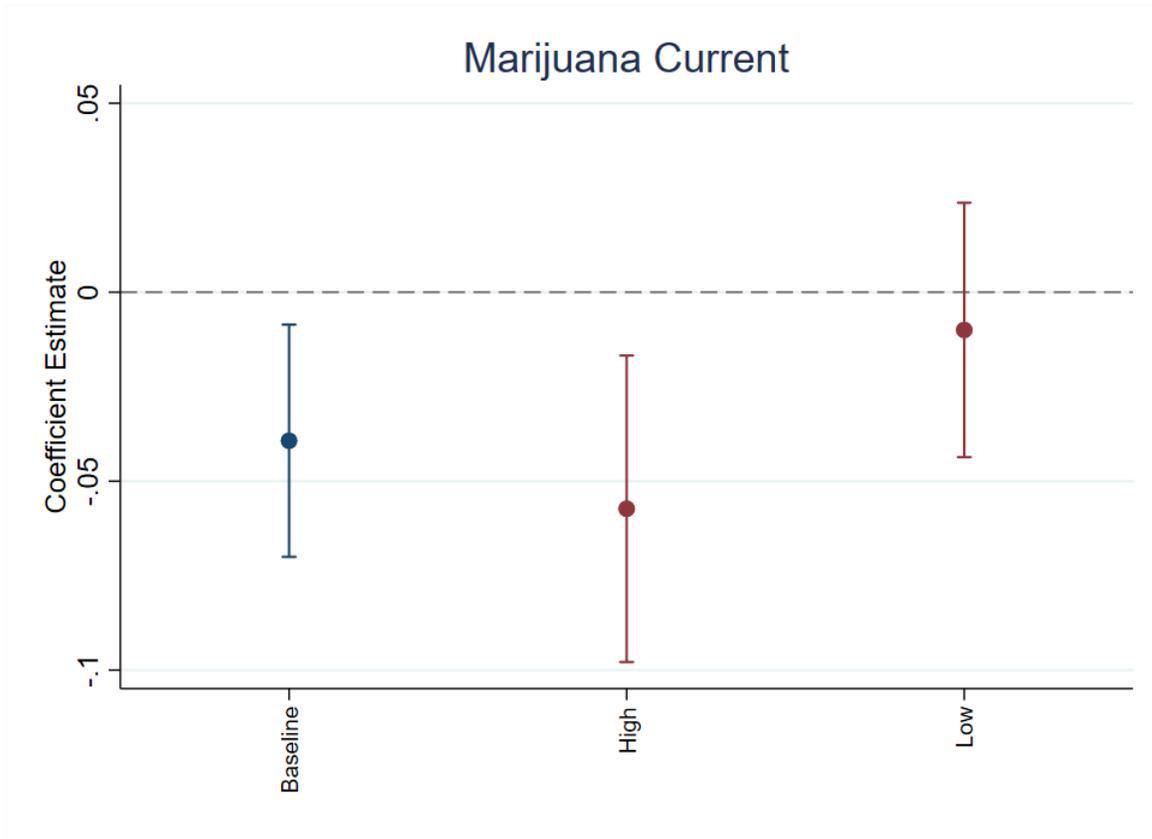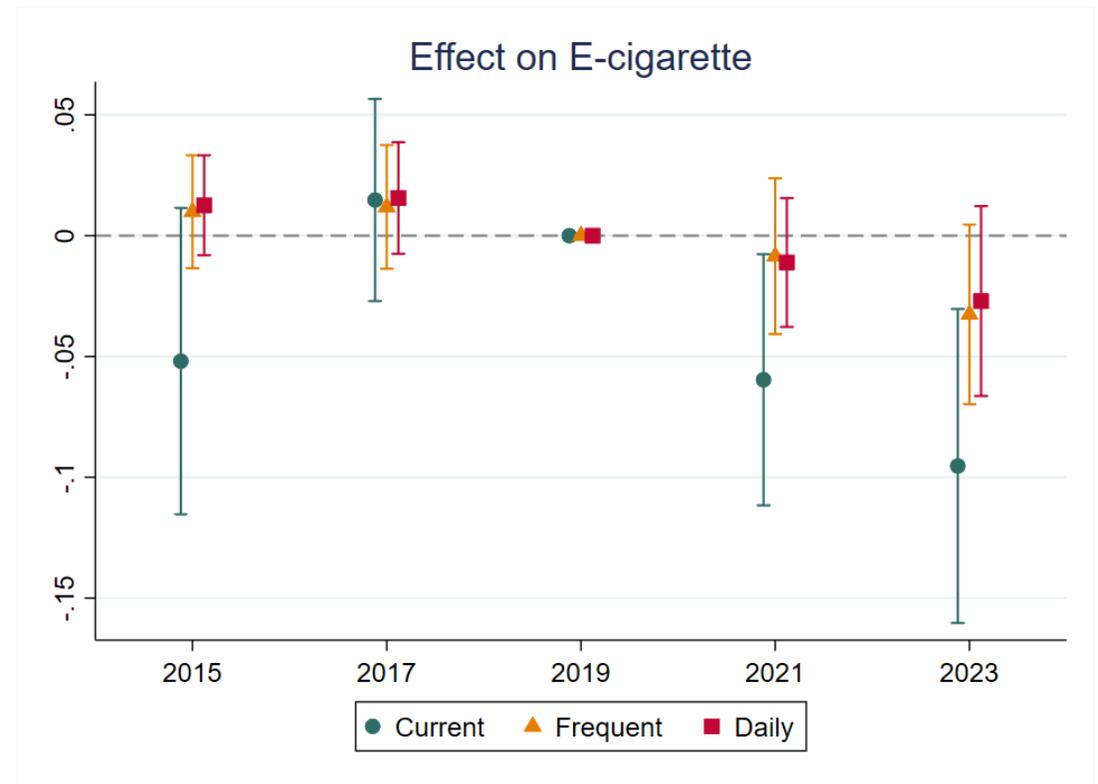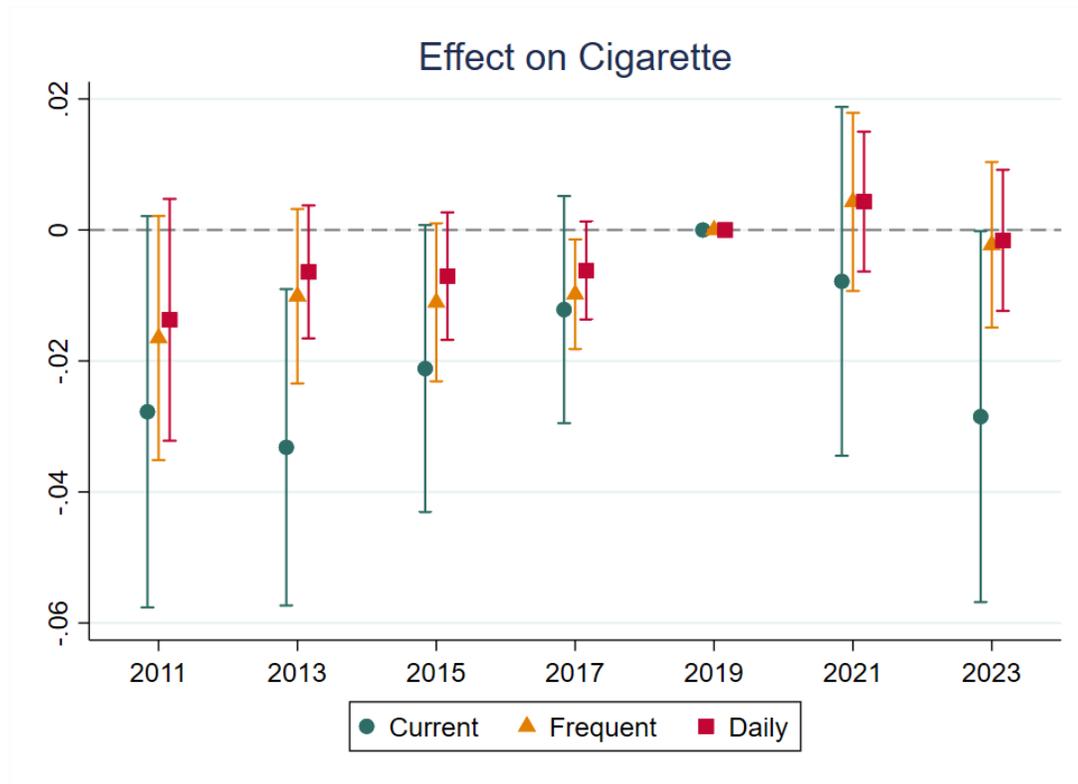
Initiation effect: Alcohol
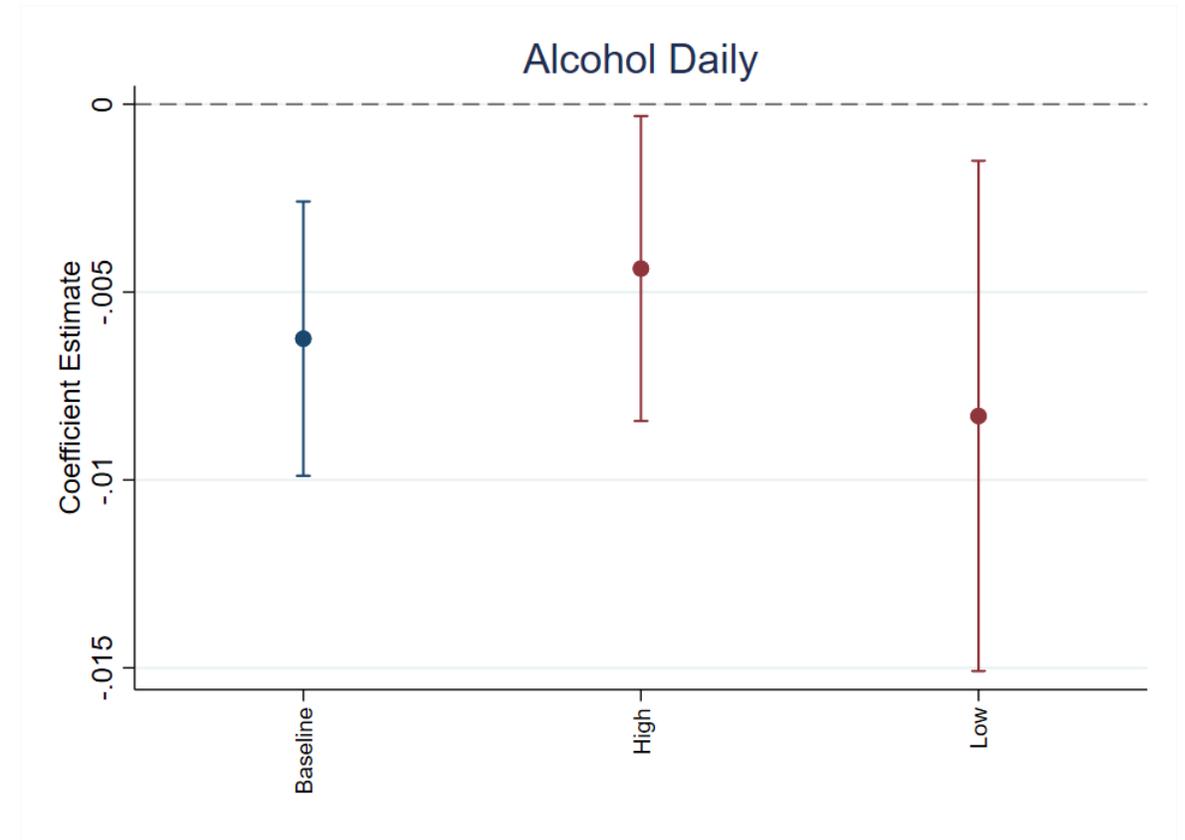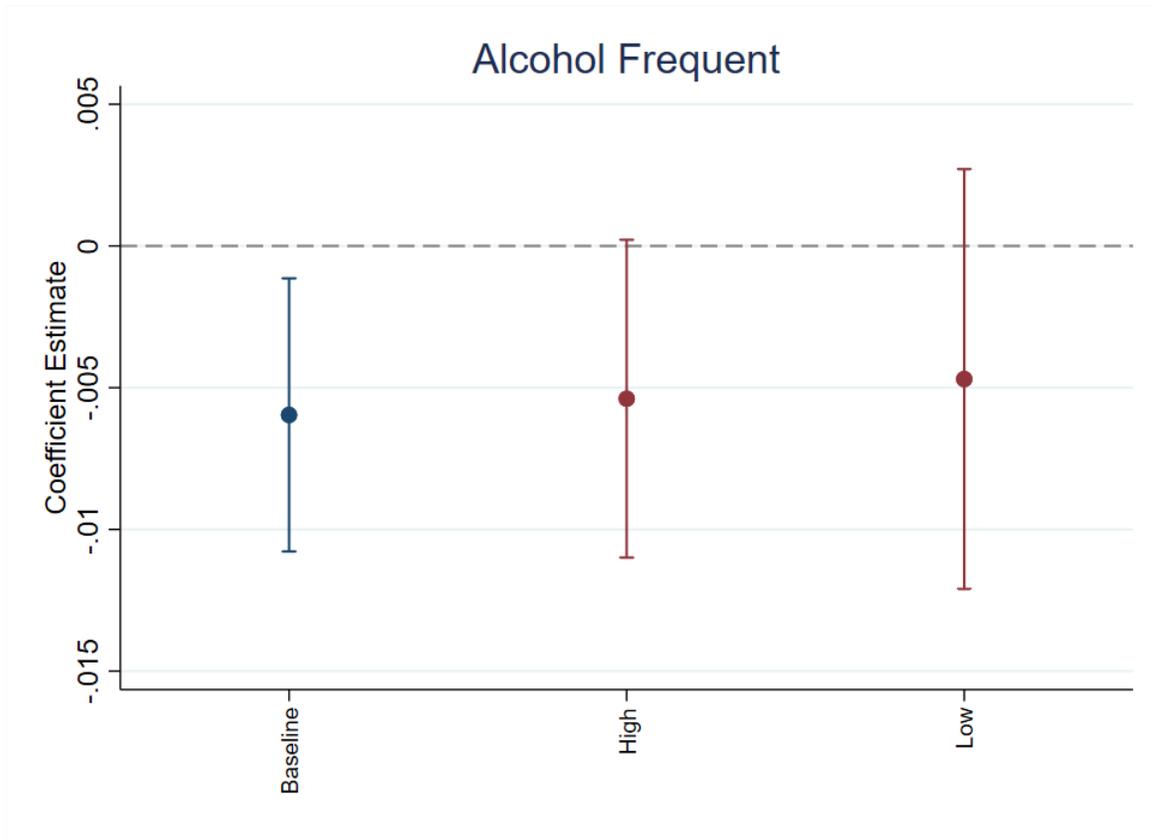
Leave-one-out: Alcohol

Leave-one-out: Marijuana

Problematic pre-trends for tobacco-related outcomes

Conclusion

- We use variation in intensity of school closure (intensity of change in in-person visits), plausibly exogenous reductions in in-person schooling, to estimate the delayed effect on youth substance use

- We estimate a student living in a state with the average 2020 school closure rate experienced compared to a student that lived in a state without any school closures:
    - A 42.8% and 66.6% decrease in frequent and daily alcohol use in 2021 and 2023
    - A 19.3% and 36.8% decrease in current and frequent marijuana use in 2021 and 2023

- Consistent with social interaction/peer exposure literature

- However, the effect size is much larger:
    - Peer effect (e.g., Powell et al., 2005; Guo et al., 2015)
    - Tax policies (e.g., Carpenter & Cook, 2008)

Conclusion

- **Limitations**
  - *Measurement error:* Likely non-classical, as mobile GPS foot-traffic correlates with school and community characteristics, potentially biasing estimates in unpredictable directions
  - *State-level treatment:* Treatment is measured at the state level due to lack of school/district identifiers in YRBSS; this masks within-state variation and may limit causal precision

- **Next steps**
  - Pre-treatment adjustment
  - Heterogeneity
  - Explore potential mechanisms

Thank you!