

Beyond Tobacco Prevention: The Effects of Tobacco 21 Laws on Young Adults' Body Weight

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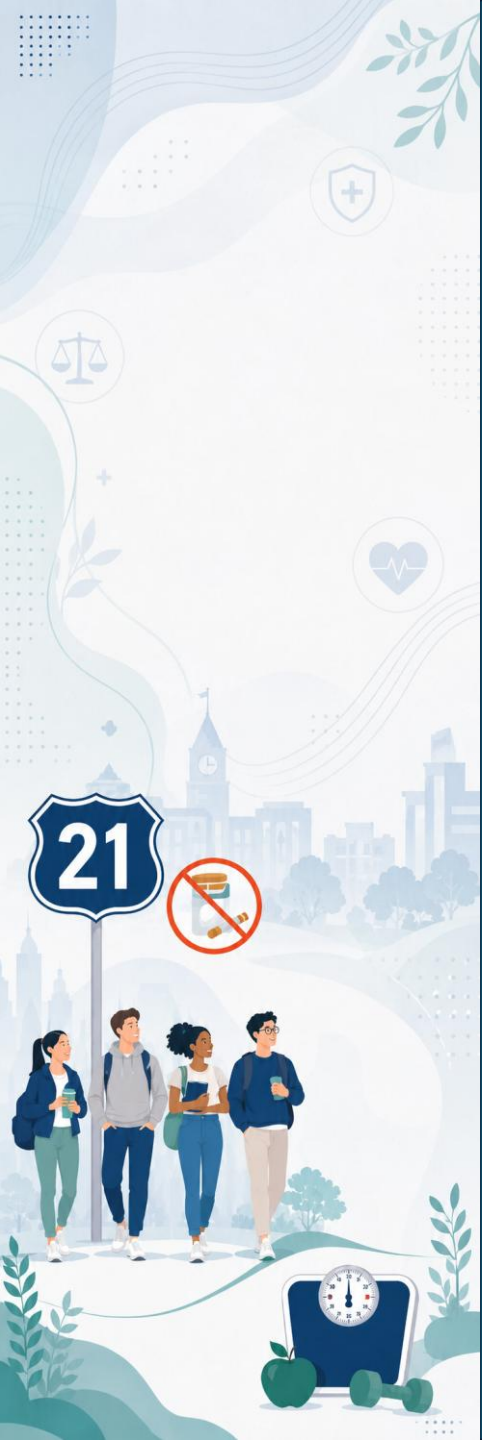
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Funding for presented work:

- No funding was received for this presented work.

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- 2023 AU-GSU internal pilot grant for a separate tobacco-related research project.
- No funding was received from tobacco companies, pharmaceutical companies, advocacy organizations, consulting, or litigation services.

Two major public health problems



Obesity

13.4% → 42.8%

Adult obesity rate rose from the 1960s to the late 2010s.

~ \$422B

annual economic cost

~ 300k

premature deaths / year



Tobacco

42% → ~12%

Adult smoking rate fell from 1965 to the early 2020s.

~ 480k

premature deaths / year

18.7%

adults still use tobacco

Tobacco regulations may affect body weight.

Tobacco regulations may affect body weight

Prior evidence is mixed:

- Higher cigarette taxes/prices reduce smoking but increase BMI or obesity.
(Chou et al., 2004; Nonnemaker et al., 2009; Baum, 2009; Tchernis et al., 2022)
- Higher cigarette taxes/prices reduce both smoking and BMI.
(Gruber and Frakes, 2006; Courtemanche, 2009; Wehby and Courtemanche, 2012)
- Worksite smoking bans and randomized cessation programs are linked to weight gain, driven by cessation.
(Liu et al., 2010; Courtemanche et al., 2018)

Tobacco regulations may affect body weight

Why may tobacco regulations **increase** body weight?

- Cessation slows metabolism and increases food craving; oral fixation; compensatory health beliefs.
(Williamson et al., 1991; Nicklas et al., 1999; Loud et al., 2021; Koksal and Wohlgenant, 2016; DeRuiter and Faulkner, 2006; Radtke et al., 2011, 2012)

Why may tobacco regulations **decrease** body weight?

- Quitting motivates healthier lifestyles; improved lung capacity; reduced tobacco spending frees resources for healthier food and fitness; complementary reduction in alcohol use.
(Courtemanche, 2009; Hedenström et al., 1986; Busch et al., 2004; Dee, 1999; Picone and Sloan, 2003)

A related concern: Could T21 increase body weight?

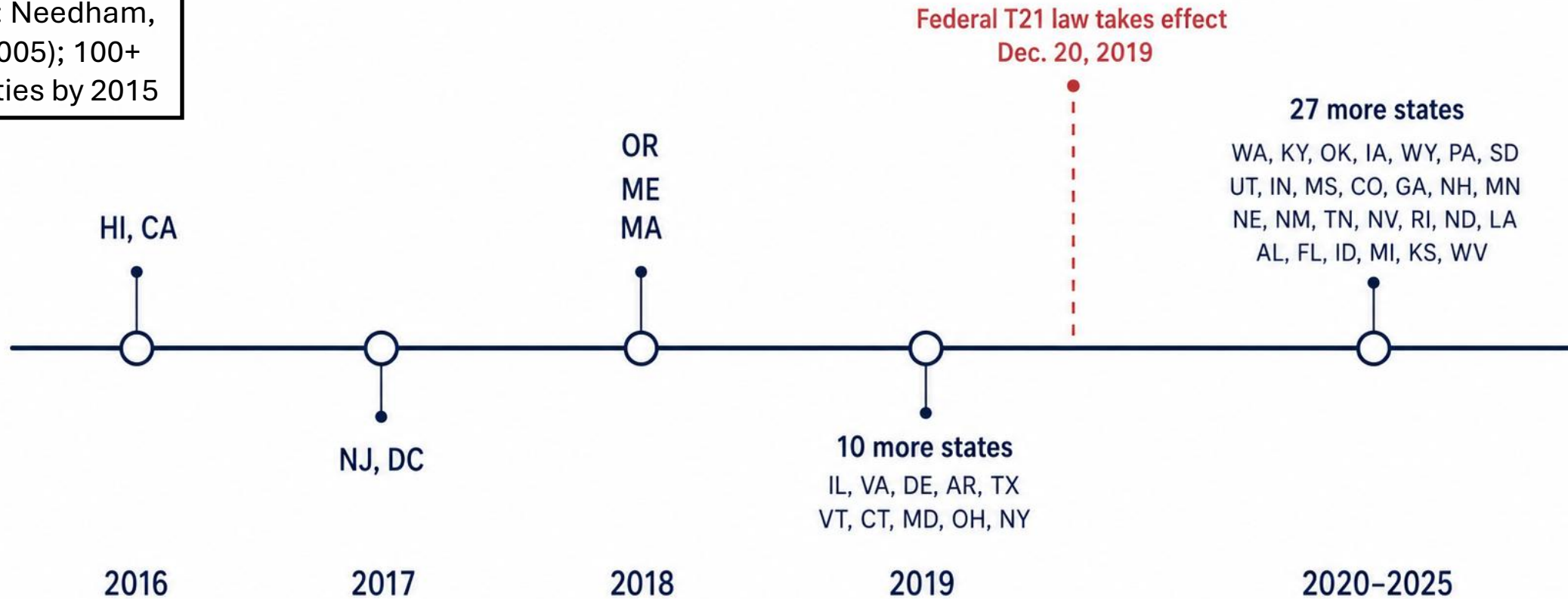
Why does this concern matter?

- T21 directly targets young adults and youths, whose long-term health habits are still forming.
 - If T21 reduces smoking but increases obesity, health gains could be partially offset.
 - If T21 improves broader health behaviors that reduce obesity, benefits may extend beyond tobacco prevention.

T21 policy history and rollout

Statewide T21 Adoption in the U.S.

Local: Needham, MA (2005); 100+ localities by 2015



7 states remained without statewide adoption by 2026: AK, AZ, MO, MT, NC, SC, WI.

Prior evidence on T21 policy effects

Youth and young adult tobacco use

- ↓ youth and young adult cigarette smoking and e-cig use.
(Friedman and Wu, 2020; Grube et al., 2021; Wilhelm et al., 2022; Hansen et al., 2023; Cotti et al., 2024; Abouk et al., 2024; Friedman and Pesko, 2024)
- No detectable change in cessation rates; ↓ smoking driven by fewer non-users initiating rather than more quitters.
(Hansen et al., 2023; Cotti et al., 2024)
- ↓ cigarette sales and large-cigar sales; effects stronger in counties with more under-21 residents.
(Ali et al., 2020; Glover-Kudon et al., 2021; Abouk et al., 2024)
- ↓ maternal smoking before and during pregnancy driven by fewer entering pregnancy as smokers; little effect on birth outcomes.
(Bersak et al., 2025; Flynn, 2025)

Prior evidence on T21 policy effects

Spillovers to other risky behaviors

- ↓ marijuana use and ↓ alcohol days among some youth.
(Hansen et al., 2023)



Potential pathways from T21 to body weight

T21 may differ from cessation-oriented tobacco regulations

- T21 targets young adults who mostly have not started smoking yet.
- Initiating nicotine doesn't necessarily reduce body weight.
(Carrasquilla et al. 2024)

Hypothesized pathways

- **Prevention effect:** T21 keeps young adults from adopting the cluster of downstream risky behaviors that often come with smoking.
- **Spillover effect:** Even *true never smokers* can benefit from healthier peers. Peer effects on diet and exercise are large in young adulthood.
(Christakis & Fowler 2007; Courtemanche 2009)

Preview of Findings

No broad weight changes in either direction.

- Obesity falls, driven by a modest weight decrease near the upper tail of the BMI distribution.
- Average BMI and overweight status show limited changes.

Improvement in weight-related health behaviors.

- Physical activities +
- Diets +
- Alcohol drinking –
- Marijuana use –
- Mental distress –

Primary data: 2009-2019 [BRFSS](#)

- Young adults aged 18-20;
- Outcomes: BMI, overweight/obese, obesity; smoking, drinking, physical activity, fruit and vegetable, mental distress.

Supplemental data: 2009-2019 [YRBS](#) (biennial)

- High schoolers aged 18+;
- Outcomes: BMI, overweight/obese, obesity; smoking, drinking, marijuana use, physical activity, fruit and vegetable, TV, soda.

Supplemental data: 2009-2019 [ATUS](#)

- Young adults aged 18-20;
- Outcomes: daily time spent doing exercise, relaxing, eating at home, eating out.

State-level controls

- Local T21 coverage;
- Other tobacco policies: cigarette taxes, state population coverages of comprehensive ISR by venue, state population coverages of comprehensive IVR by venue, standardized e-cigarette taxes, presence of MLPA for e-cigarettes at 18+;
- Alcohol & marijuana policies: beer taxes, medical marijuana laws, recreational marijuana laws;
- Weight-related policies: gasoline taxes, soda sales taxes, food sales taxes, state PE time requirements, state nutrition education standards, state school beverage nutrition standards by venue;
- Economic conditions: personal income per capita, and unemployment rates.

Baseline: Two-way fixed-effects DID

$$Y_{ist} = \beta_0 + \beta_1 T21_{st} + \beta_2 X_{ist} + \beta_3 Z_{st} + \delta_s + \tau_t + \varepsilon_{ist}$$

- Y_{ist} : outcomes; $T21_{st}$: presence of a statewide T21 law; X_{ist} : individual demographics; Z_{st} : state-level controls; δ_s : state FE; τ_t : year-month FE.

Extensions:

- Event study: dynamics and pre-trends
- Quantile regressions: distributional effects
- Subsample analysis: heterogeneous effects
- Modern DID: imputation DID and stacked DID for staggered adoption

Robustness checks for staggered policy rollout

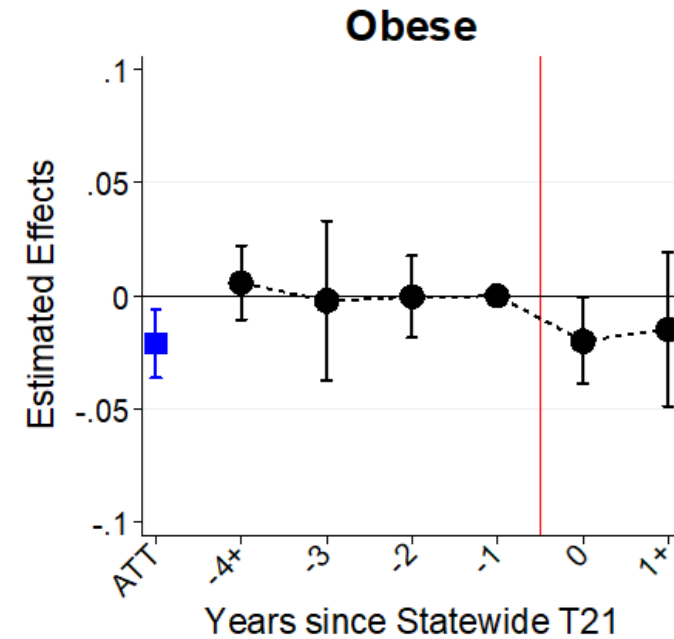
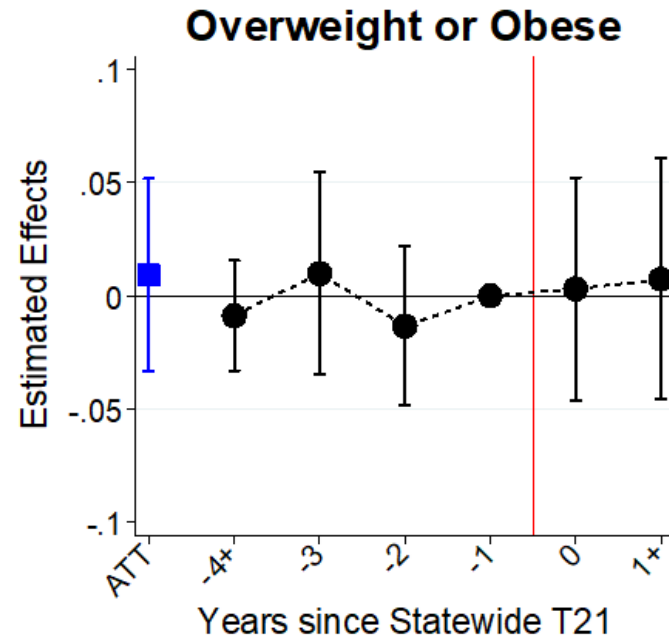
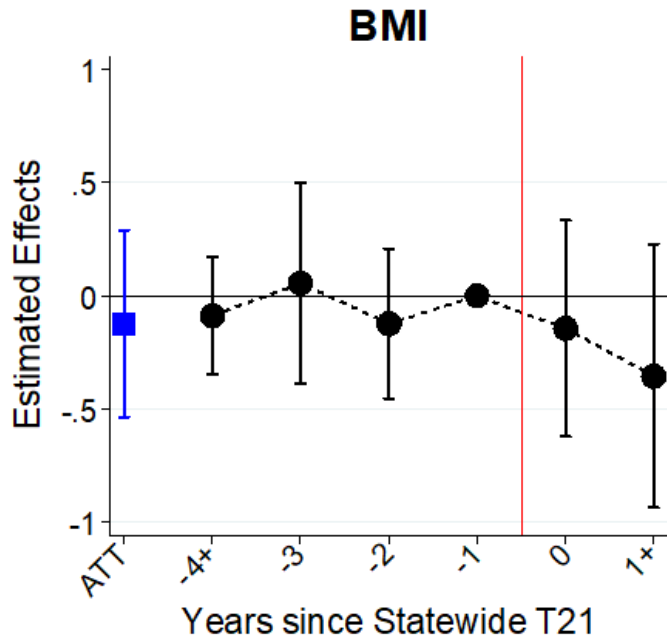
- Imputation DID:
Uses untreated observations of treated states to impute counterfactual outcomes for treated states.
(Borusyak et al., 2024)
- Trimmed stacked DID:
Builds clean treated-vs-control comparisons around each adoption cohort.
(Wing et al., 2024)

BRFSS results – TWFE DID

Dependent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
BMI	-0.112 (0.107) [-0.5%]	-0.091 (0.100) [-0.4%]	-0.088 (0.097) [-0.4%]	-0.141 (0.216) [-0.6%]	-0.151 (0.220) [-0.6%]	-0.158 (0.199) [-0.7%]	-0.123 (0.205) [-0.5%]	-0.0001 (0.232) [0.0%]
Overweight or Obese	-0.0004 (0.014) [-0.1%]	0.002 (0.013) [0.7%]	0.002 (0.013) [0.6%]	0.012 (0.021) [3.4%]	0.009 (0.022) [2.6%]	0.006 (0.021) [1.8%]	0.009 (0.021) [2.7%]	0.024 (0.027) [6.9%]
Obese	-0.008 (0.005) [-6.4%]	-0.007 (0.006) [-5.9%]	-0.007 (0.006) [-6.1%]	-0.023** (0.009) [-19.2%]	-0.022*** (0.009) [-18.6%]	-0.022*** (0.008) [-18.6%]	-0.021*** (0.008) [-17.9%]	-0.016* (0.009) [-13.9%]
Demographics		Y	Y	Y	Y	Y	Y	Y
Local T21 Coverage			Y	Y	Y	Y	Y	Y
Other Tobacco Policies				Y	Y	Y	Y	Y
Alcohol & Marijuana Policies					Y	Y	Y	Y
Weight-related Policies						Y	Y	Y
Economic Conditions							Y	Y
State-specific Trends								Y

BRFSS results – TWFE DID

Event study



- Obesity declines in the first post-T21 year and attenuates afterward.

BRFSS results – TWFE DID

Quantile regressions

Quantile	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
BMI	-0.235 (0.204) [-1.2%]	0.039 (0.150) [0.2%]	0.236 (0.159) [1.1%]	0.240 (0.164) [1.1%]	0.105 (0.158) [0.5%]	0.361 (0.228) [1.5%]	0.070 (0.272) [0.3%]	-0.580** (0.295) [-2.1%]	-1.124** (0.525) [-3.6%]
Centile Level	19.4	20.5	21.5	22.4	23.3	24.4	25.8	27.6	31.0

- Body-weight reductions are concentrated near the upper tail of the BMI distribution.

BRFSS results – TWFE DID

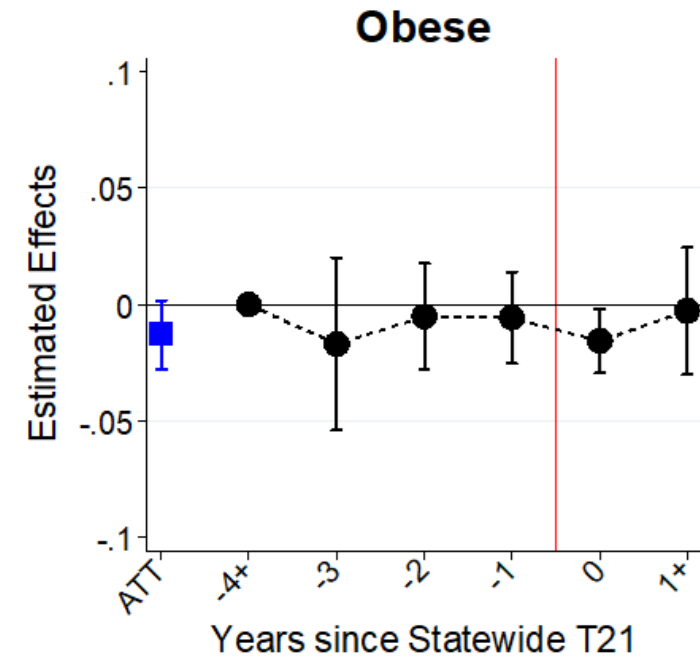
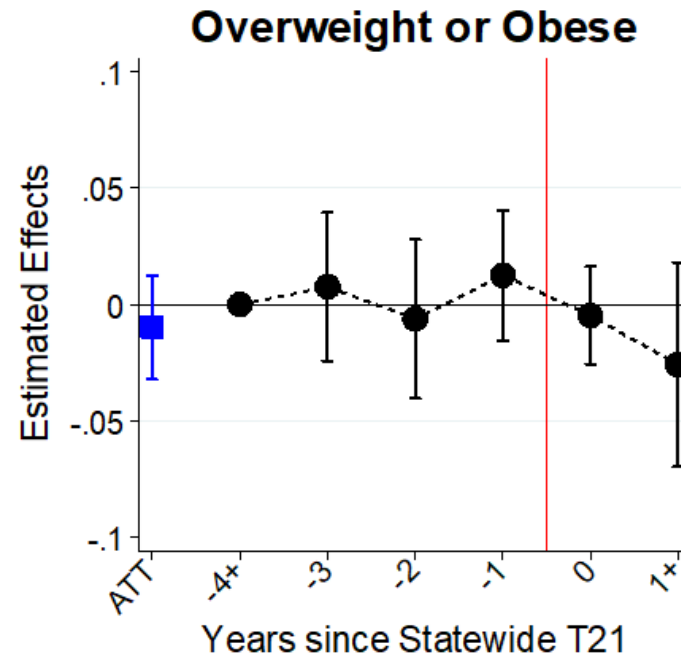
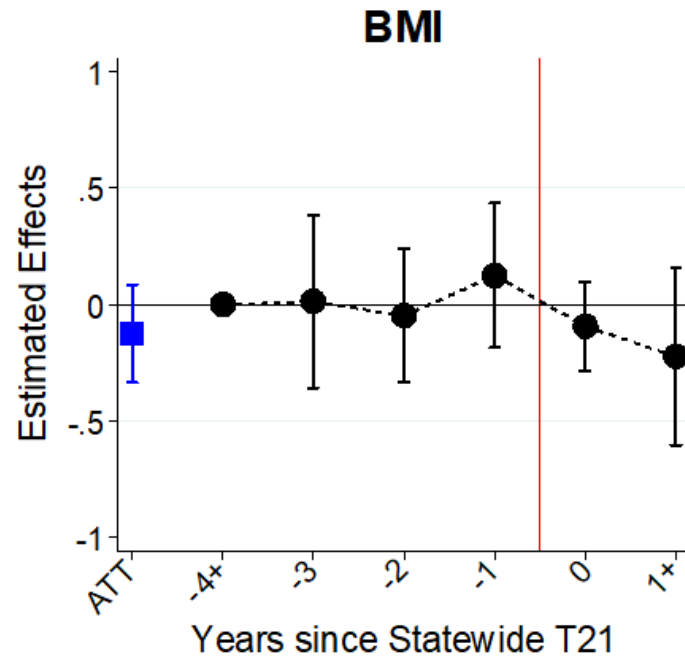
Subsample analysis

- Effects are more pronounced among males and non-Whites.
- Heterogeneous effects across education groups along the upper BMI tail.
- Effects are driven by “never smokers”, consistent with a prevention-based pathway.

	BMI (1)	Overweight or Obese (2)	Obese (3)
Male	-0.125 (0.190) [-0.5%]	-0.006 (0.023) [-1.5%]	-0.023 (0.010) ** [-19.0%]
Female	-0.061 (0.313) [-0.3%]	0.036 (0.035) [11.7%]	-0.016 (0.018) [-14.2%]
White	-0.030 (0.309) [-0.1%]	0.013 (0.032) [4.1%]	-0.017 (0.012) [-15.5%]
Nonwhite	-0.185 (0.233) [-0.8%]	0.009 (0.038) [2.3%]	-0.025 (0.012) ** [-19.5%]
High Income	-0.383 (0.553) [-1.6%]	-0.030 (0.053) [-9.7%]	-0.038 (0.025) [-38.0%]
Low Income	-0.026 (0.203) [-0.1%]	0.018 (0.020) [5.0%]	-0.014 (0.010) [-11.6%]
HSD or above	-0.117 (0.199) [-0.5%]	0.021 (0.021) [6.0%]	-0.023 (0.007) *** [-19.7%]
Less than HSD	-0.547 (0.510) [-2.3%]	-0.104 (0.053) * [-29.3%]	-0.026 (0.031) [-21.3%]
Never Smokers	-0.073 (0.212) [-0.3%]	0.013 (0.024) [3.8%]	-0.021 (0.009) ** [-17.9%]
Ever Smokers	0.010 (0.475) [0.0%]	0.016 (0.051) [4.3%]	-0.015 (0.030) [-11.3%]

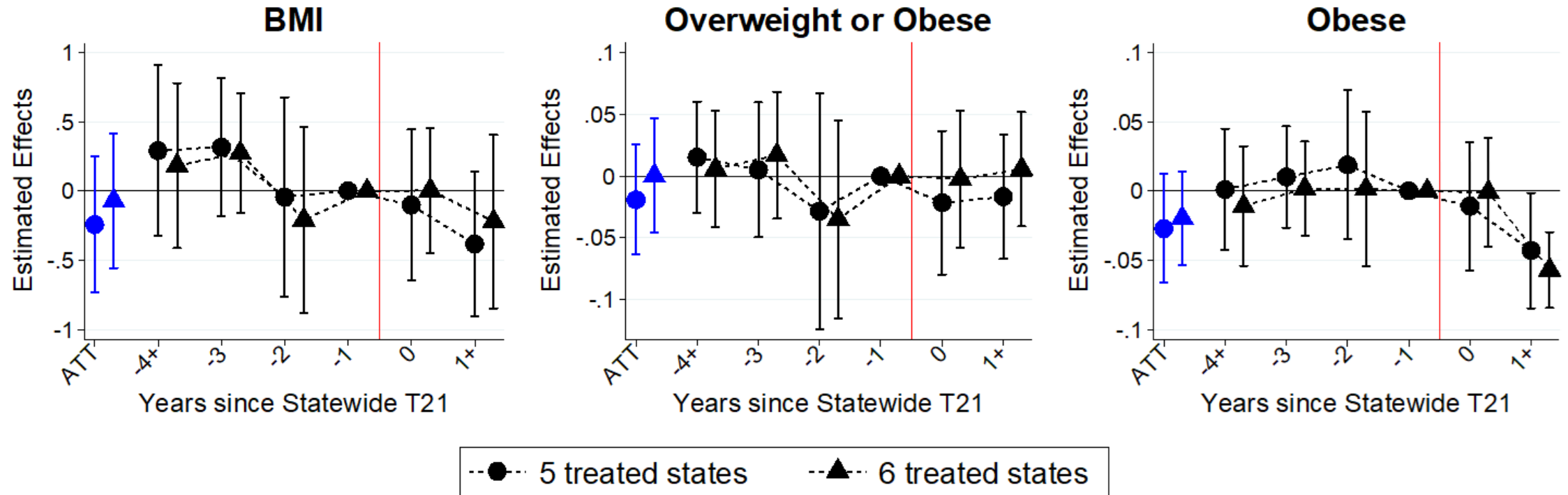
BRFSS results – Modern DID checks

Imputation DID

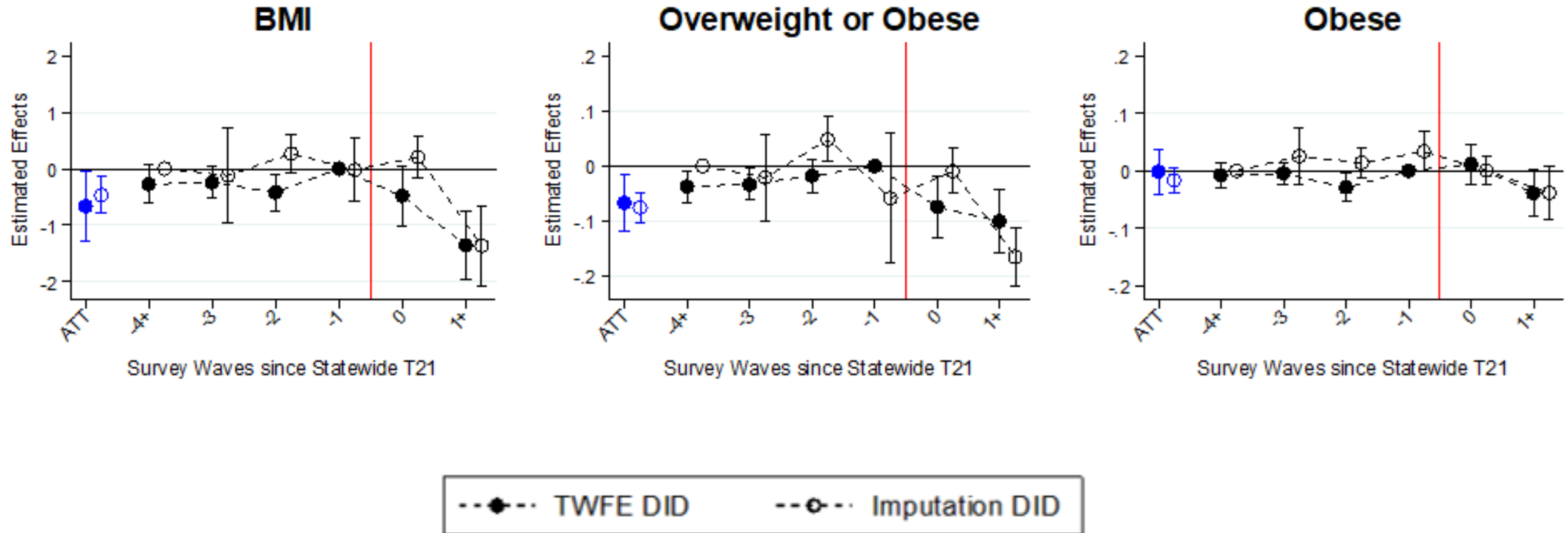


BRFSS results – Modern DID checks

Trimmed Stacked DID



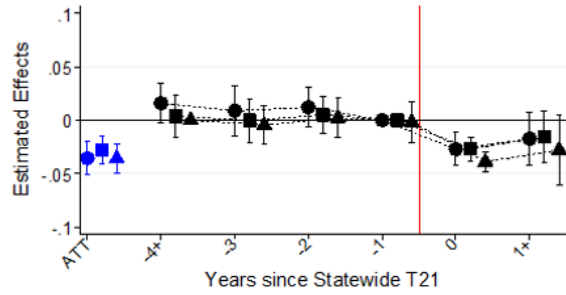
YRBS results



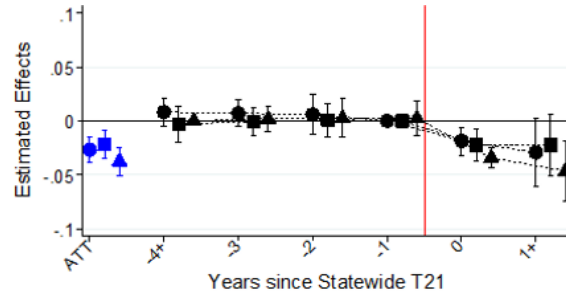
- For YRBS high schoolers aged 18+, body-weight reductions are more pronounced near the BMI cutoff for overweight (25).

Weight-related behaviors (BRFSS)

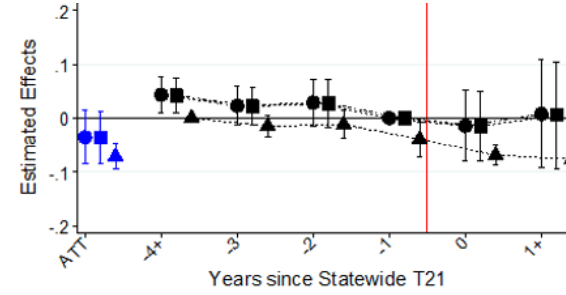
Current Smoking



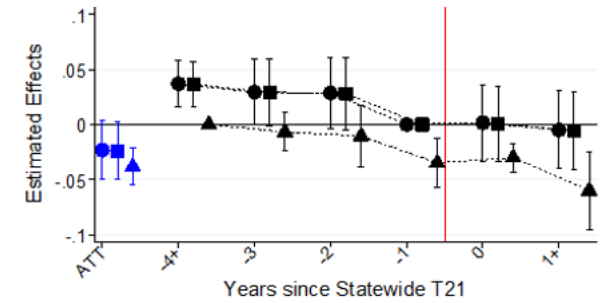
Everyday Smoking



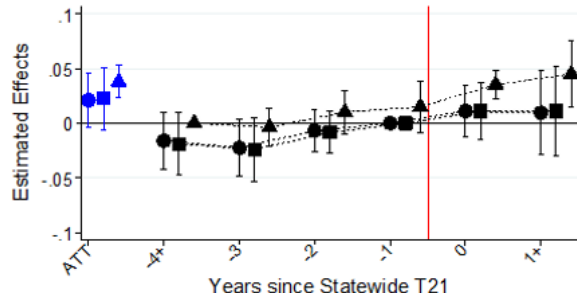
Current Drinking



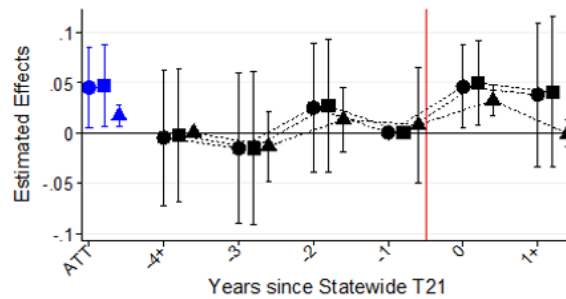
Binge Drinking



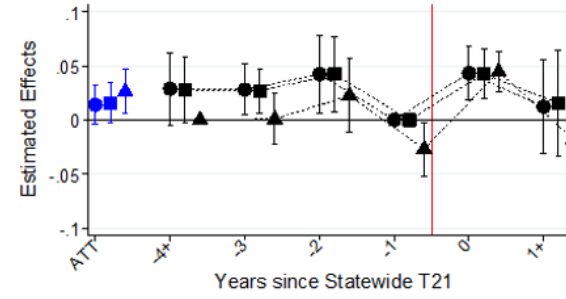
Exercise



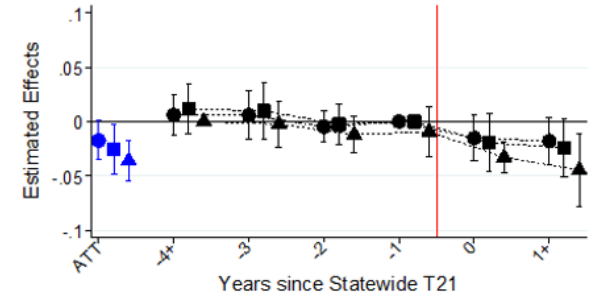
Fruit



Vegetable

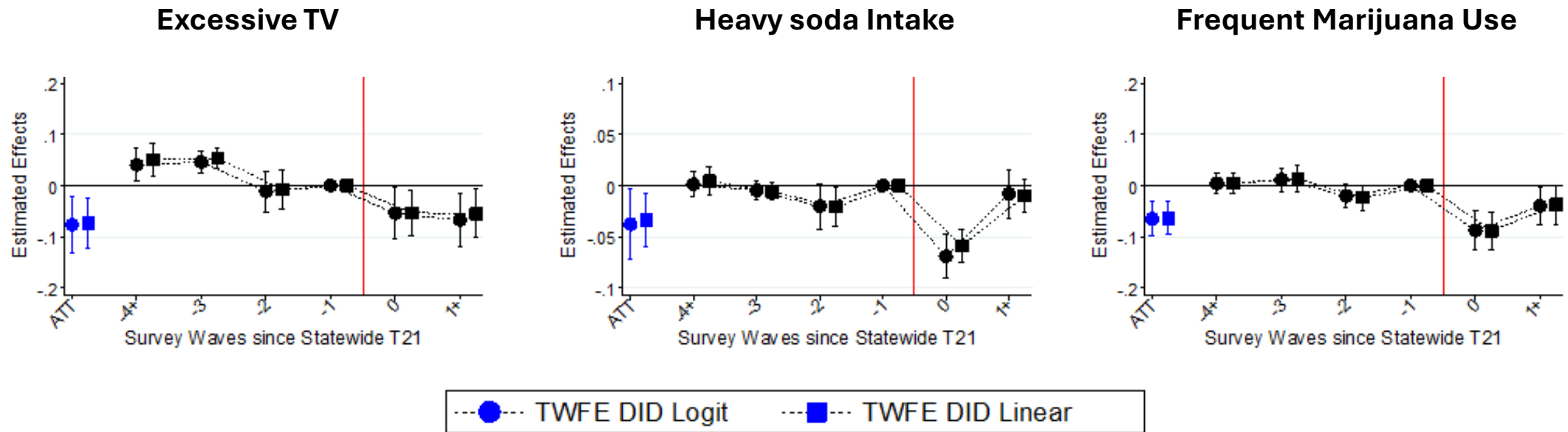


FMD



---●--- TWFE DID Logit ---■--- TWFE DID Linear ---▲--- Imputation DID

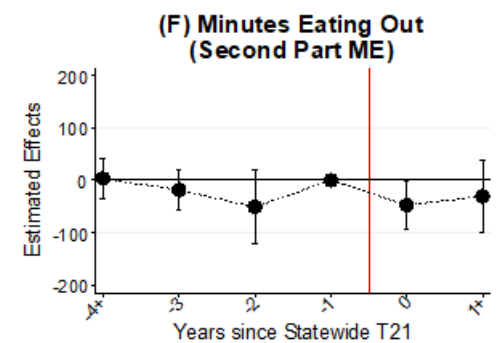
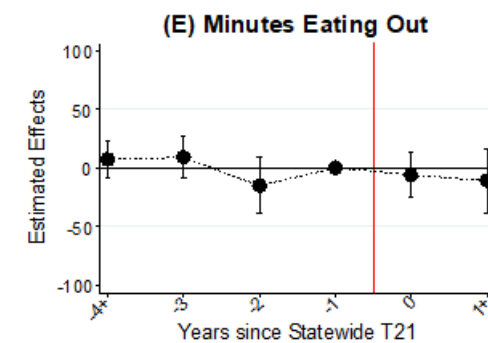
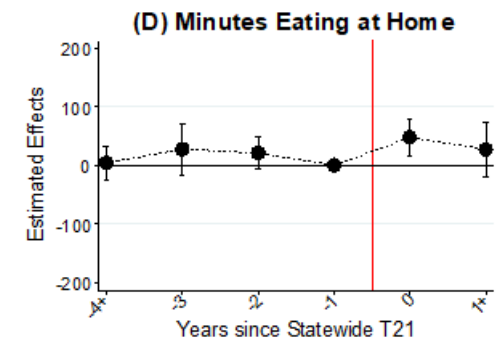
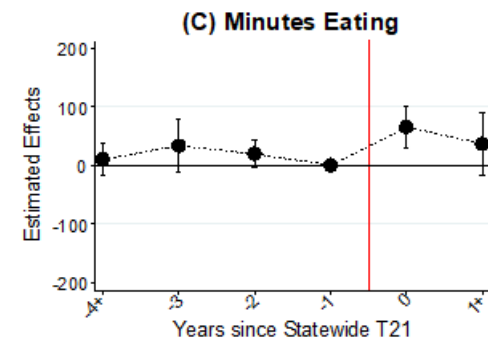
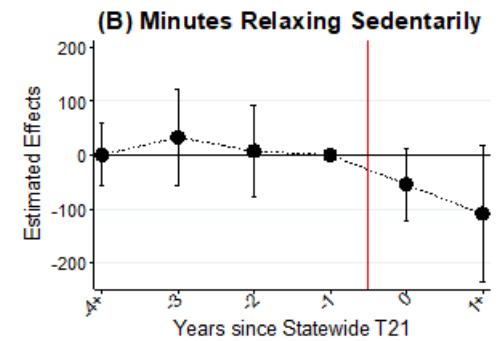
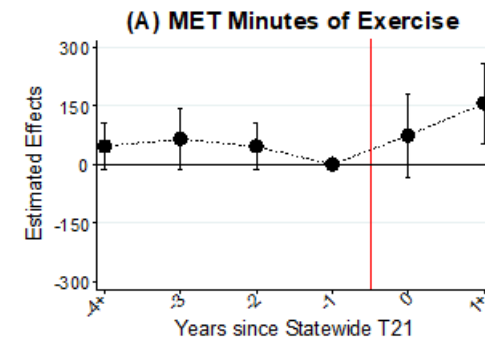
Weight-related behaviors (YRBS)



- Imputation DID is not reported because sparse biennial state-year cells in YRBS and rare outcomes make linear-based imputation DID estimates less reliable.

Weight-related behaviors (ATUS)

Dependent Variables	Estimated Coefficients		Marginal Effects
	First Part (Logit) (1)	Second Part (NB) (2)	
MET exercise	-0.169 (0.803)	0.880*** (0.218)	38.53 (34.87) [82.2%]
Relaxing sedentarily	-0.143 (0.280)	-0.187 (0.119)	-50.61* (45.41) [-20.1%]
Eating	1.428** (0.610)	0.378** (0.163)	47.19*** (15.06) [58.5%]
Eating at home	1.106*** (0.354)	0.322* (0.169)	36.44*** (11.83) [56.1%]
Eating out	0.112 (0.364)	-0.591** (0.278)	-10.03 (7.40) [-63.6%]



Conclusions and implications

Conclusions

- No evidence that T21 worsens body weight outcomes among young adults.
- No broad weight reduction either. Obesity declines, driven by upper tail change of which size is modest.
- Some improvements in weight-related behaviors.
- T21 appears to avoid cessation-related weight gain and may support healthier lifestyle formation among at-risk young adults.



Implications

- Youth-focused tobacco control policies may generate broader public health benefits beyond tobacco prevention goals.
- Heterogeneous effects suggest larger benefits for some groups than others.

Thank you! 😊

Q&A time



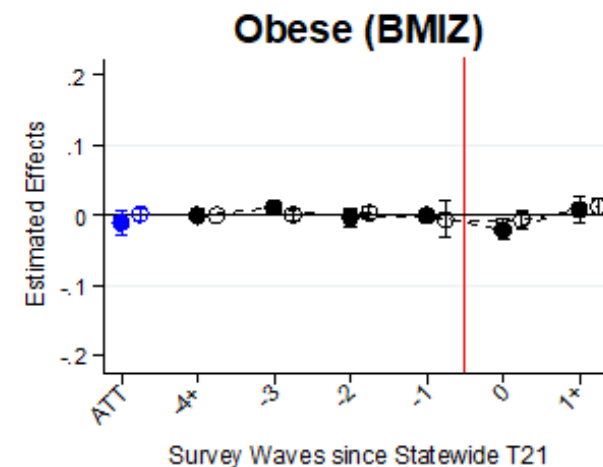
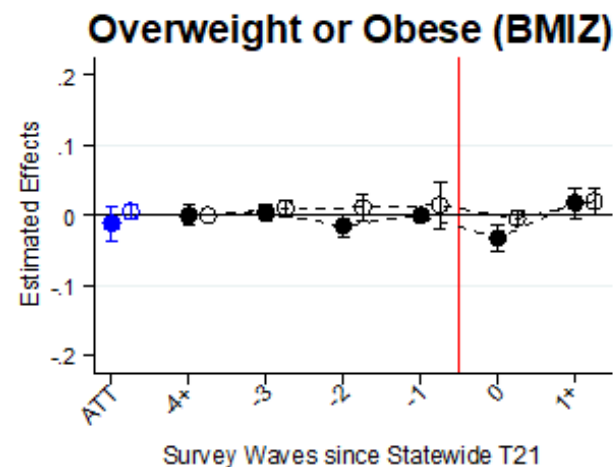
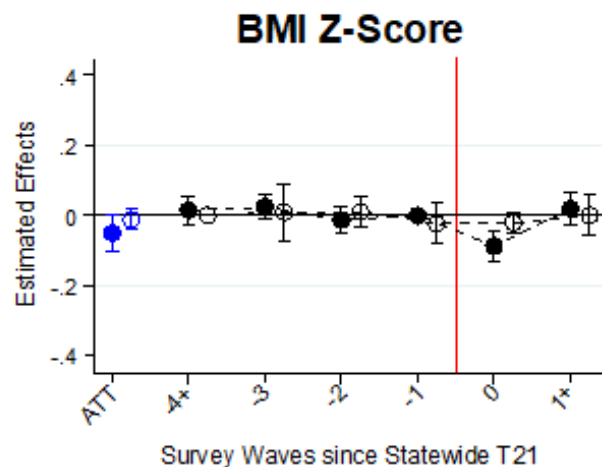
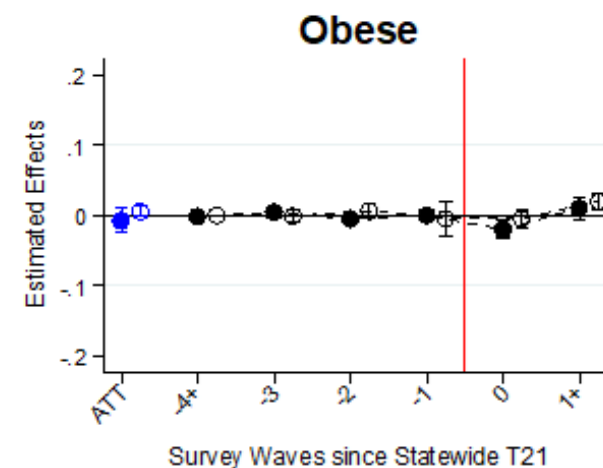
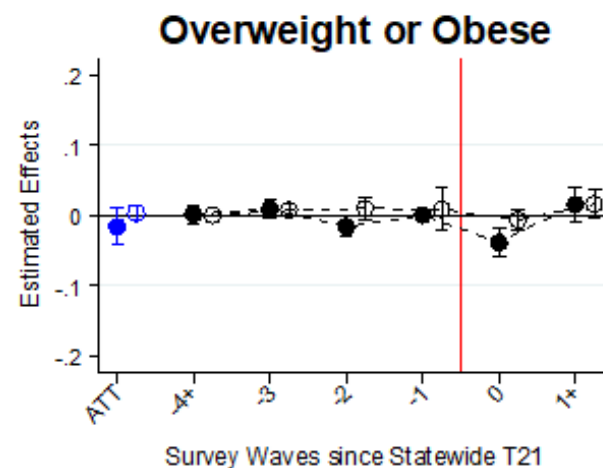
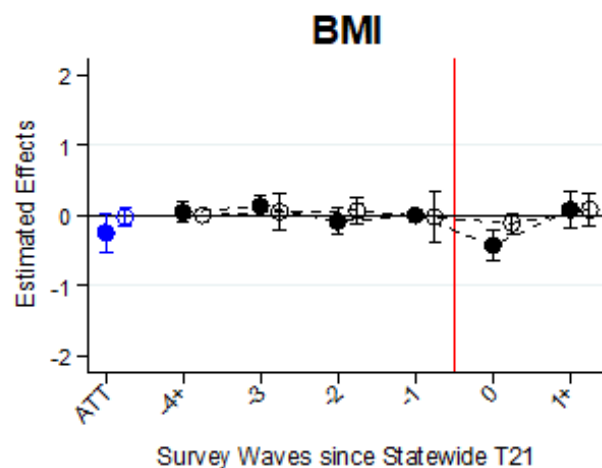
YRBS Quantile regressions

Quantile	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
BMI	-0.536	-0.232	-0.339	-0.468	-0.817*	-1.136**	-1.493**	-0.977	-1.092
	(0.329)	(0.341)	(0.389)	(0.379)	(0.436)	(0.507)	(0.596)	(0.731)	(1.005)
	[-2.8%]	[-1.1%]	[-1.6%]	[-2.1%]	[-3.5%]	[-4.7%]	[-5.8%]	[-3.5%]	[-3.5%]
Centile Level	19.1	20.3	21.2	22.1	23.0	24.2	25.6	27.6	31.4

- For YRBS high schoolers aged 18+, body-weight reductions are more pronounced near the BMI cutoff for overweight (25).

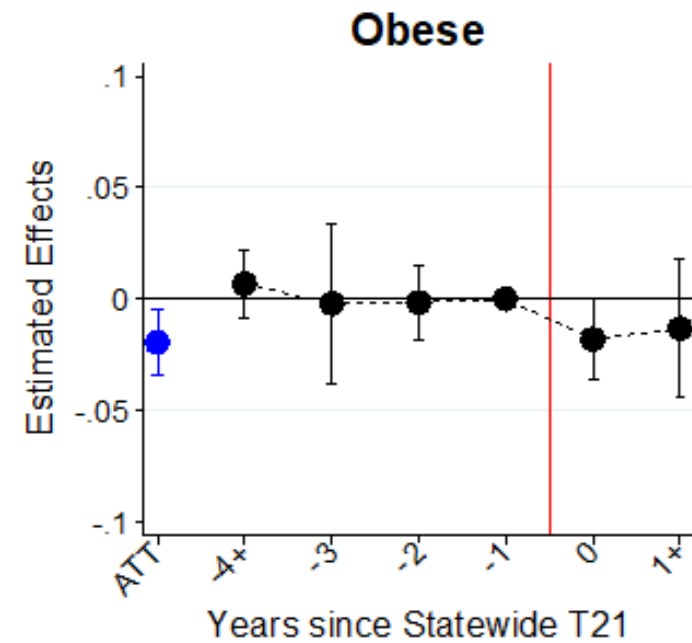
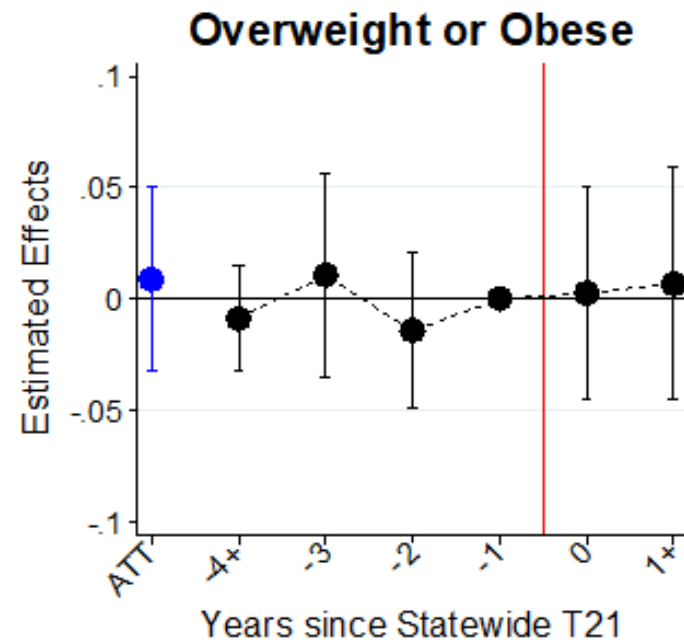
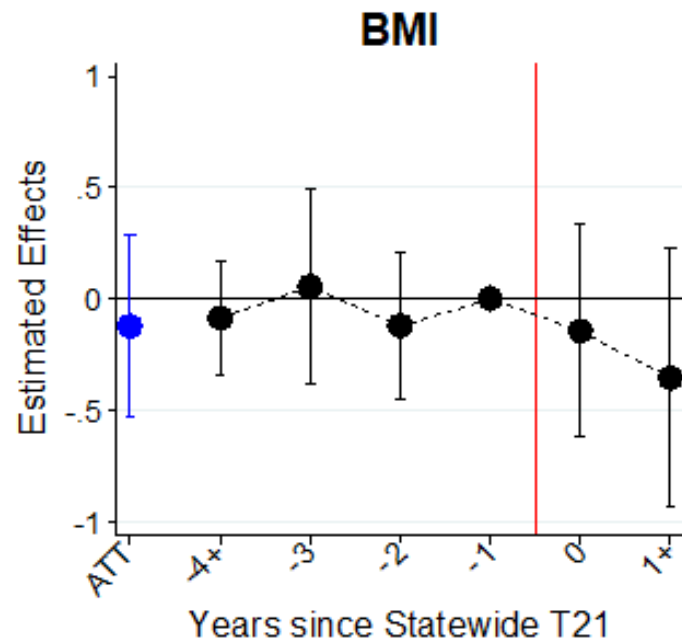
Extra slides

YRBS Age 15-17

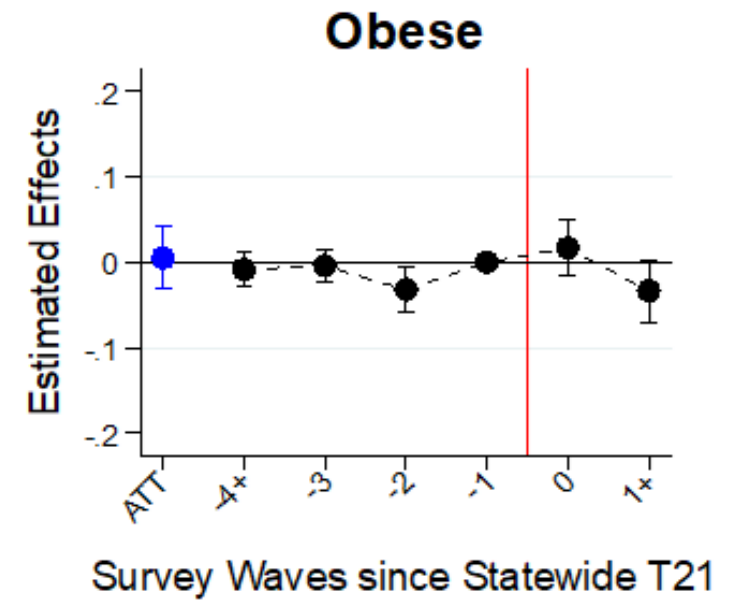
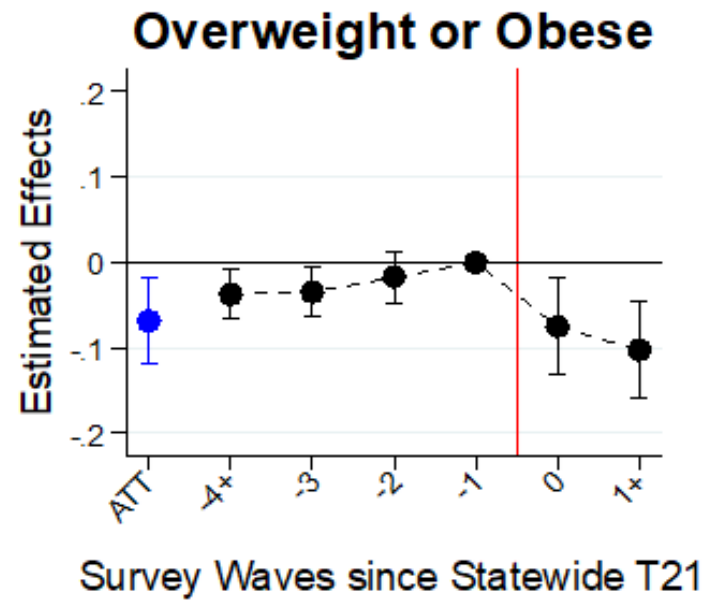
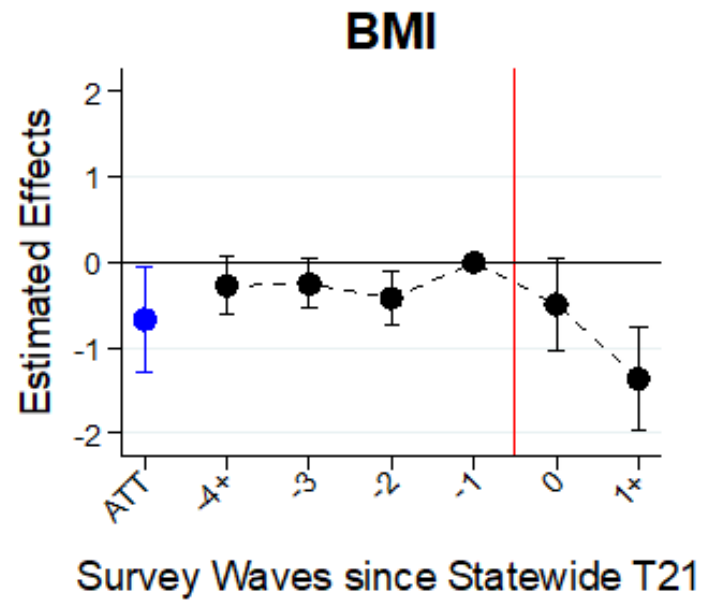


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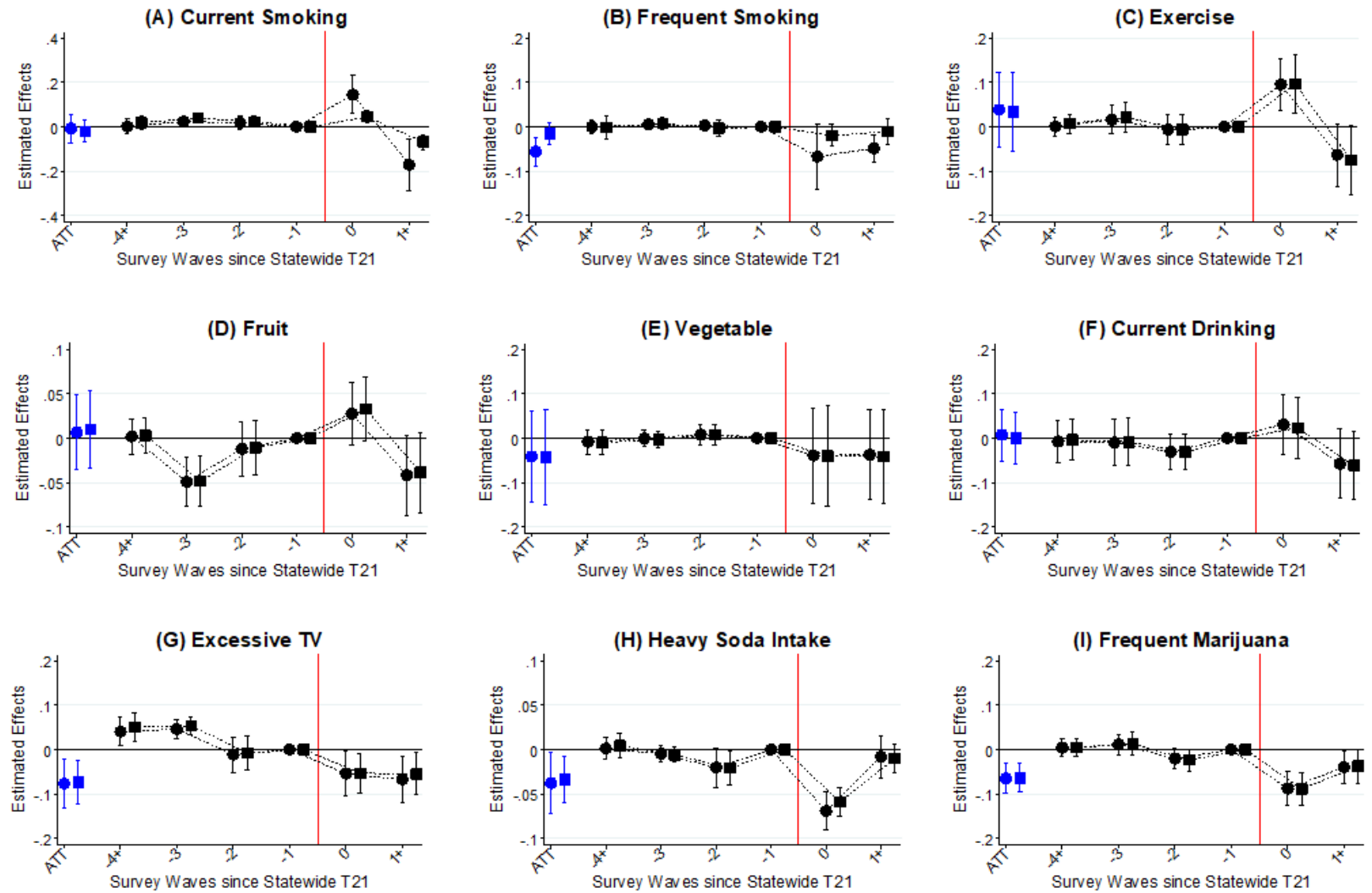
BRFSS Logit



YRBS Logit



YRBS Behaviors



---●--- TWFE DID Logit ---■--- TWFE DID Linear