

Firearm violence against children in the United States: Trends in the wake of the COVID-19 pandemic

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BACKGROUND:	This study aimed to evaluate the patterns of firearm violence against children before and after the COVID-19 pandemic, as well as the patterns of specific types of firearm violence against children over time (2016–2020).
METHODS:	Retrospective firearm violence data were obtained from the Gun Violence Archive. The rate of firearm violence was weighted per 100,000 children. A scatterplot was created to depict the rate of total annual child-involved shooting incidents over time; with a linear trendline fit to 2016 to 2019 data to show projected versus actual 2020 firearm violence. All 50 states were categorized into either “strong gun law” (n = 25) or “weak gun law” (n = 25) cohorts. Multivariate linear regressions were performed for number of child-involved shootings over time.
RESULTS:	There were a total of 1,076 child-involved shootings in 2020, 811 in 2019, and 803 in 2018. The median total child-involved shooting incidents per month per 100,000 children increased from 2018 to 2020 (0.095 vs. 0.124, $p = 0.003$) and from 2019 to 2020 (0.097 vs. 0.124, $p = 0.010$). Child killed by adult incidents also increased in 2020 compared with 2018 ($p = 0.024$) and 2019 ($p = 0.049$). The scatterplot demonstrates that total child-involved shootings in addition to both fatal and nonfatal firearm violence incidents exceeded the projected number of incidents extrapolated from 2016 to 2019 data. Multivariate linear regression demonstrated that, compared with weak gun law states, strong gun law states were associated with decreased monthly total child-involved shooting incidents between 2018 and 2020 ($p < 0.001$), as well as between 2019 and 2020 ($p < 0.001$).
CONCLUSION:	Child-involved shooting incidents increased significantly in 2020 surrounding the COVID-19 pandemic. Given that gun law strength was associated with a decreased rate of monthly child-involved firearm violence, public health and legislative efforts should be made to protect this vulnerable population from exposure to firearms. (<i>J Trauma Acute Care Surg.</i> 2022;92: 65–68. Copyright © 2021 American Association for the Surgery of Trauma.)
LEVEL OF EVIDENCE:	Epidemiological, level III.
KEY WORDS:	Pediatric; firearm violence; COVID-19; pandemic.

The coronavirus disease 2019 (COVID-19) pandemic is one of the most widespread public health disasters in recent history.¹ By March 14, 2021, the United States alone reached 29.4 million cases and approximately 535,000 COVID-19–related deaths.² With continued efforts to mitigate the spread of the virus, such as stay-at-home orders and travel restriction, everyday life has been dramatically altered.³ While these measures have been effective at slowing disease transmission, they have also led to unintended negative consequences disproportionately affecting vulnerable populations.^{4–6} In particular, children continue to be at high risk for both physical and emotional harm during this time.⁷

The reason for this elevated risk to children during the COVID-19 pandemic is likely multifactorial. For instance, stay-at-home orders have trapped children in volatile households and

limited their contact with the outside world.⁸ Moreover, there have been universal closures of schools and community organizations that serve as safety nets. With fewer opportunities to detect and report if a child is in a dangerous situation at home, these closures have increased the risk of pediatric physical and mental harm.⁹ Also, child protection agencies, which were already strained prior to COVID-19, now have fewer workers and resources available, which may lead to inappropriate handling of cases or situations where cases are missed. Workers are also not able to conduct home visits in states with stay-at-home orders.¹⁰ Finally, firearm sales have hit record-breaking levels during the COVID-19 pandemic.¹¹

In fact, a recent survey study performed by Khubchandani and Price¹² found having at least one child in a household to be a significant predictor of pandemic-related firearm purchase. Another 2021 survey found that 40% of first-time, pandemic-related gun owners kept at least one firearm unlocked for protection.¹³ Furthermore, the rates of domestic violence against children increase with the presence of unsecured firearms in the home.¹⁴ These findings may at least partially explain the increase in child-involved shootings associated with the COVID-19 pandemic that have been described in the literature.^{15,16} However, a complete review of the trends and types of firearm violence against children during the COVID-19 pandemic warrants further investigation. Thus, this study sought to evaluate the patterns of firearm violence against children before and after the COVID-19

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TABLE 1. Mann-Whitney *U* Test of Post-COVID-19 (2020) Child-Involved Incidents to Historical Data Per Month Per 100,000 Children Across the United States

Median	2020	2018	<i>p</i>	2019	<i>p</i>
All incidents	0.124	0.095	0.003	0.097	0.010
Fatal incidents	0.039	0.031	0.068	0.288	0.068
Nonfatal incidents	0.073	0.060	0.007	0.066	0.128
Child killed by a child	0.003	0.004	0.630	0.005	0.347
Child injured by child	0.006	0.008	0.242	0.007	0.551
Child killed by self	0.005	0.005	0.590	0.003	0.101
Child injured self	0.009	0.007	0.089	0.006	0.045
Child killed by an adult	0.034	0.020	0.024	0.021	0.049
Child injured by an adult	0.061	0.049	0.010	0.051	0.160

Data in bold emphasis indicate statistical significance.

pandemic, as well as the patterns of specific types of firearm violence against children over time (2016–2020), hypothesizing increased total, fatal, and nonfatal child-involved shootings during the COVID-19 pandemic.

METHODS

This study was deemed exempt by the institutional review board, and as such, no consent was needed. Retrospective firearm violence data (January 1, 2016 to December 31, 2020) were obtained from the Gun Violence Archive. This is an independent organization for evidence-based firearm research that uses automated Internet queries to collect information from over 7,500 sources.¹⁷ Incidents in children younger than 18 years were included. Data on firearm suicides were not included, as the Gun Violence Archive only provides suicide information in aggregate statistics at the end of each year. The primary outcome was the number of total child-involved shooting incidents with secondary outcomes being the number of fatal and nonfatal incidents over time. In addition, information regarding specific types of firearm violence against children were collected, including child killed or injured by child, child accidentally killed or injured by self, and child killed or injured by adult incidents.

US Census population reports were then used to weigh the rates of firearm violence per 100,000 children.¹⁸ The number of children in the United States during each year was recorded and these numbers were used in calculations for 2016 to 2019. Summary data for 2020 were not yet available. Therefore, 2020 projected pediatric population data were used from a report released by the Federal Interagency Forum on Child and Family Statistics. This forum is a collaboration of 23 Federal agencies that work together to analyze and publish statistics on children and families.¹⁹ A scatterplot was also created to depict the rate of total yearly child-involved shooting incidents over time. A linear trendline was fit to 2016 to 2019 data to show projected versus actual 2020 firearm violence.

The Giffords Law Center Annual Gun Law Scorecard grades each state using a point system to evaluate their gun legislation based on specific laws and policies. The points are tabulated, and the states are ranked from 1, which is the state with the strongest gun laws, to 50, which is the state with the weakest gun laws.²⁰ We compared the top 25 stronger gun law states to the bottom 25 weaker gun law states.

Mann-Whitney *U* tests were performed to compare median monthly trends and types of child-involved firearm violence incidents between 2018 and 2020, as well as between 2019 and 2020. Multivariate linear regressions were run for number of child-involved shootings over time. Statistical significance was set as $p < 0.05$. Statistics were performed on IBM SPSS Statistics, Version 26 (IBM Corp., Armonk, NY) (Tables 1 and 2).

RESULTS

There was a total of 1,076 child-involved shootings in 2020, 811 in 2019 and 803 in 2018. The median total child-involved shooting incidents per 100,000 children per month increased from 2018 to 2020 (0.095 vs. 0.124, $p = 0.003$), as well as from 2019 to 2020 (0.097 vs. 0.124, $p = 0.010$). From 2018 to 2020, child killed by adult (0.020 vs. 0.034, $p = 0.024$) incidents increased. Consistent, increasing trends in child killed by adult (0.021 vs. 0.034, $p = 0.049$) were also found between 2019 and 2020.

The scatterplots of total child-involved shooting incidents, as well as both fatal and nonfatal child-involved shooting incidents per 100,000 per year (2016–2020), all exceeded the projected number of incidents extrapolated from the 2016 to 2019 data (Fig. 1).

Strong Versus Weak Gun Law States Analysis

Multivariate linear regression demonstrated that, compared with weaker gun law states, stronger gun law states were associated with decreased monthly total child-involved shooting incidents between 2018 and 2020 (USC B, -0.069 ; 95% CI, -0.087 to -0.050 ; $p < 0.001$), as well as between 2019 and 2020 (USC B, -0.066 ; 95% CI, 0.014 – 0.047 ; $p < 0.001$).

DISCUSSION

Firearm violence is a rising epidemic for children in the United States with recent investigations alluding to increased firearm violence⁶ during the COVID-19 pandemic, as well as some specifically referring to pediatric firearm violence.^{15,16} This retrospective database study describes in detail the current trends and types of child-involved shootings. In the first year of the pandemic (2020), there was an increase in monthly shootings involving children, as well as incidents of children killed by an adult with a firearm.

Given the increased firearm sales during the pandemic, as well as the mortality risk associated with improperly stored

TABLE 2. Multivariate Linear Regression Comparing the Rate of All Child-Involved Shootings in 25 States With Stronger Gun Laws Versus 25 States With Weaker Gun Laws Over Time

	USC B	95% CI	<i>p</i>
2018 vs. 2020			
Gun law strength	-0.069	-0.087 to -0.050	<0.001
Year	0.029	0.010, 0.047	0.004
2019 vs. 2020			
Gun law strength	-0.066	-0.083 to -0.049	<0.001
Year	0.030	0.014, 0.047	0.001

Data in bold emphasis indicate statistical significance.

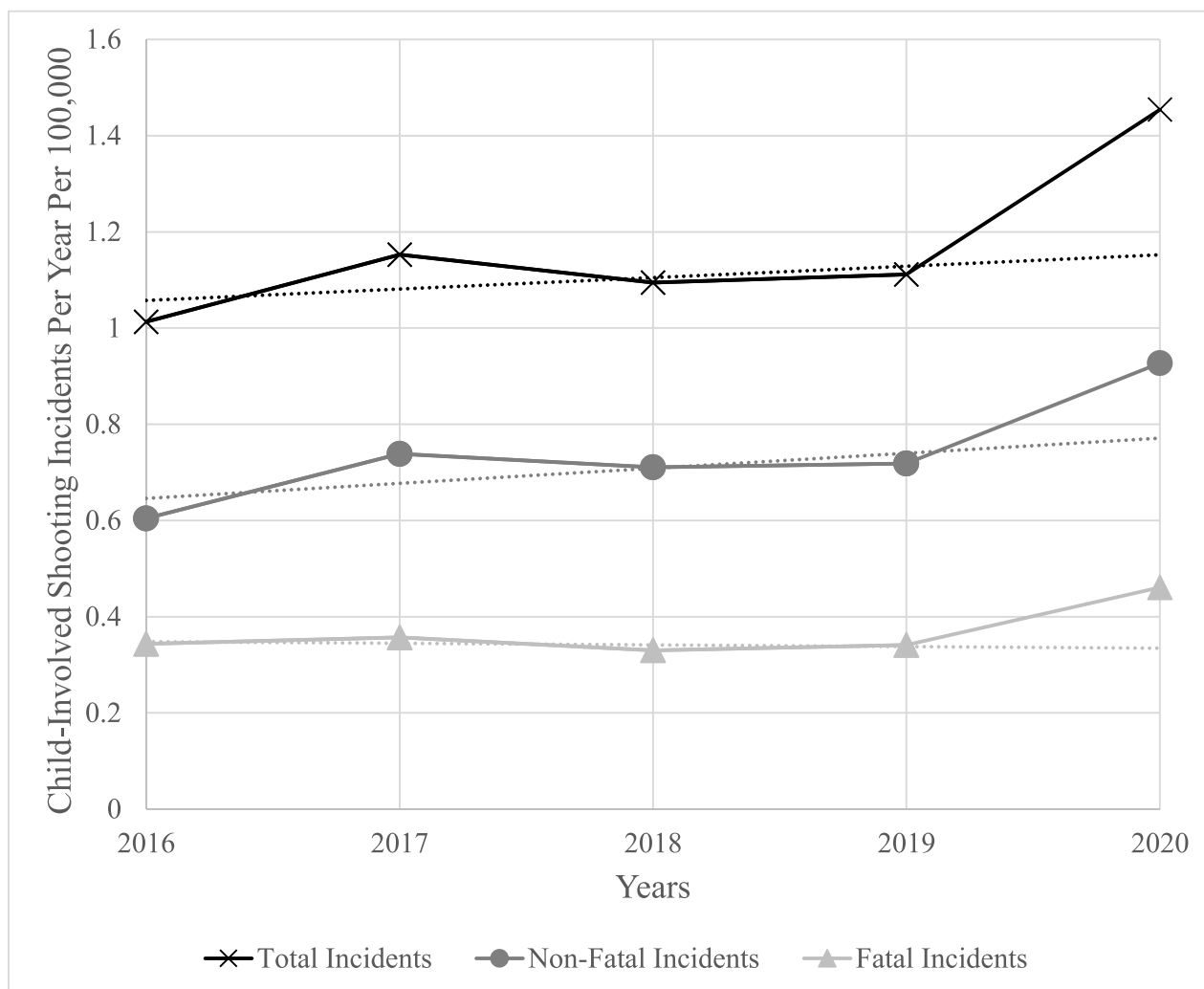


Figure 1. Rate of total, fatal, and nonfatal child-involved incidents per 100,000 children per year (2016–2020).

firearms,²¹ the finding of increased incidents of children killed by an adult with a firearm is consistent with predictions in the literature.^{9,16} Furthermore, the yearly increase in total, as well as fatal and nonfatal child-involved shooting incidents, demonstrate that actual 2020 firearm violence rates surpassed predicted 2020 rates based on linear extrapolation of data from the previous 4 years. This supports the need for proven firearm violence prevention efforts, such as education on proper firearm storage,²² improvement in mental health services to help deal with pandemic-related stressors,²³ and implementation of gun waiting periods,²⁴ which are associated with decreased firearm incidents and deaths.

One ongoing politically debated issue is whether gun laws affect firearm incidents. This study demonstrated that the top 25 stronger gun law states correlated with decreased total child-involved shooting incidents during the 2020 US pandemic compared with 2018 and 2019 historical data. Contrarily, weaker gun law states were associated with increased rates of pediatric firearm violence. This is consistent with the previously studied relationship between strength of firearm legislation and US firearm violence trends in adults.^{15,25,26} Similarly, Tseng et al.²⁷ reported that firearm-related injuries in hospitalized children were more

prevalent in states with less-restrictive gun laws. This accumulation of data suggests gun laws to be an evidence-based approach to protect children and should be evaluated by all states or at a national level.

As this study was performed using a national database, it is subject to multiple limitations, such as missing information and coding errors within the Gun Violence Archive database. Moreover, because of the fact that the Gun Violence Archive's algorithm searches the Internet for reports on firearm violence, some areas of the country may receive less coverage. This may result in an overrepresentation of firearm violence perpetrated in certain locations with an underrepresentation of violence in other areas. In addition, as US Census summary data were not yet available for 2020, a predicted pediatric population was used to calculate 2020 rates of firearm violence per 100,000 children. However, it is suspected that the 2020 Census will show the smallest decade-long growth rate in US history.²⁸ Hence, the calculated firearm violence rates for 2020, based on population trends from years prior, may be underestimated. Finally, as children are unable in most circumstances to advocate for themselves and report instances of abuse or violence, the true rates

of child-involved shooting incidents are likely underrepresented in this study.

This study found an overall increasing rate of child-involved shootings for the year of 2020 during the COVID-19 pandemic. During this time, children were more likely to be fatally injured by an adult with a firearm. In addition, the strength of gun laws was shown to be associated with decreased rates of pediatric firearm violence. Given that access to social support systems and community safety nets has been hindered by the pandemic, implementation of stronger gun laws across all states may help reduce the number of fatal and nonfatal child-involved shooting incidents.

AUTHORSHIP

M.D., A.G., J.A., and J.N. were involved in conception and design, analysis and interpretation of the data, drafting the article, critically revising the article, and providing final approval. L.S., C.M.K., K.I., D.K., and M.L. were involved in interpretation of the data, critically revising the article, and providing final approval.

DISCLOSURE

The authors declare no funding or conflicts of interest.

REFERENCES

- Izda V, Jeffries MA, Sawalha AH. COVID-19: a review of therapeutic strategies and vaccine candidates. *Clin Immunol*. 2021;222:108634.
- Johns Hopkins University & Medicine Coronavirus Resource Center. COVID-19 United States Cases By County. Updated March 6, 2021. Available at <https://coronavirus.jhu.edu/us-map>. Accessed March 6, 2021.
- McKay T, Metz J, Piemonte J. Effects of statewide coronavirus public health measures and state gun laws on American Gun Violence. *SSRN*. 2020.
- Kovler ML, Ziegfeld S, Ryan LM, Goldstein MA, Gardner R, Garcia AV, Nasr IW. Increased proportion of physical child abuse injuries at a level I pediatric trauma center during the COVID-19 pandemic. *Child Abuse Negl*. 2021;116:104756.
- Greeley CS. Child maltreatment prevention in the era of coronavirus disease 2019. *JAMA Pediatr*. 2020;174(11):e202776.
- Yeates EO, Grigorian A, Barrios C, et al. Changes in traumatic mechanisms of injury in Southern California related to COVID-19: penetrating trauma as a second pandemic. *J Trauma Acute Care Surg*. 2021;90(4):714–721.
- Silliman Cohen RI, Bosk EA. Vulnerable youth and the COVID-19 pandemic. *Pediatrics*. 2020;146(1):e20201306.
- Xue J, Chen J, Chen C, Hu R, Zhu T. The hidden pandemic of family violence during COVID-19: unsupervised learning of tweets. *J Med Internet Res*. 2020;22(11):e24361.
- Campbell AM. An increasing risk of family violence during the COVID-19 pandemic: strengthening community collaborations to save lives. *Forensic Sci Int: Reports 2*. 2020;100089.
- Substance Abuse and Mental Health Services Administration. Intimate partner violence and child abuse considerations during COVID-19. Available at <https://www.samhsa.gov/sites/default/files/social-distancing-domestic-violence.pdf>. Accessed March 18, 2021.
- Arnold C. Sales of guns to first time owners rise amid COVID-19 pandemic. *NPR*. 2020. Available at <https://www.npr.org/2020/07/16/891758050/sales-of-guns-to-first-time-owners-rise-amid-covid-19-pandemic>. Accessed March 15, 2021.
- Khubchandani J, Price JH. Public perspectives on firearm sales in the United States during the COVID-19 pandemic. *J Am Coll Emerg Physicians Open*. 2020;2:e12293.
- Lyons VH, Haviland MJ, Azrael D, Adhia A, Bellenger MA, Ellyson A, Rowhani-Rahbar A, Rivara FP. Firearm purchasing and storage during the COVID-19 pandemic. *Inj Prev*. 2021;27:87–92.
- Duncan TK, Weaver JL, Zakrisson TL, Joseph B, Campbell BT, Christmas AB, Stewart RM, Kuhls DA, Bulger EM. Domestic violence and safe storage of firearms in the COVID-19 era. *Ann Surg*. 2020;272(2):e55–e57.
- Donnelly MR, Grigorian A, Inaba K, Kuza CM, Kim D, Dolich M, Lekawa M, Nahmias J. A dual pandemic: the influence of coronavirus disease 2019 on trends and types of firearm violence in California, Ohio, and the United States. *J Surg Res*. 2021;263:24–33.
- Bleyer A, Siegel SE, Thomas CR Jr. Increasing rate of unintentional firearm deaths in youngest Americans: firearm prevalence and COVID-19 pandemic implication. *J Natl Med Assoc*. 2021;S0027–9684(20)30451–X.
- Gun Violence Archive. Available at <https://www.gunviolencearchive.org/>. Accessed February 24, 2021.
- United States Census Bureau. Available at <https://www.census.gov/data.html>. Accessed February 24, 2021.
- ChildStats.Gov. America's children in brief: key national indicators of well-being, 2020. Available at <https://www.childstats.gov/americaschildren/tables.asp>. Accessed March 11, 2021.
- Giffords Law Center To Prevent Gun Violence. Annual Gun Law Scorecard. Available at <https://giffords.org/lawcenter/resources/scorecard/>. Accessed February 24, 2021.
- Nelson DE, Grant-Worley JA, Powell K, Mercy J, Holtzman D. Population estimates of household firearm storage practices and firearm carrying in Oregon. *JAMA*. 1996;275(22):1744–1748.
- Violano P, Bonne S, Duncan T, et al. Prevention of firearm injuries with gun safety devices and safe storage: an Eastern Association for the Surgery of Trauma systematic review. *J Trauma Acute Care Surg*. 2018;84(6):1003–1011.
- Torales J, O'Higgins M, Castaldelli-Maia JM, Ventriglio A. The outbreak of COVID-19 coronavirus and its impact on global mental health. *Int J Soc Psychiatry*. 2020;66(4):317–320.
- Luca M, Malhotra D, Poliquin C. Handgun waiting periods reduce gun deaths. *Proc Natl Acad Sci U S A*. 2017;114(46):12162–12165.
- Lee LK, Fleegler EW, Farrell C, Avakame E, Srinivasan S, Hemenway D, Monuteaux MC. *JAMA Intern Med*. 2017;177(1):106–119.
- Crifasi CK, Merrill-Francis M, McCourt A, Vernick JS, Wintemute GJ, Webster DW. Association between firearm laws and homicide in urban counties. *J Urban Health*. 2018;95(3):383–390.
- Tseng J, Nuño M, Lewis AV, Srour M, Margulies DR, Alban RF. Firearm legislation, gun violence, and mortality in children and young adults: a retrospective cohort study of 27,566 children in the USA. *Int J Surg*. 2018;57:30–34.
- Frey WH. What the 2020 census will reveal about America: stagnating growth, an aging population, and youthful diversity. Brookings. Published January 11, 2021. Available at <https://www.brookings.edu/research/what-the-2020-census-will-reveal-about-america-stagnating-growth-an-aging-population-and-youthful-diversity/#:~:text=But%20the%202020%20census%20could,rate%20since%20at%20least%201900>. Accessed March 7, 2021.