

Incidence and Circumstances of Nonfatal Firearm-Related Injuries Among Children and Adolescents

Elizabeth C. Powell, MD, MPH; Edward Jovtis; Robert R. Tanz, MD

Objective: To describe the incidence and circumstances of nonfatal firearm-related injuries among children and adolescents treated in US emergency departments.

Design: Data were obtained from the Firearm Injury Surveillance Study, 1993-1997; data were collected through medical record review at hospitals participating in the National Electronic Injury Surveillance System.

Setting: The hospitals participating in National Electronic Injury Surveillance System are a stratified probability sample of all US hospitals.

Main Outcome Measures: Numbers and population rates for nonfatal firearm-related injuries among children and adolescents younger than 20 years old.

Results: An estimated 115131 (95% confidence interval, 76769-153493) children and adolescents were treated for a nonfatal gunshot wound during the study period. The estimated annual rates of injury (per 100000) were 2.0 (children 0-4 years old), 2.2 (children 5-9 years old),

15.4 (children 10-14 years old), and 106.5 (adolescents 15-19 years old). The ratios of nonfatal to fatal firearm-related injuries were 4.0 (children 0-4 years old), 4.4 (children 5-9 years old), 5.0 (children 10-14 years old), and 4.4 (adolescents 15-19 years old). An additional estimated 103814 children (95% confidence interval, 69223-138405) were shot with a nonpowder firearm (BB or pellet gun). Boys 5 to 9 and 10 to 14 years old had the highest rates of injury related to nonpowder firearms, an estimated 36.2 and 99.8 per 100000, respectively. Fifty-six percent of those 15 to 19 years old were assault victims. An estimated 48% of children and adolescents with powder firearm-related gunshot wounds and an estimated 4% with nonpowder firearm injuries were admitted to the hospital.

Conclusions: Nonfatal injuries related to powder firearms and nonpowder firearms (BB or pellet guns) are an important source of injury among US children and adolescents. Ongoing surveillance of nonfatal firearm-related injury among children and adolescents is needed.

Arch Pediatr Adolesc Med. 2001;155:1364-1368

From the Divisions of Pediatric Emergency Medicine (Dr Powell and Mr Jovtis) and General Academic Pediatrics (Dr Tanz), Children's Memorial Hospital, and the Department of Pediatrics, Northwestern University Medical School (Drs Powell and Tanz), Chicago, Ill.

THE RATE OF firearm deaths among US children far exceeds that in other industrialized nations.¹ Nonfatal firearm injuries outnumber injury fatalities, however, information about them is limited.²⁻⁴ While the first comprehensive national estimates of nonfatal firearm-related injuries reported in 1995 provided much needed information, they provided limited details about injured children.⁵ Although firearm-related death rates appear to have declined since the mid-1990s, they remain a common cause of injury death.^{6,7} Because detailed national data are lacking, we present national estimates, based on data from a representative sample of US hospitals, on the number of children and adolescents with nonfatal gun-related injuries treated in US emergency departments (EDs) over a 5-year period.

RESULTS

From January 1993 through December 1997 there were 6705 nonfatal gun-related injuries to children and adolescents between 0 and 19 years old reported through NEISS. Using the NEISS weightings, there were an estimated 244822 injuries (95% confidence interval, 172844-316800) in this age group treated in US hospital EDs. **Table 1** gives the distribution of gunshot wounds and other injuries by weapon type (powder or nonpowder firearm). Ninety percent of the injuries were the result of a gunshot wound: the remaining 10% were other firearm-related injuries and included being struck with a pistol or the butt of a gun, or being injured from weapon recoil or from parts of the firearm during clean-

MATERIALS AND METHODS

We obtained data from the Firearm Injury Surveillance Study, 1993-1997, from the National Archive of Criminal Justice Data.⁸ Firearm Injury Surveillance Study, 1993-1997, data were collected at hospitals participating in the National Electronic Injury Surveillance System (NEISS) through an agreement between the Centers for Disease Control and Prevention and the Consumer Product Safety Commission.⁵ The NEISS data have been used routinely by the Consumer Product Safety Commission to monitor injuries related to consumer products, including nonpowder guns.⁹ Prior to June 1992, the Consumer Product Safety Commission did not routinely collect data on injuries related to powder firearms.

The hospitals participating in NEISS are a stratified probability sample of all US hospitals and includes children's hospitals. Data obtained from these hospitals can be weighted to provide unbiased, statistically valid national estimates of product-related injuries.⁹ The sampling frame of NEISS was updated in 1997 to include 101 hospitals and a stratum for children's hospitals; from 1993-1996 NEISS consisted of 91 hospitals. An analysis of weighted data collected from both NEISS samples during an 8-month overlap in 1997 indicated that differences in the national estimates of firearm-related injuries were less than 1%, thus no statistical adjustments were made to adjust for the sampling frame.⁷ Additional information about the NEISS sample is available from us on request.

Gun-related injuries were defined as those cases in which a gun was involved in the incident and included powder burns, pistol-whipping, recoil injuries, and injuries sustained during cleaning of the weapon, as well as penetrating gunshot wounds. Some of the gun-related injuries were from nonpowder firearms (BB and pellet guns).⁵ Only those who were alive at the time of discharge from the ED were counted.

Cases from each hospital were assigned a sample weight by NEISS; national injury estimates were produced by summing the sample weights. The 95% confidence intervals of these estimates were calculated based on SEs for firearms reported by the Centers for Disease Control and Prevention.^{5,7} National vital statistics data for 1993-1997 from the National Center for Health Statistics were used to report firearm deaths.¹⁰ The US Census estimates for 1995, the median year of the sample, were used to calculate age- and race-specific injury incidence rates.¹¹ Race-specific rates are reported as white (non-Hispanic) and black; rates for those of Hispanic ethnicity are also reported.

ing. Overall, nonpowder injuries accounted for slightly less than half of the cases.

The estimated annual rates of powder firearm-related gunshot wounds by age, sex, and race are listed in **Table 2**. The ratio of nonfatal to fatal firearm-related injuries ranged from 4.0 to 5.0 across the age groupings. Rates of nonfatal powder firearm-related gun-

Table 1. National Estimates of Nonfatal Gun-Related Injuries Among US Children and Adolescents 0 to 19 Years Old, 1993-1997, by Weapon and Injury Type

Type of Weapon and Wound	No. of Injuries	95% Confidence Interval
Gunshot	218 945	154 575-283 315
Powder firearm	115 131	76 769-153 493
Nonpowder firearm (BB or pellet)	103 814	69 223-138 405
Other injury*	25 877	14 719-37 035
Powder firearm	21 962	12 492-31 432
Nonpowder firearm (BB or pellet)	3915	1997-5833
All gun-related	244 822	172 844-316 800

*Category includes being struck with a pistol or the butt of a gun and injury from weapon recoil or from parts of the firearm during cleaning.

shot wounds by age, sex, and race were calculated: among those younger than 14 years, nonfatal powder firearm wound rates (per 100 000) were 5.8 (white males), 1.0 (white females), 10.8 (Hispanic males), 3.8 (Hispanic females), 23.6 (black males), and 8.0 (black females). More specifically, within the group of 10- to 14-year-old males, the rates of nonfatal powder firearm-related gunshot wounds (per 100 000) were 14.6 for whites, 27.9 for Hispanics, and 60.8 for blacks; for males 15 to 19 years old the rates (per 100 000) were 52.7 for whites, 307.4 for Hispanics, and 624.5 for blacks.

The highest annual rates of penetrating trauma from nonpowder firearms (BB or pellet guns) were among males 10 to 14 years old, 99.8 per 100 000. Males 5 to 9 years old had a rate of 36.2 per 100 000 and those 15 to 19 years old had a rate of 47.6 per 100 000. A comparison of the age-specific rates among males of nonfatal gunshot wounds from powder firearms and from nonpowder firearms is shown in the **Figure**. Rates of nonpowder firearm-related injuries increased with age among school-aged boys, peaked in 13-year-olds, and declined thereafter. Powder firearm-related gunshot wounds showed minor variation by year of age between the ages of 5 and 10 years old; between the ages of 11 and 18 years old the rates of nonfatal injury increased by 50% to 100% for each year of age. The rates of powder firearm-related wounds first exceeded rates of nonpowder firearm injuries among 15-year-olds.

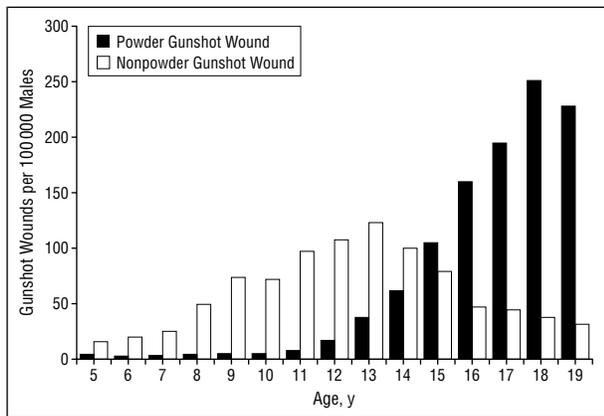
The circumstances of the injury, by age, for all firearm-related injuries are given in **Table 3**. Among those aged 14 years and younger, unintentional nonpowder firearm injuries were most common; less than 10% were assaults. Of those with powder firearm injuries, an estimated 47% were unintentional and an estimated 41% attributed to assaults (data not shown in Table 3). Among adolescents aged 15 to 19 years, an estimated 19% of powder firearm injuries were unintentional and an estimated 66% were assaults. The proportions were reversed for nonpowder firearm injuries: an estimated 64% of BB or pellet gun injuries were unintentional and an estimated 15% were assaults (data not shown in Table 3).

In almost half of the cases, the shooter was not reported. In cases for which this information was available, a minor fraction of the injuries were the consequence of a shooting by a stranger: most wounds were

Table 2. Nonfatal Powder Firearm Gunshot Wounds by Age, Sex, and Race or Ethnicity, 1993-1997, Estimated Annual Rates per 100 000, and Ratio of Nonfatal to Fatal Gunshot Wounds*

Variable	No. of Nonfatal Injuries (95% CI)	Injury Rate, %	Death Rate, %†	Ratio
Age, y				
0-4	1979 (893-3065)	2.0	0.5	4.0
5-9	2094 (945-3243)	2.2	0.5	4.4
10-14	14 522 (8175-20 869)	15.4	3.1	5.0
15-19	96 536 (59 451-133 621)	106.5	24.0	4.4
Sex				
Male	101 764 (62 670-140 858)	52.4	10.5	5.0
Female	13 367 (7524-19 209)	7.3	1.8	4.0
Race or ethnicity				
White (non-Hispanic)	25 492 (15 049-35 934)	10.4	4.1	2.5
Black	53 445 (32 390-74 500)	96.0	17.7	5.4
Hispanic	24 218 (14 297-34 139)	47.3	16.4‡	2.9

*Data exclude BB and pellet gun injuries. CI indicates confidence interval.
 †Data derived from US National Center for Health Statistics vital statistics.
 ‡The average annual number of deaths from 1990 through 1991.



Nonfatal powder and nonpowder (BB or pellet) firearm-related gunshot wounds among male subjects.

self-inflicted or inflicted by a relative or friend. The place where the injury occurred was unknown in 47% of the cases (49% of the powder firearm cases, 45% of the nonpowder firearm cases). Of cases for which the location of injury was known, it was most often the home (31%, n=76549) or the street (12%, n=28542). School accounted for an estimated 1% (n=2479) of firearm-related injuries among those in this group, most of whom were of school age.

The primary body part affected by a gunshot wound with a powder firearm was the leg or foot (37%, n=42619), upper trunk (17%, n=19339), arm or hand (16%, n=18082), head or neck (15%, n=17381), or lower trunk (14%, n=15890). The most common anatomical sites of injury with nonpowder firearms were the head or neck (33%, n=34596), arm or hand (30%, n=31202), and leg or foot (23%, n=23698). Nonpowder firearms were associated with more wounds to the head or neck and arm or hand than were powder firearms (χ^2 test, $P < .01$ for each). An estimated 48% of children and adolescents with powder firearm-related gunshot wounds were admitted to the hospital; 4% with injuries related to nonpowder firearms were

admitted to the hospital. Between 1993 and 1997, the 5 years of the study period, the annual estimated number of nonfatal firearm-related injuries among children and adolescents aged 0 to 19 years declined from 57047 (95% confidence interval, 34573-79521) in 1993 to 38386 (95% confidence interval, 22662-54110) in 1997.

COMMENT

These data indicate that from 1993-1997 an estimated 800 children younger than 10 years old were shot with a powder firearm each year, and an additional 5400 had some other firearm-related injury or were shot with a nonpowder firearm (BB or pellet gun). Among those 10- to 14-years-old, an estimated 2900 had gunshot wounds, and an estimated 11 600 were shot with a nonpowder firearm or had some other powder firearm-related injury. Most of the injuries were unintentional, and they occurred in the home disproportionately on the weekend. Treating physicians did not consider the injuries trivial: almost half of those with powder firearm-related injuries were admitted to the hospital.

Prior national estimates of the number of nonfatal firearm-related injuries among children are limited. Estimates from the first year of the Firearm Injury Surveillance Study, 1993-1997, were published in 1995. In that analysis, the 2 age groupings that included children and adolescents were 0- to 14- and 15- to 24-year-olds. There were an estimated 3768 gunshot wounds among those younger than 15 years.⁵

An analysis of firearm-related injuries in 3 American cities, Memphis, Tenn; Seattle, Wash; and Galveston, Tex, from 1992 through 1994, showed rates (per 100 000) for children 0 to 14 years old of 6.7 (white males), 16.4 (Hispanic males), 62.0 (black males), 4.7 (white females), 16.8 (Hispanic females), and 27.5 (black females).³ As observed in the 3 cities, the national estimates suggest nonfatal firearm-related injuries disproportionately affect minority youth. It is not surprising the national estimates of nonfatal firearm-related injuries are

Table 3. Circumstances and Who Inflicted the Firearm-Related Injury, by Age, United States, 1993-1997*

Variable	Age, y			
	0-4	5-9	10-14	15-19
Circumstances				
Unintentional	3931 (66)	16 213 (64)	44 889 (62)	39 528 (28)
Assault	1225 (20)	3051 (12)	12 565 (17)	78 968 (56)
Suicide	0	0	737 (1)	2813 (2)
Law enforcement	0	43	51	844 (1)
Unknown	850 (14)	5987 (24)	14 569 (20)	18 558 (13)
Who caused the injury				
Self	1481 (25)	6288 (25)	25 250 (35)	29 131 (21)
Relative	1618 (27)	4249 (17)	6757 (9)	3580 (2)
Friend	668 (11)	4127 (16)	12 470 (17)	12 639 (9)
Stranger	575 (10)	645 (3)	3314 (5)	16 998 (12)
Unknown	1664 (28)	9985 (39)	25 020 (34)	78 363 (56)

*Data are given as the number (percentage) of firearm-related injuries.

lower: firearm fatalities have been observed to be higher in cities than in nonmetropolitan areas.¹² Both local and national data about nonfatal firearm-related injuries are needed. Local data aid in the evaluation of area-specific programs, while national data allow us to recognize national trends and discuss national priorities.

These data suggest that as gunshot wounds related to BB or pellet guns among young teens declined, rates of gunshot wounds related to powder firearms increased. This trend was observed among males in all race and ethnicity groups. Others have reported injury rates related to nonpowder firearms to be highest among 5- to 14-year-old males.¹³ Injuries related to nonpowder firearms infrequently resulted in hospital admission. Case series suggest that BB or pellet gun injuries can be serious.¹⁴⁻¹⁶

Because of several recent shootings in schools, public attention has been focused on firearm violence there.¹⁷⁻¹⁹ These national data indicate that a small proportion of firearm injuries occur at school. Although the actual estimates of the numbers of nonfatal firearm injuries at school must be interpreted with caution because such low estimates are unstable, it is clear that most firearm-related injuries among school-aged children occur at home. While making schools safe havens from firearm violence is essential, allocation of resources to prevent firearm-related injuries must acknowledge the preponderance of injuries at home.

The distribution of injuries by anatomical area among those younger than 20 years that we report was similar to that reported for firearm-related gunshot wounds among all ages.⁵ Nonpowder firearms were associated with more head or neck and upper extremity injuries.

An estimated 40% of injuries among both children younger than 15 years and those 15 to 19 years old occurred on the weekend. This implies that firearms, or time to use firearms, are more available to children and adolescents during the weekend.

The NEISS has been observed to have several limitations for capturing information on nonfatal firearm-related injuries. The estimates are imprecise, as indicated by the wide confidence intervals. This also limits analysis of groups stratified by race or sex. However, we

What This Study Adds

Information about the rates of nonfatal firearm-related injury among children and adolescents is limited. National data suggest the ratio of nonfatal to fatal firearm-related injuries is 2.6:1. This review of NEISS data (1993-1997) suggests the rates (per 100 000) of nonfatal gunshot wound injuries ranged from 2.0 (children 0-4 years old) to 106.5 (adolescents 15-19 years old). The age group-specific ratios of nonfatal to fatal firearm-related injuries were between 4.0 and 5.0. Nonfatal injuries related to firearms are an important cause of injuries among youth; ongoing surveillance of nonfatal firearm-related injuries is needed.

observed that the average annual incidence of firearm injury among children 0 to 14 years old, 3719, calculated using data from 5 years (1993-1997), was similar to the estimate reported for June 1992 through May 1993 (3768), implying year-to-year stability of the estimates.⁵

Much of the imprecision results from variation in the number of gunshot wound cases treated at NEISS sample hospitals, which is affected by the level of care provided in the ED, the location of the hospital, and the patient population that is served. Not all firearm-related injuries are brought to medical attention and treated in the ED. While this would not affect the validity of the estimates we present for children treated in the ED, it would result in an underestimate of injuries.

Information about the circumstances of the injury incident was incomplete, as some medical records were missing firearm type, location of the injury, and the victim-shooter relationship. Therefore, we do not report the specific type of powder firearm (handgun or long gun). We report location of injury based on the available data. Despite incomplete data, it is useful to review the available information about injury circumstances, as any detail about the circumstances of injury among children is important for a better understanding of these injuries.

There are many social and cultural barriers to protecting children from firearms. It is clear that many chil-

dren and young adolescents have ready access to both powder and nonpowder firearms. Most injuries are unintentional, and few are inflicted by strangers. It is essential that the burden of firearm-related injury among youth be recognized and efforts made to decrease guns from the environments of children and adolescents.

Accepted for publication August 13, 2001.

Corresponding author and reprints: Elizabeth C. Powell, MD, MPH, Division of Pediatric Emergency Medicine, Box 62, Children's Memorial Hospital, 2300 Children's Plaza, Chicago, IL 60614 (e-mail: epowell@northwestern.edu).

REFERENCES

- Centers for Disease Control and Prevention. Rates of homicide, suicide, and firearm-related deaths among children—26 industrialized countries. *MMWR Morb Mortal Wkly Rep.* 1997;46:101-105.
- Dowd MD, Knapp JF, Fitzmaurice LS. Pediatric firearm injuries, Kansas City, 1992: a population-based study. *Pediatrics.* 1994;94:867-873.
- Kellermann AL, Rivara FP, Lee RK, et al. Injuries due to firearms in three cities. *N Engl J Med.* 1996;335:1438-1444.
- Powell EC, Tanz RR. Child and adolescent injury and death from urban firearm assaults: association with age, race, and poverty. *Inj Prev.* 1999;5:41-47.
- Annest JL, Mercy JA, Gibson DR, Ryan GW. National estimates of nonfatal firearm-related injuries: beyond the tip of the iceberg. *JAMA.* 1995;273:1749-1754.
- Cherry D, Annest JL, Mercy JA, Kresnow M, Pollock DA. Trends in nonfatal and fatal firearm-related injury rates in the United States, 1985-1995. *Ann Emerg Med.* 1998;32:51-59.
- Gotsch KE, Annest JL, Mercy JA, Ryan GW. Surveillance for fatal and nonfatal firearm-related injuries—United States, 1993-1998. *Mor Mortal Wkly Rep CDC Surveill Summ.* 2001;50(SS-2):1-32.
- Firearm Injury Surveillance Study, 1993-1997: United States. Available at: <http://www.icpsr.umich.edu>. Accessed November 1, 2000.
- US Consumer Product Safety Commission. *National Electronic Injury Surveillance System (NEISS) Coding Manual.* Washington, DC: US Consumer Product Safety Commission; 1994.
- Centers For Disease Control and Prevention. Available at: <http://wonder.cdc.gov>. Accessed December 1, 2000.
- US Bureau of the Census. Available at: <http://www.census.gov>. Accessed January 1, 2001.
- Fingerhut LA, Ingram DD, Feldman JJ. Homicide rates among US teenagers and young adults, differences by mechanism, level of urbanization, race, and sex, 1987 through 1995. *JAMA.* 1998;280:423-427.
- Christoffel KK, Tanz RR, Sagerman S, Hahn Y. Childhood injuries caused by non-powder firearms. *AJDC.* 1984;138:557-561.
- Harris W, Luteran A, Curreri PW. BB and pellet guns—toys or deadly weapons? *J Trauma.* 1983;23:566-569.
- Blocker S, Colin D, Chang JH. Serious air rifle injuries in children. *Pediatrics.* 1982;69:751-754.
- Ford EG, Senac MO Jr, McGrath N. It may be more significant than you think: BB air rifle injury to a child's head. *Pediatr Emerg Care.* 1990;6:278-279.
- Brooke J. Terror in Littleton. *New York Times.* April 21, 1999.
- Sack K. Guns and schools. *New York Times.* May 21, 1999.
- Firestone D. After shootings, nation's schools add to security. *New York Times.* August 13, 1999.

Books Received for Review

Primary Pediatric Pulmonology, edited by Allen J. Dozor, MD, Armonk, NY, Futura Publishing Co Inc, 2000.

Etiology and Morphogenesis of Congenital Heart Disease: Twenty Years of Progress in Genetics and Developmental Biology, edited by Edward B. Clark, MD, Makoto Nakazawa, MD, and Atsuyoshi Takao, MD, Armonk, NY, Futura Publishing Co Inc, 2000.

Russ and the Almost Perfect Day, by Janet Elizabeth Rickert, photographs by Pete McGahan, Bethesda, Md, Woodbine House, 2001.

Neurological Development from Birth to Six Years. Guide for Examination and Evaluation, by Claudine Amiel-Tison, MD, and Julie Gosselin, PhD, OT, translated by Carolyn Bastable, Baltimore, Md, The Johns Hopkins University Press, 2001.

Rediscovering Birth, by Sheila Kitzinger, New York, NY, Pocket Books, 2001.

Pride & Joy: African-American Baby Celebrations, by Janice Robinson, New York, NY, Pocket Books, 2001.

Travel & Routine Immunizations: A Practical Guide for the Medical Office, by Richard F. Thompson, MD, Milwaukee, Wis, Shoreland Inc, 2001.