



Firearm injuries in the United States



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ABSTRACT

Objective. This paper examines the epidemiology of fatal and nonfatal firearm violence in the United States. Trends over two decades in homicide, assault, self-directed and unintentional firearm injuries are described along with current demographic characteristics of victimization and health impact.

Method. Fatal firearm injury data were obtained from the National Vital Statistics System (NVSS). Nonfatal firearm injury data were obtained from the National Electronic Injury Surveillance System (NEISS). Trends were tested using Joinpoint regression analyses. CDC Cost of Injury modules were used to estimate costs associated with firearm deaths and injuries.

Results. More than 32,000 persons die and over 67,000 persons are injured by firearms each year. Case fatality rates are highest for self-harm related firearm injuries, followed by assault-related injuries. Males, racial/ethnic minority populations, and young Americans (with the exception of firearm suicide) are disproportionately affected. The severity of such injuries is distributed relatively evenly across outcomes from outpatient treatment to hospitalization to death. Firearm injuries result in over \$48 billion in medical and work loss costs annually, particularly fatal firearm injuries. From 1993 to 1999, rates of firearm violence declined significantly. Declines were seen in both fatal and nonfatal firearm violence and across all types of intent. While unintentional firearm deaths continued to decline from 2000 to 2012, firearm suicides increased and nonfatal firearm assaults increased to their highest level since 1995.

Conclusion. Firearm injuries are an important public health problem in the United States, contributing substantially each year to premature death, illness, and disability. Understanding the nature and impact of the problem is only a first step toward preventing firearm violence. A science-driven approach to understand risk and protective factors and identify effective solutions is key to achieving measurable reductions in firearm violence.

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Introduction

The tragedy in Newtown, Connecticut on December 14, 2012 cast a spotlight on firearm violence in the United States. Twenty-seven people, mostly schoolchildren and their teachers, lost their lives that day. It was the deadliest school shooting in an elementary or high-school in U.S. history. In an average week, 645 people lose their lives to firearm violence and 1565 more are treated in an emergency department for a firearm-related injury (Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, 2005). Most of these events do not make headlines, yet reflect part of the human toll of firearm violence in the United States.

The nature and frequency of firearm violence, combined with its substantial impact on the health and safety of Americans, make it an important public health problem. Many Americans are non-fatally

injured or die in acts involving a firearm each year in the United States. These include acts of interpersonal violence, self-directed violence, legal intervention (i.e., injuries inflicted by law enforcement during the course of duty), unintentional injuries involving a firearm, and acts where the intent cannot be determined. Firearm-related injuries are highly lethal and account for 7.1% of premature death or years of potential life lost before the age of 65 (Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, 2005). Firearm homicide is the second leading cause of injury death among youth 10–24 years of age. Firearm suicide, on the other hand, is the third leading cause of injury death for persons aged 35 years and older, after drug overdoses and motor vehicle crashes. Overall, firearm injuries are among the 5 leading causes of death for people ages 1–64 in the United States.

Firearm violence is preventable. The first step in preventing it is to understand the nature and extent of the problem—what it is, whom it affects, where it occurs, how patterns have changed over time and the factors contributing to these changes. An examination of the factors contributing to firearm violence and changes over time is covered

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elsewhere in this special issue. Here we provide an overview of fatal and nonfatal firearm violence in the United States—examining patterns of interpersonal, self-directed and unintentional firearm injuries and deaths, including the demographic characteristics of victimization, trends over time, and health impact.

Methods

A firearm-related injury is defined as a gunshot wound or penetrating injury from a weapon that uses a powder charge to fire a projectile. This definition includes gunshot injuries sustained from handguns, rifles, and shotguns but excludes gunshot wounds from air-powered, gas-powered, BB and pellet guns, as well as non-penetrating injuries associated with firearms (e.g., “pistol whipping”).

Fatal firearm injuries were derived from death certificate data from the National Vital Statistics System (NVSS), operated by CDC’s National Center for Health Statistics, and were obtained via CDC’s Web-based Injury Statistics Query and Reporting System (WISQARS) (Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, 2005). Firearm deaths were examined by known intent¹ (homicide, suicide, unintentional), age, race/ethnicity, and geographic region.

Data on nonfatal firearm injuries from 1993 through 2012 were from the National Electronic Injury Surveillance System (NEISS), which is operated by the U.S. Consumer Product Safety Commission (CPSC) (U.S. Consumer Products Safety Commission, 2014). Data were obtained through an interagency agreement between CDC and CPSC for an ongoing special study called the NEISS Nonfatal Firearm Injury Surveillance Study. NEISS is a stratified probability sample of 99 U.S. hospitals that have an emergency department (ED) and a minimum of 6 beds. Nonfatal injury estimates have been adjusted to account for hospital nonresponse and changes in the number of US hospital EDs over time. NEISS classifies injury intent using standard definitions for the following categories: assault, self-harm, unintentional, and legal intervention. Information on nonfatal injury by racial/ethnic group is not presented here due to large amounts of missing race/ethnicity data.² Status when released from the ED (disposition) is described in three categories: treated/released, transferred/hospitalized, and observed/left against medical advice (AMA)/unknown. NEISS data are based on a national probability sample and sample weights are summed to provide national estimates; valid regional and state-level estimates cannot be obtained from these data.

Age-adjusted and crude rates per 100,000 were calculated using U.S. Census bridged-race population estimates. To derive average annual estimates of nonfatal firearm-related injuries, weighted data³ for each year during 2010–2012 were summed and divided by 3. To calculate annualized rates, the estimates were summed for the 3 years, then divided by the sum of the population estimates for the same period and multiplied by 100,000. Similar calculations were made to derive average annual number of deaths using unweighted data and annualized mortality rates. Case fatality rates were calculated by summing fatal and nonfatal cases within intent (e.g., homicide and assault; suicide and self-harm) and dividing the fatal cases in each intent category by the sum to determine the proportion of firearm injury cases within the given intent resulting in death. SAS and Joinpoint regression analyses⁴ were used to test the significance of trends across the 20-year period from 1993 to 2012. Annual Percent Change (APC) estimates that were statistically significant at $p < 0.05$ are presented to indicate the magnitude and direction of significant

trends in age-adjusted firearm injury rates for each segment or period as determined by SAS and Joinpoint regressions.

Cost estimation methods for CDC’s WISQARS Cost of Injury module are described in detail elsewhere (Lawrence and Miller, 2014). Lifetime medical cost estimates include the cost of initial ED visits and hospitalizations for firearm injuries, and attributable lifetime medical costs (e.g., follow-up ED visits and hospitalizations, ambulance transportation, ambulatory care, prescription drugs, home health care), and nursing home and insurance claims administration costs. Loss of work estimates include lost expected employment earnings, lost fringe benefits, and lost value of household work. Medical costs were estimated from 2010 U.S. dollars (USD) data and inflated to 2012 USD using the U.S. Bureau of Economic Analysis Price Indexes for Personal Consumption Expenditures by Function. Work loss estimates for productivity loss are based on the U.S. Bureau of Labor Statistics’ Employment Cost Index, Total Compensation and are reported in 2012 USD (Lawrence and Miller, 2014).

Data were analyzed using SAS, version 9.3 (SAS Institute, Inc.) and Joinpoint, version 4.1.0 (Statistical Methodology and Applications Branch, Surveillance Research Program, National Cancer Institute), software.

Results

The extent of firearm injuries and deaths in the U.S.

On average, from 2010 to 2012, more than 32,000 people ($n = 32,529$) died each year in the U.S. from a firearm-related injury, for an annual age-adjusted rate of 10.2 per 100,000 (Table 1). Sixty-two percent of these were suicides ($n = 20,012$), 35% were homicides ($n = 11,256$), and 2% were unintentional firearm deaths ($n = 582$). The annual rate of firearm suicide was about twice as high as the annual rate of firearm homicide (7.2 vs 3.7) and about 38 times the annual rate of unintentional deaths from firearms (0.19).

During the same period of time, 67,197 people each year received medical treatment in an emergency department for a firearm-related injury from an assault, act of self-harm, or unintentionally, for an average annual age-adjusted rate of 21.6 per 100,000 people (Table 2). More than half of these cases resulted in hospitalization ($n = 36,224$ or 53.9%) and about 43% were treated and released ($n = 28,925$). The remaining cases were observed in the ED or left against medical advice ($n = 2,049$; 3%).

Unlike most causes of injury where deaths comprise a fraction of the total burden of injury, the average annual distribution of firearm-related deaths (33% of the total) to hospitalizations (37%) to emergency department visits (32%) is similar, forming more of an injury tower than a pyramid (Fig. 1). This, in part, reflects the seriousness and lethality of firearm injuries. Firearm injuries are among the most lethal of health events. The case fatality rate (i.e., the proportion of cases resulting in death), however, varies by intent. Firearm-related self-harm has the highest case fatality rate. From 2010 to 2012, the average annual case fatality rate was 85% for firearm-related self-harm, 19% for firearm-related assaults, and 5% for unintentional firearm injuries.

Who is at risk for a firearm-related injury?

Rates of fatal and nonfatal firearm injuries are not distributed equally in the population. Age, gender, and race/ethnicity are among some of the factors that distinguish population groups most at risk of a firearm injury.

Fatal firearm injuries

Males disproportionately bear the burden of firearm mortality, accounting for 86% of all victims of firearm death. The annual rate of firearm death for males from 2010 to 2012 was 6.5 times higher than the annual rate for females (18.1 versus 2.8 per 100,000) (see Table 1). During this period, the annual rate ratio of the male firearm suicide rate to the female firearm suicide rate was 7:1, while the ratio of the male to female firearm homicide rate was about 5:1. As with firearm-related homicides and suicides, the large majority of victims

¹ Firearm deaths were defined as all deaths of residents of the United States with one of following underlying cause of death codes from the *International Classification of Diseases, 10th Revision*: W32–W43 (unintentional firearm deaths), X72–X74 (firearm suicides), X93–X95 (firearm homicides), Y22–Y24 and U01.4 (firearm deaths of undetermined intent), and Y35.0 (legal intervention deaths by firearm). From 1993 to 1998, the corresponding ICD-9 codes were used to classify firearm deaths: unintentional firearm deaths (E922.0–E922.9), suicide or self-inflicted firearm injury deaths (E955.0–E955.4), assault-related firearm injury (E965.0–E965.4), legal intervention injuries by firearm (E970), firearm injuries of undetermined intent (E985.0–E985.4).

² Unintentional firearm injury data for NEISS included $n = 13,561$ missing race/ethnicity observations, approximately 20% of the total N.

³ NEISS data are weighted by size of hospital for all participating hospitals.

⁴ Joinpoint regression analysis is a statistical method that examines successive segments of time, and the amount of increase or decrease within each segment to describe changing trends. A series of joined straight lines are fitted to the age-adjusted rates and the best-fitting point or points (joinpoints) are chosen, where the rate of increase or decrease is statistically significant.

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