# IMPACT OF VAPING RESTRICTIONS IN PUBLIC PLACES ON SMOKING AND VAPING

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# DISCLOSURES

- Funding source
  - Pilot grant through Medical University of South Carolina (PI: Michael Cummings & Geoffrey Fong; NCI grant P01-CA200512).

- Conflicts of interest: nothing to disclose

# FINDINGS

- Indoor vaping restriction (IVR) coverage reduced adult vaping, with greater effect found among 18-35 aged subgroup.

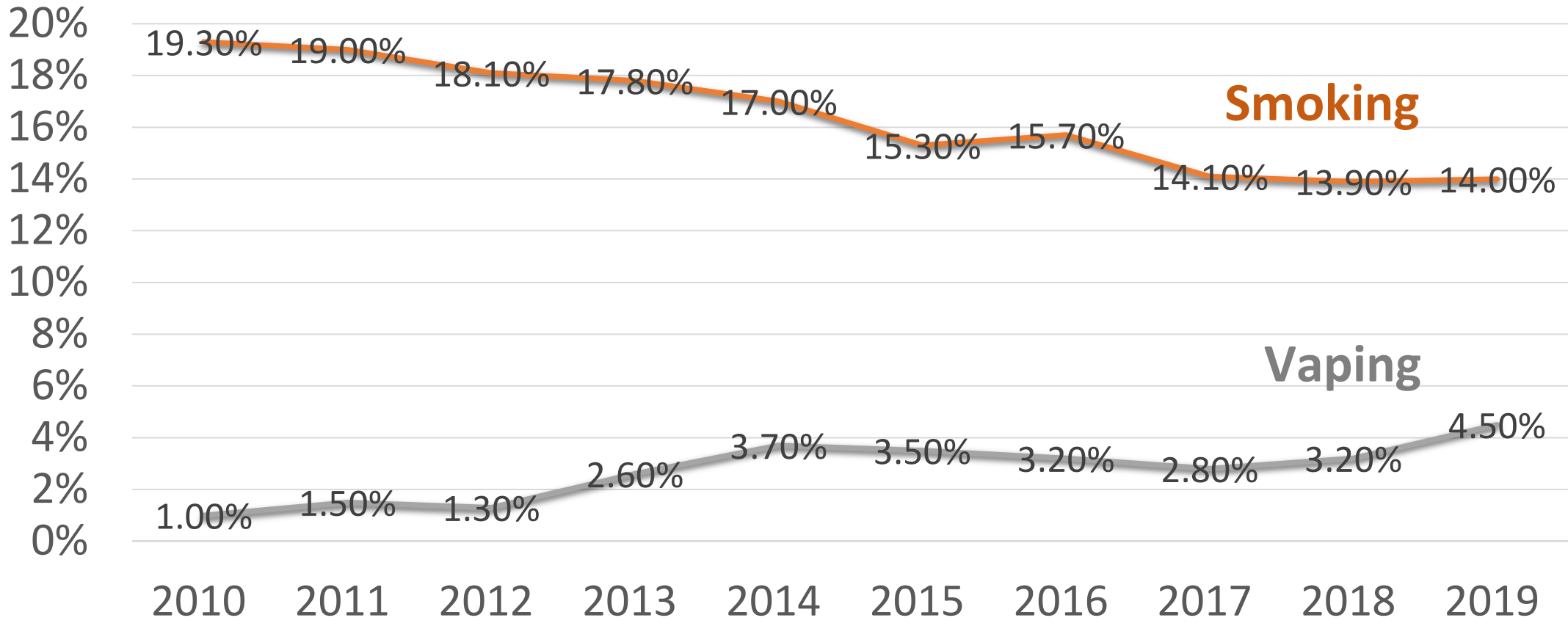
- IVR coverage increased adult cigarette smoking, with pronounced impact found among aged 35-54, males, those with more years of education and higher income.

# NICOTINE VAPING PRODUCTS (NVPs)

- NVPs commonly known as e-cigarettes
  - Sometimes called e-cigs, mods, tank systems, or electronic nicotine delivery systems (ENDS)
  - Devices operate by heating a liquid solution that produces an aerosol to inhale
- Deemed tobacco products under FDA's regulations
- NVPs claim of less harmful and less toxic than combustible cigarettes

(National Academies of Sciences Engineering and Medicine, 2018; Royal College of Physicians, 2016)

# TRENDS OF ADULT SMOKING AND VAPING 2010-2019




Source: CDC MMWR reports; CDC NCHS reports; original data come from NHIS

# ROLES AND IMPACTS OF VAPING ON SMOKING

- NVPs harm or benefit adults
  - If vaping completely replaced smoking (i.e., substitutability) -> NVPs benefit adult health
  - If vaping coupled with smoking (i.e., complementarity) -> NVPs harm adult health

- NVPs harm youths
  - Vaping increases youth nicotine dependence (esp. for those would not use cigarettes otherwise)
  - Vaping increases later-on cigarette smoking

# STUDY OBJECTIVES

- Investigate how indoor vaping restriction (IVR) influence vaping and cigarette smoking

- Aim to tackle relationship between vaping and cigarette smoking among adults
  - How IVR influence smoking?
  - economic substitutability? complementarity?

# LITERATURE ON REALTIONSHIPS BETWEEN VAPING AND SMOKING

- Public health literature
  - NVP use patterns and its profiles
  - Motivations for NVP use
  - NVP use and smoking cessation
- Economics literature
  - Experimental and quasi-experimental designs
  - Regulations on smoking or vaping and its impact on use of the other product
    - State level policies: taxations, clean indoor air laws, T21 policies

# LITERATURE ON IMPACT OF VAPING RESTRICTIONS

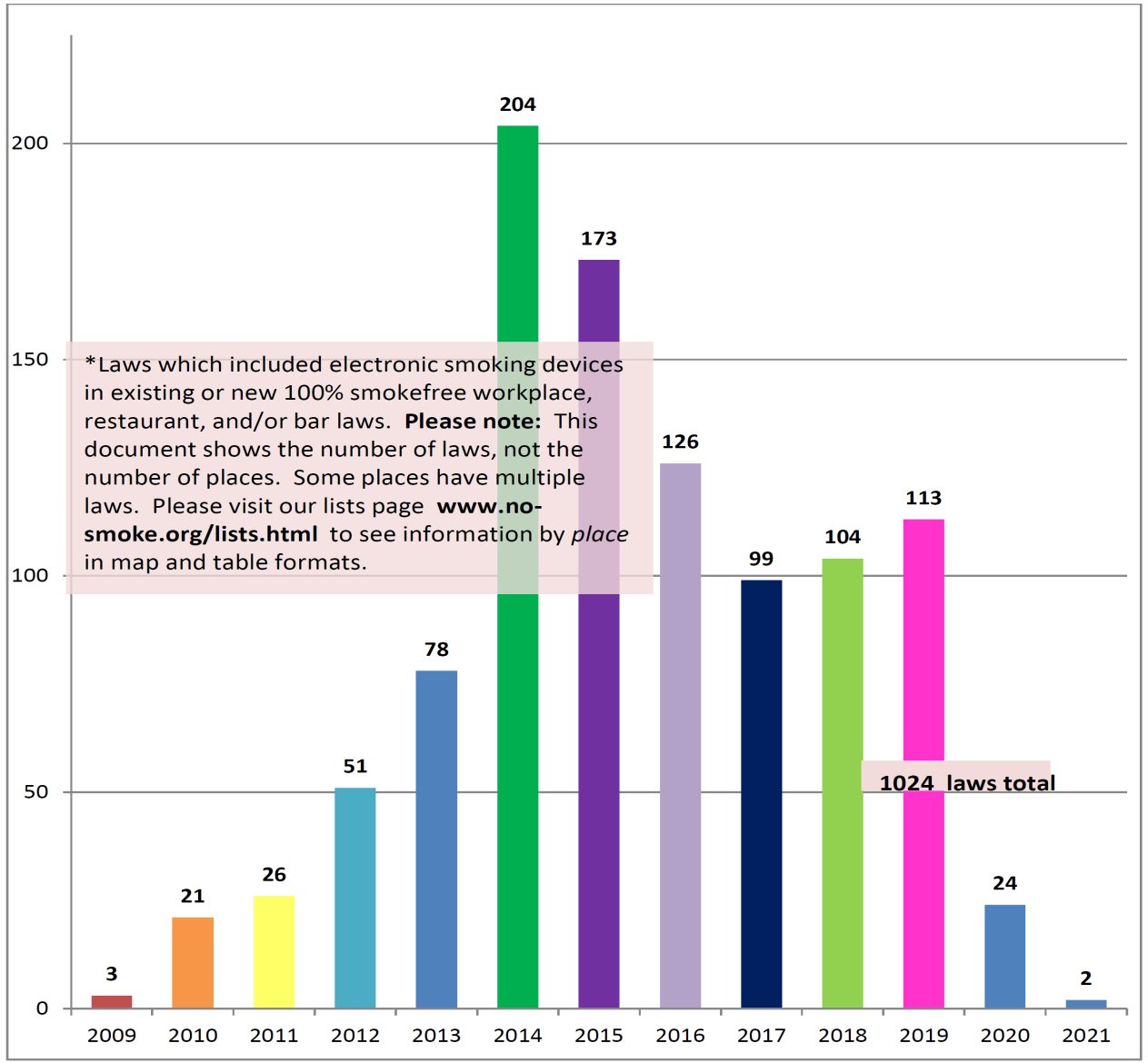
- Cooper and Pesko (2017) used US birth records 2010-2014 and found IVR coverage increased prenatal smoking.
- Cotti, Nesson, and Teft (2018) used Nielsen Homescan Panel 2011-2015, and they found that smoke-free air laws significantly reduced cigarette purchase; however, IVR did not significantly affect EC or cigarette purchase.
- Friedman, Oliver, and Busch (2021) used 2014-2018 NHIS, and found that adding vaping restrictions to smoke-free worksite was not associated with a reduction in vaping and may have attenuated impact on smoking.

# OUR CONTRIBUTION

- We investigated how IVR affects vaping and smoking among adults
  - Include adults in states with state comprehensive smokefree law
  - Take advantage of time and location variations in vapefree air laws
  - Use TUS-CPS 2010-2019

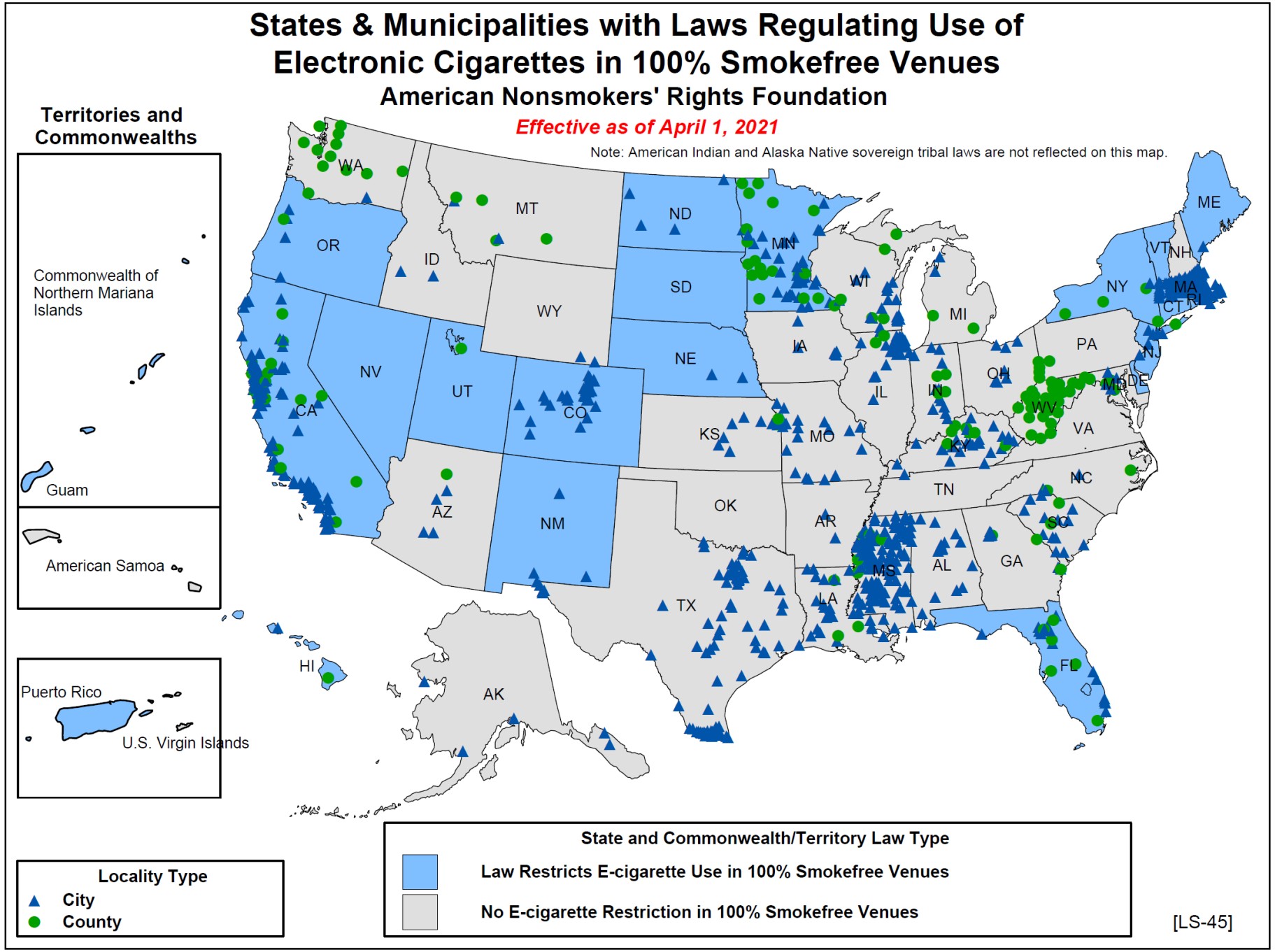
## Number of Local and State Laws* Enacted by Year that Prohibit the Use of Electronic Smoking Devices in Smokefree Environments

As of April 1, 2021




| Cumulative Totals: | 3 | 24 | 50 | 101 | 179 | 383 | 556 | 680 | 779 | 883 | 998 | 1022 | 1024 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

Source: American Nonsmokers Right Foundation https://no-smoke.org/wp-content/uploads/pdf/ECigBarChart.pdf




Source: American Nonsmokers Right Foundation https://no-smoke.org/wp-content/uploads/pdf/ecigsmap.pdf

# CONCEPTUAL FRAMEWORK: IMPACT OF IVR

- IVR *reduces* vaping
  - through increased indirect cost of vaping (i.e., increased inconvenience)

- IVR *increases* smoking
  - For adult smokers: IVR discourages vaping used to replace smoking
  - For adult former smokers: IVR discourages vaping used to replace smoking relapse
- alternatively, IVR *decreases* smoking
  - For adult smokers: IVR discourages vaping and smoking
  - For adult former smokers: IVR discourages vaping and smoking relapse

# DATA

- Tobacco Use Supplements to Current Population Survey (TUS-CPS) 2010/2011, 2014/2015, 2018/2019
  - Individual smoking, vaping, socio-demographics, state/county geocodes

- American nonsmokers right foundation tobacco control database & Census-Estimated Population (CEP) Cities and Towns
  - Clean indoor air laws (CIALs) in state and local levels
  - Strengths (partial or comprehensive smokefree) and venues (workplace, restaurant, or bar) for CIALs
  - Whether and when CIALs include NVPs
  - Used to create county IVR coverage measures

# SAMPLE

- Less than half of TUS-CPS sample (40.6%) were identified with county geocodes
  - TUS-CPS only released county identifiers for counties with population size greater than 200,000

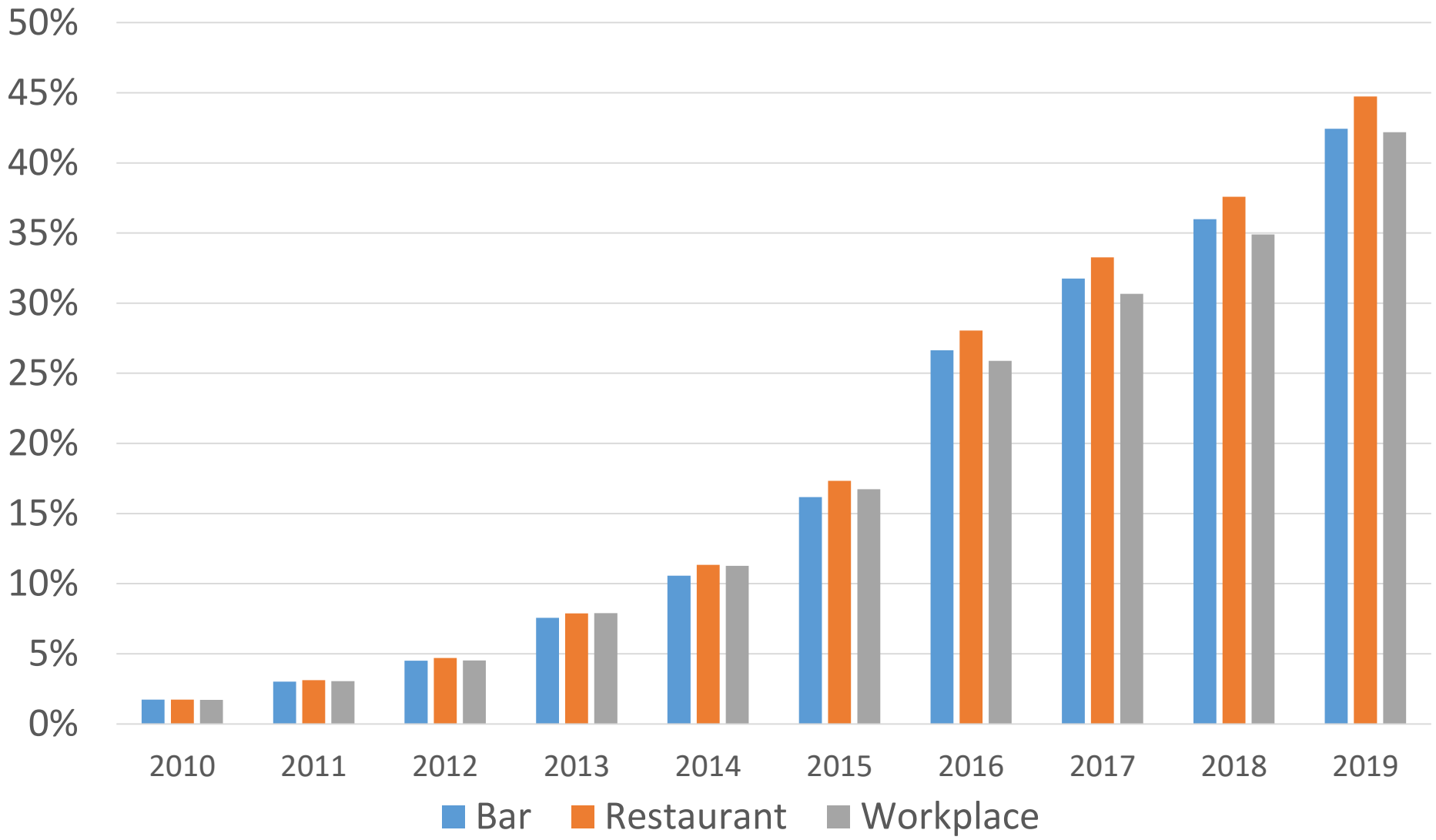
- We restricted sample to aged 18-54, living in states with state level comprehensive smokefree laws

# MEASUREMENT

- Outcome variables
  - *Smoking status*: binary variable; everyday smokers (1), otherwise (0)
  - *Vaping status*: binary variable; everyday NVP users (1), otherwise (0)

- Primary independent variables (county level IVR coverages)
  - Proportion of county population covered by IVR in worksite, restaurant, and bar venues, ranges from 0-1
  - Calculation takes into account state and local level vapefree air laws
  - State preemption is considered

# COUNTY IVR COVERAGES 2010-2019



# DIFFERENCE-IN-DIFFERENCE APPROACH

$$Y_{itcs} = \alpha + \beta IVR_{tcs} + \gamma X_i + \delta Z_{ts} + \sigma_t + \tau_{cs} + \eta_{cs} t + \varepsilon_{itcs}$$

$Y_{itcs}$ smoking or vaping for individual i at time t in the county c of state s

$IVR_{tcs}$ two-month lagged of the county-level IVR coverage in three venues

$X_i$ socio-demographics (gender, age, race, marital status, education attainment, employment status, income)

$Z_{ts}$ state level unemployment rate, gross state product per capita, cigarette tax, EC tax, and medical marijuana laws

$\sigma_t$ and $\tau_{cs}$ represent the time fixed effect and county fixed effect

$\eta_{cs} t$ denotes the county-specific linear trend

# EFFECTS OF IVR COVERAGE ON ADULT VAPING

| | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 |
|---|---|---|---|---|---|---|---|---|
| IVR bar | -0.005** | -0.001** | | | | | | |
| IVR rst | | | -0.005** | -0.009** | | | | |
| IVR wp | | | | | -0.005** | -0.007** | | |
| IVR avg | | | | | | | -0.006** | -0.009** |
| Year& County FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| County trends | No | Yes | No | Yes | No | Yes | No | Yes |
| OBS | 45,216 | 45,216 | 45,216 | 45,216 | 45,216 | 45,216 | 45,216 | 45,216 |
| Dep mean | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 |

All models control for state-level variables (unemployment rate, gross state product per capita, cigarette tax, EC tax, and medical marijuana laws). Standard errors are clustered at the county level. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

# EFFECTS OF IVR COVERAGE ON ADULT SMOKING

| | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 |
|---|---|---|---|---|---|---|---|---|
| IVR bar | 0.011** | 0.009 | | | | | | |
| IVR rst | | | 0.011** | 0.009 | | | | |
| IVR wp | | | | | 0.009* | 0.007 | | |
| IVR avg | | | | | | | 0.012** | 0.009 |
| Year& County FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| County trends | No | Yes | No | Yes | No | Yes | No | Yes |
| OBS | 73,223 | 73,223 | 73,223 | 73,223 | 73,223 | 73,223 | 73,223 | 73,223 |
| Dep mean | 0.098 | 0.098 | 0.098 | 0.098 | 0.098 | 0.098 | 0.098 | 0.098 |

All models control for state-level variables (unemployment rate, gross state product per capita, cigarette tax, EC tax, and medical marijuana laws). Standard errors are clustered at the county level. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

# HETROGENOUS EFFECTS OF IVR COVERAGE ON ADULT VAPING

| | Aged 18-35 | | Aged 36-54 | | Male | | Female | |
|---|---|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 |
| **IVR avg** | -0.010** | -0.012** | -0.002 | -0.006 | -0.010* | -0.010 | -0.003 | -0.009 |
| **Year & County FE** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **County trends** | No | Yes | No | Yes | No | Yes | No | Yes |
| **OBS** | 19,925 | 19,925 | 25,291 | 25,291 | 20,799 | 20,799 | 24,417 | 24,417 |
| **Dep mean** | 0.013 | 0.013 | 0.009 | 0.009 | 0.013 | 0.013 | 0.007 | 0.007 |

All models control for state-level variables (unemployment rate, gross state product per capita, cigarette tax, EC tax, and medical marijuana laws). Standard errors are clustered at the county level. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

# HETEROGENOUS EFFECTS OF IVR COVERAGE ON ADULT CIGARETTE SMOKING

| | Aged 18-35 | | Aged 36-54 | | Male | | Female | |
|---|---|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 |
| **IVR avg** | 0.006 | -0.011 | 0.016** | 0.024** | 0.015** | 0.021* | 0.008 | -0.000 |
| **Year & county FE** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **County time trends** | No | Yes | No | Yes | No | Yes | No | Yes |
| **OBS** | 32,082 | 32,082 | 41,141 | 41,141 | 33,331 | 33,331 | 39,892 | 39,892 |
| **Dep mean** | 0.088 | 0.088 | 0.106 | 0.106 | 0.109 | 0.109 | 0.088 | 0.088 |

All models control for state-level variables (unemployment rate, gross state product per capita, cigarette tax, EC tax, and medical marijuana laws). Standard errors are clustered at the county level. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

# HETEROGENOUS EFFECTS OF IVR COVERAGE ON ADULT CIGARETTE SMOKING

| | Less than high school | | High school graduates | | Some college | | Bachelor or above | | Household income <75k | | Household income>75k | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 |
| **IVR avg** | -0.013 | 0.022 | 0.032** | 0.022 | -0.005 | -0.010 | 0.010** | 0.015** | 0.009 | 0.007 | 0.011* | 0.008 |
| **Year and county FE** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **County trends** | No | Yes | No | Yes | No | Yes | No | Yes | No | Yes | No | Yes |
| **OBS** | 6,710 | 6,710 | 16,086 | 16,086 | 20,161 | 20,161 | 30,266 | 30,266 | 52,068 | 52,068 | 21,155 | 21,155 |
| **Dep mean** | 0.154 | 0.154 | 0.172 | 0.172 | 0.119 | 0.119 | 0.032 | 0.032 | 0.121 | 0.121 | 0.041 | 0.041 |

All models control for state-level variables (unemployment rate, gross state product per capita, cigarette tax, EC tax, and medical marijuana laws). Standard errors are clustered at the county level. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

# INTERNAL VALIDITY

- Common trends between treatment and control groups prior to treatment
  - Smoking/vaping prevalence trend parallel between treatment and control groups before intervention (i.e., IVR)
- Treatment and control groups comparable prior to treatment
- Dynamics of IVR and smoking/vaping
  - No significant 6 month- 12 month- lagged or leading effects

# EXTERNAL VALIDITY

- Results infer to residents in larger counties, 18-54 aged, and living in states with comprehensive smokefree laws

- States with comprehensive smokefree laws: 24 states, including Arizona, California, Colorado, Delaware, District of Columbia, Hawaii, Illinois, Iowa, Kansas, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Jersey, New Mexico, New York, North Dakota, Ohio, Oregon, Utah, Washington, and Wisconsin

# ROBUSTNESS CHECKS

- Findings from different model specifications consistent with our main findings
  - Conducting probit models for smoking and vaping
  - Including self respondent sampling weights
  - Focusing on venue specific vaping restriction and those covered by such law

# LIMITATIONS

- Externality issue
  - TUS-CPS only released county residency for those living in counties with population size > 200,000
  - Only include states with comprehensive smokefree laws

- Future studies may focus on how IVR impacts initiation, cessation, and use patterns (e.g., dual use, switch, complete abstinent)

# CONCLUSION & POLICY IMPLICATION

- Findings highlight essence of interplay among use and policy effect for cigarettes and NVPs
- Unintended IVR effect on smoking, particularly among certain subgroups
- Provide some insights for policy makers to consider as they develop policies/regulations on NVPs

# Thank You!

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