Sociodemographic Factors and Outcomes by Intent of Firearm Injury

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abstract

BACKGROUND AND OBJECTIVES: Firearm injuries are a leading and preventable cause of morbidity and mortality among youth. We sought to explore differences in sociodemographic factors and youth firearm injury outcomes by injury intent (unintentional, assault, and self-harm).

METHODS: We conducted a repeated cross-sectional analysis of emergency department (ED) visits among youth aged 21 and younger presenting to an ED with a firearm injury between 2009 and 2016 using the Nationwide Emergency Department Sample. We performed multivariable logistic regression to measure the strength of association between (1) patient-level factors, (2) visit-level characteristics, and (3) clinical outcomes and intent of firearm injury.

RESULTS: We identified 178 299 weighted visits for firearm injuries. The mean age was 17.9 (95% confidence interval 17.8–18.0) years; 89.0% of patients were male, 43.0% were publicly insured, 28.8% were admitted, and 6.0% died. Approximately one-third of the injuries were categorized as unintentional (39.4%), another third as assault (37.7%), and a small proportion as self-harm (1.7%). Unintentional firearm injuries were associated with younger age, rural hospital location, Southern region, ED discharge, and extremity injury. Self-harm firearm injuries were associated with older age, higher socioeconomic status, rural hospital location, transfer or death, and brain, back, or spinal cord injury. Firearm injuries by assault were associated with lower socioeconomic status, urban hospital location, and requiring admission.

CONCLUSIONS: We identified distinct risk profiles for youth with unintentional, self-harm-, and assault-related firearm injuries. Sociodemographic factors related to intent may be useful in guiding policy and informing tailored interventions for the prevention of firearm injuries in at-risk youth.

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Drs Patel, Goyal, Parikh, and Iqbal conceptualized and designed the study, supervised the analysis, and drafted the initial manuscript; Ms Badolato extracted the data, conducted the initial analyses, and drafted the manuscript; and all authors reviewed and revised the manuscript and approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

DOI: https://doi.org/10.1542/peds.2020-011957

Accepted for publication Dec 22, 2020

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PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

WHAT'S KNOWN ON THIS SUBJECT: Firearm injuries are a leading and preventable cause of morbidity and mortality among youth. Children are more likely to be victims of unintentional injuries, and adolescents are more likely to suffer from intentional injuries after an assault or suicide attempt.

WHAT THIS STUDY ADDS: We identified distinct risk profiles for youth with unintentional, self-harm-, and assault-related firearm injuries. Sociodemographic factors related to intent may be useful in guiding policy and informing tailored interventions for the prevention of firearm injuries in at-risk youth.

To cite: Patel SJ, Badolato GM, Parikh K, et al. Sociodemographic Factors and Outcomes by Intent of Firearm Injury. *Pediatrics.* 2021;147(4):e2020011957

Firearm injury is the second leading cause of death and[1] a significant cause of nonfatal injury among American youth and is largely preventable. Each year, firearms are responsible for an estimated 5000 deaths and 22 000 nonfatal injury emergency department (ED) visits in American youth.[2] Hospital systems are well poised to tackle this issue using a public health approach, although prevention efforts and policies may be differentially effective on the basis of intent of the injury.

The epidemiology of firearm injury intent in youth has been described among different cohorts of youth: trauma patients,[3,4] inpatients,[5] and ambulatory and emergency care patients.[6–11] Characterizations of injury intent vary on the basis of bias inherent to the data source because hospital- and trauma-based registries are typically composed of youth who are more severely injured. Authors in one of these studies also described predictors of firearm-related injury by intent among youth; however, their analyses only included youth evaluated by pediatric EDs.[8] Because roughly 90% of pediatric patients are evaluated in general EDs and because patient characteristics differ by ED type, further study in a more representative population could provide more generalizable risk profiles.[12] Knowledge of sociodemographic factors and outcomes associated with intent of injury could help hospitals identify at-risk youth and provide targeted interventions.[13] We sought to explore differences in sociodemographic factors and injury outcomes by injury intent in youth presenting to the ED for unintentional, assault-, or self-harm–related firearm injury.

METHODS

Study Design

We performed a repeated cross-sectional analysis of the Nationwide Emergency Department Sample (NEDS) from 2009 to 2016.[14] This study was exempt from institutional review board review.

Data Source and Study Population

As the largest all-payer ED database in the United States, NEDS provides weighted national estimates of hospital-based ED visits, representing ~135 million ED visits annually.[14] All sampled visits made by patients ≤21 years old for firearm injury from 2009 to 2016 were included in this study.

Outcome

The outcome of interest was intent of firearm injury, categorized as unintentional, self-harm, assault, multiple intents, or undetermined. From 2009 to the third quarter of 2015, intent of firearm injury was categorized by NEDS by using the *International Classification of Diseases, Ninth Revision, Clinical Modification* codes for external cause of injury.[15] During the last quarter of 2015 to 2016, intent of firearm injury was classified by using the *International Classification of Diseases, 10th Revision, Clinical Modification* codes for external cause of morbidity.[16] A small proportion of codes denoting firearm-related injuries associated with legal intervention (<2%) were categorized under assault, as has been done in previous studies[5,17] (Supplemental Table 3). Visits coded with multiple intents were excluded from the primary analysis. In a sensitivity analysis, models were rerun with these visits categorized as each different intent (Supplemental Table 4). Visits related to air guns, pellet or BB guns, and paintball guns were excluded from the analysis.

Exposure Variables

Exposure variables included patient-level characteristics, visit-level characteristics, and injury outcomes and were included on the basis of previous literature.[6,8,11,12,18,19] Patient characteristics included age, sex, insurance, and median household income. Age was categorized as 0 to 12, 13 to 17, and 18 to 21 years to account for differences in exposure risk related to intent, similar to previous literature.[8,11] Insurance status was classified as private, public, uninsured, or other. We used median household income by zip code (categorized in NEDS as quartiles) as an indicator of socioeconomic status (SES).[20] Visit characteristics included ED type, hospital teaching status, urban or rural location, and US Census region. EDs were categorized as pediatric EDs if >75% of visits were made by patients ≤18 years old.[12] NEDS designates teaching or nonteaching EDs, and visits were categorized by metropolitan statistical area, specifically, urban or rural area.

Injury outcomes included disposition (discharge, transfer, admission, death, or left against medical advice). Location of bodily injury was characterized as (1) traumatic brain injury (TBI), back injury, or spinal cord injury; (2) extremity injury; (3) torso injury; (4) >1 injury; (5) other injury; or (6) not documented.

Data Analysis

Standard descriptive measures with survey weighting were used to describe the study population. Separate multivariable logistic regression models were developed for each injury intent to identify and measure associations with patient- and visit-level characteristics as well as injury outcomes. We decided to include the same covariates in each of the 3 models, a priori, because of clinical relevance and to allow for comparison between the risk profiles. Covariates were examined for collinearity. We found that hospital teaching status was collinear with urban or rural location, so teaching status was removed from the model. A small portion of our sample was treated in pediatric EDs; however, our model had a better fit when ED type

was removed from the model. We used the goodness-of-fit test for survey data in Stata (Stata Corp, College Station, TX) to assess model fit.[21] Data were analyzed by using survey procedures in SAS version 9.3 (SAS Institute, Inc, Cary, NC) and Stata 16.0 (Stata Corp).

RESULTS

There were an estimated 178 299 ED visits (average of 22 287 per year) for firearm injuries among youth during the 8-year study period. The mean age was 17.9 (95% confidence interval [CI] 17.8–18.0) years. A majority of firearm injury visits were among youth aged 18 to 21 years (67.0%) and among male patients (89.0%). Almost half of patients were publicly insured (43.0%) and were living in the lowest quartile for median household income (52.7%). Firearm injury visits to rural hospitals (8.0%) and pediatric EDs (2.1%) were rare. The most common injuries were extremity injuries (48.9%), with 6.0% of visits resulting in death after ED presentation (Table 1).

We identified distinct risk profiles for youth with unintentional, self-harm-, and assault-related firearm injury, as described in detail below. We found overlap between unintentional and self-harm–related firearm injury as well as between self-harm- and assault-related firearm injury (Table 2). Results from the sensitivity analyses revealed similar associations (Supplemental Table 4).

Unintentional Injury

Approximately one-third of ED visits for firearm injury were unintentional (39.4%). The likelihood of unintentional injury was higher among younger children (≤12 years: adjusted odds ratio [aOR] 3.5 [95% CI 3.0–4.0]; 13–17 years: aOR 1.2 [95% CI 1.2–1.3]) compared with 18- to 21-year-olds. Unintentional injury was less common among publicly insured (aOR 0.8 [95% CI 0.7–0.8]) compared with privately insured youth.

Geographically, unintentional injury had a higher likelihood in rural EDs compared with urban EDs (aOR 2.5 [95% CI 2.1–2.9]) and in the Southern region of the United States compared with the Northeast (aOR 1.3 [95% CI 1.0–1.6]).

Unintentional firearm injury was less likely to result in hospital admission (aOR 0.5 [95% CI 0.5–0.6]) or death (aOR 0.6 [95% CI 0.6–0.7]) as compared with ED discharge. Youth with unintentional injury were more likely to sustain extremity injuries as compared with TBI, spinal cord injury, and/or back injury (aOR 1.6 [95% CI 1.4–1.7]).

Self-harm

Self-harm–related firearm injuries made up the smallest proportion of the sample (1.7%). Odds of injury by self-harm were lower in children <12 years compared with youth 18 to 21 years (aOR 0.3 [95% CI 0.2–0.6]). Self-injury was also less likely among publicly insured youth (aOR 0.4 [95% CI 0.3–0.5]) compared with those privately insured and was more common among socioeconomically advantaged youth (aOR 2.9 [95% CI 2.2–4.0]). Self-harm by firearm was twice as common in a rural ED compared with an urban ED (aOR 2.1 [95% CI 1.5–2.9]) and more common in the Midwest (aOR 1.7 [95% CI 1.0–2.7]) and Southern US Census regions (aOR 1.6 [95% CI 1.0–2.6]) compared with the Northeast.

Self-harm–related firearm injury had 11 times the odds of resulting in death as compared with ED discharge (aOR 11.0 [95% CI 8.4–14.6]). Youth with self-harm injury were 80% less likely to sustain injuries to their extremities (aOR 0.2 [95% CI 0.1–0.2]) or torso (aOR 0.2 [95% CI 0.2–0.3]) relative to TBI, spinal cord injury, and/or back injury.

Assault

Assault-related firearm injuries accounted for 37.7% of visits and were less likely in younger children compared with youth 18 to 21 years old (≤12 years: aOR 0.4 [95% CI 0.3–0.4]; 13 to 17 years: aOR 0.8 [95% CI 0.7–0.8]). Youth injured by assault were more likely to be publicly insured (aOR 1.4 [95% CI 1.3–1.5]) and were less likely to live in the highest income quartile as compared with the lowest income quartile (aOR 0.8 [95% CI 0.7–0.9]). Assault-related firearm injury was also 70% less likely in a rural ED (aOR 0.3 [95% CI 0.3–0.4]) relative to an urban ED.

Assault-related firearm injury was associated with a higher likelihood of hospital admission (aOR 1.6 [95% CI 1.4–1.8]). Youth with assault-related firearm injuries were more likely to sustain torso injuries (aOR 1.2 [95% CI 1.1–1.4]) and have >1 injury (aOR 1.5 [95% CI 1.4–1.7]) as compared with TBI, spinal cord injury, and/or back injury.

DISCUSSION

In this 8-year cross-sectional analysis of ED visit data, we found clear differences in sociodemographic risk factors and clinical outcomes between youth who presented to the ED for unintentional, self-harm-, and assault-related firearm injury. To our knowledge, the associations presented here are derived from the most comprehensive and nationally representative recent data on intent of firearm injury among youth presenting to the ED in the United States.

Consistent with the other study in which researchers measured associations between mechanism of injury and sociodemographic risk factors in youth firearm injuries (although it was limited to pediatric EDs),[8] we demonstrated that older age, public insurance, urban residence, and lower SES were predictors of assault-related injury; self-harm–related firearm injury was at highest risk for admission and death; and younger age was

TABLE 1 Characteristics of the Study Population by Intent of Firearm Injury, United States, 2009–2016

Variable	All Firearm Injuries, *n* (%)	Unintentional, *n* (%)	Self-harm, *n* (%)	Assault, *n* (%)	Multiple Intents, *n* (%)	Undetermined, *n* (%)
Totals	178 299	70 173 (39.4)	2971 (1.7)	67 147 (37.7)	27 988 (15.7)	10 020 (5.6)
Age categories, y						
0–12	8912 (5.0)	6039 (8.6)	102 (3.4)	1630 (2.4)	709 (2.5)	432 (4.3)
13–17	49 896 (28.0)	20 565 (29.3)	1031 (34.7)	17 864 (26.6)	7562 (27.0)	2874 (28.6)
18–21	119 491 (67.0)	43 569 (62.1)	1837 (61.9)	47 653 (71.0)	19 717 (70.4)	6715 (67.0)
Sex						
Female	19 524 (11.0)	8375 (11.9)	377 (12.7)	6920 (10.3)	2753 (9.8)	1099 (11.0)
Male	158 675 (89.0)	61 763 (88.0)	2594 (87.3)	60 173 (89.6)	25 229 (90.1)	8916 (88.9)
Insurance status						
Private	37 916 (21.3)	17 488 (24.9)	1382 (46.5)	12 065 (18.0)	403 (18.6)	1767 (17.6)
Public	76 660 (43.0)	28 431 (40.5)	797 (26.8)	31 888 (47.5)	963 (40.1)	4326 (43.2)
Uninsured	52 337 (29.4)	20 219 (28.8)	538 (18.1)	18 907 (28.2)	877 (33.4)	3319 (33.1)
Other	10 705 (6.0)	3813 (5.4)	220 (7.4)	4005 (6.0)	236 (7.5)	559 (5.6)
Median household income quartiles[a]						
Quartile 1	93 999 (52.7)	35 826 (51.1)	914 (30.8)	37 949 (56.5)	13 777 (49.3)	5532 (55.2)
Quartile 2	42 199 (23.7)	17 454 (24.9)	900 (30.3)	14 826 (22.1)	6698 (23.9)	2321 (23.2)
Quartile 3	26 356 (14.8)	10 791 (15.4)	641 (21.6)	8978 (13.4)	4619 (16.5)	1327 (13.2)
Quartile 4	11 117 (6.2)	4522 (6.4)	411 (13.8)	3463 (5.2)	2126 (7.6)	594 (5.9)
Disposition						
Discharged	94 840 (53.2)	44 382 (63.2)	630 (21.2)	31 310 (46.6)	12 486 (44.6)	6032 (60.2)
Admitted	51 326 (28.8)	13 715 (19.5)	418 (14.1)	25 003 (37.2)	10 307 (36.8)	1883 (18.8)
Transferred	17 938 (10.6)	7543 (10.7)	809 (27.2)	5685 (8.5)	2862 (10.2)	1038 (10.4)
Died	10 735 (6.0)	3151 (4.5)	1092 (36.8)	3712 (5.5)	1919 (6.9)	861 (8.6)
Left AMA	2179 (1.2)	697 (1.0)	5 (0.2)	934 (1.4)	403 (1.4)	140 (1.4)
Region						
Northeast	19 515 (10.9)	6539 (9.3)	233 (7.8)	9404 (14.0)	2151 (7.7)	1189 (11.9)
Midwest	45 372 (25.4)	17 008 (24.2)	874 (29.4)	19 425 (28.9)	5574 (19.9)	2490 (24.9)
South	78 552 (44.1)	33 777 (48.1)	1402 (47.2)	29 563 (44.0)	8882 (31.7)	4927 (49.2)
West	34 860 (19.6)	12 848 (18.3)	462 (15.5)	8755 (13.0)	11 380 (40.7)	1415 (14.1)
Location of bodily injury						
TBI, back, or spinal cord	19 597 (11.0)	7449 (10.6)	1435 (48.3)	6242 (9.3)	3330 (11.9)	1142 (11.4)
Extremity	87 180 (48.9)	41 055 (58.5)	483 (16.3)	29 011 (43.2)	11 631 (41.6)	4999 (49.8)
Torso	26 560 (14.9)	9251 (13.2)	339 (11.4)	10 973 (16.3)	4485 (16.0)	1512 (15.1)
Other	1211 (0.7)	577 (0.8)	59 (2.0)	358 (0.5)	143 (0.5)	74 (0.7)
Multiple	41 913 (23.5)	10 944 (15.6)	513 (17.3)	20 091 (29.9)	8205 (29.3)	2160 (21.6)
Not documented	1838 (1.0)	897 (1.3)	142 (4.9)	472 (0.7)	194 (0.7)	133 (1.3)
Teaching hospital	3778 (2.1)	2205 (1.2)	87 (2.9)	866 (1.3)	419 (1.5)	202 (2.0)
Rural hospital location	14 184 (8.0)	9307 (13.3)	501 (16.9)	2125 (3.2)	1578 (5.6)	673 (6.7)
Pediatric ED	3778 (2.1)	2205 (3.1)	87 (2.9)	867 (1.3)	419 (1.5)	202 (2.0)

AMA, against medical advice.

[a] Quartile 1, $1–$42 999; quartile 2, $40 000–$53 999; quartile 3, $50 000–$70 999; and quartile 4, $67 000+ (overlap due to changes in quartiles from year to year).

associated with unintentional injury. We also demonstrated that rural location was more frequently associated with unintentional and self-harm firearm injury among youth. Additionally, although previous studies have revealed extremities as the most common bodily location of firearm injury in youth,[6] we report differences by intent. We also found regional variations in intentionality of firearm injury.

Notably, only 2% of ED visits for firearm injury in our sample were made to pediatric hospitals. Additionally, trauma care for older youth is commonly delivered, per protocol, in adult trauma centers. The inclusion of both general and pediatric EDs in the evaluation of firearm injuries among youth is important, and our study provides much needed cross-validation of previous work by using a more comprehensive source for firearm injury data in youth.

The distribution of firearm injury intentionality reported varies by data source. In another nationally representative review of youth firearm injuries, in which the National Hospital Ambulatory Medical Care Survey between the years 2001 and 2010 was used, the authors reported 64% of injuries as unintentional.[10]

The authors of 2 other studies[9,11] reported a higher proportion of assault-related firearm injuries. Both of these studies did not include youth aged 18 to 21 years. Gani and Canner[9] also used NEDS data from 2006 to 2014 and found a distribution similar to ours when multiple intents was coded as assault.

As health care providers, researchers, and policy leaders, it is important to understand the epidemiology of intentionality in youth firearm injury and all associated risk factors.[22] A more nuanced understanding of differences in youth firearm injury by intent could inform smarter injury prevention efforts and offer a more tailored approach, which may prove more effective and efficient.

Unintentional Injury

Increasing mortality in younger children from unintentional firearm injury has largely been attributed to an increase in personal handgun ownership[23] and the ability of small children to easily pull the trigger.[24] Although we were unable to evaluate any association between the type of firearm and intent, we did find that extremity injury was more commonly associated with unintentional injury. Primary prevention would dictate not having a firearm in a home with children or at-risk youth, whereas secondary prevention would encourage safe storage of the firearm: locked and unloaded and separate from ammunition.[25,26] Our findings would support an educational program to assess (1) access to firearms and/or (2) interest in implementation of safe storage mechanisms, primarily for parents of younger children (aged <12 years) and patients seen in rural settings.

We also found that unintentional firearm injury was highest in the Southern US Census region. Regional differences could be addressed by changes in local legislation, especially as it pertains to child access to firearms. A recent study revealed that the most stringent negligence laws, laws holding the owner liable for unsafe storage of firearms, were associated with a 59% reduction in unintentional firearm deaths in children aged 0 to 14 years.[27] More detailed descriptions of incidents (type of firearm, storage and/or safety devices use, etc) by region could help to guide tailored community education and legislative prevention.

Intentional Injury: Self-harm

Suicide is the second most common cause of death in US children aged 10 to 14 years, and nearly half of all suicides are firearm related.[2] Suicide was associated with higher odds of death, and the injury pattern most associated with self-harm in this study is consistent with higher mortality, spinal injuries, and TBI. As the country with the highest per capita firearm ownership in the world, 4.6 million youth in the United States live in homes where a gun is stored loaded and unlocked.[28] Moreover, 15% to 20% of teenagers identified to be at risk for suicide in the pediatric ED report having access to firearms.[29,30] In a state-level analysis, it was found that the youth suicide rate increased by 27% for each 10% increase in household gun ownership.[31]

Our findings support targeted screening for access to firearms in youth based on associated sociodemographic risk factors for self-harm by firearm (older age, higher SES, rural ED location, and South and Midwest US Census regions). The American Academy of Pediatrics recommends that physicians screen for access to firearms in all patients with mood disorders, substance abuse, or history of suicide attempts.[32] Caregivers of suicidal youth who are provided lethal means counseling by ED physicians to temporarily restrict access to firearms are more likely to comply than those who are not asked.[33]

Moreover, the 2 US Census regions in this study that were found to be associated with firearm injury, the Midwest and South, have reports of firearm ownership of >30% of households, relative to 16% of households in the Northeast.[34] Similarly, 46% firearm ownership is reported in rural areas, compared with 19% in urban areas.[34] Areas where firearm ownership is high may receive information on firearm safety counseling differently from areas where firearm ownership is low. Future work should be focused on ascertaining these differences so that region-specific interventions could be developed. Additionally, state-level differences in firearm mortality are associated with strictness of firearm legislation.[35] A state-level analysis could help investigate why self-harm injuries are more common in certain regions.

Intentional Injury: Assault

Homicide is the third leading cause of death in US youth aged 15 to 24 years.[2] Youth injured by assault in urban EDs have higher rates of subsequent visits for firearm violence, and 1 in 4 report firearms possession.[36,37] Youth injured by assault are 88 times more likely to retaliate with violence and present with another injury.[38] Early data on violence intervention programs, both ED and hospital based, are promising.[39] Our findings support the implementation of violence intervention programs for youth injured by assault in urban hospitals. At a minimum, providers should counsel and caution youth injured by assault on the serious risks associated with retaliation.

Limitations

There are several potential limitations to this study. First, there is a risk of underestimating total firearm injuries. Firearm injuries that resulted in death before ED arrival and minor injuries that did not require ED care were not captured in NEDS. Second, the data are subject to errors in coding inherent to NEDS. Our study period began in 2009, when NEDS began to systematically identify firearm injuries, which should mitigate this limitation to some degree. Third, the study dates included

TABLE 2 Association of Risk Factors and Clinical Outcomes of Firearm Injuries Among Youth by Intent of Injury, United States, 2009–2016

Variable	Unintentional	Self-harm	Assault
Age categories, y, aOR[a] (95% CI)			
18–21	Referent	Referent	Referent
13–17	1.2 (1.2–1.3)*	1.2 (1.0–1.4)*	0.8 (0.7–0.8)*
0–12	3.5 (3.0–4.0)*	0.3 (0.2–0.6)*	0.4 (0.3–0.4)*
Male sex, aOR[a] (95% CI)	1.0 (0.9–1.1)	0.9 (0.7–1.1)	1.0 (0.9–1.1)
Insurance status, aOR[a] (95% CI)			
Private	Referent	Referent	Referent
Public	0.7 (0.7–0.8)*	0.4 (0.3–0.5)*	1.4 (1.3–1.5)*
Uninsured	0.8 (0.7–0.8)*	0.3 (0.3–0.4)*	1.1 (1.0–1.2)*
Median household income quartile,[b] aOR[a] (95% CI)			
Quartile 1	Referent	Referent	Referent
Quartile 2	1.1 (1.0–1.2)*	1.9 (1.5–2.4)*	0.9 (0.8–1.0)*
Quartile 3	1.2 (1.1–1.3)*	2.3 (1.7–3.0)*	0.9 (0.7–1.0)*
Quartile 4	1.2 (1.0–1.3)*	2.9 (2.2–4.0)*	0.8 (0.7–0.9)*
Disposition, aOR[a] (95% CI)			
Discharged	Referent	Referent	Referent
Admitted	0.5 (0.5–0.6)*	1.5 (1.1–2.1)*	1.6 (1.4–1.8)*
Transferred	0.9 (0.8–1.0)*	5.7 (4.4–7.3)*	1.0 (0.8–1.1)
Died	0.6 (0.6–0.7)*	11.0 (8.4–14.6)*	0.9 (0.8–1.1)
Left AMA	0.7 (0.5–0.9)*	0.5 (0.1–3.2)	1.3 (1.1–1.6)*
Region, aOR[a] (95% CI)			
Northeast	Referent	Referent	Referent
Midwest	1.1 (0.8–1.4)	1.7 (1.0–2.7)*	0.9 (0.6–1.3)
South	1.3 (1.0–1.6)*	1.6 (1.0–2.6)*	0.8 (0.6–1.3)
West	1.1 (0.9–1.4)	0.9 (0.5–1.5)	0.4 (0.3–0.5)*
Location of bodily injury, aOR[a] (95% CI)			
TBI, back, or spinal cord	Referent	Referent	Referent
Extremity	1.6 (1.4–1.7)*	0.2 (0.1–0.2)*	0.9 (0.8–1.0)
Torso	1.1 (1.0–1.2)*	0.2 (0.2–0.3)*	1.2 (1.1–1.4)*
Other	1.8 (1.3–2.4)*	1.0 (0.5–1.8)	0.7 (0.5–1.0)
>1	0.8 (0.7–0.9)*	0.2 (0.2–0.3)*	1.5 (1.4–1.7)*
Not documented	1.5 (1.1–2.0)*	2.5 (1.5–4.1)*	0.7 (0.5–1.0)
Rural hospital location, aOR[a] (95% CI)	2.5 (2.1–2.9)*	2.1 (1.5–2.9)*	0.3 (0.3–0.4)*
Goodness of fit, F statistic	0.896	0.157	0.393

Visits coded with multiple intents were excluded. AMA, against medical advice.

[a] Adjusted for age, sex, median household income, insurance status, disposition, region, location of injury, and hospital location.

[b] Quartile 1, $1–$42 999; quartile 2, $40 000–$53 999; quartile 3, $50 000–$70 999; and quartile 4, $67 000+ (overlap due to changes in quartiles from year to year).

* Statistically significant (regression results $P < .05$).

the transition in coding from the *International Classification of Diseases, Ninth Revision, Clinical Modification* to the *International Classification of Diseases, 10th Revision, Clinical Modification*. We reviewed trends of firearm injuries, overall and separated by intent, and did not observe any significant changes from 2014 to 2016. Fourth, the inability to code for intent due to the lack of detailed data in the source electronic medical record remains a limitation. Finally, although authors of previous studies have commented on racial and ethnic disparities in pediatric firearm-related injury, we are unable to comment on this given that NEDS does not include this variable.

CONCLUSIONS

To our knowledge, this is the first comparison of factors and outcomes associated with intentionality of youth firearm injury in a large nationally representative sample of ED visits. We were able to clearly demonstrate an association between intent of youth firearm injury and patient- and visit-related factors as well as differences in clinical outcomes by intent. This information should be leveraged to design targeted interventions based on sociodemographic risk factors. As a minimum first step, our findings support (1) screening for access to firearms in young children presenting to rural hospitals and counseling on safe storage; (2) lethal means access screening and counseling in patients who are suicidal, in rural areas, and in higher-SES settings; and (3) screening for risk of assault and/or exposure to violence and firearms access in urban, lower-SES settings. Hospitals may be more likely to support programs that are targeted, patient-centered, and relevant to their communities.

The findings of this study build on previous literature, provide insight into the overlap between risk factors and outcomes and intentionality of youth firearm injury, and reveal distinct risk profiles for unintentional, self-harm-, and assault-related youth firearm injury. Further understanding of the relationship between intentionality of youth firearm injuries and factors associated with mechanism of injury is still needed. Additionally, although NEDS appears to be one of the more representative data sources for firearm injury, there are limitations to ED data. Improvements in data sources for firearm injury will lead to more impactful and insightful research. In future work, researchers should aim to incorporate firearm ownership, type of firearm, and method of access in a standardized fashion into the electronic medical record. Furthermore, legislation and policy to prevent firearm injuries in youth should be introduced with consideration of factors related to intent.

ABBREVIATIONS

aOR: adjusted odds ratio
CI: confidence interval
ED: emergency department
NEDS: Nationwide Emergency Department Sample
SES: socioeconomic status
TBI: traumatic brain injury

FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: No external funding.

POTENTIAL CONFLICT OF INTEREST: Dr Goyal serves as an editorial board member of *Pediatrics*; the other authors have indicated they have no potential conflicts of interest to disclose.

REFERENCES

1. Cunningham RM, Walton MA, Carter PM. The major causes of death in children and adolescents in the United States. *N Engl J Med*. 2018;379(25):2468–2475
2. Centers for Disease Control and Prevention. WISQARS™ – Web-based Injury Statistics Query and Reporting System. Available at: www.cdc.gov/injury/wisqars/index.html. Accessed January 14, 2020
3. Lee J, Moriarty KP, Tashjian DB, Patterson LA. Guns and states: pediatric firearm injury. *J Trauma Acute Care Surg*. 2013;75(1):50–53
4. Nordin A, Coleman A, Shi J, Wheeler K, Xiang H, Kenney B. In harm's way: unintentional firearm injuries in young children. *J Pediatr Surg*. 2018;53(5):1020–1023
5. Kalesan B, Dabic S, Vasan S, Stylianos S, Galea S. Racial/ethnic specific trends in pediatric firearm-related hospitalizations in the United States, 1998–2011. *Matern Child Health J*. 2016;20(5):1082–1090
6. Allareddy V, Nalliah RP, Rampa S, Kim MK, Allareddy V. Firearm related injuries amongst children: estimates from the nationwide emergency department sample. *Injury*. 2012;43(12):2051–2054
7. Patel SJ, Badolato GM, Parikh K, Iqbal SF, Goyal MK. Regional differences in pediatric firearm-related emergency department visits and the association with firearm legislation [published online ahead of print February 19, 2019]. *Pediatr Emerg Care*. doi:10.1097/PEC.0000000000001779
8. Monuteaux MC, Mannix R, Fleegler EW, Lee LK. Predictors and outcomes of pediatric firearm injuries treated in the emergency department: differences by mechanism of intent. *Acad Emerg Med*. 2016;23(7):790–795
9. Gani F, Canner JK. Trends in the incidence of and charges associated with firearm-related injuries among pediatric patients, 2006–2014. *JAMA Pediatr*. 2018;172(12):1195–1196
10. Srinivasan S, Mannix R, Lee LK. Epidemiology of paediatric firearm injuries in the USA, 2001–2010. *Arch Dis Child*. 2014;99(4):331–335
11. Fowler KA, Dahlberg LL, Haileyesus T, Gutierrez C, Bacon S. Childhood firearm injuries in the United States. [published correction appears in *Pediatrics*. 2017;140(4):e20172298]. *Pediatrics*. 2017;140(1):e20163486
12. Bourgeois FT, Shannon MW. Emergency care for children in pediatric and general emergency departments. *Pediatr Emerg Care*. 2007;23(2):94–102
13. National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division; Board on Population Health and Public Health Practice. In: Wojtowicz A, French M, Alper J, eds. *Health Systems Interventions to Prevent Firearm Injuries and Death: Proceedings of a Workshop*. Washington, DC: National Academies Press (US); 2019
14. Healthcare Cost and Utilization Project. NEDS overview. Available at: https://www.hcup-us.ahrq.gov/nedsoverview.jsp. Accessed August 6, 2019
15. Centers for Disease Control and Prevention. Matrix of E-code groupings: table 1. Recommended framework of E-code groupings for presenting injury mortality and morbidity data (August 10, 2011). Available at: https://www.cdc.gov/injury/wisqars/ecode_matrix.html. Accessed August 6, 2016
16. GunPolicy.org. Firearm-related ICD-10 injury and death codes. 2020. Available at: https://www.gunpolicy.org/firearms/citations/quotes/6107. Accessed March 20, 2020
17. Eber GB, Annest JL, Mercy JA, Ryan GW. Nonfatal and fatal firearm-related injuries among children aged 14 years and younger: United States, 1993–2000. *Pediatrics*. 2004;113(6):1686–1692
18. Carter PM, Cook LJ, Macy ML, et al.; Pediatric Emergency Care Applied Research Network (PECARN). Individual and neighborhood characteristics of children seeking emergency department care for firearm injuries within the PECARN network. *Acad Emerg Med*. 2017;24(7):803–813
19. Herrin BR, Gaither JR, Leventhal JM, Dodington J. Rural versus urban hospitalizations for firearm injuries in children and adolescents. *Pediatrics*. 2018;142(2):e20173318
20. Berkowitz SA, Traore CY, Singer DE, Atlas SJ. Evaluating area-based socioeconomic status indicators for monitoring disparities within health care systems: results from a primary care network. *Health Serv Res*. 2015;50(2):398–417
21. Archer KJ, Lemeshow S. Goodness-of-fit test for a logistic regression model fitted using survey sample data. *Stata J*. 2006;6(1):97–105
22. Cunningham RM, Carter PM, Ranney ML, et al. Prevention of firearm injuries among children and adolescents: consensus-driven research agenda from the Firearm Safety Among Children and Teens (FACTS) consortium. *JAMA Pediatr*. 2019;173(8):780–789
23. Prickett KC, Gutierrez C, Deb S. Family firearm ownership and firearm-related mortality among young children: 1976–2016. *Pediatrics*. 2019;143(2):e20181171
24. Naureckas SM, Galanter C, Naureckas ET, Donovan M, Christoffel KK; The Pediatric Practice Research Group. Children's and women's ability to fire handguns. *Arch Pediatr Adolesc Med*. 1995;149(12):1318–1322
25. Grossman DC, Mueller BA, Riedy C, et al. Gun storage practices and risk of youth

suicide and unintentional firearm injuries. *JAMA*. 2005;293(6):707–714

26. 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

27. Azad HA, Monuteaux MC, Rees CA, et al. Child access prevention firearm laws and firearm fatalities among children aged 0 to 14 years, 1991–2016. *JAMA Pediatr*. 2020;174(5):463–469

28. Azrael D, Cohen J, Salhi C, Miller M. Firearm storage in gun-owning households with children: results of a 2015 national survey. *J Urban Health*. 2018;95(3):295–304

29. Teach SJ, Horowitz L. *Access to Firearms Among Patients Screening Positive for Suicide Risk in the Pediatric Emergency Departments*. Elk Grove Village, IL: American Academy of Pediatrics; 2013

30. Abaya R, Atte T, Herres J, Diamond G, Fein JA. Characteristics and behavioral risk factors of firearm-exposed youth in an urban emergency department. *J Behav Med*. 2019;42(4):603–612

31. Knopov A, Sherman RJ, Raifman JR, Larson E, Siegel MB. Household gun ownership and youth suicide rates at the state level, 2005–2015. *Am J Prev Med*. 2019;56(3):335–342

32. Dowd MD, Sege RD; Council on Injury, Violence, and Poison Prevention Executive Committee; American Academy of Pediatrics. Firearm-related injuries affecting the pediatric population. *Pediatrics*. 2012;130(5). Available at: www.pediatrics.org/cgi/content/full/130/5/e1416

33. Runyan CW, Becker A, Brandspigel S, Barber C, Trudeau A, Novins D. Lethal means counseling for parents of youth seeking emergency care for suicidality. *West J Emerg Med*. 2016;17(1):8–14

34. Parker K, Menasce Horowitz J, Igielnik R, Baxter Oliphant J, Brown A. The demographics of gun ownership. 2017. Available at: https://www.pewsocialtrends.org/2017/06/22/the-demographics-of-gun-ownership/. Accessed September 24, 2019

35. Goyal MK, Badolato GM, Patel SJ, Iqbal SF, Parikh K, McCarter R. State gun laws and pediatric firearm-related mortality. [published correction appears in *Pediatrics*. 2020;145(1):e20193232]. *Pediatrics*. 2019;144(2):e20183283

36. Carter PM, Walton MA, Newton MF, et al. Firearm possession among adolescents presenting to an urban emergency department for assault. *Pediatrics*. 2013;132(2):213–221

37. Carter PM, Walton MA, Roehler DR, et al. Firearm violence among high-risk emergency department youth after an assault injury. *Pediatrics*. 2015;135(5):805–815

38. Dowd MD. Consequences of violence. Premature death, violence recidivism, and violent criminality. *Pediatr Clin North Am*. 1998;45(2):333–340

39. Cunningham R, Knox L, Fein J, et al. Before and after the trauma bay: the prevention of violent injury among youth. *Ann Emerg Med*. 2009;53(4):490–500

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Pediatrics 2021;147;
DOI: 10.1542/peds.2020-011957 originally published online March 29, 2021;