

Association between Firearm Laws and Homicide in Urban Counties

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Abstract Laws related to the sale, use, and carrying of firearms have been associated with differences in firearm homicide rates at the state level. Right-to-carry (RTC) and stand your ground (SYG) laws are associated with increases in firearm homicide; permit-to-purchase (PTP) laws and those prohibiting individuals convicted of violent misdemeanors (VM) have been associated with decreases in firearm homicide. Evidence for the effect of comprehensive background checks (CBC) not tied to PTP is inconclusive. Because firearm homicide tends to concentrate in urban areas, this study was designed to test the effects of firearm laws on homicide in large, urban U.S. counties. We conducted a longitudinal study using an interrupted time series design to evaluate the effect of firearm laws on homicide in large, urban U.S. counties from 1984 to 2015 ($N=136$). We used mixed effects Poisson regression models with random intercepts for counties and year fixed effects to account for national trends. Models also included county and state characteristics associated with violence. Homicide was stratified by firearm versus all other methods to test for specificity of the laws' effects. PTP laws were associated with a 14% reduction in firearm homicide in large, urban counties

(IRR = 0.86, 95% CI 0.82–0.90). CBC-only, SYG, RTC, and VM laws were all associated with increases in firearm homicide. None of the laws were associated with differences in non-firearm homicide rates. These findings are consistent with prior research at the state level showing PTP laws are associated with decreased firearm homicide. Testing the effects of PTP laws specifically in large, urban counties strengthens available evidence by isolating the effects in the geographic locations in which firearm homicides concentrate.

Keywords Gun policy · Firearm · Homicide

Introduction

In 2016, there were 14,415 firearm homicides in the United States (U.S.), which accounted for nearly 75% of all homicides [1]. Firearm homicides are not distributed equally across the U.S.; 63% occurred in large, urban counties (classified as Large Central Metro and Large Fringe Metro by the U.S. Census Bureau) which contain 56% of the U.S. population [2]. States have enacted policies in response to firearm homicide, but the effect of these policies specifically in urban areas is unknown. In this study, we aim to evaluate the effect of five firearm-related policies on homicide in large, urban counties: comprehensive background checks, permit-to-purchase, right-to-carry, stand your ground, and violent misdemeanor prohibitions.

Weaknesses in federal law allow prohibited individuals to obtain firearms through unregulated private

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sales. Currently, only nineteen¹ states and the District of Columbia have laws requiring point of sale background checks be conducted when the seller is a private party. These laws are often referred to as comprehensive background check (CBC) laws. CBC laws require all sellers, both licensed retailers and private parties, to make firearm transfers contingent on the purchaser passing a background check. Private sales include those made at gun shows, sales arranged between strangers online, and transfers between friends and acquaintances. The most recent estimate by Miller and colleagues suggests that approximately 20% of guns are obtained without a background check [3]. In the 13 states with the least restrictive firearm laws, state prison inmates who were incarcerated for a gun crime were more likely to report obtaining that gun through an unregulated private sale than from a licensed dealer [4]. Data on recovered crime guns suggest more than 80% of criminals using firearms to commit crime were not the purchaser of record [5]. There is inconclusive evidence on the effect of background checks for private sales on firearm homicide at the state level.

Realizing that requiring background checks for private sales may, by itself, not be sufficient, ten states and the District of Columbia have an additional handgun purchaser licensing requirement; often referred to as permit-to-purchase (PTP) laws. PTP laws typically require that prospective handgun purchasers apply directly to a state or local law enforcement agency, many require applicants to submit fingerprints, for a purchase permit prior to approaching a seller. PTP laws may include a more thorough background check which law enforcement can take 30 days or more to complete. Sellers, both licensed and private, can only sell to someone with a valid purchase permit which is valid for varying lengths. States with longer duration permits may also require a point of sale background check to ensure that the purchaser has not become prohibited since the issuance of the permit. Prior research has found that PTP laws are associated with reductions in the diversion of guns to criminals [6] and gun homicide [7, 8].

It is important to note the differences between CBC and PTP laws because they are often conflated in research when in fact they are implemented differently, in ways that may influence their effectiveness. CBC laws generally depend upon the use of the National Instant

Criminal Background Check System (NICS) that is also used by licensed dealers; however, issues with the NICS have been identified related to the which records are reported to the system and the quality and timeliness of records that are reported [9]. PTP laws provide a longer period for law enforcement to conduct its background check at the local level, and these checks may have access to more records increasing the likelihood that law enforcement can identify and screen out those with a prohibiting condition.

Right-to-carry (RTC) laws require law enforcement to issue concealed carry permits to any individual that meets objective criteria or allow for permitless carry (permitless carry allows for individuals who are not otherwise prohibited from gun ownership to carry without obtaining a permit). RTC laws make it easier for individuals to carry loaded, concealed firearms in public spaces, and may require little or no safety training or demonstrations of competence and proficiency. Previous research suggests that RTC laws are associated with increased rates of violence at the state level [10, 11].

Stand your ground (SYG) laws are those that give individuals expanded protections for use of deadly force in a response to a perceived threat with no duty to retreat. These laws may make otherwise non-lethal encounters deadly if individuals are carrying loaded, concealed firearms, and feel emboldened to use their firearms in self-defense rather than leaving or de-escalating a volatile situation. Research on SYG laws shows they are associated with increases in rates of state-level firearm homicide [12, 13].

Violent misdemeanor (VM) prohibitions extend criminal prohibiting conditions for the purchase of a firearm to those who have been convicted of a misdemeanor crime of violence. States with these laws recognize that prohibiting a broader pool of potentially risky firearm owners may screen out individuals at risk of committing violence but who have not yet been convicted of a felony or domestic violence misdemeanor. Previous research showed decreased risk of future gun crime among those prohibited for a VM crime [14]. A recent study by Zeoli et al. found lower rates of intimate partner homicide in states with VM prohibitions [15].

Studies evaluating the effect of CBC, PTP, RTC, SYG, and VM laws on firearm homicide have been conducted at the state level. However, firearm homicide occurs more frequently in urban areas, so evaluations at the state level may underestimate the effectiveness of these laws in the places where homicides predominate.

¹ While Nevada passed a CBC law, there are implementation issues related to how the law was written and whether it will be enforced.

This study sought to explore the effects of these firearm laws on homicide in large, urban counties where firearm homicide is more likely to occur. We also sought to separate out the effects of states with CBC-only laws and those with PTP. Based on prior research, we hypothesized that PTP and VM laws would be associated with protective effects on homicide rates, CBC-only laws would have no effect, and RTC and SYG would be associated with harmful effects.

Methods

Design

We conducted a quasi-experimental longitudinal study using an interrupted time series to evaluate the effect of firearm laws on homicide in large, urban U.S. counties from 1984 to 2015. Because these laws are related to firearms, county-year counts of homicide were stratified by firearm versus all other methods to test for specificity of the laws' effects.

Data and Measures

Based on previous research, we hypothesized that, due to the specificity of the laws regarding firearms, changes to these laws would affect only firearm homicides. The primary outcome for the study was annual, county-level counts of firearm homicide obtained from the Centers for Disease Control and Prevention's Wide-ranging Online Data for Epidemiologic Research (WONDER) system [16]. Because firearm homicide tends to concentrate in urban areas, we restricted our analysis to counties with U.S. Census urbanization codes of "Large Central Metro" and "Large Fringe Metro" and populations greater than 200,000 across the study period resulting in a sample that contained 136 counties over 32 years for a total of 4352 county-year observations.²

We accessed additional county-level variables from WONDER including the percent of the population who were African American males age 15–24 and county population. County-level percent poverty was obtained from the U.S. Census and interpolated

between census years [17]. Average annual measures of county-level unemployment were obtained from the Bureau of Labor Statistics Local Area Unemployment Statistics [18]. State-level variables were used for two covariates that were not readily available at the county level: incarceration rates [19] and state law enforcement expenditures [20].

We conducted legal research to identify the effective dates for each state's policies including month, day, and year. Indicators for policy variables were generated based on these effective dates. Policy indicators were coded as 1 when a law was in effect and 0 otherwise. To reduce measurement error, the policy indicators were coded as a proportion for the number of days the policy was in effect in the year in which a policy was first implemented (see Table 1).

Exploratory data analysis revealed outliers for non-firearm homicide counts for counties near New York City in 2001 due to the attack at the World Trade Center; nearly 3000 additional lives were lost due to non-firearm homicide. For counties within approximately 50 miles of New York City, we excluded the counts of non-firearm homicide for 2001 only.

Analytic Methods

We conducted an interrupted time series analysis to estimate the effects of firearm laws on county-level firearm homicide. We used non-firearm homicide as a negative control to test for the specificity of the laws' effects. We used mixed effects Poisson regression models to account for repeated measures by county and allow counties to have unique intercepts; the likelihood ratio test for mixed effects versus a Poisson model indicated the need for random intercepts ($p < 0.001$).

County-level percent poverty, unemployment, and African American males age 15–24, state-level incarceration rates, and law enforcement expenditures were included in the final model. Year fixed effects were used to account for national trends in homicide and county-level population was included as an offset to generate incident rate ratios (IRRs). Additionally, models were run with and without a county-level proxy for firearm ownership (the ratio of firearm suicide to all suicide). Analyses were conducted using Stata IC v 14.2 [21]. This study was deemed to be "not human subjects research" by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.

² States with no counties that met the inclusion criteria: Alaska, Arkansas, Hawaii, Idaho, Iowa, Maine, Mississippi, Montana, Nebraska, New Mexico, North Dakota, South Carolina, South Dakota, Vermont, West Virginia, and Wyoming

Table 1 Firearm laws and effective dates by state

State (# of counties)	Permit to purchase	Comprehensive background check only	Right to carry	Stand your ground	Violent misdemeanor restriction
Alabama (1)			Pre-1984	6/1/06	
Arizona (1)			4/13/94	4/24/06	
California (12)		1/1/91			1/1/91
Colorado (4)		7/1/13	5/17/03		
Connecticut (1)	10/1/95				
Delaware (1)		7/1/13			
Florida (9)			10/1/87	10/1/05	
Georgia (4)			8/25/89	7/1/06	
Illinois (7)	Pre-1984		1/5/14		1/1/95
Indiana (2)		Pre-1984–11/30/98	Pre-1984	7/1/06	
Kansas (1)			1/1/07	5/26/06	
Kentucky (1)			10/1/96	7/12/06	
Louisiana (2)			4/19/96	8/1/06	
Maryland (5)	10/1/13	10/1/96–10/1/13			10/1/03
Massachusetts (6)	Pre-1984				
Michigan (4)	Pre-1984		7/1/01	10/1/06	
Minnesota (4)			5/28/03		10/1/03
Missouri (3)	Pre-1984–8/28/07		2/26/04	8/28/07	
Nevada (1)			10/1/95	10/1/11	
New Hampshire (1)			Pre-1984	11/13/11	
New Jersey (13)	Pre-1984				
New York (14)	Pre-1984				Pre-1984
North Carolina (2)	Pre-1984		12/1/95	12/1/11	
Ohio (6)			4/8/04		
Oklahoma (1)			1/1/96	11/1/06	
Oregon (3)		8/9/2015	1/1/90		
Pennsylvania (8)		10/11/95	6/17/89	8/29/11	
Rhode Island (1)		Pre-1984	Pre-1984		
Tennessee (2)		5/10/94–11/1/98	10/1/96	5/22/07	
Texas (6)			1/1/96	9/1/07	
Utah (1)			5/1/95	3/1/94	
Virginia (3)			5/5/95		
Washington (4)		12/4/14	Pre-1984		
Wisconsin (2)			11/1/11		
Total states with law during study period (total # of changes)	9 (3)	10 (9)	27 (22)	18 (18)	5 (4)

Results

Table 1 presents the laws included in the study and the associated effective dates by state for those states with counties that met our inclusion criteria.

Table 2 presents the effects of the firearm policies we examined on firearm homicide in large, urban counties after controlling for identified covariates. PTP laws were associated with a 14% reduction in firearm homicide (IRR = 0.86, 95% CI 0.82–0.90). CBC-only laws were

Table 2 Effects of firearm laws on firearm homicide in large, urban U.S. counties, 1984–2015

	IRR ^a	95% CI ^b
Permit to purchase	0.86	0.82–0.90
Comprehensive background check only	1.16	1.13–1.18
Right to carry	1.04	1.02–1.06
Stand your ground	1.07	1.05–1.10
Violent misdemeanor prohibitions	1.14	1.12–1.17
County-level % population African American male youth	1.53	1.49–1.57
County-level poverty rate	1.00	1.00–1.00
County-level unemployment rate	1.00	1.00–1.01
State-level incarceration rate	1.00	1.00–1.00
State-level law enforcement expenditures	0.99	0.99–0.99

The model also included year fixed effects

^a Incidence rate ratio

^b 95% confidence interval

associated with a 16% increase in firearm homicide (IRR = 1.16, 95% CI 1.13–1.18). RTC laws were associated with a 4% increase in firearm homicide (IRR = 1.04, 95% CI 1.02–1.06). SYG laws were associated with a 7% increase in firearm homicide (IRR = 1.07, 95% CI 1.05–1.10). VM laws were associated with a 14% increase in firearm homicide (IRR = 1.16, 95% CI 1.12–1.17). When we included the proxy for county-level firearm ownership, there were negligible differences in the point estimates; however, the firearm ownership proxy itself was associated with a 37% increase in firearm homicide (IRR = 1.37, 95% CI 1.26–1.49).

Because of the IRR estimates for CBC-only and VM laws were in the direction opposite to our hypotheses, we also tested the effects of 1-, 2-, and 3-year leads and lags of the laws. These estimates reveal firearm homicide rates trending upward in the years immediately prior to CBC-only (Fig. 1) and VM laws (Fig. 2) going into effect with statistically significant increased firearm homicide rates 1 year prior to the laws' introduction. The IRRs were above 1.0 each year following the introduction of CBC-only and VM laws, but leveled off for CBC-only and were essentially the same as the 1-year lead for VM laws.

Table 3 presents the effects of the same set of firearm policies on non-firearm homicide rates. None of the firearm policy variables of interest were associated with changes in non-firearm homicide, supporting the specificity of the laws' effects. When we included the proxy for county-level firearm ownership, there were

negligible differences in the point estimates; however, the firearm ownership proxy itself was associated with an 18% reduction in non-firearm homicide (IRR = 0.82, 95% CI 0.73–0.92).

Discussion

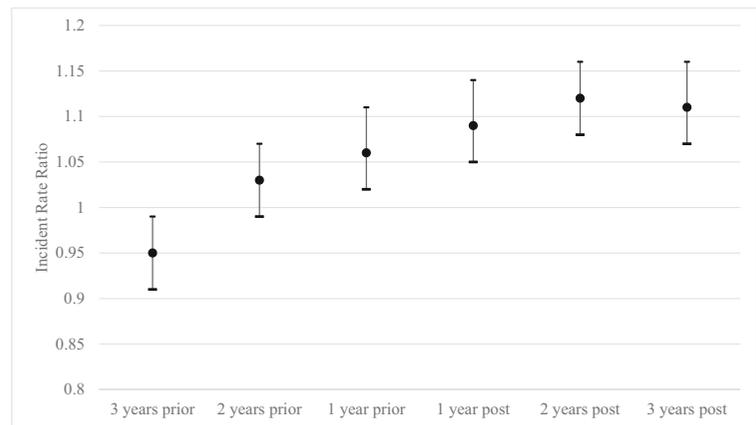
This study is the first study to our knowledge that examines the impact of PTP laws in large, urban counties where firearm homicide is more likely to occur. Our study also is the first to separate the impacts of CBC laws from PTP to understand how CBC laws affect firearm homicide independent from a permitting mechanism. Our study also examined the effects of other firearm-related policies on firearm homicide.

Our results are consistent with previous research finding that PTP reduces firearm homicides without increasing homicides by other means. However, we saw no benefit of a CBC system without a PTP law. It is possible that the application process required to obtain a permit, which puts the purchaser directly in contact with law enforcement, acts to hold potential purchasers more accountable and reduces the likelihood of straw purchases made on behalf of prohibited persons. The added time to conduct the background check at the local level may also make it easier to identify and screen out prohibited individuals who may be at increased risk of using that firearm to commit a homicide. Additionally, the built-in waiting period as part of the permitting process may prevent impulsive firearms purchases.

Our study suggests an increased risk of firearm homicide in large, urban counties associated with enactment of RTC laws which is consistent with previous research conducted at the state level. Counties in states with RTC laws experienced a 4% increase in firearm homicide relative to counties in states with more restrictions on the issuance of concealed carry weapons permits. Future research should explore whether specific elements of RTC laws, or lack thereof, have differential impacts on firearm homicide. For example, some RTC states allow law enforcement to deny issuing a concealed carry permit based on “dangerousness,” or require a demonstration of proficiency. These differences can inform policy discussions around which elements, if any, may mitigate the harmful effects of expanded carrying of loaded, concealed firearms by civilians.

Our findings related to the effects of SYG laws are also consistent with previous research on the effects of

Fig. 1 Effects of CBC-only laws on firearm homicide 1-, 2-, and 3-year pre- and post-enactment



these laws on state-level firearm homicide [12, 13]. Counties in states with SYG laws experienced a 7% increase in firearm homicide. SYG laws are common in states with RTC laws and a high prevalence of gun ownership. Removing a duty to retreat in the context of populations with many armed individuals appears to increase firearm homicide.

In contrast to recent research finding protective effects of prohibitions for violent misdemeanants on intimate partner homicide [15], our study found increased risk of firearm homicide in counties of states with VM laws. However, the increased IRR for firearm homicide associated with VM laws in the year prior to the effective date suggests that the conditions influencing the passage of VM laws may increase firearm homicides. Identifying and controlling for such factors is necessary to generate unbiased estimates of the VM law effects. Future research should explore the effects of VM laws on firearm homicide in suburban and rural counties.

The increase in firearm homicide associated with CBC-only laws should be explored further. It is possible

that CBC-only laws are harmful; however, we have not identified a plausible theory to explain how requiring a prospective firearm purchaser to undergo a background check would result in increased homicide rates. It is possible that states experiencing historically high rates of firearm homicide during the late 1980s and early 1990s were more likely to implement CBC-only laws to reduce violence. If these states then experienced slower declines in firearm homicide compared to states that did not pass these laws, the CBC-only laws would appear harmful in our analysis. The upward trend in the IRRs for CBC-only laws in the 3 years prior to implementation, and the statistically significant increased rate for CBC-only laws in the year prior, suggests there may be an endogenous relationship between CBC-only laws and firearm homicide such that states may have passed these laws in response to increasing rates of firearm homicide. The lack of any beneficial effect of CBC-only laws could also reflect issues related to enforcement of CBC-only laws. The enforceability challenges associated with CBC-only laws are beginning to be

Fig. 2 Effects of VM laws on firearm homicide 1-, 2-, and 3-year pre- and post-enactment

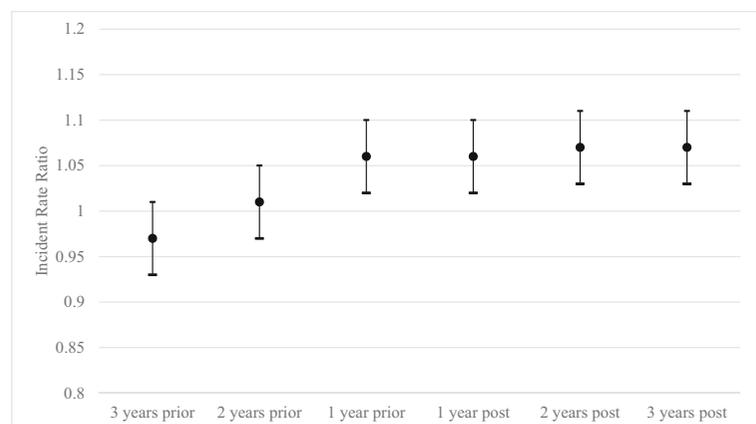


Table 3 Effects of firearm laws on non-firearm homicide in large, urban U.S. counties, 1984–2015

	IRR ^a	95% CI ^b
Permit to purchase	1.04	0.97–1.13
Comprehensive background check only	0.97	0.94–1.01
Right to carry law	1.03	1.00–1.06
Stand your ground	1.01	0.97–1.04
Violent misdemeanor prohibitions	0.99	0.96–1.02
County-level % population African American male youth	1.52	1.47–1.58
County-level poverty rate	1.01	1.00–1.02
County-level unemployment rate	0.99	0.99–1.00
State-level incarceration rate	1.00	1.00–1.00
State-level law enforcement expenditures	1.00	1.00–1.00

The model also included year fixed effects

^a Incidence rate ratio

^b 95% confidence interval

documented.[22, 23] PTP laws may be easier to comply with and enforce than CBC-only laws since sellers can only transfer a firearm to someone who has a valid permit. Future research should expand the inclusion criteria for county population size and/or urbanization. This may also allow for more states to be represented in the data and produce more robust results. Within PTP and CBC-only laws, there remain differences among states, including standards for obtaining the permit, duration of the permit, and whether a point-of-sale background check is also required in PTP states. These issues warrant additional research. Additionally, future research should explore the effects of these laws on firearm suicide at the county level.

There are some limitations to our study. As with all observational studies, there is a risk of selection bias as states choose whether to pass a policy or not. However, we attempted to minimize this bias by including county-level demographics and pre-law enactment data to estimate baseline trends. Importantly, our assessment of the effects of CBC-only and VM laws in the years prior to the laws going into effect underscores the challenges of studies of this type where omitted variables may bias estimates of the laws' impacts. This study only includes counties classified as the most urban with populations of 200,000 or greater across the entire study period. These counties may be different from those not included. Our inclusion criteria also excluded counties that may have had a population of 200,000 or more at some point

during the study period but did not maintain that population level across the entire study period. However, limiting our sample to large, urban counties where firearm homicide is more likely to occur would give us more reliable estimates of policy effects. Our study relied on two covariates that were not readily available at the county level. For example, law enforcement expenditures were only available at the state level.

This study adds to the growing body of evidence that PTP laws are associated with reductions in firearm homicide. States that are considering a range of policies related to the transfer of firearms should consider a handgun purchaser licensing system through a PTP law as a mechanism to reduce firearm homicide.

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