### **EVALUATION OF CANADIAN E-CIGARETTE POLICIES**

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# **E-CIGARETTE POLICY:**

### **AN OVERVIEW**



### E-Cigarette Policies in Canada and the US



### FOCUS OF TODAY'S TALK



- 1) Effects of e-cigarette minimum legal sales age (MLSA) policy on youth mental health
  - To shed light on effects of vaping on youth mental health



- 2) Effects of e-cig MLSA on combustible cigs
  - To address whether e-cigarettes are substitutes or complements to combustible cigarettes



- 3) Effects of flavor bans and nicotine caps on e-cig use and combustible cig use
  - To inform current debates on these policies

# EFFECTS OF E-CIG MLSA ON YOUTH MENTAL HEALTH

STUDY 1:



### Mental Health Effects of Vaping: A Debate

- Plausible mechanisms
  - Nicotine
  - Harmful ingredients
  - Vape other drugs
  - Peer pressure
- Becker et al. (2021) conducted systematic review of 40 studies
  - E-cigarette use associated with several mental disorders
  - But only associations: existing studies subject to omitted variable bias & reverse causality



#### Mental disorder $\rightarrow$ More likely to use e-cig?

### Minimum Legal Sales Age (MLSA) Policy in Canada



**DD:** Mental Health =  $\alpha + \beta_1 (MLSA \ Law)_{pt} + \beta_2 \eta_p + \beta_3 \chi_t + \beta_4 Z_{pt} + \beta_5 X_{ipt} + \xi_{ipt}$ 

**DDD:** Mental Health =  $\alpha + \beta_1 (MLSA \ Law)_{apt} + \beta_2 \Psi_a^* \eta_p + \beta_3 \Psi_a^* \chi_t + \beta_4 \eta_p^* \chi_t + \beta_5 \Psi_a + \beta_6 \eta_p + \beta_7 \chi_t + \beta_8 Z_{pt} + \beta_9 \chi_{ipt} + \xi_{ipt}$ 

- Include individual level and province level controls (cigarette prices, provincial menthol ban)
- We use *t*-distribution with (*G*<sup>\*</sup> 1) *d.f.* (*G*<sup>\*</sup> is effective number of clusters; Carter, Schnepel & Steigerwald, 2017)

### Data and Mental Health Outcomes

#### **Outcomes**

- Mood disorder (Y/N)
- Anxiety disorder (Y/N)

#### **Study Sample**

- DD sample: Age 15below MLSA
- DDD sample: Age 15-24

#### **Data Source**

#### Canadian Community Health Surveys

- Annual
- Survey cycle: Jan Dec

#### **Study Period**

 Jan 2008 – May 2018 (before federal MLSA)

#### **Trends in Mental Health Outcomes**



Note: Treated provinces are Newfoundland and Labrador, Prince Edward Island, Nova Scotia, New Brunswick, Quebec, Ontario, and British Columbia. Control provinces are Alberta Saskatchewan. Solid vertical lines indicate start and end years for implementation of provincial e-cigarette MLSA laws. Dashed vertical line indicates implementation date for the national MLSA law, i.e., May 2018.

## Prevalence declined in provinces with the law but increased in provinces without the law

### Effects of MLSA on Mental Health: DD & DDD

Outcome is $\rightarrow$	Mood disorder	Anxiety disorder
Panel A: DD analysis		
Pre-policy mean of the outcome	0.044	0.066
E-cigarette MLSA laws	-0.020*	-0.012
	(0.075)	(0.287)
R-squared	0.03	0.03
Ν	30,954	30,937
Panel B. DDD analysis		
E cigorotto MI SA lows	-0 022**	-0 028**
L-cigarette INLOA laws	(0.01.1)	-0.020
	(0.014)	(0.034)
R-squared	0.03	0.04
Ν	70,925	70,906

Notes: Models include province and year fixed effects, as well as controls for: age, sex (male; female is the excluded category), household size, urban status, language spoken at home (English; French, both English and French and other languages are excluded categories), immigrant status, real cigarette price and presence of menthol cigarette ban in the province. Reference age group for DDD estimates is 19-24 years. Standard errors are clustered at the province level. P-values using effective number of clusters are in parentheses. All estimates are weighted. Significance levels are: \*\*\*p < 0.01, \*\*p < 0.05, \*p<0.1.

### Effects of E-Cigarette Use on Mental Health: Two-Sample Instrumental Variables

Outcome is $\rightarrow$	Mood disorder	Anxiety disorder	E-cigarette
			use
Panel A: Effects of MLSA law on	mental disorders		
E-cigarette MLSA laws	-0.020*	-0.012	
C .	(0.075)	(0.287)	
Ν	30,954	30,937	
Panel B: Effects of MLSA law on (from Nguyen 2020, JAMA Pediat	e-cigarette use trics)		
E-cigarette MLSA laws			-0.043***
Ν			(0.006) 8,212
Panel C: Effects of e-cigarette us	e on mental disorders		
E-cigarette use	0.47*	0.28**	
	(0.06)	(0.05)	
Ν	30,954	30,937	

Notes: For each coefficient, *p* value are reported. P-values for percentage point changes in Panel C are based on the Delta method (Dee and Evans, 2003).

### **Mechanisms of Effects**

Outcome is →	Past 12 month cannabis use	Past 12 month illicit drug use	Feel close to people at schools	Feel being part of schools	Feel safe at schools
E-cigarette MLSA laws	-0.060**	-0.039*	0.017	0.021*	0.017
	(0.024)	(0.053)	(0.229)	(0.050)	(0.190)
Ν	141,967	135,796	143,677	143,432	142,796

Notes: Models include controls for grade, sex (male; female is the excluded category), real cigarette price and presence of menthol cigarette ban in the province as well as province and year fixed effects. Standard errors clustered at the province level. P-values using effective number of clusters are in parentheses. All estimates are weighted. Significance levels are: \*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.1.

## MLSA law for e-cigarettes reduces cannabis and illicit drug use & increases feeling of being part of schools

### **Event Study**



Note: Data are from CCHS 2008-May 2018. Shown are estimated effects from difference-in-differences regressions in which a single policy indicator variable is replaced by a series of event time indicators for yearly intervals before and after the implementation of MLSA law in each province. 1 year immediately preceding the MLSA law is the reference time period.

### No systematic trend in differences between control and treatment groups in pre-policy period

### Tests for Homogeneity in Treatment Effects (Jakiela 2021)



### **Bacon Decomposition**



Anxiety disorder



Overall DD Estimate = -.00701587 Within component = .03760044 (weight = .0143806) Overall DD Estimate = -.00919977 Within component = -.04751761 (weight = .0143806)

	Mood dis	order	Anxiety d	isorder
Comparison	Coefficient	Weight	Coefficient	Weight
Early vs Late Treated as Control	-0.004	0.37	0.008	0.37
Late vs Early Treated as Control	0.001	0.06	-0.00009	0.06
Treated groups vs Never treated	-0.001	0.56	-0.008	0.56

### Effects of MLSA on Mental Health and E-cigarette Use: Imputation Method for DD (Borusyak, Jaravel & Spiess, 2021)

Outcome is $\rightarrow$	Mood disorder (2008-May 2018)	Anxiety disorder (2008-May 2018)	E-cigarette Use (2013-2017)
E-cigarette MLSA laws	-0.025***	-0.015	-0.046***
Ν	(0.005)	(0.013)	(0.009)
Ν	30,954	30,937	8,212

Standard errors in parentheses. Significance levels are: \*\*\*p < 0.01, \*\*p < 0.05, \*p<0.1.

#### **Results similar to base case analysis**

### STUDY 2: EFFECTS OF E-CIG MLSA ON YOUTH SMOKING



### Rising E-Cigarette Use Amid Declining Smoking Rates

FIGURE 7.4: PERCENTAGE OF YOUTH AGED 15-19 WHO HAVE EVER SMOKED A WHOLE CIGARETTE, BY AGE, 1999-2017



DATA SOURCES: CANADIAN TOBACCO USE MONITORING SURVEY (CTUMS), 1999-2012; CANADIAN STUDENT TOBACCO, ALCOHOL AND DRUGS SURVEY (CSTADS), 2013, 2015; 2017

Source: University of Waterloo. https://uwaterloo.ca/tobacco-usecanada/youth-tobacco-use/smoking-initiation/ages-15-19



Source: Institut de cardiologie de Montreal 2020. https://observatoireprevention.org/en/2020/06/30/smokingcontinues-to-decline-among-young-people/

Decline in smoking started before e-cig introduced



- Recent declines in smoking larger
- No resurgence in smoking alongside increased vaping

#### E-cigarettes vs Combustible cigarettes: Substitutes or Complements??

### **Existing Studies**

#### MLSA laws



- Early studies (Friedman 2015, Pesko et al 2016) used aggregate state-level data
  - Found e-cigarette MLSA laws increase cigarette use (i.e. substitutes)
- Later studies with individual level data found mixed results
  - Reduction in cigarette use (Abouk & Adams 2017; Dutra et al. 2018)
  - Increase in cigarette use (Dave et al. 2019)

#### Effects of cigarette and e-cigarette prices and taxes

Stoklosa, Drope, and Chaloupka 2016; Zheng et al. 2016, 2017; Pesko and Warman, 2017, 2021, 2022; Huang et al. 2018; Cotti et al. 2018, 2022; Pesko et al. 2018; Cantrell et al. 2019; Pesko, Courtemanche, and Maclean 2020; Saffer et al., 2018, 2020; Abouk et al., 2021; Allcott & Rafkin 2021

### Study Outcomes & Data

#### **Study Outcomes Smoking Participation Smoking Initiation** Ever cigarette use Past 12-month smoking initiation

Current cigarette use

#### Past 12-month initiation into • regular smoking

Past 12-month initiation into experimental smoking

#### **Smoking Cessation**

Past 12-month smoking cessation

#### Data sources:

- Canadian Tobacco Use Monitoring Survey (CTUMS) 2004 2012
- Canadian Tobacco, Alcohol and Drugs Survey (CTADS) 2013-2017
- Youth Smoking Survey/Canadian Student Tobacco Alcohol and Drugs Survey (in robustness check)

#### -> More accurate coding of policy exposure with survey month information

#### Trends in Combustible Cigarette Use



Note: Treated provinces are Newfoundland and Labrador, Prince Edward Island, Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, and British Columbia. Control provinces are Alberta and Saskatchewan. Solid vertical lines indicate start and end years for implementing provincial e-cigarette MLSA laws. The dashed vertical line indicates the implementation date for the national e-cigarette MLSA law, i.e., May 2018.

### Effect of E-Cig MLSA law on Smoking Participation: DD & DDD Results – 2004-2017

	DD Results		DDD	DDD Results		
Outcome is $\rightarrow$	Ever cigarett e use	Current cigarette use	Ever cigarette use	Current cigarette use		
Panel A: Full sample						
E-cigarette MLSA laws	-0.002	0.004	0.006	0.024		
	(0.923)	(0.783)	(0.893)	(0.433)		
Ν	46,000	46,000	105,978	105,975	Finding: No significant	
Panel B: Youths aged 1	<u>5-16</u>				effects of e-	
E-cigarette MLSA laws	-0.006	0.019	0.012	0.040	cigarette MLSA	
	(0.831)	(0.507)	(0.810)	(0.205)	laws on smoking	
Ν	24,698	24,698	82,136	82,133	participation	
Panel C: Youths aged 1	<u>7-18</u>					
E-cigarette MLSA laws	-0.005	-0.014	0.008	0.009		
	(0.887)	(0.577)	(0.869)	(0.834)		
Ν	21,302	21,302	81,281	81,277		

P values are in parentheses. Significance levels are: \*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.1.

# Effect of E-cigarette MLSA law on Smoking Initiation & Cessation: DD Results – 2004-2017

Outcome is $\rightarrow$	Smoking initiation in past 12	Smoking initiation into regular	Smoking experimentation	Smoking cessation in past 12	
	months	smoking		months	
<u>Full Sample</u> Pre-policy mean of the outcome	0.025	0.008	0.018	0.064	Lower smoking
E-cigarette MLSA laws	-0.026** (0.045)	-0.012 (0.195)	-0.015** (0.048)	-0.015 (0.757)	among 17-18
R-squared N	0.00 35,859	0.00 35,196	0.00 35,539	0.01 5,541	year olds
Youths aged 15-16					$\backslash$
Pre-policy mean of the outcome	0.026	0.007	0.019	0.070	
E-cigarette MLSA laws	-0.015	-0.010	-0.006	0.003	$\backslash$
-	(0.324)	(0.496)	(0.390)	(0.945)	
R-squared	0.00	0.00	0.00	0.02	Effect on cessation
N	20,834	20,455	20,660	2,020	imprecisely
Voutho aread 17 19					estimated but large
Pre-policy mean of the outcome	0.024	0.009	0.016	0.061	magnitude for 17-
E-cigarette MLSA laws	-0.042**	-0.017	-0.026*	-0.042	18 year olds
C C	(0.018)	(0.118)	(0.097)	(0.469)	
R-squared	0.01	<b>`0.00</b> ´	0.01	<b>`0.03</b> ´	
N	15,025	14,741	14,879	3,521	

P values in parentheses. Significance levels are: \*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.1.

### Effect of E-Cig MLSA law on Smoking Initiation & Cessation: DDD Results – 2004-2017

Smoking initiation	Smoking	Smoking	Smoking
in past 12 months	initiation into	experimentation	cessation in past
	regular smoking		12 months
-0.018	-0.010	-0.008	-0.041
(0.177)	(0.348)	(0.215)	(0.413)
0.01	0.00	0.01	0.01
67,485	66,639	67,036	21,625
-0.002	-0.003	0.001	0.036
(0.909)	(0.856)	(0.869)	(0.243)
0.01	0.01	0.01	0.01
50,833	50,289	50,549	17,538
-0.032**	-0.018	-0.016	-0.073
(0.028)	(0.168)	(0.218)	(0.174)
0.01	0.01	0.01	0.01
46 651	46 184	46 376	19 605
	Smoking initiation in past 12 months (0.177) 0.01 67,485 -0.002 (0.909) 0.01 50,833 -0.032** (0.028) 0.01 46,651	Smoking initiationSmoking initiation into regular smoking-0.018-0.010 $(0.177)$ $(0.177)$ $(0.348)$ $0.01$ $0.01$ $0.00$ $67,485$ $66,639$ -0.002-0.003 $(0.856)$ $0.01$ $0.01$ $0.01$ $50,833$ $50,289$ -0.032**-0.018 $(0.168)$ $0.01$ $0.01$ $0.01$ $46,651$	Smoking initiation in past 12 months initiation into regular smoking Smoking experimentation   -0.018 -0.010 -0.008   (0.177) (0.348) (0.215)   0.01 0.00 0.01   67,485 66,639 67,036   -0.002 -0.003 0.001   (0.909) (0.856) (0.869)   0.01 0.01 0.01   50,833 50,289 50,549   -0.032** -0.018 -0.016   (0.028) (0.168) (0.218)   0.01 0.01 0.01   46,651 46,184 46,376

P values in parentheses. Significance levels are: \*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.1.

- Consistent with DD results
- Null effect on participation due to offsetting reductions in smoking initiation and cessation, concentrated among 17-18 year olds

### **Event Study: Smoking Participation**



No significant differences in trends between treated and control provinces in prepolicy period

### **Bacon Decomposition**



Within component = -.11811754 (weight = .01207427)

Comparison	Coefficient	Weight
Early vs Late treated as control	-0.015	0.42
Late vs early treated as control	-0.0003	0.01
Treated vs Never treated	-0.012	0.57



Overall DD Estimate = -.00806664 Within component = -.0829403 (weight = .01207427)

Comparison	Coefficient	Weight
Early vs Late treated as control	-0.007	0.42
Late vs early treated as control	-0.0003	0.01
Treated vs Never treated	-0.0007	0.57

#### Current cigarette use

### Robustness check: Callaway and Sant'Anna (2021)

	Ever cigarette use	Current cigarette use	Smoking initiation in past 12 months	Smoking initiation into regular smoking	Smoking experimentation	Smoking cessation in past 12 months
Only Never Treated	as Control					
Full sample	-0.040	-0.021	-0.004	-0.001	-0.003	-0.068**
	(0.038)	(0.031)	(0.008)	(0.010)	(0.004)	(0.034)
Age 15-16	-0.036*	-0.006	0.004	0.009	-0.005**	-0.038
	(0.019)	(0.020)	(0.012)	(0.013)	(0.002)	(0.041)
Age 17-18	-0.045	-0.035	-0.015***	-0.017	0.000	-0.103
	(0.063)	(0.046)	(0.006)	(0.012)	(0.009)	(0.066)
Never Treated + Not	Yet Treated as C	ontrol				
Full sample	-0.039	-0.014	-0.001	0.002	-0.003	-0.098***
	(0.036)	(0.030)	(0.007)	(0.008)	(0.005)	(0.038)
Age 15-16	-0.048***	-0.009	0.008	0.014	-0.006***	-0.064
	(0.014)	(0.018)	(0.010)	(0.011)	(0.002)	(0.070)
Age 17-18	-0.034	-0.023	-0.014***	-0.016	0.001	-0.135*
	(0.061)	(0.045)	(0.005)	(0.012)	(0.010)	(0.075)

### **STUDY 3:**

### EFFECTS OF E-CIG FLAVOR BAN & NICOTINE CAPS ON YOUTH VAPING AND SMOKING



### Flavor Bans and Nicotine Caps in Canada



#### **EXISTING STUDIES**

- Lower e-cigarette sales (Ali et al. 2022)
- Lower combustible cigarette use (Friedman 2021)

### **Data and Study Outcomes**



### Trends in E-cigarette Use and Cigarette Use, Nova Scotia vs Control Provinces



### Trends in E-cigarette Use and Cigarette Use, British Columbia vs Control Provinces



### Difference-in-Differences Results

Outeema	Deet 20 deux e simerette une	Dest 20 dev sizerette ves
Outcome	Past 30-day e-cigarette use	Past 30-day cigarette use
Panel A: Nova Scotia vs Control		
rovinces		
Age 15-19	-0.082**	-0.025*
	(0.019)	(0.008)
Ν	12,055	55,907
Age 20-24	-0.002	0.010
	(0.905)	(0.008)
Ν	11,057	44,693
<u>Panel B: British Columbia vs</u>		
Control provinces		
Age 15-19	-0.047	0.012
	(0.019)	(0.010)
Ν	12,193	55,390
Age 20-24	0.027	0.067***
	(0.018)	(0.008)
N	11,232	44,249

### Robustness Checks

Outcome	Nova Scotia vs Control provinces		British Columbia vs Control provinces	
	Past 30-day e-	Past 30-day	Past 30-day e-	Past 30-day
	cigarette use	cigarette	cigarette use	cigarette use
		use		
Panel A: Excludin	ng control for cigarette C	PI		
Age 15-19	-0.081**	-0.024	-0.047*	0.009
	(0.016)	(0.013)	(0.016)	(0.012)
Ν	12,055	55,907	12,193	55,390
Age 20-24	-0.002	0.013	0.024	0.051*
	(0.016)	(0.016)	(0.020)	(0.017)
Ν	11,057	44,693	11,232	44,249
Panel B: Syntheti	ic control			
Age 15-19		-0.021		-0.005
		(p=0.50)		(p=1.00)
Age 20-24		0.019		0.015
		(p=1.00)		(p=0.75)

### **Summary and Discussions**

- 1. E-cigarette MLSA laws reduce risks of mood and anxiety disorders
  - Benefits of MLSA laws extend beyond reducing e-cigarette use
  - E-cigarettes may **contribute** to youth mental health crisis
- 2. Null effect of e-cigarette MLSA law on youth smoking participation masks reduction in smoking initiation and lower smoking cessation
- Relationship between e-cigs and combustible cigarettes depends on smoking status
  - Never smokers: Lower smoking initiation & lower e-cig use → complements
  - Existing smokers: Lower smoking cessation & lower e-cig use → substitutes



3. Flavor bans and nicotine caps **appear to reduce e-cigarette use**, with **no changes in combustible cigarette use**.



### THANK YOU

### **Questions?**

# Synthetic Control for Combustible Cig Outcome (Flavor bans & Nicotine caps)

#### **NS VS CONTROL**

Age 15-19

Age 20-24





**BC VS CONTROL** 



Age 20-24

