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RESEARCH ARTICLE

Using a Difference-in-Differences Approach to Examine the Impact of Child Access Prevention Laws on Youth Firearm Suicides

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Abstract

The aim of the present study is to determine the relationship between Child Access Prevention (CAP) laws and state-level youth firearm suicide rates. This paper differs from prior research in several ways. First, this is one of the few studies to focus exclusively on youth firearm suicide rates. Second, this study uses one of the largest and most recent data sets of any study on this topic. Third, this study uses a difference-in-differences approach, an empirical technique that has not been previously used to study the effect of CAP laws on youth firearm suicides. Results of the present study indicate that CAP laws are associated with lower state-level youth suicide rates.

Keywords: Child Access Prevention Laws,Youth Firearm Suicides, Difference-In-Differences, Propensity Score Matching.

JEL Codes: K14, K42.

1. Introduction

In 2020, for persons aged 0-19, there were 149 unintentional firearm deaths and 1,293 firearm suicides. One policy that may have an impact on youth unintentional deaths and suicides due to firearms is a Child Access Prevention (CAP) law. CAP laws impose criminal liabilities on adults who allow children to have unsupervised access to firearms.CAP laws compelparents or guardians to supervise children's access to firearms to reduce the likelihood of potentially dangerous situations, such as a suicide or an accident, that may arise when children have unsupervised access to guns.It is important to note that suicide is the second leading cause of death among teenagers.

Although there is no federal CAP law, many states have enacted such laws. As of 2020, 27 states have enacted some type of CAP law (Gius, 2020). Some state laws impose a criminal liability when an adult does not secure a weapon.Others only prohibit an adult from providing a firearm to a child. CAP laws also have varying definitions of "minor". In some states, adults must secure firearms from children who are 14 years of age or younger; in other states, adult supervision is required for all persons 18 years of age or younger (Gius, 2020). Some states require secured access for all types of firearms; other states only require it for handguns. Finally, most states have exceptions for hunting, sport shooting, and other legitimate purposes.Table 1 lists those states that have CAP laws and the year when the law was enacted.

The purpose of the present study is to determine the impact of CAP laws on youth suicide rates. Most recent studies found that CAP laws reduce youth suicides (Gius, 2020, 2015; Hooman, et al.,2020; Kivisto, et al.,2021; Lott and Whitley, 2001; Webster, et al., 2004). The present study differs from this prior research in several ways. First, this is one of the few studies to focus exclusively on youth firearm suicide rates. Second, this study uses one of the largest and most recent data sets of any study on this topic. Third, this study uses a differences-in-difference model,

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an empirical technique that has not been previously used to study the effect of CAP laws on youth firearm suicides. Results of the present study indicate that CAP laws are associated with lower youth suicide rates.

Table 1. *States with CAP Laws*

State	Year Enacted	State	Year Enacted
California*	1992	Mississippi	1994
Colorado*	1992	Nevada*	1992
Connecticut	1991	New Hampshire	2001
Delaware	1995	New Jersey*	1992
Florida	1990	North Carolina	1994
Georgia	2010	Oklahoma*	1992
Hawaii*	1992	Pennsylvania	1995
Illinois	2000	Rhode Island	1996
Indiana	1994	Tennessee	1994
Iowa	1991	Texas	1996
Kentucky	1994	Utah*	1992
Maryland*	1992	Virginia*	1992
Massachusetts	1999	Wisconsin*	1992
Minnesota	1994		

*States included in treatment group. All other states listed on this table are excluded from the sample.

Sources: *Marvell (2001), the Brady Center website, the Law Center to Prevent Gun Violence website, and Ludwig and Cook (2003). If the above references contradicted one another, the author examined the original state law in order to determine if a state had a CAP law.*

2. Materials and Methods

There has been much prior research on the effects of CAP laws on suicides, unintentional deaths, and other gun-related issues (Miller, Zhang, Rowhani-Rahbar, and Azrael (2022); James, Khallouq, and Swana (2021); Kivisto. Kivisto, Gurnell, Phalen, and Ray (2021); Hooman, Monuteaux, Rees, Siegel, Mannix, Lee, Sheehan, and Fleegler (2020); Gius (2020); Anderson and Sabia (2018); Hamilton, Miller, Cox, Lally, and Austin (2017);Gius (2015); DeSimone, Markowitz, and Xu (2013); Hepburn, Azrael, Miller, and Hemenway (2006); Webster, Daniel, Jon Vernick, April Zeoli, and Jennifer Manganello (2004); Lott and Whitley (2001); Webster and Starnes (2000); and Cummings, Grossman, Rivara, and Koepsell (1997). Most of the prior research in this area used count data and either a negative binomial model or a Poisson model (James, Khallouq, and Swana, 2021; Kivisto, 2021; Hooman, et al., 2020; Hamilton, et al., 2017; De Simione, Markowitz, and Xu, 2013; Hepburn, et al., 2006; Webster, et al., 2004; Webster and Starnes, 2000; Cummings, et al., 1997). Other studies used synthetic control methods (Gius, 2020), fixed effects models (Gius, 2015) and qualitative dependent variablemodels (Miller, et al., 2022; Anderson and Sabia, 2018; Lott and Whitley; 2001).

Some of the above studies looked at the effects of CAP laws on unintentional deaths (Hepburn, et al., 2006; Webster and Starnes, 2000). Others look at the effects of CAP laws on pediatric firearm injuries (James, Khallouq, and Swana, 2021; Hamilton, et al., 2017; DeSimione, Markowitz, and Xu, 2013). Anderson and Sabia (2018) examined the impact of CAP laws on gun carrying and bullying among youths, and Miller, et al., (2022) looked at the effects of CAP laws on firearm storage behavior. Two of the more relevant studies are Gius (2020 and Lott and Whitley (2001).

Gius (2020) used state level data for period 1981-2017 and a synthetic control method and found that CAP laws had mixed effects on youth firearm suicides. For nine of the states examined, CAP laws resulted in lower youth suicide rates, but for thirteen states, CAP laws had no significant effects on youth suicides.All 50 states were examined, twenty-seven of which had implemented CAP laws. It is important to note, however, that in an earlier paper, Gius (2015) used state-level data for the period 1981-2010 and a fixed effects model and found that states with CAP laws had lower rates of youth firearm suicides.

Lott and Whitley (2001) looked at CAP laws and laws requiring the use of gun locks to secure firearms. Using data for the 15 states that had implemented CAP laws and a fixed effects Tobit model, Lott and Whitley found that CAP laws had no significant effects on youth firearm-related unintentional deaths or suicides. These results were similar tothose found in Gius (2020).

The focus of the present study is the impact of CAP laws on youth suicide rates. This study uses a much larger and much more recent data set than previous studies. In addition, this study uses a difference-in-differences model, an empirical technique not previously used to study the impact of CAP laws on youth firearm suicides.

In the difference-in-differences approach, the effect of the treatment is estimated by comparing the treatment group after the treatment was implemented (states that enacted CAP laws) to the treatment group before treatment (before CAP laws were enacted) and to a control group (states that did not enact CAP laws during the period in question). For the purposes of the present study, only states that enacted CAP laws in 1992 were included in the treatment group. States that never enacted CAP laws were included in the control group. States that enacted CAP laws in years other than 1992 were excluded from the analysis.

Given the above, the following equation is estimated in the present study:

$$Y = \beta_1 POST\_CAP_i + \beta_2 TREATMENT_i + \beta_3 POST\_CAP_i * TREATMENT_i + \boldsymbol{\beta_4 X} + \varepsilon \quad (1)$$

POST_CAP denotes the post-treatment period (years after 1992). TREATMENT denotes the states that enacted CAP laws. POST_CAP*TREATMENT denotes the differences-in-difference estimate of the effects of CAP laws on youth suicide rates. **X** denotes a vector of control variables. State-level data was used, and the outcome variable that was examined was the state-level suicide rate for youths aged 10-19 (suicides per 100,000 persons). This age range was chosen because CAP laws are designed to protect minors; in addition, very few children younger than aged 10 commit suicide using a firearm.

The "treatment" is when a state adopts a CAP law. Only those treatment states that enacted CAP laws in 1992 were included in the present study. The primary reasons for only looking at states that enacted a CAP law in 1992 is because a relatively large number of states enacted this law in that year and because the use of only one treatment year is the appropriate way to estimate a difference-in-differences model. Given that the data used in the present study begins in 1981, there is adequate pre-treatment data in both treated and control states to test for parallel trends, which is a necessary assumption for difference-in-differences. Finally, states that adopted the treatment remained treated throughout thepost-treatment period.

To mitigate potential differences in outcome variable trends, it was necessary to take account of factors that may differ between control states and treated states. Hence, the following control variables were used in the present study: percentage of population that is white;population density; percentage of population with a four-year college degree; per capita median income; percentage of population aged 10-19; per capita alcohol consumption; and divorce rate per 100,000 residents.These control variables are based upon their use in prior research (Hamilton, Miller, Cox, Lally, and Austin, 2017; Gius, 2015; Gius, 2011; Webster, Vernick, Zeoli, and Manganello, 2004; Conner & Zhong, 2003; Lott & Whitley, 2001; Marvell, 2001; Ludwig & Cook, 2000).

3. Results and Discussion

All data are state-level and are for the years 1981-2017. State-level socioeconomic data were obtained from the *Statistical Abstract of the United States*and other relevant Census Bureau documents.State-level data on youth (ages 10-19) firearm-related suicides were obtained from the National Center for Injury Prevention and Control, the Centers for Disease Control (CDC). The WISQARS system was used to obtain the necessary data from the CDC website. Information on state-level CAP laws wasobtained from Marvell (2001), the Brady Center website, the Law Center to Prevent Gun Violence website, and Ludwig and Cook (2003). If the above sources contradicted one another, the author examined the original state law to determine if a state had a CAP law. Descriptive statistics are presented on Table 2. Sample size is 1,332.

Equation (1) was estimated using a two-way fixed effects model. Results are presented on Table 3. These results indicate that states that enacted CAP laws saw

Table 2. *Descriptive Statistics*

Variable	Mean	Standard Deviation
Youth Suicide Rate (10-19 years of age) (deaths per100,00persons)	1.913	1.12
Percent White (percentage)	0.818	0.139
Population Density (persons per square mile)	98.86	110.79
Percent College Degree (percentage)	0.234	0.056
Real Per Capita Median Income (dollars)	$15,027	$3,038
Percent Aged 10-19 (percentage)	0.085	0.032
Per Capita Alcohol Consumption (gallons per capita)	2.29	0.423
Divorce Rate (divorces per 1,000 persons)	4.45	1.18

Table 3. *Two Way Fixed Effects Results Outcome Variable: Youth Firearm Suicide Rate*

Variable	Coefficient	Standard Error	Test Statistic
Treatment	-0.0237	0.188	-0.13
Post-Treatment	0.167	0.082	2.04**
Treatment*Post-Treatment	-0.275	0.086	-3.17***
Percent White	0.59	0.324	1.82*
Population Density	-0.00219	0.0008	-2.77***
Percent College Degree	1.556	0.741	2.10**
Real Per Capita Median Income	-0.000076	0.00002	-4.60***
Percent Aged 10-19	5.29	1.027	5.15***
Per Capita Alcohol Consumption	-0.106	0.100	-1.06
Divorce Rate	0.233	0.035	6.61***

Note: Adjusted $R^2 = 0.336$

"*" = 10% Significance; "**" = 5% Significance; "***" = 1% Significance N=1332

an average reduction in their youth firearm suicide rates of 0.275, which is 14.4% of the overall average youth suicide rate. Hence, these results indicate that CAP laws are associated with fewer youth firearm fatalities. Most of the control variables were statistically significant with the expected signs.

As a check on the robustness of the difference-in-differences results, a propensity score matching model was also estimated. This procedure attempts to measure the change in the average value of the outcome variable that occurs due to a treatment. This change is known as the average treatment effect. To estimate the average treatment effect, observations are matched based on certain characteristics, known as propensity scores. States with similar propensity scores are expected to have similar characteristics. The strategy is for a treated state with a certain propensity score to be matched with an untreated (control) state with the same propensity score. The effect of the treatment is the difference between the values of the outcome variable for the matched states. The average across all matched states is the average treatment effect.

Table 4. *Propensity Score Model Results Logit Based on Treatment*

Variable	Coefficient	Standard Error	Test Statistic
Percent White	-3.69	0.534	-6.911***
Population Density	-0.00011	0.00078	-0.138
Percent College Degree	11.28	2.108	5.351***
Real Per Capita Median Income	0.0002	0.000042	4.687***
Percent Aged 10-19	4.65	2.14	2.166**
Per Capita Alcohol Consumption	-2.319	0.212	-10.909***
Divorce Rate	-0.027	0.084	-0.325

Note: "" = 10% Significance; "**" = 5% Significance; "***" = 1% Significance*

Number of Treated Observations = 319 , Number of Controls = 972

Estimated Average Treatment Effect = -0.171

Estimated Standard Error = 0.0792

Test Statistic = -2.154

Table 5. *Partitioning Range of Propensity Scores*

	Controls			Treatment			
Range	Number of Observations	Mean	Standard Deviation	Number of Observations	Mean	Standard Deviation	F Test
0.016 - 0.204	678	0.096	0.053	44	0.111	0..054	3.43
0.204 - .391	195	0.28	0.051	122	0.29	0.057	1.68
0.391 – 0.57	60	0.471	0.049	54	0.452	0.044	4.74
0.57 – 0.76	20	0.65	0.054	49	0.69	0.054	6.55
0.76 – 0.955	19	0.83	0.039	50	0.84	0.05	0.19

In the present study, the treatment is the enactment of a CAP law. The outcome variable is the youth suicide rate. States were matched using the same control variables that were used in the fixed effects model. Propensity score results are presented on Tables 4 and 5. The estimated average treatment effect found using the propensity score matching method was -0.171, indicating that states with CAP laws have, on average, lower youth suicide rates than states without CAP laws. These results verify the results found using the difference-in-differences model.

4. Conclusion

It is typically acknowledged that the presence of a firearm in a household increases the probably that a child or young adult will commit suicide. In order to reduce this probability, many states have adopted child access prevention laws that require adults to properly secure firearms so that young adults cannot use them to potentially commit suicide.

The purpose of the present study was to ascertain the relationship between CAP laws and state-level youth firearm suicide rates. This paper differs from prior research in several ways. First, this is one of the few studies to focus exclusively on youth firearm suicide rates. Second, this study uses one of the largest and most recent data sets of any study on this topic. Third, this study uses the difference-in-differences approach, an empirical technique that has not been previously used to study this topic.

Results of the present study indicate that CAP laws were associated with lower rates of youth firearm suicides. States with CAP laws had firearm suicide rates that were 14.4% lower than states without CAP laws. The average treatment effect in a propensity score matching analysiswas also found to be statistically significant and negative. Given that the model used in the present study is different from those used in prior studies on CAP laws, the results of this study should be considered both novel and robust, thus indicating that CAP laws are effective in reducing youth firearm suicides.

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