

The Impact of Smoke-Free Air Laws and Conventional Cigarette Taxes on Cardiovascular Hospitalizations



Jon F. Oliver

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Disclaimer

- The findings and conclusions in this presentation are those of the author and do not necessarily represent the official position of the U.S. Department of Health and Human Services
- This research has no funding sources to report
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Outline

- Background
- Motivation
- Research Questions
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- Results
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Background

- Tobacco use associated with more than 480,000 deaths annually (USDHHS 2014)
 - Conventional cigarette smoke is a leading risk factor for heart disease, stroke
 - Elevated risk among current and former smokers, secondhand smoke exposure
 - Risk declines with time since quitting, returns to baseline levels after ~5 years (USDHHS 2010)
- Policymakers at local, state, federal level have turned to smoke-free air (SFA) laws and conventional cigarette taxes to increase the costs of smoking
 - Local SFA laws began in the 1970s
 - First federal conventional cigarette tax occurred in the late 1800s, state taxes in the early 1900s
 - Large differences exist across states and counties



Existing Evidence on Tobacco Control Policies

- SFA laws
 - Single-city: 29% reduction in acute cerebrovascular disease, 40% in acute myocardial infarction (Sargent et al. 2004, Head et al. 2012)
 - State-level: 8% declines in acute myocardial infarction, 18% in acute cerebrovascular disease (Juster et al. 2007, Loomis and Juster 2012)
 - Nationwide samples: null effect to 21% decline in acute myocardial infarction (Vander Weg et al. 2012, Shetty et al. 2010, Ho et al. 2017)
 - Reduces smoking prevalence 2.7-3.0 percentage points, up to 3.8 percentage point increase in smoking cessation, 1.2-2.0 fewer cigarettes consumed per day (Callinan et al. 2010, CPSTF 2013)
- Conventional cigarette taxes
 - 10% increase in price associated with 4.0% reduction in smoking (WHO 2016)



Effects of Tobacco Control Policies

- SFA laws
 - Direct effect
 - Decrease exposure to secondhand smoke
 - Indirect effect
 - Reduce conventional cigarette consumption, smoking prevalence
 - Increase quit attempts
- Conventional cigarette taxes
 - Direct effect
 - Reduce smoking prevalence, conventional cigarette consumption, and smoking initiation
 - Indirect effect
 - Decrease exposure to secondhand smoke



Motivation

- Active smoking, secondhand smoke are hazardous to human health
- As of 2021, only 62% of US population covered by SFA laws in all public venues, state conventional cigarette tax as low as \$0.17/pack
- Current health outcome estimates largely based on hospital-specific data
- Nationally representative results needed to guide future policy



Research Questions

- How do SFA laws and conventional cigarette taxes affect population health nationwide?
 - Examine hospitalizations from 2005-2014 in counties that did and did not enact SFA laws and cigarette taxes, pre- and post-implementation
- Do these effects vary by age?
 - Estimate diagnoses separately for working age adults (ages 18-64) and older adults (ages 65+)
- Do these health effects change over time?
 - Separately estimate impact of new and established laws



Outcome Data

- Hospital inpatient discharge data from up to 40 states
 - Public health departments, hospital associations, and the Healthcare Cost and Utilization Project (HCUP)
 - Diagnoses of interest include acute myocardial infarction, acute cerebrovascular disease, hip fracture
 - Identified by primary diagnosis code, using HCUP's Clinical Classification System (CCS)
- Data provided at either individual- or county-level
 - Individual-level: contains diagnosis code, admission date, patient age, patient county of residence (FIPS or ZIP code)
 - Aggregated to county-year level for each diagnosis and age group (18-64 and 65+)
 - County-level: data pre-aggregated by vendor to county-year level for each diagnosis and age group



Policy Variables

- SFA laws in worksites, restaurants, and bars, containing few or no exemptions (local, state)
 - American Nonsmokers' Rights Foundation (2018) database, and US Census
 - Using implementation date and population data, calculate percentage of county population covered by SFA laws each year
 - Ex 1: County A enacts worksite SFA law on January 1, 2008
 - Entire county population is covered; coverage spans the full year; includes 1/3 venues
 - Ex 2: City B (located in County B) enacts SFA laws in worksites, restaurants, and bars on July 1, 2008
 - Only a portion of County B population is covered; coverage spans half the year; includes 3/3 venues
- Conventional cigarette taxes (local, state, federal)
 - Institute for Health Research and Policy at the University of Illinois at Chicago, and individual statutes
 - Calculate single tax value at the county level using implementation date and population data



Additional Covariates

- Population estimates by age and race
 - US Census
- Median household income
 - US Census
- Uninsured rate
 - US Census SAHIE
- Unemployment rate, CPI
 - Bureau of Labor Statistics
- Tobacco control funding
 - CDC STATE System



Methods

- Poisson model estimates the relationship between tobacco control policies and cardiovascular hospitalizations in county c and year t

- $y_{c,t} = \exp(\beta_0 + \beta_1 SFA_{c,t} + \beta_2 Cig\ Tax_{c,t} + \theta X_{c,t} + \alpha_c + \delta_t + \epsilon_{c,t})$

- $X_{c,t}$: matrix of county characteristics
 - Age-specific population, percent of population that is non-white, real median household income (in thousands, 2014\$), uninsured rate, unemployment rate, state-level real tobacco control funding (in millions, 2014\$)
- α_c, δ_t : county and year fixed effects; standard errors clustered at the state level



Methods, cont.

- Replace $\beta_1 SFA_{c,t}$ with $\beta_1 New\ Law_{c,t} + \beta_2 Established\ Law_{c,t}$
 - *New Law_{c,t}*: indicator equal to one in the first year that average SFA coverage in a county is greater than zero, and zero otherwise
 - *Established Law_{c,t}*: indicator equal to one in all subsequent years, and zero otherwise
- Specification check: separately estimate impact of SFA laws for each individual year leading up to and following implementation



Summary Statistics

Table 1: Summary Statistics by Smoke-Free Air (SFA) Status, 2005-2014, Means/(Standard Deviations)

	2005		2014	
	Counties with no SFA coverage by 2014	Counties with SFA coverage by 2014	Counties with no SFA coverage by 2014	Counties with SFA coverage by 2014
Hospitalizations (per 1,000)				
Acute myocardial infarction				
Ages 18-64	1.92 (0.88)	1.49 (0.89)	1.90 (0.93)	1.43 (0.83)
Ages 65+	10.68 (5.28)	9.74 (4.78)	7.92 (3.57)	7.11 (3.46)
Acute cerebrovascular disease				
Ages 18-64	1.10 (0.64)	0.81 (0.53)	1.28 (0.71)	0.93 (0.60)
Ages 65+	10.12 (4.70)	9.32 (4.06)	8.48 (3.45)	7.60 (3.09)
Hip fracture				
Ages 18-64	0.25 (0.25)	0.20 (0.20)	0.25 (0.23)	0.22 (0.21)
Ages 65+	7.43 (3.16)	6.97 (3.27)	6.05 (2.39)	5.66 (2.49)
N _{Counties}	658	1,881	645	1,865

Note: Summary statistics from 2005 and 2014 for counties with available hospitalization data. Smoke-free air coverage is defined as the average percent of the population covered by smoke-free air laws in worksites, restaurants, and bars during any year from 2005-2014.



Summary Statistics, cont.

Table 1a: Summary Statistics by Smoke-Free Air (SFA) Status, 2005-2014, Means/(Standard Deviations)

	2005		2014	
	Counties with No SFA Coverage by 2014	Counties with SFA Coverage by 2014	Counties with No SFA Coverage by 2014	Counties with SFA Coverage by 2014
CC Tax (\$)	0.87 (0.27)	1.47 (0.60)	1.74 (0.46)	2.37 (0.82)
State Tobacco Control Funding (in millions)	8.71 (5.82)	15.76 (19.23)	7.86 (5.01)	14.27 (15.72)
Population, Non-White (%)	12.31 (15.60)	9.97 (13.02)	12.65 (14.81)	11.06 (12.92)
Unemployment Rate	5.98 (1.76)	5.22 (1.75)	6.74 (2.14)	5.96 (2.11)
Median HHI (in thousands)	42.29 (9.38)	49.82 (12.84)	41.70 (9.67)	49.24 (12.30)
Uninsured Rate	20.62 (6.72)	17.44 (6.03)	18.08 (5.17)	13.21 (4.63)
N _{Counties}	658	1,881	645	1,865

Note: Summary statistics from 2005 and 2014 for counties with available hospitalization data. CC refers to conventional cigarettes. All prices are in real 2014 dollars.



Summary Statistics Pre and Post Policy

Table 2: Summary Statistics Before and After SFA Enactment, 2005-2014,
Means/(Standard Deviations)

	One Year Pre-SFA (1)	One Year Post-SFA (2)
Hospitalizations (per 1,000)		
Acute Myocardial Infarction		
Ages 18-64	1.53 (0.86)	1.46 (0.84)
Ages 65+	9.02 (4.53)	8.42 (3.93)
Acute Cerebrovascular Disease		
Ages 18-64	0.83 (0.55)	0.86 (0.65)
Ages 65+	8.92 (3.86)	8.47 (3.74)
Hip Fracture		
Ages 18-64	0.21 (0.21)	0.21 (0.20)
Ages 65+	6.94 (3.33)	6.36 (2.94)
N_{Counties}	1,368	1,532

Note: Summary statistics from 2005-2014 for counties with available hospitalization data, one year before and after a county's average level of smoke-free air coverage is greater than zero.



Summary Statistics Pre and Post Policy, cont.

Table 2a: Summary Statistics Before and After SFA Enactment, 2005-2014, Means/(Standard Deviations)

	One Year Pre-SFA (1)	One Year Post-SFA (2)
CC Tax (\$)	1.68 (0.68)	1.95 (0.70)
State Tobacco Control Funding (in millions)	12.76 (8.65)	13.82 (8.89)
Population, Non-White (%)	9.49 (12.63)	9.74 (12.67)
Unemployment Rate	5.84 (2.89)	6.68 (2.73)
Median HHI (in thousands)	48.99 (12.41)	48.98 (12.32)
Uninsured Rate	16.73 (5.77)	16.60 (5.31)
N _{Counties}	1,369	1,543

Note: Summary statistics from 2005-2014 for counties with available hospitalization data, one year before and after a county's average level of smoke-free air coverage is greater than zero. All prices are in real 2014 dollars.



Results

Table 3: Effect of Smoke-Free Air Laws and Conventional Cigarette (CC) Taxes on Hospitalizations, 2005-2014, Coefficients/(Standard Errors)

	<u>Ages 18-64</u>	<u>Ages 65+</u>
	(1)	(2)
Acute Myocardial Infarction		
Smoke-Free Air Laws	0.995 (0.013)	0.986 (0.015)
CC Tax (\$)	1.015 (0.010)	1.002 (0.012)
Observations _{County-Year}	25,090	25,085
Mean of Dependent Variable	75.894	102.888
Acute Cerebrovascular Disease		
Smoke-Free Air Laws	1.000 (0.017)	0.976* (0.011)
CC Tax (\$)	0.996 (0.011)	1.006 (0.013)
Observations _{County-Year}	25,033	25,033
Mean of Dependent Variable	56.343	113.576
Hip Fracture		
Smoke-Free Air Laws	0.995 (0.016)	0.978 (0.013)
CC Tax (\$)	0.999 (0.015)	0.997 (0.010)
Observations _{County-Year}	23,589	23,802
Mean of Dependent Variable	11.377	80.915

Note: Poisson regressions use hospital inpatient discharge data from up to 40 US states. Controls not shown include age-specific population and percent of population that is non-white, unemployment rate, median household income, uninsured rate, and state-level tobacco control funding. All prices are in real 2014 dollars. All models include county and year fixed effects, and standard errors are clustered at the state level. *p< 0.05, **p< 0.01



New vs. Established Laws

Table 4: Effect of New and Established Smoke-Free Air Laws and Conventional Cigarette (CC) Taxes on Hospitalizations, 2005-2014, Coefficients/(Standard Errors)

	<u>Ages 18-64</u>	<u>Ages 65+</u>
	(1)	(2)
Acute Myocardial Infarction		
New Laws	1.004 (0.007)	0.997 (0.008)
Established Laws	0.988 (0.014)	0.975 (0.016)
CC Tax (\$)	1.015 (0.010)	1.001 (0.012)
Observations _{County-Year}	25,090	25,085
Mean of Dependent Variable	75.894	102.888
Acute Cerebrovascular Disease		
New Laws	0.995 (0.009)	0.980** (0.007)
Established Laws	1.000 (0.017)	0.972* (0.012)
CC Tax (\$)	0.996 (0.011)	1.005 (0.013)
Observations _{County-Year}	25,033	25,033
Mean of Dependent Variable	56.343	113.576

Note: Poisson regressions use hospital inpatient discharge data from up to 40 US states. CC refers to conventional cigarettes. Controls not shown include age-specific population and percent of population that is non-white, unemployment rate, median household income, uninsured rate, and state-level tobacco control funding. All prices are in real 2014 dollars. All models include county and year fixed effects, and standard errors are clustered at the state level. *p< 0.05, **p< 0.01



New vs. Established Laws, cont.

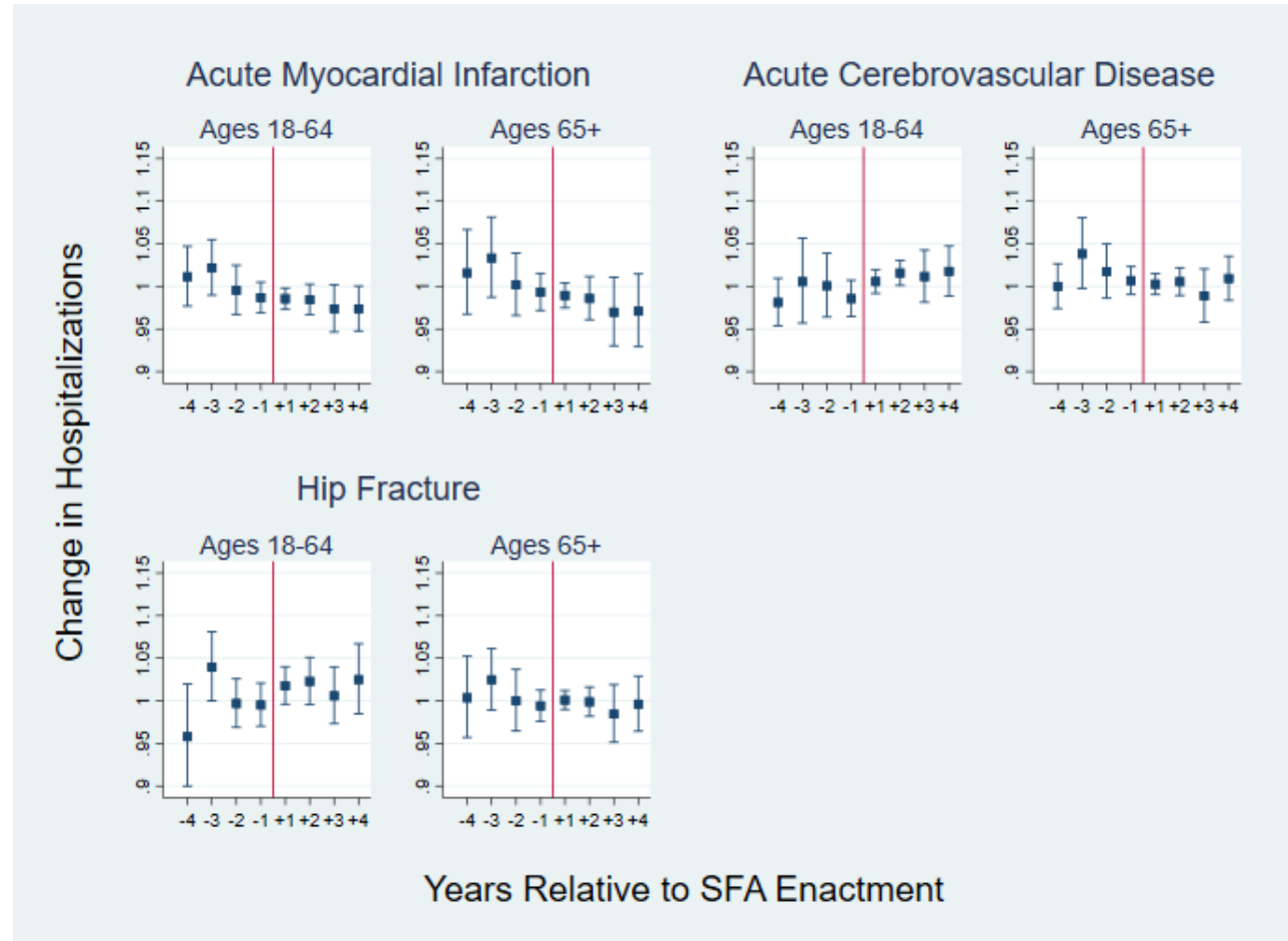
Table 4a: Effect of New and Established Smoke-Free Air Laws and Conventional Cigarette (CC) Taxes on Hospitalizations, 2005-2014, Coefficients/(Standard Errors)

	Ages 18-64 (1)	Ages 65+ (2)
Hip Fracture		
New Laws	0.991 (0.010)	0.989 (0.009)
Established Laws	1.005 (0.015)	0.975 (0.013)
CC Tax (\$)	0.999 (0.015)	0.996 (0.010)
Observations _{County-Year}	23,589	23,802
Mean of Dependent Variable	11.377	80.915

Note: Poisson regressions use hospital inpatient discharge data from up to 40 US states. CC refers to conventional cigarettes. Controls not shown include age-specific population and percent of population that is non-white, unemployment rate, median household income, uninsured rate, and state-level tobacco control funding. All prices are in real 2014 dollars. All models include county and year fixed effects, and standard errors are clustered at the state level. *p< 0.05, **p< 0.01



Specification Check



Conclusions

- Smoke-free air laws are associated with significant reduction in acute cerebrovascular disease among older adults, larger declines from established laws
- No significant change in acute myocardial infarction hospitalizations from either tobacco control policy
- Estimates are smaller than research examining local or multi-state populations, but consistent with national-level analyses
 - Controlling for local + county conventional cigarette taxes, tobacco control spending → reduced omitted variable bias
- Potential sources of bias
 - Individual exposure to each policy is unknown
 - Informal smoking bans prior to formal laws may bias estimates towards zero
 - Assumes other tobacco control policies not enacted simultaneously



Implications

- Expansion of SFA laws and increased conventional cigarette taxes → potential health benefits
- Opportunities for additional tobacco control policies going forward
 - As of 2021, only 62% of US population covered by SFA laws in all public venues
 - State conventional cigarette tax as low as \$0.17/pack
 - Few localities tie conventional cigarette tax to inflation



Questions/Comments



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