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Racial/Ethnic Specific Trends in Pediatric Firearm-Related Hospitalizations in the United States, 1998–2011

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Abstract *Objectives* To determine the temporal patterns and the difference in trends by race/ethnicity of pediatric firearm hospitalizations (FH) among those aged 15 years or younger in the United States. *Methods* Data on pediatric FH was retrieved from the Nationwide Inpatient Sample between 1998 and 2011 (n = 16,998,470) using external cause of injury codes (E-codes) of the *International Classification of Diseases*, *Ninth Revision*, *Clinical modification*, (assault: E9650-E9654, unintentional: E9220-E9224, E9228, and E9229, suicide: E9550-E9554, E9556, and E9559, undetermined: E9850-E9854, and E9856 and legal: E970). Meta-regression was used to determine the significance of temporal trends. Survey logistic regression adjusted for survey year was used to examine association of pediatric FH with social and demographic characteristics. *Results* An annual reduction of 1.07 per 100,000 hospitalizations (p-trend = 0.011) was observed between 1998 and 2011. There was reduction in rate of unintentional-FH (p-trend = 0.013), suicide-FH (p-trend = 0.029), and undetermined-FH (p-trend = 0.002), but not assault-FH (p-trend = 0.18). A decline in rates of FH was observed among whites (p-trend = 0.021) and Hispanics (p-trend = 0.03) while an increase in rates of assault-FH was observed among black children. All other intents and all other racial/ethnic groups showed declining rates during this interval. *Conclusions* There was an overall decline in rates of pediatric FHs in this time period driven by a decline in unintentional-FHs. However there was an increase in assault FH among black children during this same time period.

Keywords Firearm injury · Temporal trends · Injury severity · Hospitalization · Pediatric

Abbreviations
FH Firearm hospitalization

Significance

Firearm-related morbidity and mortality among children is markedly high in the United States. Pediatric fatal and non-fatal firearm injuries have demonstrated a decline, but differences in temporal patterns according to racial/ethnic groups or intent of injury have not yet been documented. We found a reduction in overall pediatric firearm hospitalizations (FH) over 14 years, which was driven by a decline in unintentional injuries. FHs were more likely to be black than white children, with a decline among white and Hispanic children and a significant increase among black children hospitalized due to assault firearm injuries.

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Introduction

Firearm-related morbidity and mortality among children is markedly high in the United States [18]. This excessive burden is jointly attributed to both fatal and non-fatal firearm-related injuries [4]. The most recent data in 2013 indicates that on an average, every month, firearms fatally injure 49 children and non-fatally injure 171 children [3, 4]. In contrast to adult firearm injuries, where unintentional injuries are minimal, the vast majority of pediatric firearm injuries are unintentional [10, 17]. The burden of injury and costs directly related to emergency room visits and subsequent severe morbidity with repeat hospitalizations remain high among those who survive firearm-related injuries [5, 19].

Although the evidence on time trends of pediatric fatal and non-fatal firearm injuries demonstrates a decline [12, 16], there has been no documented differentiation of temporal patterns according to racial/ethnic groups or intent of injury. While pediatric firearm injuries were predominantly among black children [11, 12] the evidence regarding intent thus far is inconsistent. Both assault and unintentional injuries have been implicated as leading causes of FH depending on the age of the children [12, 17]. Recent evidence suggests that the declining trend in firearm fatalities was attributed to decline in firearm homicide rates among those aged 15–19 years [6], and that FHs among those <15 years have different risk profiles as compared to older children [9]. The difference in firearm injury by race is associated with the intent of injury, where white children were injured after unintentional firearm discharge, whereas most black children were shot violently [17].

In this study, we document the overall national, intent- and race/ethnicity-specific trends in pediatric FH from 1998 to 2011 among children and adolescents, 15 years of age or younger. Additionally, we assessed the racial/ethnic difference among intent-specific temporal patterns of pediatric FH during the same time period.

Materials and Methods

Data Source

We used in-patient hospital administration data collected as part of the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality, the Nationwide Inpatient Sample (NIS) [1]. NIS data are nationally representative and contains data on approximately hospital stays in 1000 hospitals sampled to represent a 20 % stratified sample of US community hospitals from 46 states. Each year of the NIS provides information on approximately 8 million inpatients stays from the 1000 sampled hospitals. Because the NIS is available yearly, beginning with 1988, analysis of trends over time is possible.

Columbia University IRB deemed the study exempt from federal regulations for the protection of human research participants.

Study Population

NIS data sets from 1998 to 2011 were used in this analysis. The dataset was then restricted to patients 15 years of age or younger. Neonatal hospitalizations were also excluded resulting in a survey-weighted total of 83,129,094 hospitalization records. Each record refers to a single hospitalization; as a result, a person may have multiple hospitalizations, and unique patient records may not be identified.

Variables and Definitions

All pediatric FH were identified from external cause of injury codes (E-codes) of the *International Classification of Diseases, Ninth Revision, Clinical modification* (ICD-9) in the NIS datasets. Types of firearm injuries defined by intent were: assault (E9650-E9654), unintentional (E9220-E9224, E9228, and E9229), suicide (E9550-E9554, E9556, and E9559), undetermined (E9850-E9854, and E9856) and legal (E970). For analytical purposes, we included legal under the assault category.

Age was categorized into three groups: 0–5, 6–10, and 11–15 years of age. Race/ethnicity was classified into: white, black, Hispanic, and other (Asian and all other race, excludes those missing race/ethnicity). Those hospitalizations that were missing race/ethnicity were included in the overall pediatric FH. In addition, we also used gender (male and female), US census regions (Northeast, Midwest, South and West), pre-existing comorbidities (alcohol abuse, depression, drug abuse and psychosis), and hospital characteristics such as teaching status (teaching and non-teaching), hospital bed size (small, medium and large), and location (rural and urban).

Statistical Analysis

First we analyzed annual hospitalizations from 1998 to 2011 to derive observed counts and rates of overall, intent-, and race-specific pediatric FH per 100,000 pediatric hospitalizations after weighting the data from each year to be generalizable to US pediatric hospital discharges using survey analysis. Survey analysis was performed using discharge weights and sixty strata that were defined depending on geographical region, teaching status, and hospital. Second, using survey-weighted logistic regression model with survey year added as a linear term, we derived

predicted rates and standard deviation (SD) for overall and by intent of pediatric FH. Third, using a random-effects meta-analysis, the observed and predicted rates of pediatric FH was pooled to obtain summary rates of pediatric FH per 100,000 across 14 years. We used meta-analysis since the data were pseudo-panel, cross-sectional data. Meta-regression was used to assess trends across survey years and to determine annual changes in observed and predicted rates and SDs of pediatric FH with the assumption of linearity in trends. Here, the pooled summary estimates were modeled along with survey year. *p* values for trend (p-trend) across years for overall, race/ethnicity-, and intent-specific pediatric FH were derived from meta-regression of survey-weighted rates and SD. Difference in temporal trends of pediatric FH by race/ethnicity groups in each intent of pediatric FH was assessed using meta-regression. Finally, we determined associations of social, demographic, hospital, and regional characteristics with overall and intent-specific pediatric FH using survey logistic regression as odds ratios (OR) and 95 % confidence intervals (95 % CI) adjusted for survey year. All analyses were conducted using STATA V.13.1 (StataCorp LP, College Station, Texas, USA; 2009).

Results

Out of the 83,129,094 pediatric hospitalizations recorded in the NIS between 1998 and 2011, we identified 23,259 pediatric FH. Majority of pediatric FH were male (male 82 % vs. female 18 %) and 11–15 years old (74 %). The overall observed and predicted rates of pediatric FH from 1998 to 2011 are presented in Fig. 1 and Table 1. The 14-year pediatric FH rate was 27.97 per 100,000 pediatric hospitalizations. Rates of pediatric FH during this time period ranged from a high of 46.96 (in 1998) to a low of 19.05 (in 2011) per 100,000. A significant annual reduction of −1.07 per 100,000 hospitalizations per year (p-trend = 0.011) was observed.

Annual observed rates of pediatric FH and annual change according to racial/ethnic subgroups are presented in Table 1. During the overall study period, blacks were observed to have the highest overall rate of pediatric FH (72.33 per 100,000), followed by Hispanics (27.23 per 100,000). Whites and Asian/other had similar overall rate of pediatric FH (17.37 and 17.36 per 100,000) respectively. Significant annual change of −0.83 and −1.05 per 100,000 were observed among whites (p-trend = 0.021) and Hispanics (p-trend = 0.03). Blacks (annual change = −1.30) and those categorized, as other race (annual change = −0.45) did not show any change, p-trend = 0.14 and 0.28 respectively.

The cumulative predicted rates and observed rates of different intents across the 14 years are presented in Fig. 2 and Table 1. Over the study period, 49.8 % of all pediatric FH were unintentional (14.42 per 100,000), followed by assault (10.91 per 100,000) at 37.9 %, while very few were by suicide (0.85 per 100,000) and undetermined intent (1.66 per 100,000) accounting for 2.9 and 5.7 % respectively. Annual change pediatric FH rate showed a significant decline when the intent was unintentional (change =

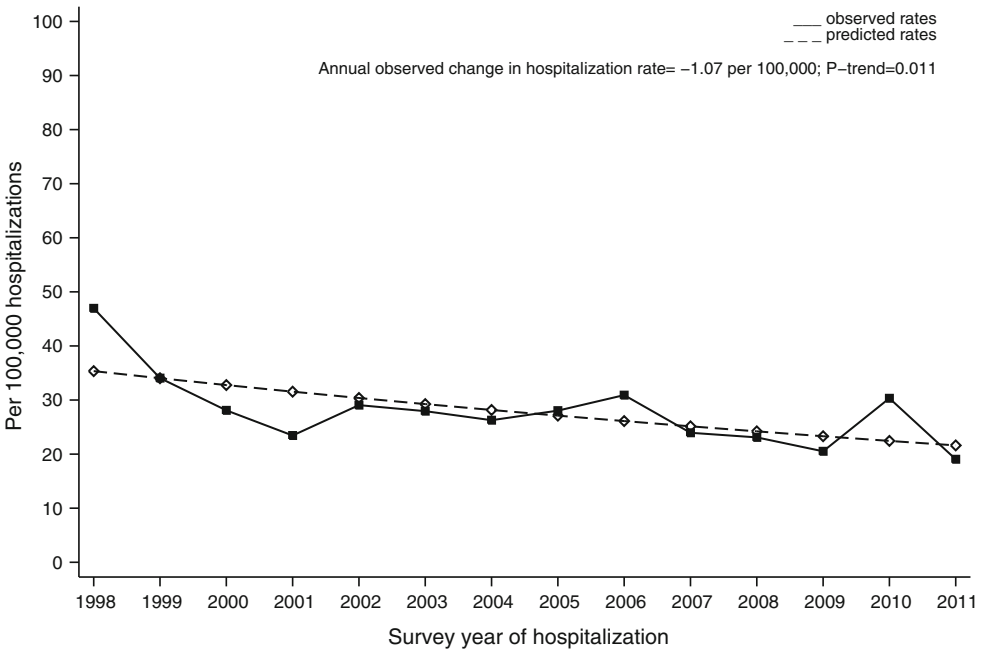

Fig. 1 Temporal trends of pediatric FHs per 100,000, 1998–2011. The *solid line* indicates observed change in pediatric FHs from year to year. The *dashed line* indicates the predicted annual change in pediatric FHs. Annual change denotes average annual change in rate, derived from meta-regression. p-trend denotes *p* value for trend, derived from meta-regression. Meta-regression is random effects meta-regression analysis using survey weighted counts of hospitalizations and event-related hospitalizations

Table 1 Trends in firearm-related pediatric hospitalizations (0–15 years) in the United States, NIS 1998–2011

	Age-adjusted firearm deaths per 100,000 population								
	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total, N	5,588,274	5,982,394	5,891,486	5,883,189	5,998,847	6,024,101	6,181,096	6,487,946	6,115,901
Overall	2624 (46.96)	2037 (34.05)	1655 (28.09)	1379 (23.44)	1743 (29.06)	1683 (27.94)	1624 (26.27)	1819 (28.03)	1890 (30.90)
Race/ethnicity									
White	32.27	20.22	15.90	19.25	15.31	21.80	20.02	13.36	17.97
Black	90.46	89.10	72.53	59.74	72.26	66.14	61.28	74.91	79.48
Hispanic	38.94	36.94	38.21	20.19	31.45	24.88	18.56	27.86	36.55
Other	30.73	14.05	15.78	10.93	20.13	25.52	20.28	21.59	21.58
Intent									
Homicide	15.80	11.53	12.51	7.58	11.07	9.56	8.64	10.80	14.81
Suicide	1.68	0.90	1.12	0.59	0.98	1.34	0.70	0.74	0.96
Undetermined	3.67	2.81	1.39	1.26	1.83	1.71	1.41	2.10	1.85
Unintentional	25.34	18.77	13.04	13.90	15.07	15.22	15.43	14.27	13.16
Legal	0.45	0	0	0.08	0.07	0.08	0.08	0.11	0.08

	Age-adjusted firearm deaths per 100,000 population						Change	p-trend
	2007	2008	2009	2010	2011	Total		
Total, N	6,272,363	5,876,071	5,823,869	5,738,420	5,265,137	83,129,094		
Overall	1502 (23.95)	1357 (23.09)	1195 (20.52)	1740 (30.32)	1003 (19.05)	23,259 (27.97)	−1.07	0.011
Race/ethnicity								
White	11.07	9.25	12.94	19.97	13.67	17.37	−0.83	0.021
Black	82.88	74.14	61.02	82.52	42.90	72.33	−1.30	0.14
Hispanic	27.32	23.03	17.74	27.81	20.12	27.23	−1.05	0.030
Other	8.18	11.13	12.73	18.46	17.36	17.36	−0.45	0.28
Intent								
Homicide	12.08	10.26	9.56	11.27	6.93	10.91	−0.22	0.18
Suicide	0.22	0.66	0.58	0.85	0.63	0.85	−0.05	0.029
Undetermined	1.82	0.99	1.20	0.78	0.34	1.66	−0.15	0.002
Unintentional	9.71	11.16	8.91	17.29	10.99	14.42	−0.64	0.013
Legal	0.06	0	0.22	0.09	0.13	0.10	−0.001	0.91

All values are rates per 100,000 hospitalizations. Overall are survey weighted counts (rates per 100,000 hospitalizations). Change denotes annual change in rate per 100,000. Negative value indicates decline in firearm hospitalization rates per 100,000 from 1998 to 2011 and positive value indicates increase in firearm hospitalization rate per 100,000 from 1998 to 2011. CI denotes confidence intervals of the annual change in firearm hospitalization rate per 100,000. p-trend calculated using meta-regression indicates the significance of the decline or the increase in firearm related hospitalization rates from 1998 to 2011. Total denotes total weighted number of hospitalizations

−0.64, p-trend = 0.013), suicide (change = −0.05, p-trend = 0.029) and undetermined (change = −0.15, p-trend = 0.002), but there was no change among the homicide injuries (change = −0.22, p-trend = 0.18). Figure 3 presents the predicted probabilities of different intents of pediatric FH by race/ethnicity. A significant decline was observed among all race/ethnic subgroups of all intents except among blacks with assault injuries, where a significant increasing trend was observed (change = 0.25, p-trend < 0.0001) and among other race with suicide injuries, where there was no significant change (−0.03, p-trend = 0.64).

Table 2 presents the association between the socio-demographic and hospital characteristics and overall and different intents of pediatric FH. All pediatric FH were less likely to involve girls than boys (OR 0.24, 95 % CI 0.22–0.26) and was similar among different intents (assault: OR 0.27, 95 % CI 0.24–0.30; unintentional: OR 0.22, 95 % CI 0.19–0.24; suicides: OR 0.26, 95 % CI 0.17–0.41; undetermined: OR 0.29, 95 % CI 0.21–0.40). We also observed that pediatric FH was most likely to involve older children as compared to children between 0 and 5 years old (OR 94.71, 95 % CI 80.56–111.3), with the greatest likelihood for suicide (OR 173.2, 95 % CI 89.72–334.3) and

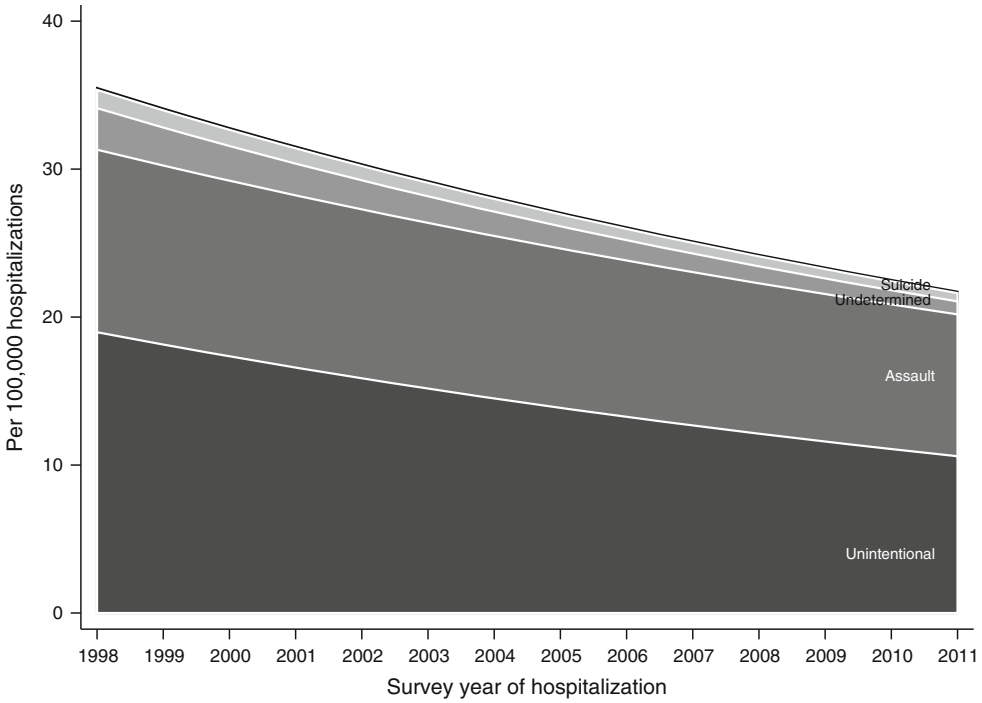

Fig. 2 Cumulative rate of pediatric FHs per 100,000 by intent of injury, 1998–2011. This *figure* represents the magnitude of observed annual change in intent-specific pediatric FH. From *bottom* to *top*, these *shades* represent pediatric FH attributable to unintentional, assault, undetermined, and suicide injury intents

	Rate per 100,000, 1998, (SE)	Rate per 100,000, 2011 (SE)	Annual change (95% CI)	p
Assault				
White	2.81 (0.20)	1.55 (0.22)	-0.10 (-0.12 to -0.07)	<0.0001
Black	37.53 (0.17)	40.83 (0.16)	0.25 (0.23 to 0.27)	<0.0001
Hispanic	16.87 (0.24)	12.42 (0.27)	-0.34 (-0.38 to -0.31)	<0.0001
Other race	7.19 (0.29)	5.31 (0.23)	-0.14 (-0.17 to -0.11)	<0.0001
Unintentional				
White	17.71 (0.09)	9.71 (0.10)	-0.61 (-0.65 to -0.58)	<0.0001
Black	34.98 (0.16)	20.02 (0.14)	-1.15 (-1.20 to -1.09)	<0.0001
Hispanic	13.65 (0.15)	8.55 (0.16)	-0.39 (-0.41 to -0.37)	<0.0001
Other race	10.79 (0.20)	8.50 (0.20)	-0.17 (-0.20 to -0.15)	<0.0001
Suicide				
White	1.31 (0.24)	0.81 (0.28)	-0.04 (-0.07 to -0.01)	0.020
Black	1.55 (0.37)	0.25 (0.52)	-0.10 (-0.16 to -0.04)	0.002
Hispanic	2.29 (0.35)	0.21 (0.60)	-0.16 (-0.22 to -0.11)	<0.0001
Other race	0.55 (1.02)	0.17 (1.35)	-0.03 (-0.17 to 0.11)	0.64
Undetermined				
White	1.43 (0.23)	0.48 (0.33)	-0.07 (-0.11 to -0.04)	0.001
Black	7.32 (0.29)	3.90 (0.27)	-0.26 (-0.30 to -0.22)	<0.0001
Hispanic	2.47 (0.31)	0.49 (0.37)	-0.16 (-0.20 to -0.11)	<0.0001
Other race	0.43 (0.41)	0.80 (0.43)	-0.14 (-0.21 to -0.08)	<0.0001

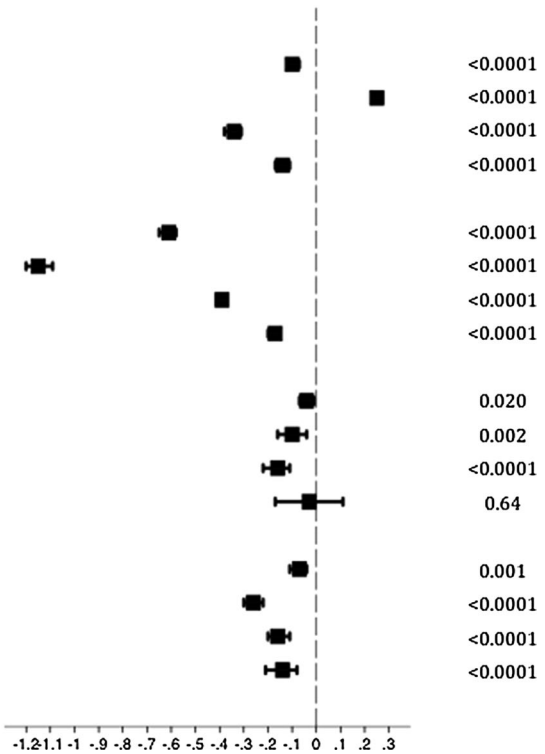

Fig. 3 Change in predicted rates of different intents of pediatric FHs by race/ethnicity. This forest plot illustrates the relative magnitude of annual change in intent- and race-specific pediatric FH between 1998 and 2011. The *squares* represent predicted rates of annual change and the *horizontal lines* represent 95 % CT. *p* value denotes *p* value for trend, derived from random effects meta-regression analysis using survey weighted counts of hospitalizations and event-related hospitalizations

Table 2 Association of socio-demographic and hospital characteristics with overall and intent of firearm hospitalization, 1998–2011

	All firearm hospitalizations	Intent categories of firearm hospitalizations			
		Assaults	Unintentional	Suicides	Undetermined
Gender (Ref: male)					
Female	0.24 (0.22–0.26)*	0.27 (0.24–0.30)*	0.22 (0.19–0.24)*	0.26 (0.17–0.41)*	0.29 (0.21–0.40)*
Age (Ref: 0–5 years)					
6–10	25.7 (21.8–30.6)*	20.6 (14.1–30.0)*	29.1 (24.6–34.3)*	10.8 (3.90–29.8)*	21.9 (12.5–38.7)*
11–15	94.7 (80.6–111.3)*	140.9 (108.0–183.9)*	68.3 (57.2–81.6)*	173.2 (89.72–334.3)*	121.8 (75.9–195.4)*
Race/ethnicity (Ref: white)					
Black	4.15 (3.54–4.87)*	18.5 (14.7–23.4)*	1.99 (1.71–2.33)*	0.70 (0.38–1.31)	6.22 (3.67–10.6)*
Hispanic	1.60 (1.28–1.99)*	6.86 (4.89–9.61)*	0.83 (0.68–1.01)	0.82 (0.48–1.38)	1.29 (0.81–2.03)
Other	1.03 (0.84–1.26)	2.92 (2.14–3.96)*	0.74 (0.59–0.91)*	0.31 (0.11–0.87)*	1.77 (0.76–4.14)
Hospital bed size (Ref: small)					
Medium	0.85 (0.54–1.32)	1.07 (0.51–2.23)	0.77 (0.57–1.04)	1.08 (0.48–2.43)	0.47 (0.16–1.35)
Large	1.03 (0.71–1.49)	1.26 (0.73–2.16)	0.95 (0.72–1.25)	1.49 (0.71–3.13)	0.63 (0.23–1.72)
Hospital location (Ref: rural)					
Urban	2.14 (1.77–2.58)*	15.2 (8.35–27.6)*	1.27 (1.06–1.51)*	1.42 (0.71–2.84)	2.17 (1.15–4.10)*
Hospital teaching (Ref: non-teaching)					
Teaching	3.49 (2.82–4.32)*	5.84 (3.36–10.1)*	2.55 (2.17–2.99)*	2.78 (1.78–4.35)*	4.16 (2.66–6.49)*
Region (Ref: Northeast)					
Midwest	1.39 (0.94–2.04)	1.45 (0.79–2.65)	1.29 (0.97–1.71)	1.64 (0.83–3.24)	1.56 (0.69–3.51)
South	1.30 (0.99–1.70)	0.71 (0.46–1.10)	1.86 (1.46–2.36)*	1.48 (0.77–2.85)	1.37 (0.85–2.20)
West	1.28 (0.93–1.77)	1.47 (0.88–2.47)	1.12 (0.87–1.43)	1.98 (1.02–3.87)*	0.86 (0.51–1.45)
Pre-existing co-morbidity					
Alcohol abuse	29.2 (20.4–41.8)*	54.7 (38.6–77.5)*	9.10 (4.56–18.2)*	25.8 (6.22–106.9)*	35.0 (13.9–88.1)*
Depression	4.89 (3.54–6.75)*	5.34 (3.33–8.57)*	2.44 (1.34–4.46)*	52.3 (29.4–93.0)*	1.89 (0.26–13.7)
Drug abuse	22.4 (15.8–31.7)*	38.4 (25.7–57.4)*	9.21 (5.93–14.3)*	50.1 (26.8–93.8)*	20.1 (8.68–46.7)*
Psychosis	2.84 (1.90–4.24)*	1.11 (0.43–2.89)	2.26 (1.22–4.18)*	41.8 (21.0–83.2)*	2.31 (0.32–16.5)

All values are unadjusted odds ratio (OR) and 95 % confidence intervals (CI) for all firearm injuries calculated using survey logistic regression adjusted for survey year

* p value <0.05

lowest among unintentional (OR 68.32, 95 % CI 57.21–81.58). All pediatric FH was 4-times more likely to be black (OR 4.15, 95 % CI 3.54–4.87) and 60 % likely to be Hispanic (OR 1.60, 95 % CI 1.28–1.99) as compared to whites. The increased likelihood among blacks as compared to whites was greatest among assault pediatric FH (OR 18.52, 95 % CI 14.66–23.41) followed by undetermined (OR 6.22, 95 % CI 3.67–10.56) and unintentional (OR 1.99, 95 % CI 1.71–2.33). Hispanics were 6.86 times more likely than whites to have assault pediatric FH (OR 6.86, 95 % CI 4.89–9.61) while the risk among other race as compared to whites was mainly for assault firearm injuries (OR 2.92, 95 % CI 2.14–3.96) and 69 % reduced risk for suicide injuries (OR 0.31, 95 % CI 0.11–0.87). Overall, there was no difference in rate of pediatric FH between US Census regions when compared to the Northeast, with a significant association only between unintentional pediatric FH and south US regions as compared to Northeast (OR 1.86, 95 % CI 1.46–2.36). While there was no significant association between hospital bed size and pediatric FH, pediatric firearm injuries were more likely to be admitted at an urban than rural hospital location (OR 2.14, 95 % CI 1.77–2.58). Pediatric FH was associated with pre-existing morbidities of alcohol abuse (OR 29.21, 95 % CI 20.43–41.77), substance abuse (OR 22.40, 95 % CI 15.83–31.69), depression (OR 4.89, 95 % CI 3.54–6.75) and psychosis (OR 2.84, 95 % CI 1.90–4.24). The relationship was strongest between substance abuse, psychosis and depression with suicide pediatric FH, while alcohol abuse was most likely among assault pediatric FH.

Discussion

In our analysis of nationally representative hospitalizations between 1998 and 2011 among children 15 years and younger, we report four primary findings. First, over the

14 year period of observation, we documented a moderate decline in the rate of pediatric FHs with half of pediatric FH being unintentional followed by assault injuries. Second, the decline in pediatric FH was driven primarily by the reduction in rates of unintentional injury hospitalizations and to a lesser extent by suicide and undetermined FH. Third, FH were 4-times more likely to be black than white children and 60 % more likely to be Hispanic than white. However, a decline in rates was observed only among whites and Hispanics. Fourth, an increase in rates was observed only among black pediatric FHs when the intent was assault while the rates in all intents across all other race/ethnic groups demonstrated a decline.

Although, the observed moderate annual decline in rate of pediatric FH's in our study follows the direction of change seen in another trend analysis of emergency department visits between the years 1993 and 2000, the magnitude of decline in our study appears to be much smaller [7]. This reduced magnitude in decline may be explained by the data on fatal and non-fatal injuries from Centers for Disease Control and Prevention (CDC), where only 50–60 % of non-fatal firearm injuries are hospitalized after emergency visit [4]. However, the results from our analysis are similar to those of an earlier report on FHs that include adults and children using national data from 2000 to 2010 [10]. Together with these studies, our analysis suggests that over the past two decades there appears to be an overall decrease in annual decline of pediatric FH's. Our results are in congruence with the data between 1993 and 2000, which also reported almost half of cumulative pediatric FHs resulting from unintentional injury, followed very closely by assault or legal intervention [7]. Another study using administrative emergency department data, reported that most frequently documented firearm injuries were assaults followed by unintentional injuries among those children who were $\leq$18 years old [2]. This reversal maybe due to the inclusion of pediatric FH below 16 years, and can be rationalized by the distinct firearm injury differences between children (<16 years) and adolescents [9]. Unlike the experience of the pediatric FHs in our study, national cumulative FHs were mostly due to assault intent, where majority were adults [10].

To our knowledge, this is the first study to analyze temporal trends of pediatric FHs according to intent of injury, as earlier studies were underpowered to perform accurate calculations [7]. Over this study's time period, the overall decline in pediatric FHs was primarily attributable to reduction in rates of unintentional injury and to a lesser extent by suicide and undetermined FH. Our study results differed from an earlier reported study of all FH that included adults, where the self-inflicted injury mainly drove the decline in overall FHs [10]. However, in both studies we found the decline was also driven by undetermined FH [10]. On the other hand, many states have increasingly adopted child access prevention laws over the years in an effort to reduce childhood injuries, which was has previously been suggested as the driver for the decline in unintentional firearm injury rates [11].

Our third finding of wide differences in FH among minorities as compared to whites, in conjunction with declining rates among whites, is a direct manifestation of and underlines the persisting social phenomenon of structural racial disparities in the US. Earlier reports using national data from 1993 to 1997 indicated that firearm injuries were over twice more likely to be black than white children and no more likely to be Hispanic than white [13]. Our results therefore suggests a widening of racial disparities in pediatric FHs. Our findings are also in agreement with the results from national FHs which showed an even larger likelihood of FH among black individuals compared to whites [10]. While rates of overall FHs among all ages were observed to be declining among blacks and whites in the overall population [10], rates of pediatric FH were only observed to be declining among Hispanics and whites. This decline among whites and Hispanics were similar to the decline in non-fatal pediatric injuries from 2001 to 2013 in the CDC WISQARS data [3]. These consistent findings suggest that the existing racial/ethnic difference between FHs in the overall population and FH extends to the pediatric population.

Finally, amidst either the declining or unchanging rates across all intents and all race/ethnic groups, an increase in rates of pediatric FH was observed singly among black children when the intent was assault. This direction of change or an incline in rates of overall FHs was not observed in a previous study using national hospitalization data from 2000 to 2010 [10], suggesting that this finding may be unique to persons under 15 years of age in the US. As the national conversation gains momentum on reducing pediatric firearm injuries, this finding warrants further investigation into the potential factors that may have influenced this outcome, and demonstrates the necessity to re-evaluate policies involved in prevention of assault-related FHs among children.

Implications for Health Services and Policy Makers

Although there are firearm control laws such as child handgun restrictions, reducing access of firearms to children and age restrictions on firearm purchases targeted to prevent pediatric firearm injuries, these legislations are not federally implemented, but state implemented [8]. There are wide state-specific variations that are further complicated by additional firearm laws that could be either restrictive or permissive [14]. The declining pediatric FH rates mainly driven by reduction in unintentional injuries and the higher rates among African American as compared

to White children sustaining assault injuries found in our study, indicates the relevance of socio-demographic factors. However, current firearm control policies targeted towards preventing pediatric injuries were implemented without considering the need to address both underlying social disparities and racial differences simultaneously. Therefore, tailored programs targeted to reduce pediatric firearm injuries in different racial/ethnic groups and communities are required along with comprehensive firearm control laws are necessary. Health professionals working in settings where pediatric firearm injuries are high such as high crime and inner city neighborhoods and neighborhoods where firearm ownership is high could implement effective community-based programs to reduce firearm violence and firearm ownership.

Strengths and Limitations

Our study results are subject to several limitations characteristic to the administrative nature of the data. First of all, NIS data does not provide patient-level data which makes it impossible to distinguish between incident hospitalization and recurrent admission. Non-fatal firearm patients have a high risk of repeat hospitalizations due to increased physical and mental health outcomes [15], which we cannot differentiate and have implications in the overall burden of injury. Second, approximately one-fourth of the hospitalizations in the NIS have missing values for race. However, our results regarding racial disparities would prove valid because these missing values are likely non-differential and therefore our calculated measures of association would only be biased toward the null. Third, the analysis was limited to covariates available in the NIS database and thus we were unable to adjust our analyses for potential confounders such as socio-demographic factors and variables more specific to firearm ownership. Of all the pediatric firearm injuries, about one-fifth sustains fatal wounds, one-third is treated in the emergency department and the majority is treated in the hospital for their firearm injuries [3, 4]. Our results are based on a subgroup of pediatric firearm injuries that survived long enough to reach the emergency department while sustaining injuries that are severe enough to warrant extended treatment.

Conclusions

We found that an overall decline in pediatric FHs from 1998 to 2011. This reduction was driven by a decline in unintentional injuries, which were half of all pediatric FH. The rate of pediatric FH was fourfold greater among blacks than among whites during the 14-year study period. Pediatric FH rates among black children hospitalized for assault injuries increased, while the rates in different intents among all race/ethnic groups showed significant decline.

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Compliance with Ethical Standard

Conflict of interest The authors have no conflicts of interest relevant to this research to disclose.

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