Impact of a Permitless Concealed Firearm Carry Law in West Virginia, 1999–2015 and 2016–2020

Eric W. Lundstrom, PhD, MPH, Jacob K. Pence, DO, and Gordon S. Smith, MD, MBChB, MPH

We used firearm mortality and sales data to assess the impact of HB 4145, a May 2016 law that legalized concealed firearm carry without a permit in West Virginia. Firearm mortality was significantly higher (29%) in the years after the enactment of the law; handgun mortality was also higher (48% increase), whereas long gun deaths and firearm sales were unaffected. This may suggest that HB 4145 increased rates of firearm-related mortality in West Virginia without affecting firearm sales in the state. (*Am J Public Health*. 2023;113(11):1163–1166. https://doi.org/10.2105/AJPH.2023.307382)

Several US states have recently enacted permitless concealed firearm carry laws, which do not require an individual to apply for a permit to legally carry a concealed firearm in public.[1] Other systems are more restrictive, with "may-issue" schemes giving states substantial discretion in deciding when to issue a permit and "shall-issue" systems requiring authorities to issue permits to any individual meeting basic requirements.[2] Gun owners in permitless carry states report significantly higher rates of past-30-day loaded handgun carrying than those in permit-issuing states,[3] indicating that such laws have a measurable effect on carrying behavior.

INTERVENTION AND IMPLEMENTATION

In May 2016, the West Virginia legislature enacted HB 4145, a permitless concealed carry law; before enactment of HB 4145, West Virginia was a shall-issue state.[1]

PLACE, TIME, AND PERSONS

HB 4145 was enacted on May 24, 2016, and applied to all legal residents of West Virginia.[4]

PURPOSE

HB 4145 repealed West Virginia's previous shall-issue permit-issuing system, which was established in 1989 and allowed "any United States citizen or legal resident thereof at least twenty-one years of age and not otherwise prohibited from possessing a firearm [to] carry a concealed deadly weapon without a license."[4]

EVALUATION AND ADVERSE EFFECTS

We used both descriptive and inferential statistical approaches to assess the impact of HB 4145 on firearm mortality in West Virginia. We extracted West Virginia firearm fatality data from CDC WONDER (Centers for Disease Control and Prevention Wide-ranging ONline Data for Epidemiologic Research), which reports mortality data collected through state death certificate registries.[5] Mean annual age-adjusted fatality rates per 100 000 population for 1999 through 2015 and 2016 through 2020 were extracted for demographics of interest, including gender, race, and urbanization, as well as by injury intent and gun type involvement. Although annual 2021 data were available at the time of our analysis, age-adjusted rates for a 2016 through 2021 postintervention period could not be obtained as CDC WONDER can be queried only for 1999 through 2020 or only for 2018 through 2021 as a result of a race categorization series break occurring in 2018.

We calculated monthly crude firearm death rates, available for 1999 through 2021, using total monthly firearm mortality counts from CDC WONDER and annual population estimates; CDC WONDER does not provide monthly age-adjusted mortality rates.

AJPH November 2023, Vol 113, No. 11

Monthly firearm sales data for 2000 through 2022 were extracted from The Trace, which estimates state-level firearm sales using Federal Bureau of Investigation background check data.[6]

We used interrupted time series analysis (ITSA) to assess the impact of HB 4145 on monthly firearm mortality and sales in West Virginia. ITSA quantifies temporal effects of interventions for which no control population exists, making it useful for assessing the effects of public health events.[7] The preintervention period was defined as January 1999 to April 2016 and the postintervention period as May 2016 (the month HB 4145 was enacted) to December 2021. Using monthly data, we assessed the intervention effect as a step change, representing an overall increase or decrease in the rate of fatalities. We controlled serial correlation in monthly data using autoregressive integrated moving average modeling[7] (Table A, available as a supplement to the online version of this article at http://www.ajph.org). To allow comparisons with national trends, we conducted an ITSA of monthly US firearm mortality per 100 000 population.

Mean annual firearm mortality rates in West Virginia during 2016 through 2020 were significantly higher (29%) than in 1999 through 2015, both overall and for each of the strata examined except for large fringe metro urbanization, unintentional and undetermined injury intents, and deaths associated with long gun use (Table 1). Homicides and suicides increased by 48% and 22%, respectively. Stratified by urbanization, the largest significant increases were seen in noncore (most rural) areas (34%). Although more than half of firearm types were unspecified, the percentage identified as handguns increased significantly (45%), whereas the percentage identified as long guns did not. Temporally, annual firearm mortality increased after the enactment of HB 4145; homicides showed a steadier increase than suicides (Figure A, available as a supplement to the online version of this article at http://www.ajph.org).

An ITSA of monthly firearm fatalities per 100 000 population showed that rates increased by 26.2% (95% confidence interval [CI] = 19.8, 31.7). US firearm fatality rates exhibited nonsignificant increases after passage of HB 4145 (−0.9%; 95% CI = −6.2, 4.4; Table 2; detailed modeling results are available in Table A). Stratified analyses of monthly West Virginia firearm mortality data were not possible because of data suppression by CDC WONDER. An ITSA of monthly firearm sales in West Virginia did not reveal any impact associated with HB 4145. There was a small spike in sales after HB 4145 was enacted, but the

TABLE 1— Age-Adjusted Firearm Mortality Rates: West Virginia, 1999–2015 Versus 2016–2020

Demographic Category	1999–2015 Rate (95% CI)	2016–2020 Rate (95% CI)	Percentage Increase
Total	13.8 (13.4, 14.2)	17.8 (16.9, 18.7)	29
Gender			
Male	24.1 (23.3, 24.9)	29.6 (27.9, 31.2)	23
Female	4.4 (4.1, 4.8)	6.3 (5.5, 7.1)	43
Race			
African American	17.3 (14.9, 19.8)	27.2 (21.8, 32.5)	57
White	13.8 (13.3, 14.2)	17.3 (16.4, 18.2)	25
Urbanization[a]			
Large fringe metro	8.6 (6.7, 10.9)	12.0 (8.4, 16.7)	40
Medium metro	12.0 (11.1, 12.9)	15.8 (13.8, 17.7)	32
Small metro	13.0 (12.3, 13.6)	16.1 (14.8, 17.5)	24
Micropolitan	15.4 (14.3, 16.5)	19.9 (17.6, 22.3)	29
Noncore (most rural)	16.4 (15.5, 17.4)	21.9 (19.7, 24.1)	34
Injury intent			
Unintentional	0.5 (0.4, 0.6)	0.4 (0.3, 0.6)	−20
Suicide	9.9 (9.6, 10.2)	12.1 (11.4, 12.9)	22
Homicide	3.1 (2.9, 3.3)	4.6 (4.1, 5.1)	48
Undetermined	0.2 (0.1, 0.2)	0.2 (0.1, 0.4)	0
Gun type[b]			
Handgun	3.1 (2.9, 3.3)	4.5 (4.1, 4.9)	45
Long gun	2.5 (2.4, 2.7)	2.6 (2.2, 2.9)	4
Unspecified	8.0 (7.7, 8.3)	10.4 (9.7, 11.1)	30

Note. CI = confidence interval.
Source. Data were derived from CDC WONDER (Centers for Disease Control and Prevention Wide-ranging ONline Data for Epidemiologic Research).

[a]West Virginia has no areas designated "large central metro," the most urban code in the urban–rural classification scheme used in CDC WONDER.
[b]Gun involvement strata were identified via *International Classification of Diseases, 10th Revision* underlying cause of death codes for handgun (W32, X72, X93, and Y22), long gun (W33, X73, X94, and Y23), and undetermined (W34, X74, X95, and Y24) gun involvement.

TABLE 2— Results of Interrupted Time Series Analyses of Mean Monthly Firearm Mortality per 100 000 Population Before and After Implementation of HB 4145: West Virginia and the United States

Region	Estimated Monthly Firearm Deaths per 100 000 Population		Percentage Increase (95% CI)
	January 1999–April 2016	May 2016–December 2021	
West Virginia	1.204	1.519	26.2 (19.8, 31.7)
United States	0.913	0.904	−0.9 (−6.2, 4.4)

Note. CI = confidence interval. Rates were calculated via interrupted time series analyses of monthly firearm mortality per 100 000 population; pre–HB 4145 (January 1999–April 2016) values correspond to the model intercept, whereas post–HB 4145 enactment (May 2016–December 2021) values correspond to the model intercept along with the step change value shown in Table A (available as a supplement to the online version of this article at http://www.ajph.org).

increase was mild relative to historical data (Figure B, available as a supplement to the online version of this article at http://www.ajph.org).

SUSTAINABILITY

Polling research has shown that an estimated 82% of rural US gun owners cite the right to own a firearm as essential to their sense of freedom,[8] emblematic of the strong gun culture in rural areas of the country. As West Virginia is mostly rural, it is unlikely that HB 4145 will be replaced with a more stringent law soon. In fact, future firearm exposure in West Virginia may increase further given that the state legislature recently passed the Campus Self-Defense Act, which allows concealed firearm carrying on college campuses in the state with few exceptions.[9]

PUBLIC HEALTH SIGNIFICANCE

Previous literature has revealed increases in officer-involved shootings in West Virginia after the enactment of HB 4145.[1] To our knowledge, however, this is the first study to assess the impact of HB 4145 on overall firearm mortality in the state. Although suicides were the leading cause of West Virginia firearm deaths throughout the study period, homicides, which are more closely related to concealed firearm carry, showed a greater increase after 2016 (Table 1). Descriptive statistics indicate that the number of handgun deaths was significantly higher after HB 4145 enactment, whereas the number of long gun deaths remained unchanged (Table 1); because long guns are not generally concealable, HB 4145 is unlikely to affect long gun death rates.

Moreover, the number of deaths with no gun specified was significantly higher in 2016 through 2020 than in 1999 through 2015; it is reasonable to assume that these deaths were primarily handgun related given that most US firearm homicides[10] and suicides[11] are associated with handguns, including in rural areas. Evidence-based firearm injury prevention measures may be needed to reduce public exposure to firearms, including safe firearm storage practices and community-driven violence prevention programs.[12] AJPH

ABOUT THE AUTHORS

Eric W. Lundstrom and Gordon S. Smith are with the Department of Epidemiology and Biostatistics, West Virginia University, Morgantown. Jacob K. Pence is with the Transitional Year Residency Program, West Virginia University.

CORRESPONDENCE

Correspondence should be sent to Eric W. Lundstrom, PhD, MPH, 64 Medical Center Dr, Morgantown, WV 26506 (e-mail: ewlundstrom@gmail.com). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

PUBLICATION INFORMATION

Full Citation: Lundstrom EW, Pence JK, Smith GS. Impact of a permitless concealed firearm carry law in West Virginia, 1999–2015 and 2016–2020. *Am J Public Health*. 2023;113(11):1163–1166.

Acceptance Date: June 28, 2023.

DOI: https://doi.org/10.2105/AJPH.2023.307382

CONTRIBUTORS

E. W. Lundstrom drafted the article. E. W. Lundstrom performed the statistical analyses and J. K. Pence performed data extraction. G. S. Smith provided expert opinion on injury epidemiology and prevention. All authors contributed to the conceptualization of the study.

ACKNOWLEDGMENTS

Gordon S. Smith was supported in part by the National Institute of General Medical Sciences (grant 2U54GM104942).

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

HUMAN PARTICIPANT PROTECTION

The institutional review board of West Virginia University determined that this study did not meet the definition of human participant research.

REFERENCES

1. Doucette ML, Ward JA, McCourt AD, Webster D, Crifasi CK. Officer-involved shootings and concealed carry weapons permitting laws: analysis of gun violence archive data, 2014–2020. *J Urban Health*. 2022;99(3):373–384. https://doi.org/10.1007/s11524-022-00627-5

2. Smart R, Morral AR, Smucker S, et al. Concealed-carry laws. Available at: https://www.rand.org/content/dam/rand/pubs/research_reports/RR2000/RR2088/RAND_RR2088.pdf. Accessed October 19, 2022.
3. Rowhani-Rahbar A, Gallagher A, Azrael D, Miller M. Trend in loaded handgun carrying among adult handgun owners in the United States, 2015–2019. *Am J Public Health.* 2022;112(12):1783–1790. https://doi.org/10.2105/AJPH.2022.307094
4. West Virginia Legislature. House Bill 4145. Available at: https://www.wvlegislature.gov/Bill_Status/bills_text.cfm?billdoc=HB4145%20SUB%20ENG.htm&yr=2016&sesstype=RS&i=4145. Accessed October 19, 2022.
5. Centers for Disease Control and Prevention. Wide-ranging ONline Data for Epidemiologic Research (WONDER). Available at: https://wonder.cdc.gov. Accessed October 19, 2022.
6. Nass D, Barton C. How many guns did Americans buy last month? Available at: https://www.thetrace.org/2020/08/gun-sales-estimates. Accessed January 22, 2023.
7. Schaffer AL, Dobbins TA, Pearson SA. Interrupted time series analysis using autoregressive integrated moving average (ARIMA) models: a guide for evaluating large-scale health interventions. *BMC Med Res Methodol.* 2021;21(1):58. https://doi.org/10.1186/s12874-021-01235-8
8. Kim Parker B, Horowitz J, Igielnik R, et al. America's complex relationship with guns. Available at: https://assets.pewresearch.org/wp-content/uploads/sites/3/2017/06/06151541/Guns-Report-FOR-WEBSITE-PDF-6-21.pdf. Accessed January 22, 2023.
9. Yohe R. West Virginia universities, colleges preparing for campus carry law. Available at: https://wvpublic.org/w-va-universities-colleges-preparing-for-campus-carry-law. Accessed May 25, 2023.
10. Alper M, Glaze L. Source and use of firearms involved in crimes: survey of prison inmates, 2016. Available at: https://bjs.ojp.gov/content/pub/pdf/suficspi16.pdf. Accessed May 25, 2023.
11. Hanlon TJ, Barber C, Azrael D, Miller M. Type of firearm used in suicides: findings from 13 states in the National Violent Death Reporting System, 2005–2015. *J Adolesc Health.* 2019;65(3):366–370. https://doi.org/10.1016/j.jadohealth.2019.03.015
12. Kegler SR, Simon TR, Zwald ML, et al. Vital signs: changes in firearm homicide and suicide rates—United States, 2019–2020. Available at: https://stacks.cdc.gov/view/cdc/116520. Accessed May 25, 2023.