Handbook of
Injury and Violence Prevention

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Foreword

We live in challenging times and our attention becomes focused on the public health threats that lead daily news reports. Yet, there is one health threat that the public has accepted as *fait accompli*—injuries. Injuries kill more Americans in their first three decades of life than any other cause of death. In fact, injuries—both unintentional and those caused by acts of violence—are among the top 10 killers for Americans of all ages. However, injuries do not have to be an accepted risk of living. Lives can be saved and disabilities prevented. That is why I am pleased to present the *Handbook of Injury and Violence Prevention.* This comprehensive manual details injury and violence interventions that have proven to work effectively with vulnerable populations across all stages of life. It will benefit practitioners who manage, implement, or evaluate injury or violence prevention programs; policymakers who influence injury or violence prevention through legislation and other policies; university faculty who teach course work in injury and violence prevention; and graduate students preparing to work in or with injury or violence prevention programs.

Much effort has gone into making this manual a useful reference tool. In addition to providing information on a wide range of health threats and prevention strategies, the manual summarizes trends, controversies, future research, and training issues for injury and violence prevention. The appendices also contain a wealth of valuable resources.

The *Handbook of Injury and Violence Prevention* is a "must read" for all who strive to make our world safer and healthier.

Julie Louise Gerberding, MD, MPH Director,
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Acknowledgments

We thank the many authors who contributed to this book for sharing their research and expertise in injury and violence prevention and control to make this handbook possible. They are among a small but growing number of researchers and practitioners devoted to uncovering "what works" in injury and violence prevention. Their commitment, enthusiasm, and persistence in documenting the impact of their own work and the work of others will surely benefit the growing support for injury prevention as an integral part of public health.

Lynda Doll expresses her gratitude to the CDC Injury Center for providing time and resources in preparing this book and, in particular, her coeditors, Sandra Bonzo, James Mercy, and David Sleet, who have worked diligently to bring together what we hope is a useful resource for our colleagues in injury and violence research and practice. To Elizabeth Haas, our managing editor, whose commitment, careful attention to editorial detail, and management of the many logistics associated with manuscript development and review were absolutely essential to the success of this project. To her colleagues, Sue Binder and Ileana Arias, who provided excellent counsel throughout this project. To her family, Ted and Jennifer Doll and Abigail Devine, who have been so wonderfully supportive and patient throughout her career and to her granddaughters, Ansley and Halle, for whose future we write this book.

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Introduction

Chapter 1

The Epidemiology and Costs of Unintentional and Violent Injuries

Richard W. Sattin and Phaedra S. Corso

1.1. INTRODUCTION

Injuries are the number one killer of children and young adults in the United States (Centers for Disease Control and Prevention [CDC], 2005). More than 28 million injuries serious enough to require emergency medical care occur annually (CDC, 2005). The lives of millions of others have been dramatically affected by injuries to themselves or someone they love. Injury leads to pathological conditions and impaired physiological functioning that can affect any part, organ, or system of an individual and can have both short-term and long-term effects (Sattin, 1992). Due to the potential extensive nature of injuries, outcomes depend on a broad continuum of multidisciplinary care.

Injury has been described, until recently, as the "neglected disease" because it occurs in such great numbers but has been tacitly accepted as a normal occurrence of living in a modern society (Committee on Trauma, and Committee on Shock, Division of Medical Sciences, National Academy of Sciences/National Research Council [Committee on Trauma], 1966). However, the 1985 report *Injury in America* noted that a public health approach similar to that used for other diseases could lead to significant reduction in injuries (Committee on Trauma Research, Commission on Life Sciences, National Research Council and the Institute of Medicine [Committee on Trauma Research], 1985).

Injuries can be viewed as a problem in medical ecology—that is, as a relationship between a person (the host), an agent, and the environment (Haddon, 1970; Haddon & Baker, 1981; Sattin, 1992). The underlying agent of injury is not a microbe or carcinogen but energy, most often in the form of mechanical force (Haddon, 1970). The dose of energy received; the dose's distribution, duration, and rapidity; and the individual's response to the transfer of the energy can deter-

mine if a physical injury occurs or is prevented (Committee on Trauma Research, 1985). For example, a large mechanical energy load quickly transmitted to a hip during a fall involving an older person may lead to a fracture. If that same energy load could be dissipated through use of energy-absorbing flooring or mats or through hip pads or other new technologies, the fracture that occurred during the fall could have been prevented. Likewise, exercises leading to strengthening of the lower extremities or to improving gait and balance among older persons could lead to preventing the fall itself (AGS Panel on Falls Prevention [AGS], 2001) or to improving reflexes that would lead to dissipating the energy or changing the location of that energy to a more forgiving body area.

The basic injury paradigm of host, agent, and environment mentioned above needs to include energy tranference by perpetrators, the threat of energy transference by potential perpetrators of violence, and the effect of the social as well as physical environment. Victims of violence can experience physical injury; adverse mental health consequences such as depression, anxiety, and low self-esteem; and harmful physical health consequences such as suicide attempts, cardiovascular disease, and substance abuse (National Center for Injury Prevention and Control [NCIPC], 2002). Any of these consequences can lead to hospitalization, disability, or death. Programs and policies that provide counseling for batterers, improve parenting skills, or prevent dating violence, intervene with perpetrators and potential perpetrators before the violence occurs or recurs can prevent energy or threat of energy transference. In some social contexts, intimate partner violence, sexual violence, and child maltreatment are considered normative behavior (NCIPC, 2002). To design effective interventions, researchers must first identify the particular social norms and beliefs that support these types of violence and then find ways to alter or replace them with ones that prevent violence. Even when such violent behaviors are not considered "acceptable," cultural attitudes and beliefs may exacerbate these problems by blaming victims or by supporting attitudes and behaviors that create social atmospheres conducive to, or tolerant of, such violence (NCIPC, 2002).

The classification of injury poses a number of epidemiological issues. One can classify injuries by the actual nature of the injury (e.g., fracture of the hip, traumatic brain injury, splenic rupture), by the mechanism of the injury (e.g., fall, motor vehicle, poisoning), and by the intent (e.g., unintentional, intentional, undetermined). If one classifies by the nature of the injury, then one needs to decide to analyze by the number of injuries or the number of injurious episodes or both, and the choice of the denominator is critical. The mechanism and intent of the injury is useful in quantifying the problem of falls, motor-vehicle crashes, suicide, domestic violence, and so forth in the community, and that information can be used to implement effective intervention strategies. However, sometimes a fall, motor-vehicle incident, or suicide attempt, occurs that does not lead to physical injury. These incidents are important, though, because opportunities for preventing future injuries may be lost. For example, a person involved in an alcohol-related motor-vehicle crash who is brought to an emergency department but who has sustained no physical injury might benefit from counseling on alcohol use before being discharged from the emergency department (Hungerford & Pollock, 2002). Finally, definitions of some mechanisms of injury can vary significantly. For example, most definitions of a fall are clinically or research oriented, are subjective, and are likely to miss a substantial number of falls (Sattin, 1992). Even though the number of falls can be ascertained from medical records and by using the *International Classification of*

Diseases's external causes of injuries (E-codes), falls have been shown to be significantly underreported using such data sources (Fife, 1987).

Despite these issues, injury epidemiology has shown significant progress over the last several decades and has led to a better understanding of mechanisms, behavior, and prevention strategies. Motor vehicle safety has improved through the development and use of safety equipment, the enactment and enforcement of traffic safety laws, and the changes in driver behavior (CDC, 1999). Although the design of safety equipment in motor vehicles was based primarily on biomechanical data, epidemiological analysis of crash data was critical in defining the problems, determining high-risk populations, and identifying solutions to improve safety behavior. The benefits of using bicycle helmets to prevent death and disability among youth was demonstrated through epidemiological analysis (Thompson, Rivara, & Thompson, 1989). The idea that violence is a public health issue is now largely accepted based on epidemiological analyses begun in the 1980s (Mercy & O'Carroll, 1988). As the field of injury continues to grow; and as new events unfold, new aspects of injury present challenges that can be addressed through epidemiological analyses. For example, the events of September 11, 2001, showed that the care of the acutely injured during a terrorist event is a critical role for public health and that better, compatible data systems are needed to evaluate and improve the effectiveness of trauma care (CDC, 2002a, 2002b; NCIPC, 2005).

1.2. METHODS

In this chapter, we report the incidence and costs of injuries stratified by age group, sex, mechanism (e.g., falls, motor vehicle), and intent (e.g., intentional or unintentional). Throughout, we include unique injury episodes occurring in 2000 (the most current year for which data are available), meaning that if someone suffered multiple injuries (e.g., a hip fracture and a wrist fracture) in one event (e.g., a fall), the episode would be counted only once. For readability, we use the terms *persons injured* and *number of injuries* synonymously to refer to injury episodes.

Given space limitations, we have chosen not to include, beyond basic mechanisms, the epidemiology of specific injury problems, such as drowning, fires, motor vehicles, sports injuries, falls, child maltreatment, youth violence, intimate partner violence, elder abuse, suicide, sexual violence, and firearms. We do provide references to these topics for the interested reader (Table 1.1).

The incidence and cost estimates presented in this chapter are divided into two mutually exclusive categories that reflect the highest level of treatment for an injury, as a proxy for severity: (1) injury resulting in death, including deaths occurring within and outside a health care setting, and (2) nonfatal injuries, including injuries resulting in hospitalization with survival to discharge and injuries requiring medical attention without hospitalization (e.g., injuries requiring an emergency department visit, an office visit, or a hospital outpatient visit). Injuries that were not severe enough to result in medical attention are not included in our calculations. We sum the incidence and costs of fatal and nonfatal injuries to quantify total lifetime medical costs.

Incidence data used to develop these estimates were taken from a variety of sources. Fatal injury counts were taken from the 2000 National Vital Statistics System (NVSS) data. We used the 2000 Healthcare Cost and Utilization Project—Nationwide Inpatient Sample (HCUP-NIS) to estimate the incidence of nonfatal

Table 1.1. References to Detailed Epidemiologic Descriptions of Specific Injury Problems

Specific Injury Problems	Reference(s)
Drowning	Quan, L., & Cummings, P. (2003). Characteristics of drowning by different age groups. *Injury Prevention, 9* (2), 163–168.
	Centers for Disease Control and Prevention. (2004). Nonfatal and fatal drownings in recreational water settings—United States, 2001–2002. *Morbidity and Mortality Weekly Report, 53,* 447–452.
Falls	Tideiksaar, R. (2002). *Falls in Older People: Prevention & Management.* Baltimore, Health Professionals Press.
	Rubenstein, L. Z., & Josephson, K. R. (2002). The epidemiology of falls and syncope. *Clinics in Geriatric Medicine, 18* (2), 141–158.
Fires	Warda, L., Tenenbein, M., & Moffatt, M. E. K. (1999). House fire injury prevention update. Part 1. A review of risk factors for fatal and non-fatal house fire injury. *Injury Prevention, 5,* 145–150.
Motor vehicles	National Highway Traffic Safety Administration. (2005). *Traffic safety facts 2003:* A *compilation of motor vehicle crash data from the Fatality Analysis Reporting System and the General Estimates System.* (Report No. DOT HS 809-775). Washington, DC: U.S. Department of Transportation.
Sports injuries	Caine, D. J., & Maffulli, N. (Eds.). (2005). *Epidemiology of pediatric sports injuries: Vol. 48. Individual sports.* Farmington, CT: S. Karger.
	Maffulli, N., & Caine, D. J. (Eds.). (2005). *Epidemiology of pediatric sports injuries: vol. 49. Team sports.* Farmington, CT: S. Karger.
Interpersonal violence, sexual violence	Tjaden, P., & Thoennes, N. (2000). *Extent, nature, and consequences of intimate partner violence: Findings from the National Violence against Women Survey* (NCJ 181867). Washington, DC: U.S. Department of Justice, Office of Justice Programs, National Institute of Justice.
	Paulozzi, L. J., Saltzman, L. E., Thompson, M. P., Holmgreen, P. (2001). Surveillance for homicide among intimate partners—United States, 1981–1998. (2001).*MMWR Surveillance Summaries, 50,* (no. SS-3), 1–15.
Youth violence	*Youth Violence: A Report of the Surgeon General. Surgeon General's Office, Public Health Service.* (2001). Retrieved July 5, 2005, from www.hhs.gov/surgeongeneral/library/youthviolence.
Suicide	Goldsmith, S. K., Pellmar, T. C., Kleinman, A. M., & Bunney, W. E. (Eds.). Committee on Pathophysiology & Prevention of Adolescent & Adult Suicide, Board on Neuroscience and Behavioral Health (2002). *Reducing suicide: A national imperative.* Washington, DC: National Academy of Sciences.
Child maltreatment	Department of Health and Human Services, Administration on Children, Youth, and Families (2005). *Child maltreatment 2003.* Washington DC: U.S. Government Printing Office. Retrieved April 5, 2005, from www.acf.hhs.gov/programs/cb/publications/cm03.pdf.

injuries resulting in hospitalization. We estimated the incidence of nonfatal, non-admitted medically treated injuries using the 1999 Medical Expenditure Panel Survey (MEPS), the 2001 National Electronic Injury Surveillance System—All Injury Program (NEISS-AIP), the 1999 and 2000 National Hospital and Ambulatory Medical Care Survey (NHAMCS), and the 1999 and 2000 National Ambulatory Medical Care Survey (NAMCS).

Incidence of injury episodes and corresponding rates apply to the civilian, noninstitutionalized U.S. population (n = 276,410,000). *Incidence,* as defined in this analysis, addresses injury resulting in the use of medical care as the primary outcome only and does not necessarily reflect the many other adverse sequelae and other long-term health consequences that can and do result from physical injury

to society, families, and communities. For example, incidence data that are missing include use of mental-health services that were not identified as injury related but were needed due to the psychological trauma of injury. Based on a survey of mental health providers, Cohen and Miller (1998) estimated that 3.4 million physical and sexual assaults resulted in mental health treatment, often without treatment in other medical settings. These treatment episodes are unlikely to be coded as injury related. Likewise, injuries resulting in the use of nontraditional health care services (e.g., chiropractors, acupuncturists, and alternative medicine providers) are not included in this analysis.

We computed unit costs for injuries by the same strata identified for incidence, separately for fatal and nonfatal injuries. Costs, presented in 2000 U.S. dollars, include all those direct medical expenditures required in the use of health care services and losses in productivity. Medical expenditures include costs associated with inpatient admissions, emergency department (ED) care, outpatient services, rehabilitation costs, transport, coroner/medical examiner, long-term care for permanent disability, and nursing home costs. Productivity losses include short- and long-term losses in wages and household productivity. All future costs were converted to present value using a 3% discount rate.

Productivity losses were also estimated separately for fatal and nonfatal injuries using the same strata identified earlier. For someone of a given sex and age who sustained a fatal injury, we summed the product of the sex-specific probability of surviving to each subsequent year of age and sex-specific expected earnings for someone in that age bracket (using 10-year age brackets) (Haddix, Teutsch, & Corso, 2003). Earnings at future ages, including salary and the value of fringe benefits, were adjusted upward to account for a historical 1% productivity growth rate (Haddix et al., 2003) and then discounted to present value using the 3% discount rate. Parallel calculations valued lost household work, again using unit costs by age group and sex.

For nonfatal injuries, productivity loss equals the sum of the value of wage and household work lost due to short-term disability in the acute recovery phase and, for the subset of injuries that cause lasting impairments that restrict work choices or preclude return to work, the value of wage and household work lost due to permanent or long-term disability. A more complete description of the data and methods used to calculate these estimates will be available soon (Finkelstein, Corso, & Miller, 2006).

We also provide incidence of injury death by race, ethnicity, and sex for injuries overall and by intent for the year 2000, based on a different data source than the stratifications described above—that is, from the Web-Based Injury Statistics Query and Reporting System (WISQARS) (CDC, 2005). Cost-of-injury estimates for race or ethnicity were not calculated for this chapter because of limited information.

1.3. RESULTS

1.3.1. Total Injury Incidence and Cost

In 2000, injuries in the United States resulted in approximately 149,000 fatalities and nearly 50 million nonfatal injuries (Table 1.2). Of the nonfatal injuries, 1.9 million resulted in hospitalization, and 48.1 million resulted in nonhospitalized treatment episodes. This sums to a total of 50.1 million injury episodes in 2000, or

Table 1.2. The Incidence, Rate (per 100,000), and Total Lifetime Costs for Injuries by Age and Sex, 2000

	Incidence						Costs (in Millions)		
	Fatal	Rate*	Nonfatal	Rate*	Total	Rate*	Medical Costs	Productivity Losses	Total
Total	149,075	54	49,978,023	18,081	50,127,098	18,135	$80,248	$326,042	$406,289
0–4	3,532	18	3,423,039	17,385	3,426,571	17,403	3,729	12,264	15,992
5–14	3,741	9	7,942,051	19,239	7,945,792	19,249	8,170	26,400	34,569
15–24	23,698	63	8,794,716	23,540	8,818,414	23,604	12,895	66,940	79,835
25–44	48,487	59	15,504,520	18,759	15,553,007	18,818	22,704	141,188	163,892
45–64	31,935	53	8,782,618	14,696	8,814,553	14,750	14,278	66,311	80,589
65–74	10,595	60	2,368,679	13,428	2,379,274	13,488	5,865	7,541	13,406
75+	27,087	179	3,162,399	20,888	3,189,486	21,067	12,608	5,399	18,007
Male	103,900	77	26,461,330	19,659	26,565,230	19,736	$44,445	$238,688	$283,133
0–4	2,059	20	2,076,975	20,224	2,079,034	20,244	2,438	8,733	11,170
5–14	2,397	11	4,539,032	21,676	4,541,429	21,688	4,973	18,810	23,783
15–24	18,609	98	5,110,966	26,928	5,129,575	27,026	8,346	52,930	61,276
25–44	37,126	92	8,516,730	21,123	8,553,856	21,215	14,033	107,019	121,052
45–64	23,313	81	4,185,422	14,477	4,208,735	14,558	7,999	45,612	53,611
65–74	6,916	87	1,048,797	13,129	1,055,713	13,215	2,704	3,873	6,578
75+	13,480	228	983,409	16,599	996,889	16,827	3,952	1,712	5,663
Female	45,175	32	23,516,693	16,584	23,561,868	16,616	$35,803	$87,353	$123,156
0–4	1,473	16	1,346,065	14,295	1,347,538	14,311	1,291	3,531	4,822
5–14	1,344	7	3,403,019	16,731	3,404,363	16,737	3,197	7,589	10,786
15–24	5,089	28	3,683,750	20,031	3,688,839	20,059	4,549	14,010	18,559
25–44	11,361	27	6,987,790	16,508	6,999,151	16,535	8,671	34,169	42,840
45–64	8,622	28	4,597,196	14,902	4,605,818	14,930	6,279	20,699	26,978
65–74	3,679	38	1,319,882	13,673	1,323,561	13,711	3,160	3,668	6,828
75+	13,607	148	2,178,990	23,636	2,192,597	23,783	8,656	3,687	12,343

*Rate per 100,000 people.

18 injuries requiring medical attention per every 100 civilian, noninstitutionalized U.S. residents. Injuries that occurred in 2000 will cost the U.S. health care system $80.2 billion in medical care costs, with an additional cost of $326 billion in productivity losses.

1.3.2. Overall Age and Sex Patterns

The overall number of injuries among males (26.6 million) was only slightly higher than that among females (23.6 million) (Table 1.2). Taking into account population size, the overall rate of injuries for males was 19,736 per 100,000 people and that for females was 16,616 per 100,000 people. Of the total injuries in 2000, almost one third (15.6 million) occurred among 25- to 44-year-olds, but this age group also represents approximately one third of the U.S. population. In comparison, 15- to 24-year-olds represent only 14% of the U.S. population but accounted for 18% of injuries. Thus those aged 15–24 years, with 8.8 million injuries, had the highest *rate* of injuries, 23,604 per 100,000 persons; the second-highest rate, 21,067 per 100,000 people, occurred among those aged 75 years or older; and the third-highest rate, 19,249 per 100,000 people, occurred among those aged 5–14 years. These high injury rates across different age groups reveal that, unlike chronic conditions (e.g., heart disease, diabetes, and osteoarthritis), which disproportionately affect the elderly, injuries affect both the young and the old alike. Thus it is possible that the economic burden of injuries is much larger than that for many chronic conditions because injuries are more likely to affect people during their peak earning years.

The highest rate of injury fatalities, 179 per 100,000, occurred among people aged 75 years and older (Table 1.2), and was nearly three times greater than the next highest rate, 63 per 100,000, which occurred among those aged 15–24 years. Males in every age group were more likely to sustain a fatal injury than females. The overall rate of injury fatalities among males (77 per 100,000) was more than double that among females (32 per 100,000). Injuries among males accounted for $44.4 billion, or approximately 55% of all medical costs for injuries; injuries among females accounted for $35.8 billion, or approximately 45% of all medical costs for injuries (Table 1.2). This cost distribution is similar to the incidence distribution. When productivity losses are included in lifetime costs, males had more than a twofold increased cost overall than females, $283 billion vs. $123 billion. From ages 0 through 64 years, males had between a twofold and threefold greater lifetime cost than females of similar ages. For ages 65 years and older, females had higher lifetime costs of injury than males. This is due, in part, to the higher rate of nonfatal injuries in females aged 75 years and older (23,636 per 100,000) compared to males of the same age (16,599 per 100,000). Those aged 25–44 years accounted for $22.7 billion, or nearly 30% of injury-attributable medical costs. This age group also represents 30% of the U.S. population and accounted for 30% of all injuries. In contrast, those aged greater than 75 years (representing 5% of the population) accounted for only 6% of all injuries, yet they represent 16% (or $12.6 billion) of the medical costs for injuries. This likely reflects the frail nature of elderly persons and their inability to recover as quickly from an injury compared to their younger counterparts. About 79% of injury-attributable medical costs among people aged 75 years or older resulted from fatal (3%) and hospitalized injuries (76%) (results not shown). In contrast, only 15% of the medical costs for injuries among people aged 5–14 years resulted from fatal (<1%) and hospitalized injuries (14.6%).

Conversely, the percentage of medical costs attributable to nonhospitalized injuries decreased as age increased.

1.3.3. Race and Ethnicity Patterns

For males, African Americans had the highest age-adjusted rate of injury fatality, 107.4 per 100,000 people, followed by American Indian/Alaska Native (AI/AN), 100.55 per 100,000, by Whites, 75.5 per 100,000 and by Asian/Pacific Islanders, 36.8 per 100,000 (data not shown). Non-Hispanic males had a higher age-adjusted rate of injury fatality, 53.3 per 100,000, than Hispanic males, 44.4 per 100,000. Males had consistently higher fatality rates than females regardless of race or ethnicity: 3.5 times higher in African Americans, 2.6 times higher in Whites, 2.4 times higher in AI/AN, 2.0 times higher in Asian/Pacific Islanders, and 3.2 times higher in Hispanics. AI/AN males had the highest age-adjusted rate of unintentional injury fatality, 71.0 per 100,000, followed by African Americans, 58.3 per 100,000, by Whites, 49.2 per 100,000, and by Asian/Pacific Islanders, 23.2 per 100,000. Hispanic males had a lower age-adjusted rate of unintentional injury fatality than non-Hispanic males, 44.6 per 100,000 vs. 49.6 per 100,000. African American males had nearly twice the rate of violence-related fatalities than AI/AN and White males, 46.0 per 100,000 vs. 27.0 per 100,000 and 24.4 per 100,000, respectively, and more than three times the fatality rate than Asian/Pacific Islanders, 13.0 per 100,000 people. Hispanic males had a slightly lower rate of death from violence, 13.5 per 100,000, than non-Hispanic males, 16.7 per 100,000.

1.3.4. Injury Mechanisms

The two leading mechanisms of fatal injuries were motor vehicles and firearms, accounting for 43,802 and 28,722 deaths (16 and 10 per 100,000 people), respectively (Table 1.3). These two mechanisms were responsible for nearly half (49%) of all injury fatalities. In contrast, falls caused both the highest incidence (11.6 million or 23%) and rate (4,180 per 100,000) of nonfatal injuries. Being struck by or against an object (10.7 million) and motor vehicles (5 million) were the next most likely mechanisms for nonfatal injury. Treatment for falls ($26.9 billion) and motor vehicle incidents ($14 billion) represented roughly half of injury-attributable medical costs. Yet, these two mechanisms represented only one third of injury incidence. Thus falls and motor-vehicle incidents represent a disproportionate fraction of medical costs, reflecting the severity of resultant injuries (i.e., injuries caused by these mechanisms are more likely to result in a fatality or hospitalization). In contrast, struck by/against injuries, which accounted for 21% of all injuries in 2000, represented only 14% of medical costs for injuries.

Injuries categorized as “other” resulted from varied mechanisms. For fatal injuries, these mechanisms, representing 20% of fatal injuries, primarily included inhalation/suffocation (8% of all deaths) and unspecified (7% of all deaths) (results not shown). Of the 16.5 million nonfatal other injuries, overexertion accounted for nearly 5.2 million (32%), other specified accounted for 4.3 million (26%), and bites/stings accounted for 3.3 million (20%). Of the other nonfatal injuries resulting in hospitalization (representing 16% of all hospitalized injuries), the mechanisms were largely related to other specified or unspecified mechanisms (50%), overexertion (14%), and other transport (13%).

Table 1.3. Total Lifetime Costs for Injuries, by Mechanism, 2000

	Incidence						Costs (in Millions)		
	Fatal	Rate*	Nonfatal	Rate*	Total	Rate*	Medical Costs	Productivity Losses	Total
Total	149,075	54	49,978,023	18,081	50,127,098	18,135	$80,248	$326,042	$406,289
Motor vehicle/other road user	43,802	16	4,966,637	1,797	5,010,439	1,813	14,026	75,130	89,156
Falls	14,052	5	11,552,690	4,180	11,566,742	4,185	26,892	54,028	80,920
Struck by/against	1,301	0	10,672,879	3,861	10,674,180	3,862	11,028	37,104	48,132
Cut/pierce	2,293	1	4,121,792	1,491	4,124,085	1,492	3,662	12,664	16,326
Fire/burn	3,922	1	770,454	279	774,376	280	1,345	6,202	7,546
Poisoning	20,261	7	1,247,204	451	1,267,465	459	2,236	23,707	25,944
Drowning/submersion	4,168	2	5,915	2	10,083	4	95	5,215	5,310
Firearm/gunshot	28,722	10	102,291	37	131,013	47	1,225	35,226	36,451
Other	30,554	11	16,538,162	5,983	16,568,716	5,994	19,738	76,767	96,505
Male	103,900	77	26,461,332	19,659	26,565,232	19,736	44,445	238,688	283,133
Motor vehicle/other road user	29,686	22	2,521,644	1,873	2,551,330	1,895	8,713	55,214	63,927
Falls	7,647	6	5,194,029	3,859	5,201,676	3,865	11,778	31,824	43,602
Struck by/against	1,109	1	6,659,192	4,947	6,660,301	4,948	7,493	29,123	36,617
Cut/pierce	1,678	1	2,600,406	1,932	2,602,084	1,933	2,442	9,775	12,217
Fire/burn	2,333	2	369,655	275	371,988	276	764	4,078	4,842
Poisoning	13,721	10	575,179	427	588,900	438	1,063	18,319	19,382
Drowning/submersion	3,198	2	3,818	3	7,016	5	61	4,389	4,450
Firearm/gunshot	24,638	18	92,391	69	117,029	87	1,081	31,809	32,890
Other	19,890	15	8,445,018	6,274	8,464,908	6,289	11,050	54,157	65,207
Female	45,175	32	23,516,693	16,584	23,561,868	16,616	35,803	87,353	123,156
Motor vehicle/other road user	14,166	10	2,444,939	1,724	2,459,105	1,734	5,313	19,916	25,229
Falls	6,405	5	6,358,661	4,484	6,365,066	4,489	15,114	22,204	37,318
Struck by/against	192	0	4,013,688	2,831	4,013,880	2,831	3,535	7,981	11,516
Cut/pierce	615	0	1,521,386	1,073	1,522,001	1,073	1,221	2,889	4,109
Fire/burn	1,589	1	400,800	283	402,389	284	581	2,124	2,704
Poisoning	6,540	5	672,025	474	678,565	479	1,173	5,388	6,562
Drowning/submersion	970	1	2,097	1	3,067	2	34	825	859
Firearm/gunshot	4,084	3	9,900	7	13,984	10	144	3,417	3,561
Other	10,664	8	8,093,143	5,707	8,103,807	5,715	8,688	22,610	31,298

*Rate per 100,000 people.

Males had a higher incidence and rate of fatal injuries than females, regardless of mechanism (Table 1.3). This difference was particularly pronounced for motor-vehicle-related and firearm-related fatal injuries. The rate of fatal motor-vehicle-related injuries among males (22 per 100,000 people) was more than double that among females (10 per 100,000); the rate of fatal firearm injuries among males (18 per 100,000) was six times that among females (3 per 100,000).

Males had a higher incidence and rate of nonfatal injuries than females from all mechanisms except falls, fires/burns, and poisoning (Table 1.3). Of all fall-related nonfatal injuries, 55% occurred among females, at a rate of 4,484 per 100,000 females. This rate was 16% higher than the rate of nonfatal fall injuries among males (3,859 per 100,000 males). The rate of nonfatal fires/burns was 3% higher for females compared to males, and the rate of nonfatal poisoning was 11% higher. The largest difference in overall incidence of injuries between males and females by mechanism was for firearm-related injuries, with males suffering 90% of these injuries. The rate of firearm injuries among males, 87 per 100,000 people, was almost nine times more than that for females, 10 per 100,000. With the exception of falls (44%) and poisonings (48%), males accounted for more than half of the medical costs associated with each injury mechanism. The medical costs associated with struck by/against and cut/pierce injuries among males were double those for females; the medical costs associated with firearm injuries among males were more than seven times those for females. These cost disparities, however, were largely driven by a higher incidence of these injuries among males.

1.3.5. Injury-Related Hospitalizations

As a percentage of all injuries, fatal injuries accounted for 0.3% of the total, hospitalized or ED-treated injuries accounted for 59%, and injuries seen in an outpatient setting or during a doctor's visit accounted for the remaining incidences (Table 1.4). Medical costs were greatest for hospitalized ($33.7 billion) and for ED-treated ($31.8 billion) injuries. However, when productivity losses were added to direct medical costs, fatal injuries accounted for the greatest costs ($143 billion), followed by ED-treated injuries ($99 billion). Females accounted for 968,000 (52%) of hospitalizations, but males had higher incidence counts and rates of hospitalization for all mechanisms other than falls and poisonings (data not shown). The rate of fall-related hospitalized injuries among females (386 per 100,000) was 69% higher than that among males (228 per 100,000), and that of poisonings (91 per 100,000) was 36% higher than that among males (67 per 100,000). Males had higher hospitalized injury rates than females for motor vehicles (125 per 100,000 vs. 76 per 100,000), for struck by/against (50 per 100,000 vs. 13 per 100,000), for cut/pierce (37 per 100,000 vs. 15 per 100,000), for fire/burn (11 per 100,000 vs. 7 per 100,000), for drowning/submersion (2 per 100,000 vs. 1 per 100,000), and for firearm/gunshot (20 per 100,000 vs. 2 per 100,000). For females, both the highest number (408,000, or 42%) and the highest rate of injury hospitalizations occurred among those aged 75 years and older. In fact, the rate of injury hospitalizations (4.4 per 100 people) among older females was nearly four times greater than that among any other age group. For males, although the highest number of injury hospitalizations (272,000, or 30%) occurred among those 25–44 years old, the highest *rate* of injury hospitalizations (2.5 per 100 people) occurred among those aged 75 years or older.

Table 1.4. The Incidence, Rate (per 100,000), and Total Lifetime Costs of Injuries by Treatment Location, 2000

	Incidence						Costs (in Millions)		
	Fatal	Rate*	Nonfatal	Rate*	Total	Rate*	Medical Costs	Productivity Losses	Total
	149,075	54	49,978,023	18,081	50,127,098	18,135	$80,248	$326,041	$406,289
Fatal	149,075	54		—	149,129	54	1,113	142,041	143,154
Hospital	—	—	1,869,857	676	1,869,857	676	33,737	58,716	92,453
Emergency department treated	—	—	27,928,975	10,104	27,928,975	10,104	31,804	67,288	99,092
Outpatient	—	—	590,554	214	590,554	214	526	1,553	2,079
Medical dotor visit	—	—	19,588,637	7,087	19,588,637	7,087	13,068	56,443	69,511

*Rate per 100,000 people.

For hospitalized injuries, males accounted for a greater percentage of attributable medical costs than did females for all age groups younger than 65 years (data not shown). Comparing the distribution of injury-attributable medical costs with that of injury incidence, except for males aged 0–4 and 5–14 years, males accounted for a greater percentage of medical costs than similarly aged females for hospitalized injuries than they accounted for the incidence of hospitalized injuries. In particular, males aged 15–24, 25–44, and 45–64 years accounted for 74%, 71%, and 62% of medical costs for hospitalized injuries, but only 65%, 63%, and 54% of hospitalized injuries. This may indicate that hospitalized injuries among males in these age groups are, on average, more severe or more difficult to treat than injuries among same-age females. For nonhospitalized injuries, the medical cost distribution between males and females in all age groups is nearly identical to the corresponding incidence distribution.

The rate of fall-related hospitalized injuries (309 per 100,000 people) was more than three times greater than any other specified mechanism category, followed by motor vehicles (100 per 100,000) and poisonings (79 per 100,000) (data not shown). In contrast to all nonfatal injuries for which people aged 15–24 years had the highest rate, people aged 75 years or older had the highest rate of hospitalized injuries (3,663 per 100,000 people), more than three times that of any other age group (data not shown). People aged 75 years and older accounted for nearly 555,000 injury hospitalizations, or 30% of the total injury hospitalizations. The increased rate of serious injuries (i.e., fatal and hospitalized injuries) among older persons compared to other age groups may be due in part to underlying co-morbid conditions, poorer gait and balance, and loss of elasticity of tissues and organs.

1.3.6. Intentionality

According to the data sources used to develop these estimates, nearly two thirds of all injury fatalities were reported as unintentional, resulting in more than $74 billion in medical costs alone (Table 1.5). Of fatalities owing to intentional causes, 64% were suicides (29,416) and 36% were homicides (16,830). Whereas less than 1% of unintentional injuries were fatal, 9% of self-inflicted injuries were fatal. Males accounted for 80% of self-inflicted injury fatalities, 65% of unintentional injury fatalities, 77% of assault fatalities, and 97% of military/legal fatalities (results not shown). For nonfatal injuries, 95% (or 47.4 million) were due to unintended mechanisms. The rate of unintentional nonfatal injuries for males, 18,635 per 100,000 persons, was 18% greater than that for females, at 15,722 per 100,000 people (results not shown). The rate of assault-related nonfatal injuries among males, 885 per 100,000, was 26% higher than the rate among females, at 703 per 100,000. Females, on the other hand, accounted for 59% of self-inflicted nonfatal injuries, at a rate of 122 per 100,000, which was 36% greater than that for males, at 90 per 100,000.

1.4. CONCLUSION

Injuries represent a substantial burden to society. As we have shown in this chapter, the burden can be considered in several ways: by incidence, defined as total or fatal versus nonfatal; by incidence rates; or by total costs, defined by medical costs

Table 1.5. The Incidence, Rate (per 100,000), and Total Lifetime Costs of Injuries by Intent, 2000

	Incidence						Costs (in Millions)		
	Fatal	Rate*	Nonfatal	Rate*	Total	Rate*	Medical Costs	Productivity Losses	Total
Total	149,075	54	49,978,023	18,081	50,127,098	18,135	$80,248	$326,040	$406,289
Unintentional	98,622	36	47,375,945	17,140	47,474,567	17,175	74,145	255,159	329,304
Self-inflicted	29,416	11	294,636	107	324,052	117	1,364	31,994	33,358
Assault	16,830	6	2,187,268	791	2,204,098	797	4,277	32,826	37,103
Legal/military	377	0	61,899	22	62,276	23	110	743	853
Undetermined	3,830	1	58,278	21	62,108	22	351	5,319	5,670

*Rate per 100,000 people.