



Effects of changes in permit-to-purchase handgun laws in Connecticut and Missouri on suicide rates



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ABSTRACT

Objective. In 2013, more than 40,000 individuals died from suicide in the United States. Restricting access to lethal means has the potential to prevent suicide, as suicidal thoughts are often transient. Permit-to-purchase (PTP) laws for handguns could potentially reduce suicides by making it more difficult for persons at risk of suicide to purchase a handgun.

Methods. We used a quasi-experimental research design with annual, state-level suicide data to evaluate changes to PTP laws in Connecticut and Missouri. Data were analyzed for 1981–2012. We used synthetic control modeling as the primary method to estimate policy effects. This methodology provided better prediction of pre-PTP-law-change trends in the two states with PTP law changes than econometric models and is thus likely to provide more accurate estimates of policy effects.

Results. The synthetic control model estimated a 15.4% reduction in firearm suicide rates associated with Connecticut's PTP law. Missouri's PTP law repeal was associated with a 16.1% increase in firearm suicide rates. Evidence that PTP laws were associated with non-firearm suicide rates was mixed in Connecticut and negative in Missouri.

Conclusion. The findings are consistent with prior research linking firearm availability to increased risk of suicide and lower suicide risks associated with PTP handgun laws.

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Introduction

In the United States, suicide is the second leading cause of death for persons age 15–34 years, and the tenth leading cause of death overall (CDC, 2015a). In 2013 alone, more than 40,000 individuals lost their lives to suicide, compared to approximately 16,000 homicides (CDC, 2015b). More than half of all suicides were committed with a firearm (CDC, 2015a).

Household-level and state-level studies have found that access to firearms is positively associated with suicide risk after controlling for other risk factors (Anglemyer et al., 2014). Case fatality rates for suicide attempts by firearm exceed 90% (Miller et al., 2004). Though many commonly think that a person contemplating suicide will use an equally lethal alternative method if the original means of suicide is restricted, suicidal ideation is often transient (Miller et al., 2006; Deisenhammer et al., 2009). And for many individuals attempting suicide, the time between suicidal ideation and attempt can be as little as 10 min (Deisenhammer et al., 2009). If a person's access to particularly lethal means can be restricted during periods of distress or impulsivity, a suicide may be prevented. For these reasons, suicide prevention research

has explored what impact lethal means restriction can have on suicide attempts and completion (Hawton, 2007; Barber & Miller, 2014).

Laws requiring permits to purchase firearms represent one method of means restriction for firearms, especially for some high-risk individuals, which require handgun purchasers to obtain a permit-to-purchase (PTP) that is contingent upon the applicant passing a background check. These PTP laws typically require an in-person application at a law enforcement agency and, in some cases, applicants must successfully complete safety training and experience significant waits for review. Permits are required for virtually all transfers of handguns including those conducted by private unlicensed sellers. A background check requirement for private sales should prevent a sale to someone with a prohibiting condition that reflects heightened risk for suicide, including conviction for violent crimes, being under a restraining order for domestic violence, multiple offenses involving drugs or alcohol abuse, and being involuntarily committed to a mental hospital or found by a court to be a threat to themselves or others due to mental illness. Also, the additional time required to obtain a gun in states with a PTP law could restrict access to firearms among those not already owning firearms during times of suicidal ideation or planning. Federal law does not require a permit or background check for handgun purchasers are only required under federal law if the seller is a licensed gun dealer.

Missouri had a PTP law for handguns in place beginning in 1921. Anyone wanting to legally purchase a handgun from a licensed dealer or

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private seller was required to apply in-person at a local sheriff's office. A PTP for a handgun was issued to approved individuals and good for 30 days. Missouri's PTP law was repealed effective August 28, 2007, reducing a barrier to handgun access for prohibited persons. Prior research evidence indicates that the PTP law repeal was associated with an increase in the diversion of guns to criminals Webster et al., 2013 and homicides committed by firearms in Missouri (Webster et al., 2014).

Prior to 1995, Connecticut's laws regarding background checks for handgun sales could be characterized as vague. In 1965, the state enacted a law requiring all handgun sellers and buyers to use a written application that was to be mailed to the local authorities prior to a sale. If that municipal authority were to "have knowledge" that the buyer had a felony conviction, then the authority would notify that seller that no sale could take place. A one week waiting period – extended to two weeks in 1975 – was also instituted. A new state law went into effect in October 1994, establishing an optional eligibility certificate for handgun buyers that could be issued by local authorities upon the purchaser passing a background check. Holders of an eligibility certificate for handgun purchases were not required to comply with the waiting period. Local authorities were instructed to make a "reasonable effort" to determine if any applicant was ineligible to own a handgun. It was not until October 1, 1995 that Connecticut established a mandatory PTP system applicable to all handgun buyers and made it illegal to sell a handgun to anyone who did not have an eligibility certificate. Such certificates required the applicant to pass a background check and successfully complete an 8-hour handgun safety course. A recent study demonstrated that enactment of Connecticut's PTP law was associated with decreases in firearm homicides and had no impact on homicides committed by other means (Rudolph et al., 2015).

The current study was designed to estimate the effects that these two changes in PTP handgun laws had on suicide rates. Prior research has shown a negative association between the presence of PTP laws and suicide rates; Andrés & Hempstead, 2011; Flegler et al., 2013 however, most of the variation examined in these studies was cross-sectional and did not focus on whether the policies changed the risk of suicides over time in states when they adopted or repealed a PTP law. A recently published study by Anestis et al. (Anestis et al., 2015) also explored this topic, however, this study had important limitations including that it principally estimated cross-sectional associations. Our study seeks to provide a thorough and rigorous evaluation of the impact of changing PTP handgun laws on suicide in Connecticut and Missouri.

Methods

Design

A quasi-experimental research design was used with annual, state-level suicide rates and counts to contrast differences pre- versus post-PTP law change in Connecticut and Missouri compared with states that did not experience a PTP law change. State-level data for suicides were available for the years 1981–2012. Suicides were stratified by mechanism (firearm vs. non-firearm) to test the specificity of the policy effects and examine if possible method substitution occurred following the PTP law change.

Data

Suicide data were accessed from the Centers for Disease Control and Prevention's Web-based Injury Statistics Query and Reporting System (WISQARS) CDC, 2015c for years 1981–2007. For data after 2007, WISQARS suppresses the data if counts for individual state-years are less than 10 – which was particularly prevalent when examining the data within age strata. Data were obtained for years 2008–2012 through a request to the National Association for Public Health Statistics and Information Systems (NAPHISIS, National Association for Public Health Statistics and Information Systems, 2014).

The analyses controlled for a number of factors previously associated with suicide rates at the state level including: unemployment; poverty; demographics (percentage of the population that was male, black, Hispanic, married, completed high school, a military veteran, or who lived in a Metropolitan Statistical Area

(MSA)), per capita consumption of ethanol spirits, firearm availability, and rate of religious adherence. The analyses also included control variables for states with strong mental health parity laws because access to mental health services could protect against suicides.

Annual unemployment rates (per 100 population age 16 or older) were accessed from the Bureau of Labor Statistics (BLS, 2012). Poverty rates (per 100 population) were from the Current Population Survey (Census, 2012a). Percent MSA was obtained from the Crime in the United States reports (FBI, 2012). The proportions of state population that were black or Hispanic were from the Census Bureau and interpolated between census years (Census, 2012b). Marital status, percent completing high school, proportion male, and proportion of the state that are military veterans were accessed from Census data and the American Community Survey (Census, 2015). Per capita ethanol spirit consumption was obtained from National Institute on Alcohol Abuse and Alcoholism (NIAAA, 2014). Rates of religious adherence were obtained from the Religion and Congregation Membership Survey interpolated between census years (ARDA, 2014). A commonly used firearm availability proxy (ratio of firearm suicides to all suicides) was created using data from WISQARS (used only to improve matching in the synthetic control models) (CDC, 2015c).

A significant challenge to deriving valid estimates of the impact of new state policies on public health and safety outcomes is the considerable heterogeneity among states and the inability to directly measure important factors that influence trends that vary across states. An innovative approach for dealing with this challenge is creating so-called "synthetic controls" to estimate the counterfactual for states that adopt new policies. This method uses data from a pool of potential comparison states that do not have the type of law being evaluated to create a synthetic control. This synthetic control is derived from a combination of observations from the comparison pool that are weighted according to their ability to accurately predict the pre-law trends in the outcome variable of the state where the law of interest is being changed. This approach can produce a more accurate counterfactual for the state where the law change occurs and therefore a more accurate estimate of a policy impact than analytic approaches that estimate policy effects based on a much broader set of data that include non-intervention comparisons that may be substantially different from the intervention state.

The synthetic control methodology avoids the heterogeneity assumption, that an intervention has constant effects across all observations, which underlies estimates derived from regression analyses. This methodology allows us to separately estimate the effects of a law's change on suicide for Connecticut and Missouri over different time periods.

To construct appropriate synthetic controls, we restricted the donor pool of comparison states for Connecticut's synthetic control to the 39 other states without a PTP handgun law in 1995. For Missouri, which repealed its PTP law in 2007, we included the other 9 states (excluding the District of Columbia and Connecticut) that had a PTP law in 2007. We used covariate and suicide data from 1981–2006 for Connecticut, which adopted its law in late 1995, avoiding extrapolation beyond ten years after the passage of Connecticut's PTP law as recommended by Abadie, Diamond, and Hainmueller (Abadie et al., 2010). For Missouri, which repealed its law in 2007, we used data from 1981–2012. Dependent variable rates were smoothed by analyzing three-year moving averages for Y_{t-1} , Y_t , and Y_{t+1} to ease interpretation of otherwise volatile data (Rudolph et al., 2015; Abadie et al., 2010; Abadie & Gardeazabal, 2003; Abadie et al., 2015). Separate analyses were performed for firearm suicides and non-firearm suicides to assess whether any estimates of policy effects were specific to firearm suicides and if the policy change was associated with method substitution. The synthetic controls' ability to predict pre-law-change trends in suicide rates in the states that changed their PTP laws was assessed by calculating the root mean square prediction error (RMSPE) and contrasting it with the RMSPE for a simple average of the entire pool of control states that were used to predict suicide rates in Connecticut and Missouri.

Because this method does not produce traditional p-values or tests of statistical significance, we performed so-called placebo tests with each of the states in the donor pool of control states for Connecticut and Missouri. Using firearm suicide rates, we ran the analyses with each state from the donor pool as if it were the "treated" state that experienced the PTP law change at the time that Connecticut or Missouri did. We then calculated the cumulative percent change in firearm suicides during the post-law change periods for Connecticut (1996–2005) and Missouri (2008–2012). We calculated the percent difference in cumulative post-law-change firearm and non-firearm suicide rates between the observed and the counterfactual estimated by each of the synthetic controls. This allowed us to examine the estimated percentage change associated with the changes in the PTP laws in Connecticut and Missouri in comparison to the percentage change estimates from the placebo tests in the states from each of

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