Unintentional Injuries and Violence

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PUBLIC HEALTH IMPORTANCE

Whereas injuries are the leading cause of death for all Americans <45 years of age, the overall injury rate is highest among older adolescents and young adults (*1*).* Among children and adolescents, injuries have different patterns in different age-groups, largely as a result of varying developmental levels and the activities that these levels influence. Adolescents engage in activities that reflect the turbulence of the transition from childhood to adulthood. Compared with younger children, adolescents are more frequently exposed to certain risk factors, such as motor vehicles and firearms, yet they may not have developed the skills, experience, or judgment to reduce their injury risks. Early experiences with alcohol and other drugs may further increase their risk for injury.

Injury-Related Mortality

Unintentional injuries are the leading cause of death among young persons 10–14, 15–19, and 20–24 years of age (Table 1). Fifty-six percent of injury deaths before 20 years of age occur among adolescents, even though they account for only 26% of the pediatric (under 20 years of age) population (*1*). The overall rate of fatal injuries among adolescents increases dramatically with age. The injury fatality rate is almost five times greater among adolescents 15–19 years of age than it is among those aged 10–14 years; the injury fatality rate then increases about 20% for persons 20–24 years of age. Injuries account for more than three fourths of all deaths among adolescents 15–19 years of age. Older adolescents and young adults are at a particularly increased risk of death from motor vehicle crashes, suicides, and homicides. Of all motor vehicle crash deaths that occur before the age of 20 years, 75% occur among adolescents 15–19 years of age, compared with 87% of suicides and 62% of homicides occurring before the age of 20 years (*1*).

Injury-Related Morbidity

Nonfatal injury data are not available nationally. Estimates based on certain hospital-based studies demonstrate injury hospitalization rates to be six to nine times higher for adolescents than for younger children (*2*). Adolescents 15–19 years of age account for more than three fourths of nonfatal injuries and direct care costs among persons <20 years of age.

Rates of severe disabling conditions such as traumatic head and spinal cord injuries increase

* In this chapter, we focus on older children, adolescents, and young adults in three age-groups: 10–14,15–19, and 20–24 years.

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TABLE 1. Ten leading causes of death,* by age-group — United States, 1990

Rank	Age-groups (years) 10–14	15–19	20–24
1	**Unintentional injuries 1,897**	**Unintentional injuries 7,561**	**Unintentional injuries 8,680**
2	Malignant neoplasms 525	**Homicide 3,042**	**Homicide 4,312**
3	**Homicide 356**	**Suicide 1,979**	**Suicide 2,890**
4	**Suicide 258**	Malignant neoplasms 759	Malignant neoplasms 1,060
5	Heart disease 184	Heart disease 344	Heart disease 573
6	Congenital anomalies 182	Congenital anomalies 224	Human immunodeficiency virus 493
7	Bronchitis, emphysema, and asthma 81	Pneumonia and Influenza 85	Congenital anomalies 267
8	Pneumonia and Influenza 58	Bronchitis, emphysema, and asthma 82	Cerebrovascular disease 160
9	Benign neoplasms 47	Cerebrovascular disease 74	Pneumonia and influenza 146
10	Cerebrovascular disease 40	Human immunodeficiency virus 48	Bronchitis, emphysema, and asthma 96

* Cause and number of deaths are represented in each cell.

Source: NCHS mortality tapes.

dramatically among adolescents compared with younger children. Preliminary data reported to CDC from four states indicate that in 1990–1991, the rate of spinal cord injury (per 1 million population) was 5.3 for children <5 years of age, 9.8 for children 5–14 years of age, and 71.1 for adolescents 15–19 years of age (*Sniezek JE, unpublished data, 1993*). This increase in traumatic spinal cord injuries was particularly dramatic for males.

Cross-National Comparisons

Adolescent rates of death from natural causes are similar in the United States, France, Netherlands, England, Wales, Sweden, Canada, Japan, and Australia (*3*). However, adolescent rates of death from injuries and violence are significantly higher in the United States than in these other countries. For example, suicide and homicide rates among youths aged 15–19 years are higher in the United States than in most other industrialized countries. Excess homicide among adolescents is particularly striking. In 1985, 1,579 homicides among adolescents aged 15–19 years were reported in the United States, compared with 159 homicides among adolescents in the same age-group in the Federal Republic of Germany, France, England, Wales, Sweden, Canada, and Japan combined—even though the combined population of these countries is 1.4 times that of the United States (*3*).

HISTORY OF DATA COLLECTION

The history of injury surveillance systems and data gathering is similar for all childhood and adolescent age-groups. For a summary of this historical perspective, see the Injury and Child Abuse chapter.

CDC SURVEILLANCE ACTIVITIES

CDC's injury surveillance activities are described in detail in the Injury and Child Abuse chapter. Details about the Youth Risk Behavioral Surveillance System can be found in the Youth Risk Behavior chapter.

GENERAL FINDINGS

Unintentional Injuries

The magnitude of unintentional injuries dwarfs all other causes of death among adolescents. Unintentional injuries alone account for more fatalities among youths aged 10—19 years than the next nine leading causes of death combined (Table 1).

For adolescents and young adults, motor vehicle crashes are the leading cause of injury fatalities, accounting for >40% of injury deaths among those 10–24 years of age (Table 2). For young adolescents 10–14 years of age, motor vehicle-related fatalities occur principally among vehicle passengers (42%) and pedestrians (22%). Bicycle-related fatalities among young adolescents (149 in 1990) often involve motor vehicles. From 1979 through 1988, motor vehicle-related death rates for youths aged 10–24 years declined 15.5%, with the greatest decreases occurring among those aged 15–19 years (16.6%) and 20–24 years (15.0%) (*4*).

Alcohol use increases the risk for a motor vehicle crash for all drivers, but for young drivers the risk begins to increase at very low blood alcohol concentrations (*5*). Data from the Fatal Accident Reporting System of the National Highway Traffic Safety Administration show that the proportion of alcohol-related traffic fatalities among young persons 15–24 years old decreased from 1982 to 1989. Reductions in the proportion of these deaths were greater for persons aged 15–17 years (31%) and 18–20 years (22%) than for those aged 21–24 years (7%) and ≥25 years (11%) (*5*).

Data from the 1990 Youth Risk Behavior Survey demonstrated that we could expect even greater reductions in motor vehicle-related fatalities if more adolescents adopted known preventive measures (*6*). In the survey, less than one fourth (24.3%) of students in grades 9–12 reported "always" using safety belts when riding in a car or truck driven by someone else; 13.4% reported "never" using safety belts. Other students reported that they did not use safety belts regularly. Observational studies from 1989 in 19 cities indicate that adolescents have the lowest safety-belt use of any age-group (28.9%), even in locations with mandatory safety-belt laws (*7*).* Among students who rode motorcycles, 59.8% wore motorcycle helmets "always" or "most of the time." Only 2.3% of bicycle riders wore helmets "always" or "most of the time."

* Observers categorized subjucts into age-groups (<1, 1–4, 5–12, 13–18, >18 year) to the best of their ability by observation alone.

TABLE 2. Leading causes of injury-related deaths among youths aged 10–24 years, by age and sex — United States, 1990

	Numbers (and rates)* of injuries																	
	10–14 years						15–19 years						20–24 years					
	Males		Females		Total		Males		Females		Total		Males		Females		Total	
All injury causes	1,736	(19.87)	792	(9.52)	2,528	(14.82)	9,884	(107.75)	2,823	(32.42)	12,707	(71.06)	13,217	(135.66)	2,850	(30.35)	16,067	(83.98)
Motor vehicle crash	665	(7.61)	424	(5.10)	1,089	(6.38)	4,172	(45.48)	1,746	(20.05)	5,918	(33.10)	5,189	(53.26)	1,500	(15.98)	6,689	(34.96)
Drivers	50	(0.57)	21	(0.25)	71	(0.42)	1,636	(17.84)	593	(6.81)	2,229	(12.47)	2,228	(22.87)	663	(7.06)	2,891	(15.11)
Passengers	208	(2.38)	254	(3.05)	462	(2.71)	1,116	(12.17)	674	(7.74)	1,790	(10.01)	935	(9.60)	431	(4.59)	1,366	(7.14)
Pedestrians	162	(1.85)	78	(0.94)	240	(1.41)	244	(2.66)	95	(1.09)	339	(1.90)	402	(4.13)	104	(1.11)	506	(2.64)
Motorcyclists	27	(0.31)	1	(0.01)	28	(0.16)	297	(3.24)	6	(0.07)	303	(1.69)	569	(5.84)	8	(0.09)	577	(3.02)
Bicyclists	131	(1.50)	18	(0.22)	149	(0.87)	113	(1.23)	11	(0.13)	124	(0.69)	58	(0.60)	7	(0.07)	65	(0.34)
Firearms	441	(5.05)	119	(1.43)	560	(3.28)	3,678	(40.10)	495	(5.68)	4,173	(23.34)	4,781	(49.07)	588	(6.26)	5,369	(28.06)
Homicide	229	(2.62)	127	(1.53)	356	(2.09)	2,571	(28.03)	471	(5.41)	3,042	(17.01)	3,651	(37.47)	661	(7.04)	4,312	(22.54)
Suicide	191	(2.19)	67	(0.81)	258	(1.51)	1,656	(18.05)	323	(3.71)	1,979	(11.07)	2,504	(25.70)	386	(4.11)	2,890	(15.11)
Drowning	207	(2.37)	53	(0.64)	260	(1.52)	439	(4.79)	39	(0.45)	478	(2.67)	393	(4.03)	37	(0.39)	430	(2.25)
Fire/burns	66	(0.76)	41	(0.49)	107	(0.63)	114	(1.24)	51	(0.59)	165	(0.92)	231	(2.37)	51	(0.54)	282	(1.47)
Poisoning	23	(0.26)	9	(0.11)	32	(0.19)	144	(1.57)	47	(0.54)	191	(1.07)	259	(2.66)	69	(0.73)	328	(1.71)
Falls	17	(0.19)	7	(0.08)	24	(0.14)	105	(1.14)	18	(0.21)	123	(0.69)	156	(1.60)	13	(0.14)	169	(0.88)

* Rates per 100,000 population; categories may not be mutually exclusive.
Sources: NCHS mortality tapes and US Bureau of the Census decennial census data for 1990.

Young persons also are overrepresented among firearm-related injuries nationwide. In 1990, firearms use was second only to motor vehicle crashes as a specific cause of death among adolescents (Table 2). From 1985 to 1990, adolescent rates of death caused by firearms use increased 18% for youths 10–14 years old and 77% for those 16–19 years old (*8*). Of all unintentional firearm-related deaths, 30% occurred among youths aged 10–19 years (*9*). Firearm-related death rates among young male adolescents are up to 10 times higher than for females of the same race (*8*). Overall, adolescents living in nonmetropolitan regions were more than twice as likely to die from an unintentional gunshot wound as those living in metropolitan areas (*9*). Specific behavioral characteristics associated with adolescence—such as impulsivity, feelings of invincibility, and curiosity about firearms—combined with easy access to firearms place adolescents at a particularly high risk for firearm-related injuries (*10*).

Drowning rates increase among children aged 1–3 years, and a secondary rise in rates occurs among adolescents aged 15–19 years, but only among boys. Unlike drownings among toddlers and young children that are most likely to occur in swimming pools, drownings among adolescent boys occur in a wide variety of locations: rivers, lakes, canals, and oceans (*11*). Even in states with substantial coastlines, the vast majority of adolescent drownings occur in fresh water (*11*). Drowning rates for adolescent blacks are twice those for adolescent whites and may be related to blacks' exposure to more dangerous, unsupervised open bodies of water and lack of access to swimming skills programs, although these hypotheses are largely unexplored. Boating incidents play a larger role

in drownings among adolescents when compared with younger children, and alcohol use is believed to be a major contributing factor in 40%–50% of drownings among adolescent boys (*11*).

Sports are the leading cause of injuries requiring medical treatment among youths aged 12–17 years (*12*). Each year, one child in 27 sustains a sports injury severe enough to result in hospital treatment. Almost two thirds of all sports injuries result from team contact sports such as football, basketball, or soccer. During the 6 academic years from fall 1982 to spring 1988, an average of 49 catastrophic injuries (death or severe functional disability) were reported annually among high school participants, and an average of 13 such injuries were reported annually among college participants (*12*). Most sports-related deaths among adolescents were not caused by trauma, but, rather, were caused by cardiac failure or heat exhaustion.

Injuries Caused by Violence

Homicide follows only unintentional injuries as a cause of death among persons 15–24 years of age (Table 1). Among black males and females aged 10–24 years, homicide ranks first as a cause of death for reasons that are not yet clear but are being explored (*13*). In 1990, 31% of all homicides occurred among young persons aged 10–24 years; >95% of these persons were 15 years of age or older. Unlike adolescent unintentional injury and overall fatality rates, which have been declining in recent years, adolescent homicide rates have increased. From 1984 to 1990, homicide rates increased 40.3% for youths aged 10–14 years, 72% for those aged 15–19 years, and 28.2% for those aged 20–24 years. In 1990, most adolescent homicides were related to firearms—82% among persons 15–19 years of age and 76% among persons 20–24 years of age (*8*). Homicide rates for black males have increased sharply. In each youth age-sex category, firearm-related homicide rates were higher for blacks than for youths of other races: eleven times higher for males aged 15–24 years, eight times higher for females aged 10–14 years, and five times higher for males aged 10–14 years and females aged 15–24 years.

Suicide is the third leading cause of adolescent deaths, with rates increasing most profoundly among younger adolescents. From 1979 to 1988, suicide rates for young adolescents 10–14 years of age increased >75% (*4*). At the same time, suicide rates for youths aged 15–19 years increased 34.5%, whereas suicide rates for persons 20–24 years of age showed a slight decline (8.5%). In 1990, male:female rate ratios for adolescent suicide were 2.7 for youths aged 10–14 years, 4.9 for those aged 15–19 years, and 6.3 for those aged 20–24 years. Most suicides were related to firearms (*8*). Firearm-related suicide rates, unlike firearm-related homicide rates, were higher for white males than for black males aged 15–24 years, although the race differences were considerably smaller than for firearm homicides.

INTERPRETATION ISSUES

Among all age groups, adolescents and young adults are at the highest risk for traumatic head and spinal cord injuries. Despite the severe consequences of central nervous system injuries, no surveillance systems adequately monitor their effects in the United States. Many states maintain specialized registries of persons sustaining these injuries (*14*). Although these are potentially valuable sources of injury surveillance data, the key purpose of these systems is to identify the affected persons to allow the delivery of services. Moreover, registries may not provide ongoing population-based incidence and etiology information that is useful for public health programs. Registry data may only reflect those persons seeking treatment at a particular hospital or group of hospitals. The data characterize only a limited segment of all affected persons and do not include information on persons who receive treatment elsewhere. In addition, the data may not be comparable across states. Other states are developing population-based surveillance systems to address these issues. The following example illustrates the need for population-based surveillance systems.

During a 6-week period in 1988, eight patients with cervical spinal cord injuries received treatment at two spinal cord injury centers in Milwaukee, Wisconsin (*15*). During similar periods the centers reported five spinal cord injuries in 1986 and three in 1987. Seven of the injuries in 1988 occurred in natural bodies of water, and some investigators hypothesized that the increased frequency was a result of diving into bodies of water with reduced levels caused by a drought. Because no statewide data were available for Wisconsin before 1988, investigators were unable to make comparisons to previous years. After conducting a case-control study to assess this hypothesis, they concluded that the increase in reported water-related spinal cord injuries at the two centers was a reporting artifact caused by a change in referral patterns for the treatment of spinal cord injury (*16*). The presence of a population-based spinal cord injury surveillance system would have allowed comparisons to previous years, thus facilitating the detection of clusters of such injuries.

EXAMPLES OF USING DATA

Football-Related Spinal Cord Injuries in Louisiana

Louisiana law requires the reporting of all spinal cord injuries to the Office of Public Health of the Louisiana Department of Health and Hospitals. Four high school football players sustained cervical spinal cord injuries during the 1989 high school football season (*17*). All injuries resulted in quadriplegia; in three of the injuries, no motor or sensory function was preserved below the zone of injury. The injuries occurred when players were tackling or blocking with the head as a point of contact. Their heads were not, however, in the typical head-down or spearing position typically associated with spinal cord injury.

On the basis of Louisiana's experience from 1978 through 1988, one spinal cord injury would be expected during a period of <4 years. Reasons for the occurrence of the four spinal cord injuries during the 1989 high school football season in Louisiana are not known. In response to these injuries, the state produced and distributed an instructional video, targeted to high school coaches and trainers, explaining safe tackling techniques. Other suggestions for prevention included 1) enforcing existing tackling rules; 2) educating officials, coaches, and players about the mechanisms of injury; 3) requiring proper conditioning exercises to strengthen players' necks; 4) requiring medical examinations of players before participating in football and before resuming participation after injury; and 5) increasing awareness among school administrators and coaches about the proper handling of any injured player during practice or competition.

Traumatic Head Injuries in Utah

Traumatic head injury is a reportable condition in Utah. Cases are ascertained through a statewide injury reporting system maintained by the Utah Department of Health's Bureau of Epidemiology. The system identifies cases from discharge data from all of the state's acute care hospitals and death certificates.

In 1990–1991, overall rates of traumatic head injury (fatal and nonfatal) were higher for adolescents aged 15–19 years than for persons aged 20–24 years (209.4 per 100,000 vs. 119.6). Among persons aged 15–19 years, rates for males were almost twice those for females (276.9 vs. 141.0). Among persons 20–24 years old, rates for males were almost three times those for females (181.6 vs. 59.5). Major causes of traumatic head injury were motor vehicle crashes and firearms use. The state is using these data to develop interventions based on the leading causes of traumatic head injury. The surveillance system will be useful for evaluating the effectiveness of these intervention programs.

FUTURE ISSUES

Over the coming decade, the major challenges in injury surveillance will be diverse, ranging from the modification of mechanisms used to collect data on nonfatal injuries to the development of new systems for the surveillance of childhood injuries. For details about these future challenges

and the national year 2000 health objectives see the Injury and Child Abuse chapter. Of particular relevance to the prevention of adolescent injuries will be the surveillance of firearm-related injuries and traumatic head and spinal cord injuries.

Firearm-Related Injuries

As is true for other nonfatal injuries, national data are not available to adequately depict the incidence and distribution of nonfatal firearm-related injuries. Consequently, the Firearm Injury Surveillance Study is being conducted to determine the usefulness of the National Electronic Injury Surveillance System (NEISS) to obtain national estimates of the incidence, cost, and disability associated with nonfatal firearm-related injuries treated in hospital emergency departments. The U.S. Consumer Product Safety Commission (CPSC) operates NEISS and uses the data to track product-related injuries. Although the CPSC has regulatory authority for other consumer products but does not regulate firearms, it collects data on firearm injuries for CDC through an interagency agreement.

In June 1992, the CPSC began collecting data for the Firearm Injury Surveillance Study, ascertaining information on nonfatal firearm injuries in all 91 NEISS hospital emergency departments; the commission continued data collection through September 1993. The 91 NEISS hospitals represent a national probability sample drawn from approximately 6,100 U.S. hospitals that have emergency departments and are located in metropolitan, smaller urban, suburban, and rural areas.

The NEISS provides useful information on the incidence of nonfatal firearm injuries, characteristics of the persons injured, as well as morbidity and circumstances about the injury event, such as the intent of injury, the type of firearms used to inflict injuries, and victim-perpetrator relationships. Preliminary results based on NEISS data obtained in 1992 suggest that approximately 102,000 nonfatal gunshot wounds occur annually in the United States. About 25,000 of these gunshot wounds involve persons 19 years of age and younger; this is about five times the number of fatalities that occurred in this age-group during 1990. The data also indicate that at least 35% of these children and adolescents were shot by a handgun and that at least 40% were the result of assaults.

The magnitude and severity of these nonfatal firearm injuries emphasize the need for effective prevention strategies. Of the 102,000 persons receiving gunshot wounds in 1992, 64% were transported to the emergency department by emergency medical services, and 58% were severe enough to require hospitalization. Of those hospitalized, at least 17% had primary injuries to the head and neck region. The morbidity and disability associated with these severe nonfatal injuries—especially among children and adolescents—have a tremendous effect on society in terms of human suffering, medical-care costs, and loss of productivity.

Traumatic Head and Spinal Cord Injuries

Because of the devastating effects of injuries to the central nervous system, a number of states are developing registries or surveillance systems to provide services and plan prevention programs. CDC currently receives spinal cord injury data from five states—Arkansas, Colorado, Louisiana, Mississippi, and Utah. Some states use the traditional reportable disease model, whereas others use hospital discharge data and abstract medical records to obtain more complete information. Although the purposes and methods of data collection may differ across jurisdictions, a standardized approach (i.e., case definitions and minimum data sets) would allow data comparisons among states and facilitate national surveillance.

To meet these needs, CDC's National Center for Injury Prevention and Control has worked with government agencies, professional organizations, and consumer groups to develop standard guidelines—including case definitions and a minimum data set—for the surveillance of traumatic head and spinal cord injuries. These guidelines, which are based on the CDC

National Electronic Telecommunications Surveillance System format, are being field-tested and should be finalized in 1994.

REFERENCES

1. Guyer B, Ellers B. Childhood injuries in the United States: mortality, morbidity, and cost. Am J Dis Child 1990;144:649–52.

2. Rodriguez JG, Brown ST. Childhood injuries in the United States. Am J Dis Child 1990;144:627–46.

3. Public Health Service. Childhood injuries in the United States. Atlanta: US Department of Health and Human Services, Public Health Service, Centers for Disease Control, 1990.

4. CDC. Mortality trends and leading causes of death among adolescents and young adults—United States, 1979–1988. MMWR 1993;42:459–62.

5. CDC. Alcohol-related traffic fatalities among youth and young adults—United States, 1982–1989. MMWR 1991;40:178–82.

6. CDC. Safety-belt and helmet use among high school students—United States, 1990. MMWR 1992;41:111–4.

7. National Highway Traffic Safety Administration. Restraint use in 19 US cities: 1989 annual report. Washington, DC: US Department of Transportation, National Highway Traffic Safety Administration; DOT publication no. HS-807-595.

8. Fingerhut LA. Firearm mortality among children, youth, and young adults 1–34 years of age, trends and current status: United States, 1985–1990. Hyattsville, Maryland: US Department of Health and Human Services, Public Health Service, CDC, NCHS, 1993. (Advance data from vital and health statistics; no. 231.)

9. CDC. Unintentional firearm-related fatalities among children and teenagers—United States, 1982–1988. MMWR 1992;41:442–5,451.

10. Committee on Adolescence, American Academy of Pediatrics. Firearms and adolescents. AAP News 1992;(January):20–1.

11. Wintemute GJ. Childhood drowning and near-drowning in the United States. Am J Dis Child 1990;144:663–9.

12. Baker SP, O'Neill B, Ginsburg MJ, Li G. The injury fact book. 2nd ed. New York: Oxford University Press, 1992.

13. Hammett M, Powell KE, O'Carroll PW, Clanton ST. Homicide surveillance—United States, 1979–1988. MMWR 1992;41(No. SS-3):1–33.

14. Harrison CL, Dijkers M. Spinal cord injury surveillance in the United States: an overview. Paraplegia 1991;29:233–46.

15. CDC. Diving-associated spinal cord injuries during drought conditions—Wisconsin, 1988. MMWR 1988;37:453–4.

16. Branche CM, Sniezek JE, Sattin RW, Mirkin IR. Water recreation-related spinal injuries: risk factors in natural bodies of water. Accid Anal & Prev 1991; 23(1):13–7.

17. CDC. Football-related spinal cord injuries among high school players—Louisiana, 1989. MMWR 1990:39:586–7.