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Original Research

Firearm legislation, gun violence, and mortality in children and young adults: A retrospective cohort study of 27,566 children in the USA

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ABSTRACT

Background: Firearm violence results in the death of thousands of children in the US annually. The effects of firearm legislation on gun violence are published but widely contested.

Materials and Methods: The Kid's Inpatient Database from 2000 to 2009 were queried to capture hospitalizations of children diagnosed with a firearm-related injury. Cases were categorized into five levels of firearm legislation strictness by Brady State Scorecard. Trends of injuries were explored in terms of legislative strength, age, and race.

Results: 27,566 children analyzed in the study. Most were adolescents aged 15–19 (87.3%), male (89.7%), and black (53.7%). The proportion of accidental injuries increased relative to state law leniency ($R^2 = 0.90$), with highest percentage in lenient states (33.2%) compared to strict (16.7%). The proportion of suicide attempts were higher in states with lenient laws (4.4%) compared to strict (1.3%). Accidents were inversely related to age (59.3% in ages 0–4 compared to 22.0% in adolescents), while assaults were positively related to age (31.6% in ages 0–4 compared to 66.6% in adolescents). Whites were most likely to present with accidental injuries (44.6%), and Blacks and Hispanics with assaults (68.2% and 75.6%). Race ($p = 0.009$), age ($p < 0.001$), and firearm injury type ($p = 0.001$) were associated with mortality; Hispanics (OR 1.36, 95% CI: 1.03–1.78), children age 5–9 (2.03, 1.30–3.17) and suicide attempts (15.6, 11.6–20.9) had higher odds of in-hospital mortality.

Conclusions: Firearm-related injuries types in hospitalized children are associated with age, race, and state level legislation. Accidents are most prevalent in young children, Whites, and states with lenient gun laws, while suicide attempts are more common in adolescents, Whites, and states with lenient gun laws. Suicide attempts are also associated with the greatest odds of in-hospital mortality. To address firearm violence, consideration should be given to legislation that promote safe gun storage behaviors and restrict firearm accessibility to children.

1. Introduction

Pediatric gun violence is a major public health concern in the United States. In 2015, 2824 children and teens died from gun-related injuries [1]. Studies show that guns are present in one out of three households with children, and that these weapons are often left unlocked or loaded [2]. 73% of young children in households with guns know where the weapons are kept, and 36% have actually handled the weapon, contrary to their parents' beliefs [3]. Overall, these statistics reflect the prevalence of firearm ownership and violence in the U.S.

Firearm legislation in the U.S. varies widely from state to state. The federal government lays down the groundwork with basic gun control laws, while states have the autonomy to incorporate additional legislation to restrict firearm accessibility. Notably, there are no Child Access Prevention (CAP) laws at the federal level; these decisions are deferred to individual states [4]. Existing studies show a relationship between firearm state laws and children safety. For example, states that enact CAP laws have a 23% decrease in unintentional firearm injuries [5]. In addition, states with strict firearm legislation and CAP laws have lower firearm ownership rates in families with children, as well as safer gun storage behaviors [6]. However, the results of these studies are widely contested and debated.

In November 2016, representatives of 42 public health programs and 17 leading gun violence prevention advocacy organizations met in

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Table 1
Baseline characteristics of 27,566 firearm-related injuries in children and adolescents, 2000–2009.

Variables	All patients N = 27566	Brady State Grade					p value
		A (Strict) 9977 (36.2)	B 1862 (6.8)	C 3276 (11.9)	D 1746 (6.3)	F (Lenient) 10705 (38.8)	
Age in years, N (%)							0.001
0–4	457 (1.7)	93 (0.9)	24 (1.3)	54 (1.7)	25 (1.4)	260 (2.4)	
5–9	595 (2.1)	186 (1.9)	17 (0.9)	90 (2.7)	50 (2.8)	253 (2.4)	
10–14	2445 (8.9)	701 (7.0)	156 (8.4)	343 (10.5)	183 (10.5)	1063 (9.9)	
15–19	24069 (87.3)	8996 (90.2)	1666 (89.5)	2788 (85.1)	1489 (85.3)	9129 (85.3)	
Male, N (%)	24380 (89.7)	8711 (90.7)	1693 (90.9)	2947 (90.0)	1583 (90.7)	9446 (88.3)	0.001
Race, N (%)							< 0.001
White	3914 (17.6)	826 (9.1)	84 (8.4)	567 (22.7)	179 (22.3)	2260 (25.4)	
Black	11985 (53.7)	4803 (52.7)	590 (59.1)	1573 (63.1)	547 (68.2)	4473 (50.3)	
Hispanic	5143 (23.1)	2965 (32.5)	280 (28.1)	199 (8.0)	14 (1.7)	1686 (19.0)	
Other	1256 (5.6)	526 (5.8)	44 (4.4)	157 (6.3)	62 (7.7)	469 (5.3)	

Missing data rates: race (19.1%), gender (1.4%).

Boston and issued a call to action amongst the academic public health community, citing a paucity of research in strategies that mitigate firearm morbidity and mortality [7]. The current literature lacks studies on the effect of state-level gun laws on firearm injuries in the healthcare system. In addition, the differences in firearm injury types by age and race are unclear. To address these topics, we used a national inpatient database to evaluate trends of pediatric firearm-related injuries in terms of age, race, and firearm legislation strength.

2. Materials and Methods

2.1. Data source and patient selection

The Kids' Inpatient Database (KID) is part of a family of nationwide databases and software tools developed for the Healthcare Cost and Utilization Project (HCUP). It includes 80% of pediatric discharges from community non-rehabilitation hospitals from participating HCUP state partners. In this retrospective cohort study, we used the KID database from 2000, 2003, 2006, and 2009 and identified minors up to the age of 19 who were discharged from a hospital with a firearm-related injury as per the International Classification of Diseases-Ninth Revision-Clinical Modification (ICD-9-CM) and the supplementary classification of external causes of injury and poisoning. Discharges are weighted based on the sampling scheme to permit inferences for a nationally representative population.

2.2. Stratification of cases by state level firearm laws

Due to the wide breadth of state laws, the Brady Campaign to Prevent Gun Violence and the Law Center to Prevent Gun Violence designed a scoring system to compare the strength of state gun laws. Each state was assigned a score based on thirty policy approaches. They were graded from A to F, with the weakest gun laws receiving an F, and the strongest receiving an A [8]. This grading scale serves a reference tool to compare the effects of state gun laws in a systematic fashion.

Firearm-related injuries were classified according to Brady grades according to their discharge hospital. Patients discharged from a hospital located in states CA, CT, MD, NJ, NY were classified as Brady A. Similarly, Brady grade groups B, C, D, and F include discharges from the following states: (B): HI, IL, MA, RI, (C): CO, IA, MI, MN, PA, WA, WI, (D): IN, NE, OH, OR, VA, and (F): AK, AR, AZ, FL, GA, KS, KY, LA, ME, MO, MS, MT, NC, ND, NH, NM, NV, OK, SC, SD, TN, TX, UT, VT, WV, WY. Brady grade classification was conducted on a per-year basis.

2.3. Data and outcome variables

Patients' ages were categorized into four groups (0–4, 5–9, 10–14, 15–19), along with sex (male vs. female), and race (e.g. white, black). Information on patient demographics, types of firearm injury, and location (state) were collected. In-hospital mortality was reported for the entire cohort.

2.4. Statistical analysis

Standard descriptive statistics were provided for all patients, as well as cohorts stratified by Brady grade groups. The significance of differences between Brady grade groups was estimated using the Pearson's chi-squared. Adjusted odds ratio of mortality and 95% confidence intervals (CI), and corresponding p values were calculated utilizing a multivariable logistic regression model. A p-value less than or equal to 0.05 was statistically significant. All statistical analyses were conducted in SAS 9.3 (SAS Institute, Cary, NC, USA). The work in this study have been reported in line with STROCSS criteria [9].

3. Results

A total of 27,566 firearm-related injuries admitted to participating hospitals were documented between 2000 and 2009 (Table 1). Most cases involved adolescents of age 15–19 years (87.3%) and males (89.7%). The majority of patients were Black (53.7%), followed by Hispanic (23.1%), and White (17.6%).

The proportion of injury types in relation to age, Brady grade, and race are detailed in Figs. 1–3, respectively. An increasing trend of accident-related injuries was observed among states with lenient Brady laws (R [2] = 0.92, Fig. 1). Patient hospitalizations corresponding to Brady Grade A were classified as accidents 16.7% of the time, compared to 33.2% of cases with Brady Grade F. Assaults were more common in states with strict Brady laws. For instance, patients discharged from hospitals classified by Brady A states were reported in 76.1% of the time while Brady grade F states had a rate of 52.9% ($p < 0.001$). An age by injury type trend analysis showed that accident-related injuries decreased consistently with increasing age (Fig. 2); 59.3% of injuries were accidents in the 0–4 age group, compared to the 22.0% among adolescents 15–19 year old (R [2] = 0.88). Simultaneously, adolescents (66.6%) experienced significantly more firearm related assaults compared to 0-4 year-olds (31.6%, $R^2 = 0.86$). Race by type of injury trend analysis showed that Hispanics, followed by Blacks reported more assault related firearm related injuries than all other groups (R [2] = 0.88, Fig. 3). Whites (44.6%) experienced the highest rate of accident-related injuries compared to all other cohorts (16.9%–25.4%).

In-hospital mortality for the entire cohort was 6.4% (data not shown). Suicide/self-inflicted injuries had significantly higher mortality (38.6%) compared to accidents (4.5%), assaults (5.2%), and legal intervention (7.9%). Mortality was also higher in injuries that involved military weapons per ICD-9 designation (13.1%) compared to handguns (6.7%), shotguns (4.0%), and hunting rifles (4.2%). Mortality estimates