

# Homicide and Suicide Rates Associated With Implementation of the Brady Handgun Violence Prevention Act

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**T**HE BRADY HANDGUN VIOLENCE Prevention Act,<sup>1</sup> implemented in February 1994, provides an unusual opportunity to conduct a systematic evaluation of a national system of background checks and waiting periods for the purchase of handguns from federally licensed firearms dealers (FFLs). The intent of the legislation was to interrupt sales of firearms to persons who are legally prohibited from purchasing them. A total of 18 states and the District of Columbia already met requirements, but dealers and law enforcement officials in the other states ("treatment" states) had to institute new more stringent procedures. The result is a sort of natural experiment, with 1 group of states in the change or treatment condition and the no-change states serving as "controls."

The population directly affected by the Brady Act is residents of treatment states aged 21 years or older who sought to purchase a handgun from an FFL. (Those <21 years have been legally barred from making such purchases since 1968). Some may have intended to shoot themselves or someone else and changed their minds during the 5-day waiting period mandated by the Brady Act. Some of those with felony records may have had no specific intent, but because they were stopped

**For editorial comment see p 616.**

**Context** In February 1994, the Brady Handgun Violence Prevention Act established a nationwide requirement that licensed firearms dealers observe a waiting period and initiate a background check for handgun sales. The effects of this act have not been analyzed.

**Objective** To determine whether implementation of the Brady Act was associated with reductions in homicide and suicide rates.

**Design and Setting** Analysis of vital statistics data in the United States for 1985 through 1997 from the National Center for Health Statistics.

**Main Outcome Measures** Total and firearm homicide and suicide rates per 100000 adults ( $\geq 21$  years and  $\geq 55$  years) and proportion of homicides and suicides resulting from firearms were calculated by state and year. Controlling for population age, race, poverty and income levels, urban residence, and alcohol consumption, the 32 "treatment" states directly affected by the Brady Act requirements were compared with the 18 "control" states and the District of Columbia, which had equivalent legislation already in place.

**Results** Changes in rates of homicide and suicide for treatment and control states were not significantly different, except for firearm suicides among persons aged 55 years or older ( $-0.92$  per 100000; 95% confidence interval [CI],  $-1.43$  to  $-0.42$ ). This reduction in suicides for persons aged 55 years or older was much stronger in states that had instituted both waiting periods and background checks ( $-1.03$  per 100000; 95% CI,  $-1.58$  to  $-0.47$ ) than in states that only changed background check requirements ( $-0.17$  per 100000; 95% CI,  $-1.09$  to  $0.75$ ).

**Conclusions** Based on the assumption that the greatest reductions in fatal violence would be within states that were required to institute waiting periods and background checks, implementation of the Brady Act appears to have been associated with reductions in the firearm suicide rate for persons aged 55 years or older but not with reductions in homicide rates or overall suicide rates. However, the pattern of implementation of the Brady Act does not permit a reliable analysis of a potential effect of reductions in the flow of guns from treatment-state gun dealers into secondary markets.

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from purchasing a handgun by the background check were discouraged from obtaining one and hence were not in a position to shoot someone later when the occasion arose. The result of the Brady act may thus be to reduce shootings, including firearm suicides and homicides, by adult handgun buyers in the treatment states. It is also possible that the Brady Act has the addi-

tional consequence of reducing the flow of guns from treatment-state FFLs into the *secondary gun market*, defined as all gun transfers that do not involve an FFL,<sup>2</sup> which in turn may reduce gun

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violence by perpetrators of all ages in both the treatment and control states. Our evaluation compared homicide and suicide rates before and after the Brady Act went into effect to determine whether specific changes in these rates were associated with implementation of this policy.

## METHODS

Our main outcome measures are homicide, firearm homicide, suicide, and firearm suicide rates per 100 000 population, as well as the percentage of homicides and suicides committed with a gun. These outcome measures are calculated from the vital statistics census of deaths of US residents from the National Center for Health Statistics for the period 1985 through 1997. We calculated these rates separately by year for each state.

We also refined our analysis by using data for adults only, the primary target population of the Brady Act regulations. Because the vital statistics database only provides information on the age of the shooter for suicides, we focused on fatal firearm injuries to adult victims ( $\geq 21$  years). Because there is a high correlation between the ages of killers and victims,<sup>3</sup> this produces a sample in which a large proportion of perpetrators are adults. The results are also replicated using data for older victims ( $\geq 55$  years). Because suicide is more common and gun ownership is less common among older US residents compared with other adults,<sup>4,5</sup> the effects of the Brady Act on firearm suicides should be most pronounced among older residents.

We also controlled for state-level changes in the following factors that may influence rates of crime and violence: consumption of alcohol per capita (measured in gallons of ethanol),<sup>6</sup> percentage of the population living in metropolitan areas,<sup>7</sup> percentage of the population living below the official poverty line and income level per worker (in 1998 constant dollars),<sup>8,9</sup> percentage who are African American,<sup>10</sup> and the percentage of the population falling into 7 different age groups

(<15, 15-17, 18-24, 25-34, 35-44, 45-54, and 55-64 years).<sup>11</sup> Each of these state-level variables is measured annually with the exception of race and poverty level, which are statistics that come from the decennial census and are interpolated for intercensal years.<sup>12-15</sup>

## Classification of Treatment States

When the Brady Act went into effect in February 1994, a total of 32 states were required to implement the background check and a 5-day waiting period: Alabama, Alaska, Arizona, Arkansas, Colorado, Georgia, Idaho, Kansas, Kentucky, Louisiana, Maine, Minnesota, Mississippi, Montana, Nebraska, New Hampshire, New Mexico, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Washington, West Virginia, and Wyoming. The remaining states were exempted because they already required a background check of those buying handguns from FFLs. Most of these requirements were enacted 4 or more years prior to the passage of the Brady Act. In 1994, 5 states originally classified as treatment states met the act's exemption requirements (Colorado, Idaho, Minnesota, Tennessee, and Utah). New Hampshire and North Carolina were granted exemptions in 1995 and Washington in 1996. Nevada was originally exempt but later became subject to the Brady Act's requirements.<sup>16-18</sup>

For our analysis we classified all 32 original states as the treatment states and the remaining states (including the District of Columbia) as the control states. In particular, we classified as treatment states the 8 original states that were later granted exemptions because the effect for that group was the same as for the other treatment states that were required by the Brady Act to institute a background check in 1994. We do not count Nevada in the treatment group because its February 1994 restrictions were strict enough to warrant a Brady Act exemption.

There is a minor question about whether the Brady Act's treatment was still in effect in 1997, the last year for

which we have vital statistics data. In June of that year, the US Supreme Court invalidated the requirement that state officials conduct a background check (*Printz v the United States* 117 US 2365 1997), on Tenth Amendment grounds that the law violated state sovereignty rights. In practice, law enforcement officials in all but 2 of the treatment states (Ohio and Arkansas) voluntarily continued to conduct background checks.

## Evaluation Strategy

One possible consequence of the Brady Act may be a reduction in overall rates of gun violence in the United States as a whole. We explored this possibility by estimating equation 1 using our state-level data for the period 1985 through 1997, where  $Y_{it}$  represents some mortality measure for state,  $i$ , in period,  $t$ , and  $X_{it}$  represents the set of control variables described above. The model includes separate dichotomous indicator variables for each state,  $d_i$ , to capture unmeasured state-specific *fixed effects* that cause the level of violence to differ across states and a set of year-indicator variables,  $g_t$ , that capture changes in the overall rate of violence in the United States conditional on the observed covariates. Our initial analysis focused on the pattern of these year effects before and after the Brady Act was implemented.

$$(1) \quad Y_{it} = a_0 + a_1 X_{it} + d_i + g_t + v_{it}$$

Equation 1 is estimated via weighted least squares, a technique that corrects for heteroskedasticity in the stochastic term by premultiplying the dependent and explanatory variables by the square root of the state's population.<sup>19</sup> We calculated Huber-White SEs to adjust for the non-independence of observations from the same state.<sup>20,21</sup> We also estimated an autoregressive version of model 1 that includes the 1-year lag of the dependent variable as an explanatory variable in an attempt to control for unmeasured time-varying factors.<sup>22</sup>

The estimates from equation 1 identify changes in the US homicide or suicide rates that are not explained by the model's covariates. Changes in these pat-

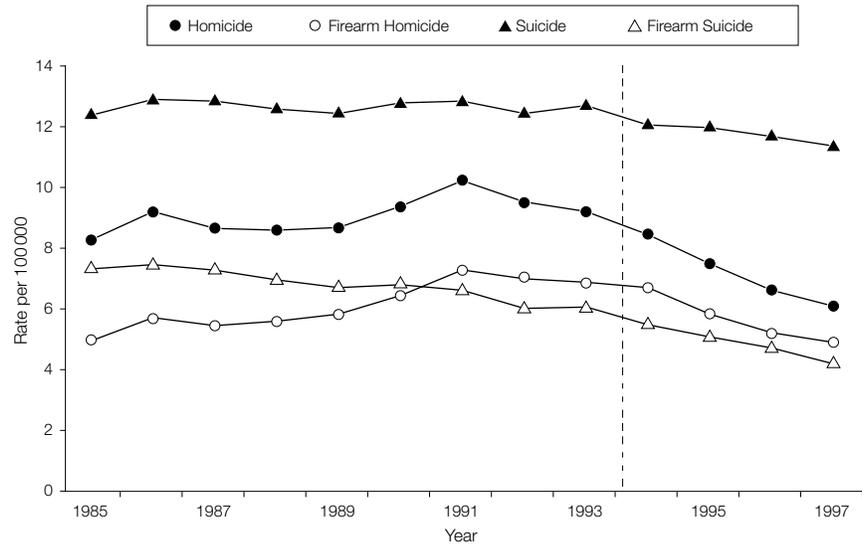
terns around the time the Brady Act was enacted may be due to its implementation but could also be due to other unmodeled factors that have changed over time and have affected the nationwide trend in violence. To overcome this problem, we used the natural experiment generated by the Brady Act by comparing the change in gun violence rates in the treatment states from the pre-Brady Act to post-Brady Act period with the change in gun violence rates over the same period observed in the control states. This approach differences out the influences of unmodeled factors that are common across states and are associated with trends in homicide and suicide.

Our estimates come from slightly modifying equation 1 by including an indicator variable  $T_{it}$  that is equal to 1 in the treatment states following implementation of the Brady Act and equal to 0 otherwise, as in equation 2. Since state fixed-effects are included in the model, the key coefficient of interest,  $b_2$ , reflects the difference between the treatment and control states in the trend in violence rates from the pre-Brady Act and post-Brady Act periods. (This is easy to see by noting that the inclusion of dummy variables for each state is equivalent to measuring all of the dependent and explanatory variables as deviations from the state's average value of the variable over the sample period.<sup>23</sup>) The  $b_2$  captures any 1-time shift in the rate of gun violence in the treatment states vs the control states around the time the Brady Act was implemented and should be negative if gun violence was reduced because of the Brady Act.

$$(2) Y_{it} = b_0 + b_1 X_{it} + b_2 T_{it} + d_i + g_t + e_{it}$$

Because we have 4 years of vital statistics data after the law became effective (1994-1997), for comparability, we defined the period before the Brady Act as the 4 years prior to the law's implementation (1990-1993). This evaluation approach assumes that treatment and control states would have had similar trends in homicide and suicide rates had the Brady Act not been enacted. One way to test this assumption is to determine whether the treatment and

**Figure 1.** Mortality Trends for United States, 1985-1997



Regression-adjusted trend in homicide and suicide rates for United States as a whole based on vital statistics data, holding demographic characteristics, poverty and income level, and alcohol consumption of the population constant at 1985 levels (see "Methods" section). Dashed vertical line indicates implementation of the Brady Act (February 1994).

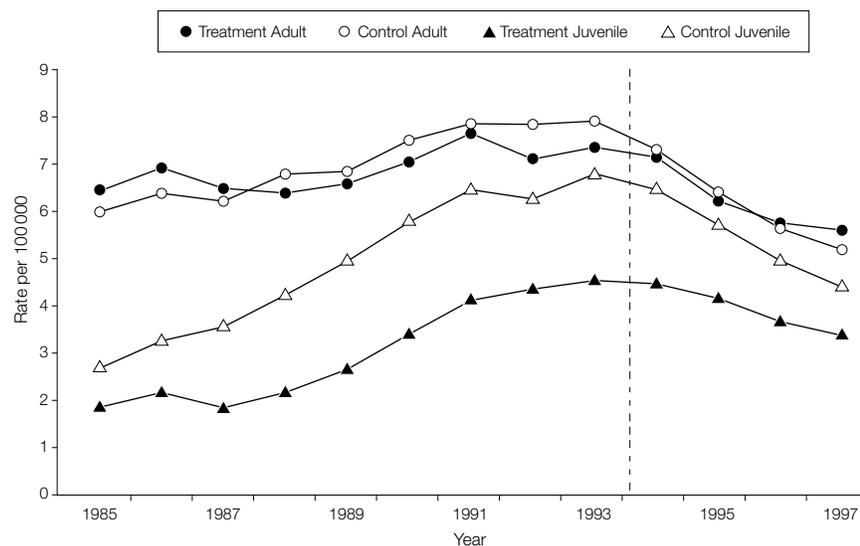
control states have similar trends during the period before the Brady Act was implemented.

To examine the robustness of our findings to alternative model specifications, we reproduced our estimates using the natural logarithm of  $Y_{it}$  as the dependent variable, which is appropriate if the Brady Act has the same proportional (rather than absolute) effect on violence across states. The regression coefficient in this case represents the proportional change in the outcome of interest. Equation 2 is also reestimated using a negative binomial model that yields somewhat more precisely measured estimates expressed as incidence rate ratios.<sup>24</sup> In addition, we replicated our estimates excluding 1993 and 1994 data from the sample, since these years could have been contaminated by either the expectation of the Brady Act during 1993 or an implementation lag during 1994, and we examined the sensitivity of our results to the experiences of large control states such as New York and California, which experienced unusually large reductions in crime during the 1990s for reasons that remain poorly understood.<sup>25,26</sup>

For policy purposes, it is important to isolate the association between waiting periods and gun violence. To do this, we used a second natural experiment embedded within the Brady Act. Of the original treatment states, 5 did not experience an increase in waiting periods, either because they had enacted an instant background-check requirement almost immediately following the implementation of the act (Colorado and Utah, both March 1, 1994), or because the state already had a waiting period of 5 days or more in effect prior to implementation (Minnesota, 7 days; Rhode Island, 7 days; Washington, 5 days). We reestimated equation 2 first by comparing the control states with the 5 partial-treatment states that experienced no change in waiting periods and then compared the control states with the remaining 27 full-treatment states. If waiting periods are negatively correlated with mortality rates, we would expect the latter difference to be larger in absolute value than the former (ie, a more negative number).

## RESULTS

FIGURE 1 presents our estimates for the year effects, from equation 1, which

**Figure 2.** Firearm Homicide Rates Among Adults and Juveniles in Treatment vs Control States, 1985-1997

Results are based on calculations of unadjusted mortality rates using vital statistics data. Definition of treatment and control states provided in "Methods" section. Dashed vertical line indicates implementation of the Brady Act (February 1994).

shows the pattern of homicide and suicide rates (from all causes, and isolating deaths from firearms) over time for the United States holding the values of the explanatory variables described above constant at their 1985 values. The results of this time-series analysis suggest that homicide and suicide rates to victims of all ages began to decline in the United States overall before the Brady Act went into effect in 1994. When we reestimated equation 1 including the lagged homicide or suicide rate as an explanatory variable in an attempt to control for unmodeled factors, we obtained similar results (data not shown).

FIGURE 2 shows actual (unadjusted) disaggregated firearm-homicide trends for the treatment and control states for juvenile victims (<21 years) and adult victims ( $\geq 21$  years). The trends in rates of juvenile gun homicide for the treatment and control states diverged even before the Brady Act went into effect. In 1993, the difference in juvenile gun homicide rates between the treatment and control states was 2.27 per 100 000, nearly triple the 1985 difference (0.82). On the other hand, for adult victims, the

trends in firearm homicides (Figure 2) and firearm suicides (data not shown) in the treatment and control states track each other quite closely during the period before the Brady legislation. These results indicate that the key assumption underlying our estimation procedure in equation 2 is met for adult homicide and suicide rates but not for juvenile rates or, by extension, homicide rates to victims of all ages (which includes juveniles). In what follows we focus on presenting the results of estimating equation 2 using data for adult victims.

For victims aged 21 years or older, none of the differences between the treatment and control states in any of the homicide or suicide measures are statistically significant at the traditional 95% level (TABLE 1).

On the other hand, firearm suicides to victims aged 55 years or older declined by 0.92 per 100 000 population (95% confidence interval [CI], -1.43 to -0.42) in the treatment states relative to the control states, equal to about 6% of the gun suicide rate to those aged 55 years or older in the control states during the pe-

riod after the Brady legislation. We also observed a statistically insignificant increase in nongun suicides to this population (0.38 per 100 000; 95% CI, -0.04 to 0.80), a reduction in the proportion of suicides with a firearm of -2.2% (95% CI, -3.9 to -0.5), and a modest (though not statistically significant) reduction in the overall suicide rate (-0.54 per 100 000; 95% CI, -1.27 to 0.19).

The general pattern of results is not sensitive to whether we had estimated either a log-linear or negative-binomial model. The results are also similar when we excluded the years 1993 and 1994 from our analytic sample, dropped atypical and influential control states such as New York and California from the sample, or dropped the few control states that had experienced a change in background-check or waiting-period regulations between 1990 and 1994 (data not shown).

However, we found that the reduction in firearm suicides among older residents is limited to those treatment states that experienced changes in both waiting period and background-check requirements. There are no statistically significant changes in any of our homicide or suicide measures when we compared the control states with the partial-treatment states that had experienced changes in background-check regulations but not in waiting periods (TABLE 2). Conversely, the full-treatment states that also had experienced increases in the waiting period for handgun purchases had a reduction in firearm suicides to older residents equal to -1.03 per 100 000 (95% CI, -1.58 to -0.47) relative to control states.

## COMMENT

Our analyses provide no evidence that implementation of the Brady Act was associated with a reduction in homicide rates. In particular, we find no differences in homicide or firearm homicide rates to adult victims in the 32 treatment states directly subject to the Brady Act provisions compared with the remaining control states.

The evaluation strategy used herein was based on the assumption that the greatest reductions in homicide rates

would be within states that were required to institute background checks and waiting periods as a result of the Brady Act. However, it is possible that the Brady Act may have had a negative association with homicide rates in both the treatment and control states by reducing the flow of guns from treatment-state gun dealers into secondary gun

markets. If such indirect effects exist and have a greater impact on gun violence in control than treatment states, our estimate of the direct impact will understate any negative association between the Brady Act and rates of violence in the treatment states; the opposite bias is introduced if the indirect effects are greater in the treatment states.

The best available evidence suggests that treatment-state gun dealers are important sources of guns that have been used in crimes in both the treatment and control states. Interstate gun-running is often the source of guns being used in crimes in the control states, with many of these guns coming from states with more lenient gun laws such as the

**Table 1.** Differences in Homicide and Suicide Trends From Pre-Brady Act and Post-Brady Act Periods in Treatment vs Control States\*

	Victims ≥21 Years			Victims ≥55 Years		
	Weighted Least Squares, Difference (95% CI)	Natural Logarithm of Dependent Variable, Difference in Logs (95% CI)	Negative Binomial, Incidence Rate Ratio (95% CI)	Weighted Least Squares, Difference (95% CI)	Natural Logarithm of Dependent Variable, Difference in Logs (95% CI)	Negative Binomial, Incidence Rate Ratio (95% CI)
<b>Homicide</b>						
Overall rate per 100 000	-0.34 (-1.58 to 0.91)	-0.13 (-0.34 to 0.07)	0.97 (0.87 to 1.08)	-0.09 (-0.61 to 0.44)	0.03 (-0.11 to 0.17)	1.00 (0.90 to 1.12)
Gun homicide rate	-0.12 (-1.12 to 0.88)	-0.11 (-0.33 to 0.11)	0.99 (0.86 to 1.13)	0.05 (-0.16 to 0.25)	0.07 (-0.04 to 0.19)	1.07 (0.97 to 1.16)
Nongun homicide rate	-0.22 (-0.52 to 0.08)	-0.07 (-0.15 to 0.02)	0.94 (0.87 to 1.02)	-0.14 (-0.53 to 0.26)	0.01 (-0.18 to 0.20)	0.95 (0.81 to 1.12)
Homicides committed with firearm, %	1.2 (-0.8 to 3.2)	1.9 (-1.4 to 5.1)	1.02 (0.99 to 1.04)	3.3 (-1.4 to 8.1)	4.3 (-6.2 to 14.7)	1.07 (0.98 to 1.18)
<b>Suicide</b>						
Overall rate per 100 000	-0.43 (-1.31 to 0.45)	-0.10 (-0.22 to 0.03)	0.98 (0.93 to 1.03)	-0.54 (-1.27 to 0.19)	-0.04 (-0.08 to 0.01)†	0.97 (0.93 to 1.01)
Gun suicide rate	-0.32 (-0.73 to 0.10)	-0.09 (-0.22 to 0.04)	0.98 (0.94 to 1.02)	-0.92 (-1.43 to -0.42)‡	-0.07 (-0.12 to -0.02)‡	0.94 (0.90 to 0.98)‡
Nongun suicide rate	-0.11 (-0.90 to 0.68)	0.03 (-0.03 to 0.09)	1.01 (0.95 to 1.08)	0.38 (-0.04 to 0.80)†	0.03 (-0.05 to 0.11)	1.03 (0.97 to 1.11)
Suicides committed with firearm, %	-0.2 (-1.2 to 0.8)	0.7 (-1.4 to 2.7)	1.17 (0.87 to 1.58)	-2.2 (-3.9 to -0.5)‡	-3.6 (-6.3 to -1.0)‡	0.97 (0.94 to 0.99)‡

\*The study period before the Brady Act went into effect is 1990 through 1993; the period after is 1994 through 1997. Regressions are calculated by estimating equation 2 ("Methods" section) using state population as weights to adjust for heteroskedasticity. CI indicates confidence interval.

†Statistically different from 0 at the 10% cutoff.

‡Statistically different from 0 at the 5% cutoff.

**Table 2.** Estimates of Differences in Homicide and Suicide Trends in Control vs Full-Treatment or Partial-Treatment States\*

	Victims ≥21 Years		Victims ≥55 Years	
	Treatment States Without Change in Waiting Periods	Treatment States With Change in Waiting Periods	Treatment States Without Change in Waiting Periods	Treatment States With Change in Waiting Periods
<b>Homicide</b>				
Rate per 100 000	0.67 (-0.69 to 2.03)	-0.50 (-1.72 to 0.72)	0.27 (-0.29 to 0.84)	-0.11 (-0.65 to 0.43)
Gun homicide rate	0.67 (-0.49 to 1.84)	-0.24 (-1.23 to 0.75)	0.31 (-0.20 to 0.82)	0.02 (-0.20 to 0.24)
Nongun homicide rate	-0.01 (-0.28 to 0.27)	-0.26 (-0.55 to 0.03)†	-0.03 (-0.27 to 0.21)	-0.13 (-0.53 to 0.27)
Homicides committed with firearm, %	3.0 (-1.6 to 7.5)	0.7 (-1.2 to 2.7)	9.2 (-4.6 to 23.1)	2.4 (-2.0 to 6.8)
<b>Suicide</b>				
Rate per 100 000	-0.27 (-1.55 to 1.01)	-0.46 (-1.39 to 0.46)	-0.09 (-1.20 to 1.02)	-0.60 (-1.39 to 0.18)
Gun suicide rate	-0.07 (-0.85 to 0.71)	-0.36 (-0.81 to 0.09)	-0.17 (-1.09 to 0.75)	-1.03 (-1.58 to -0.47)‡
Nongun suicide rate	-0.20 (-1.15 to 0.75)	-0.10 (-0.92 to 0.71)	0.08 (-0.52 to 0.67)	0.43 (-0.02 to 0.87)†
Suicides committed with firearm, %	5.7 (-11.9 to 23.4)	9.0 (-13.0 to 31.0)	-1.2 (-4.1 to 1.7)	-2.4 (-4.3 to -0.5)‡

\*Regressions are calculated by applying weighted least squares to equation 2 ("Methods" section) using state population as weights to adjust for heteroskedasticity. The difference between homicide and suicide trends in the years before and after the Brady Act legislation, minus the difference in control states, β (95% confidence interval) in treatment states with no changes in waiting periods vs control states and in treatment states with changes in waiting periods vs control states.

†Statistically different from 0 at the 10% cutoff.

‡Statistically different from 0 at 5% cutoff.

treatment states.<sup>27,28</sup> However, in 26 of the 32 treatment states, the majority of guns used in crimes were first purchased from a gun dealer within the same state.<sup>24</sup> Unfortunately there is no direct evidence that enables us to determine whether the Brady Act has had a greater effect on secondary gun markets in the treatment or in the control states.

If implementation of the Brady Act were associated with a reduction in homicide rates of similar magnitude in control states as in treatment states, our comparisons of treatment and control state trends would have failed to detect it. Although changes in both treatment and control states would be reflected in principle in the nationwide homicide rate, we are wary about associations derived from a single-data series for the United States overall because of the difficulty in ruling out alternative explanations for changes in the trend line. Even our formal time-series model is a weak substitute for having a reliable control group.

Our findings are generally consistent with most of the previous evaluations of state-level background-check and waiting-period laws.<sup>29-31</sup> For example, 1 analysis of would-be handgun purchasers in California<sup>32</sup> suggests that background checks may slightly reduce gun misuse. Although Californians who were denied purchase of a handgun due to a felony-conviction record had fewer violent-crime arrests than those who were permitted to purchase a handgun despite a record of 1 or more felony arrests, the follow-up arrest rates for both groups were fairly low, and only 3% of these violent-crime arrests were for homicide. If we project the results of this study to the 44000 applicants who were denied their application to purchase a handgun in 1996 in treatment states,<sup>33</sup> the result is a prediction of just 8 fewer homicides. Such an association is too small to be identified with state-level vital statistics data.

The only previous study of the association between homicide and the national Brady Act found a statistically

insignificant reduction in the murder rate of 2.3% in the treatment states compared with control states, and statistically significant increases in rape and aggravated assault equal to 3.9% and 3.7%, respectively.<sup>34</sup> Our evaluation improves on this earlier work by using 4 years, rather than 10 months, of post-program crime data. We also focus on violent crimes among adults rather than among victims of all ages. Because homicides among juvenile victims have followed different trends in the treatment and control states even before the Brady Act went into effect, comparisons of treatment and control states using data on victims of all ages (which include juveniles) are likely to be biased.

Our findings do not imply that screening FFL (or primary-market) gun sales is of no consequence for gun crime. Even before the Brady Act went into effect, federal law required FFLs to record the identity of each handgun buyer. Since this paperwork provides law enforcement with the means of tracing guns used in crimes back to the original purchaser, screening may have deterred most convicted felons from shopping for guns in the primary market in treatment states even before background checks and waiting periods were mandated by the Brady Act.

More importantly, the effects of primary-market gun regulations may depend on the extent to which the secondary market in guns is regulated. Secondary-market sales account for about 40% of the approximately 10 million gun transfers in the United States each year<sup>2,4</sup> and are the source for the large majority of guns obtained by juveniles and criminals.<sup>2,35-37</sup> The secondary market in guns, which is currently almost completely unregulated, is thus an enormous loophole that limits the effectiveness of primary-market regulations.<sup>38</sup>

Although our study detected no reduction in homicide rates in treatment states compared with control states, we found that suicide rates for persons aged 55 years or older were reduced in the treatment states. The estimated association between the Brady

Act treatment and gun suicide rates among persons aged 55 years and older is equal to  $-0.92$  per 100000 (95% CI,  $-1.43$  to  $-0.42$ ), or about 6% of the gun suicide rate among this age group in the control states after the Brady Act had become law.

However, we did not detect an association of the Brady Act with overall suicide rates. We find some signs of an offsetting increase in nongun suicides to those aged 55 years or older, which makes the reduction in the total suicide rate smaller than the reduction in gun suicides. Neither the increase in nongun suicides nor the decrease in suicides from all causes are statistically significant at the conventional 95% level, though the overall pattern of findings is consistent with theories of "weapon substitution."<sup>39</sup>

That the countervailing increase in nongun suicides appears to be of a smaller magnitude than the reduction in gun suicides suggests that either some people aged 55 years or older are deterred from attempting suicide when the effective price of acquiring firearms increases or there is a "weapon instrumentality" effect for suicide (ie, firearms are more lethal than other commonly used methods of attempting suicide, such as poisoning, which was the second most frequent method [behind guns] for suicide among those aged 65 years and older in the United States from 1990 through 1996).<sup>40</sup>

Finally, the federally required waiting period was eliminated as a result of a sunset provision in the Brady Act. Since December 1, 1998, FFLs have been required to conduct an instant check of would-be buyers through a nationwide system managed by the Federal Bureau of Investigation. Our analysis finds that the association with firearm suicides among persons aged 55 years or older was limited to those states that changed both their background-check and waiting-period requirements. These findings suggest that the shift away from waiting periods could increase the firearm suicide rate (and potentially the overall suicide rate) among older US citizens.

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## REFERENCES

1. Brady Handgun Violence Prevention Act. Pub L No. 103-159, 107 Stat 1536.
2. Cook PJ, Molliconi S, Cole T. Regulating gun markets. *J Criminal Law Criminol.* 1995;86:59-92.
3. Cook PJ, Laub J. The unprecedented epidemic of youth violence. In: Moore M, Tonry M, eds. *Crime and Justice: An Annual Review of Research.* Chicago, Ill: University of Chicago Press; 1998:26-64.
4. Cook PJ, Ludwig J. *Gun Violence: The Real Costs.* New York, NY: Oxford University Press; 2000.
5. Cook PJ, Ludwig J. *Guns in America: Results of a Comprehensive Survey of Gun Ownership and Use.* Washington, DC: Police Foundation; 1996.
6. Parker RN, Auerhahn K. Alcohol, drugs, and violence. *Annu Rev Sociol.* 1998;24:291-311.
7. Sampson RJ. Crime in cities: the effects of formal and informal social control. In: Reiss AJ, Tonry M, eds. *Communities and Crime.* Chicago, Ill: University of Chicago Press; 1986:271-312.
8. Bailey WC. Poverty, inequality, and city homicide rates: some not so unexpected findings. *Criminology.* 1984;22:531-550.
9. Messner SF. Regional and racial effects on the urban homicide rate: the subculture of violence revisited. *Am J Sociol.* 1983;88:997-1007.
10. Land KC, McCall PL, Cohen LE. Structural covariates of homicide rates: are there any invariances across time and social space? *Am J Sociol.* 1990;95:922-963.
11. Cohen LE, Land KC. Age structure and crime: symmetry vs asymmetry, and the projection of crime rates through the 1990s. *Am Sociol Rev.* 1987;52:170-183.
12. Moody C. The Research Materials Web site. Available at [faculty.wm.edu/cemood/research.html](http://faculty.wm.edu/cemood/research.html). Accessed March 8, 2000.
13. Raphael S. The deinstitutionalization of the mentally ill and growth in the US prison populations: 1971 to 1993. Berkeley, Calif: Goldman School of Public Policy, University of California; 1999. Working Paper.
14. Bureau of Justice Statistics. *Prison and Jail Inmates at Midyear 1998.* Washington, DC: US Dept of Justice, Office of Justice Programs; 1999. Publication NCJ 173414.
15. Bureau of the Census. *Statistical Abstract of the United States: 1999,* 119th ed. Washington, DC: US Government Printing Office; 1999.
16. General Accounting Office. *Gun Control: Implementation of the Brady Handgun Violence Prevention Act.* Washington, DC: US Government Printing Office; 1996. GAO Report 96-22.
17. US Department of the Treasury, Bureau of Alcohol, Tobacco and Firearms. *Firearms State Laws and Published Ordinances, 1994.* 20th ed. Washington, DC: Bureau of Alcohol, Tobacco and Firearms; 1994.
18. US Department of the Treasury, Bureau of Alcohol, Tobacco and Firearms. *Firearms State Laws and Published Ordinances, 1995.* 21st ed. Washington, DC: Bureau of Alcohol, Tobacco and Firearms; 1998.
19. Greene W. *Econometric Analysis.* 2nd ed. New York, NY: Macmillan; 1993.
20. Huber PJ. The behavior of maximum likelihood estimates under non-standard conditions. In: *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability.* Vol 1. Berkeley, Calif: University of California Press; 1967:221-233.
21. White H. A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica.* 1980;48:817-830.
22. Enders W. *Applied Econometric Time Series.* New York, NY: John Wiley; 1995.
23. Hsiao C. *Analysis of Panel Data.* New York, NY: Cambridge University Press; 1986.
24. Cameron CA, Trivedi PK. *Regression Analysis of Count Data.* New York, NY: Cambridge University Press; 1998.
25. Ludwig J. Concealed-gun-carrying laws and violent crime: evidence from state panel data. *Int Rev Law Econ.* 1998;18:239-254.
26. Fagan J, Zimring FE, Kim J. Declining homicide in New York: a tale of two trends. *J Criminal Law Criminol.* 1998;88:1277-1323.
27. Allen L, Portes J. *Expert Report of Lucy Allen and Jonathan Portes, Hamilton v Accu-Tek.* White Plains, NY: National Economic Research Assoc; 1995.
28. Weil DS. *Traffic Stop: How the Brady Act Disrupts Interstate Gun Trafficking.* Washington, DC: Center to Prevent Handgun Violence; 1997.
29. Kleck G, Patterson, EB. The impact of gun control and gun ownership levels on violence rates. *J Quant Criminol.* 1993;9:249-287.
30. Lott JR, Mustard DB. Crime, deterrence, and right-to-carry concealed handguns. *J Leg Studies.* 1997; 26:1-68.
31. McDowall D, Loftin C, Wiersema B. Easing concealed firearms laws: effects on homicide in three states. *J Criminal Law Criminol.* 1995;86:193-206.
32. Wright MA, Wintemute GJ, Rivara FP. Effectiveness of denial of handgun purchase to persons believed to be at high risk for firearm violence. *Am J Public Health.* 1999;89:88-90.
33. Manson DA, Gilliard DK. Presale handgun checks, 1996: a national estimate. *Bureau of Justice Statistics Bulletin.* Washington, DC: US Dept of Justice; 1997. Publication NCJ 165704:1-6.
34. Lott JR. *More Guns, Less Crime.* Chicago, Ill: University of Chicago Press; 1998.
35. Sheley J, Wright J. *Gun Acquisition and Possession in Selected Juvenile Samples.* Washington, DC: National Institute of Justice; 1993.
36. Wright J, Rossi P. *Armed and Considered Dangerous: A Survey of Felons and Their Firearms.* Hawthorne, NY: Aldine; 1986.
37. Ash P, Kellermann A, Fuqua-Whitley D, Johnson A. Gun acquisition and use by juvenile offenders. *JAMA.* 1996;275:1754-1758.
38. Cook PJ, Leitzel JA. "Perversity, futility, jeopardy": an economic analysis of the attack on gun control. *Law Contemp Problems.* 1996;59:91-118.
39. Cook PJ. The Technology of personal violence. In: Tonry M, ed. *Crime and Justice: An Annual Review of Research.* Chicago, Ill: University of Chicago Press; 1991:1-71.
40. Stevens JA, Hasbrouck LM, Durant TM, et al. Surveillance for injuries and violence among older adults. *MMWR Morb Mortal Wkly Rep.* 1999;48: 27-50.