A Review of Unintentional Injuries in Adolescents*

David A. Sleet,1 Michael F. Ballesteros,1 and Nagesh N. Borse1,2

1Division of Unintentional Injury Prevention, National Center for Injury Prevention and Control, 2Office of Workforce and Career Development, Centers for Disease Control and Prevention, Atlanta, Georgia 30341; email: dds6@cdc.gov

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Abstract
Unintentional injuries are the largest source of premature morbidity and mortality and the leading cause of death among adolescents 10–19 years of age. Fatal injury rates of males are twice those of females, and racial disparities in injury are pronounced. Transportation is the largest source of these injuries, principally as drivers and passengers, but also as cyclists and pedestrians. Other major causes involve drowning, poisonings, fires, sports and recreation, and work-related injuries. Implementing known and effective prevention strategies such as using seat belts and bicycle and motorcycle helmets, installing residential smoke alarms, reducing misuse of alcohol, strengthening graduated driver licensing laws, promoting policy change, using safety equipment in sports and leisure, and protecting adolescents at work will all contribute to reducing injuries. The frequency, severity, potential for death and disability, and costs of these injuries, together with the high success potential of prevention strategies, make injury prevention a key public health goal to improve adolescent health in the future.
INTRODUCTION

Injuries have plagued societies throughout history and have posed a particular threat to adolescents. Today, unintentional injuries are among the top public health problems facing young people today. In fact, more adolescents ages 10–19 in the United States die from injuries than from all other causes of death combined (24).

Although risk taking is a normal part of adolescent life, managing risks and distinguishing between safe and unsafe risks are important survival skills. Injuries are a frequent and sometimes devastating outcome of risk taking but are also inherent in the environment in which adolescents live, work, and play (6, 27).

Unintentional injury is responsible for nearly half (45.9%) of all deaths to adolescents, here defined as those ages 10–19, killing and crippling young people in the prime of their lives. In 2006, 7873 U.S. adolescents ages 10–19 died from unintentional injuries: the equivalent of 22 deaths each day (24). The majority of unintentional injury deaths (70.1%) result from car crashes. What were referred to for decades as “accidents” we now refer to as “unintentional injuries.” Injuries are not the result of accidents or acts of fate; adolescent injuries result from events that are both predictable and preventable. A major public health goal is to help adolescents achieve healthy independence by increasing the number of adolescents who are healthy, safe, independent, and productive members of society (21). Of the 467 Healthy People 2010 objectives, 107 are relevant for adolescents, and at least 29 are related to unintentional injury (98).

UNINTENTIONAL INJURIES

An injury is defined as “damage to the body resulting from acute exposure to thermal, mechanical, electrical, or chemical energy or from the absence of such essentials as heat or oxygen” (98). Unintentional injuries can be further classified by cause and include injuries from motor vehicle crashes, fires and burns, falls, drowning, poisoning, choking, suffocation, and animal bites.

Unintentional injuries are the leading cause of death throughout adolescence, and motor vehicle crashes account for 57.9% of the unintentional injury deaths in those ages 10–14 and 72.3% of the unintentional injury deaths in those ages 15–19 (Figures 1 and 2). Of the five leading causes of death in ages 10–14 and 15–19, unintentional injury is ranked number one (Table 1).

In 2006, there were more than twice the number of fatal injuries for males (5464) than for females (2409). Death rates from injury for those ages 15–19 (31.3 per 100,000) were more than 5 times the rate of those ages 10–14 (5.9 per 100,000) (24).

Racial disparities in injury are pronounced. Among adolescents, American Indians and Alaska Natives (AI/AN) and blacks consistently had higher total injury death rates than did whites, and AI/AN adolescents had the highest rates of motor vehicle traffic deaths (10).

In a state-by-state analysis of unintentional injury deaths from 2000 to 2006 (Figure 3), rates of adolescents ages 10–19 varied from a high of 36.3 per 100,000 persons in Mississippi to a low of 10.4 in the District of Columbia (the U.S. average rate is 19.8). The numbers of unintentional injury deaths in adolescents also vary widely from 5179 in California, to 51 deaths in the District of Columbia, with a median of 921 over the seven-year period for all states (Figure 4).

Table 1 The five leading causes (and number) of adolescent deaths, United States, 2006. Source: Reference 24

<table>
<thead>
<tr>
<th>Rank</th>
<th>Ages 10–14</th>
<th>Ages 15–19</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Unintentional injury</td>
<td>Unintentional injury</td>
</tr>
<tr>
<td>1214</td>
<td></td>
<td>6659</td>
</tr>
<tr>
<td>2</td>
<td>Malignant neoplasms</td>
<td>Homicide</td>
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<tr>
<td>448</td>
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<td>2291</td>
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<td>3</td>
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<td>Suicide</td>
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<tr>
<td>241</td>
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<td>1555</td>
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<td>4</td>
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<tr>
<td>216</td>
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<td>675</td>
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<tr>
<td>5</td>
<td>Heart disease</td>
<td>Heart disease</td>
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<tr>
<td>163</td>
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<td>360</td>
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</tbody>
</table>
Deaths are only part of the picture because for every injury death, there are ~12 injury hospitalizations and 641 emergency department visits (24). Annually, more than five million adolescents suffer injuries requiring emergency department visits (24). Costs per injury case for unintentional injuries, on average, were $5348 for those ages 10–14 and $7266 for those ages 15–19 (63). Nonfatal unintentional injuries in adolescents indicate that more than 1.3 million
males and 860,723 females (ages 10–14) and 1.7 million males and 1.0 million females (ages 15–19) were treated in emergency departments for an injury in 2006 (24).

The five most common injuries treated in emergency departments for 10–14-year-olds were struck by or against (being struck by, hit, or crushed or striking against a human, animal, 

Figure 4

Number of deaths
or inanimate object other than a vehicle or machinery), falls, overexertion, cut or pierce (by instruments such as knives, power hand tools, and household appliances), and pedal cycle injuries (such as bicycles). For 15–19-year-olds, the most common injuries were stuck by or against, falls, motor vehicle occupant injuries, overexertion, and cut or pierce (24).

The types of unintentional injuries that result in hospitalization among adolescents also differ by age. For 10–14-year-olds, the leading causes of hospitalization were falls (7471 admissions), motor vehicle crashes (4514 admissions), and struck by or against (3907 admissions). For 15–19-year-olds, the leading causes were motor vehicle crashes (23,733 admissions), falls (7465 admissions), and poisoning (5590) (24).

Adolescent unintentional injuries are also recognized as a global health problem. Road traffic injuries are the leading cause of death for youth around the world (73, 111). Evidence demonstrates the dramatic successes in reducing adolescent injuries in countries that have made a concerted effort, and investment, in injury prevention (111).

**SETTINGS FOR ADOLESCENT INJURY**

Adolescent injuries occur in many settings. In addition to considering specific injuries that afflict adolescents, such as motor vehicle crashes, drowning, and poisoning, injuries to adolescents can be viewed according to the settings in which they occur: at school, in sports, and at work.

**School-Related Injuries**

Approximately 10%–25% of all child and adolescent injuries occur at school, making injury one of the most common health problems treated by school health personnel (74). Fatalities at school are rare; ∼1 in 400 injury-related fatalities (violence and unintentional) among children ages 5–19 years occur at school (64).

In a 2007 nationwide survey among school students in grades 9–12 who exercised or played sports in the past 30 days, 21.9% had to see a doctor or nurse for an injury (34). In another study, injuries to children ages 5–19 accounted for an estimated 26% (15,405,392) of visits to the emergency department, of which 1,859,215 injuries occurred at school (55). School injuries can also result in costly lawsuits for schools and school districts, with a median judgment of $50,000 (7).

School-associated injuries are most likely to occur on playgrounds, particularly on climbing equipment, athletic fields, and in gymnasiums (49). Male students are injured 1.5 times more often than female students are (64), and males are three times more likely than females to sustain injuries requiring hospitalization (32). Middle- and high-school students sustain more school injuries than do elementary school students: 41% of school injury victims are ages 15–19 years, 31% are ages 11–14 years, and 28% are ages 5–10 years (64).

**Sports-Related Injuries**

In the United States, more than eight million high-school students participate in school- or community-sponsored sports annually (17, 29). More than one million serious sports-related injuries occur annually to adolescents ages 10–17 (11), accounting for one-third of all serious injuries in this age group. Sports cause more than 55% of nonfatal injuries at school (80).

Males are twice as likely as females to experience a sports-related injury. Among sports with many female participants, gymnastics, track and field, and basketball pose the greatest risk of nonfatal injury (61).

In many sports, risk of injury has been reduced by rule changes, conditioning, equipment and surface changes, coaching education, and use of protective gear and clothing (40). Changes in personal behavior and the environment in which adolescents play sports can help
reduce many injuries (59). Some interventions known to be ineffective, such as taping normal ankles to prevent sprains, are unfortunately still being used (40).

**Work-Related Injuries**

In 2001, ∼3.7 million children between the ages of 15 and 17 worked (103). Although adolescents who work derive many benefits (such as making money, developing job skills, and building responsibility), they are also exposed to injury risks. Approximately 60–70 adolescents under 18 years of age die on the job every year, hundreds more are hospitalized, and tens of thousands require treatment in hospital emergency departments (69, 70). Sixteen- and 17-year-old workers die from the leading causes of work-related fatalities—motor vehicle injuries, job-related homicide, and injuries associated with machinery—at rates comparable to or slightly higher than those for adult workers (70).

Nearly two million children and adolescents live or work on farms. Adolescents who work or live on farms are more likely to be exposed to farming-related injury hazards, including tractors, farm machinery, large animals, farm vehicles, rotary mowers, and pesticides (83). Seasonal application of pesticides adds to the risk of cumulative exposures. Adolescents can be exposed through the air they breathe, the food they eat, the water they drink, or a combination of exposures. Duration and concentration of exposures are important considerations (60). Adult supervision can be an important adjunct to environmental and engineering solutions (65).

The Fair Labor Standards Act (FLSA) is designed to protect youth under age 18 from hazardous work conditions and specifies minimum ages for different types of work, prohibits work during hazardous times (such as at night), and dictates maximum daily hours worked. Although 40 states have laws that require young workers under age 18 to first obtain a work permit or employment certificate issued by the Labor Department or a school (101), the effectiveness of the permit system on health and safety is not known (79). The Teen Drive for Employment Act (Public Law 105–334) is an example of a workplace policy that prohibits all on-the-job driving for 16-year-olds and limits the amount of driving permitted for 17-year-olds. However, the FLSA does not cover the new adolescent drivers aged 18 and older who are at risk due to inexperience (75).

**SPECIFIC UNINTENTIONAL INJURIES AFFECTING ADOLESCENTS**

**Motor Vehicle Injuries**

Motor vehicle–related injuries are the leading cause of death for adolescents in the United States, accounting for 32% of deaths from all causes in this age group and 70% of all unintentional injury-related deaths (12, 24). In 2006, 5517 adolescents (10–19 years of age) died in motor vehicle–related crashes. Of these deaths, 2759 occurred as occupants in motor vehicles. In 2006, an estimated 900,589 adolescents were treated in hospital emergency departments for unintentional nonfatal motor vehicle–related injuries (including motorcycle, pedestrian, and bicycle). Of these, over half were drivers or passengers (24). The likelihood that children and adolescents will suffer fatal injuries in motor vehicle crashes increases when they do not use seat belts or when a driver transporting children or adolescents has been drinking (77) and when new and inexperienced drivers transport other teenage passengers (26). Figure 5 shows that as adolescents age, the proportion of unintentional injury deaths attributed to motor vehicle crashes climbs.

**Teen Drivers and Passengers**

In 2006, each day an average of 7 teenagers per day ages 13–19 years died as motor vehicle traffic occupants, and more than 1250 teenagers per day ages 13–19 years sustained nonfatal injuries as motor vehicle occupants (24). Teenage male
occupant death rates are about twice that of females (24).

Although teenagers drive less than most other drivers, they are involved in a disproportionately high number of crashes. The fatal crash rate per mile driven for 16–19-year-olds is three times the risk for older drivers (age 60+), and fatal crash risk is highest at age 16 (45). Crash risk for both males and females is particularly high during the first months of driving and drops as young drivers accumulate more experience behind the wheel (45). The comprehensive costs of motor vehicle occupant, pedal cyclist, and pedestrian injury, including monetized quality adjusted life years lost among adolescents ages 10–19 years, were more than $45 billion in 2000 (63).

Bicyclists, Motorcyclists, and Pedestrians

In 2006, as bicyclists, 122 adolescents were killed, and an estimated 162,808 were treated in emergency departments for bicycle-related nonfatal injuries (24). Among the bicycle-related deaths, 90% are attributed to collisions with motor vehicles (22). Severe head injuries are responsible for 64%–86% of bicycle-related fatalities (92), and children ages 10–14 years have the highest rate of bicycle-related fatalities. Research has clearly shown that bicycle helmets save lives, yet few adolescents wear a helmet (17). To promote helmet use, the Centers for Disease Control and Prevention (CDC) published and disseminated a set of bicycle helmet recommendations (14) designed for use in planning programs to prevent head injuries by encouraging the use of bicycle helmets (78).

In 2006, as motorcyclists, 199 males and 38 females ages 10–19 years were unintentionally killed. Male death rates were nearly five times that of females. An estimated 54,935 males and 6675 females were treated in emergency departments for nonfatal motorcycle injuries (24).

In 2006, as pedestrians, 485 adolescents died unintentionally. Another 20,403 males and 17,936 females were treated for pedestrian injuries in hospital emergency departments (24).

Most pedestrian deaths occur at night—25% from 6 P.M. to 9 P.M. and 22% between 9 P.M. and midnight (17). Of all pedestrians ages 16 and older killed in nighttime crashes, 55% had blood alcohol levels of 0.10 or higher, higher than the legal limit in every state (17).

Adolescent Development and Motor Vehicle Injuries

The high incidence of adolescent traffic-related injury is due in part to lack of experience and lack of maturity. Many months or even years of experience may be needed for adolescents to become proficient in driving (57). Young drivers may also lack experience to recognize, assess, and respond to hazards, and they may be willing to accept higher levels of risks while walking, riding a bike, or driving a car or motorcycle (47). These risks may be fueled by emotions, peer pressure, and other adolescent stressors.

In addition, adolescence is characterized by increased independence from parents and social pressure from peers (90). Adolescent alcohol use exacerbates these problems. Distracted driving, the use of cell phones while driving, the presence of teen passengers, and the increased use of in-vehicle technologies present additional safety concerns. Technologies such as cell phones, texting, in-vehicle Internet use, and on-board navigation systems place additional demands on the adolescent’s attention and their impact on safe driving is not well understood (75).

STRATEGIES FOR REDUCING ADOLESCENT MOTOR VEHICLE INJURIES

A number of effective strategies would, if implemented, reduce motor vehicle–related injuries in adolescents. Among the most important strategies are graduated licensing and safety belt use.

Graduated Driver Licensing

One proven method for helping teens to become safer drivers is graduated driver
licensing (GDL). Research shows reductions in fatal crashes of 38% for sixteen-year-olds under the most comprehensive and strict GDL (5). GDL systems work because they directly target the risk factors by giving newly licensed adolescent drivers experience under low-risk driving conditions. GDL systems include restrictions on driving that are lifted as adolescents gain driving experience and competence over a three-staged development process, allowing for time to acquire the skills, maturity, and experience as they prepare for full licensure. Nearly all states and the District of Columbia have enacted at least some components of GDL, but they vary widely from state to state (46). Currently, only 31 states and the District of Columbia have GDL systems that are considered “good” by the Insurance Institute for Highway Safety, and even those states rated good do not contain all the elements of an optimal GDL system. As of April 2009, 19 states still have “fair” or “marginal” GDL ratings (Figure 6) (46).

Other strategies embedded within GDL include implementing seat belt use mandates, following speed limits, eliminating the distraction caused by talking or texting on a cell phone, reducing the number of teen passengers, restricting the hours of driving, and establishing zero tolerance for alcohol use when driving (85). Many of these strategies have been successfully implemented within the context of parent management of teen driver intervention conducted within driver education (112).

Seat Belts and Helmets
Proper use of lap and shoulder belts could prevent ~60% of deaths to motor vehicle occupants in a crash (66). Motorcycle helmets can be 35% effective in preventing fatal injuries to motorcyclists and 67% effective in preventing brain injuries (66). Proper use of bicycle helmets can eliminate 65%–88% of bicycle-related brain injuries and 65% of serious injuries to the face (94, 95, 96).

Adolescents are among the lowest users of seat belts or helmets. Nationwide in 2007, 11.1% of high-school students claim they never or rarely use seat belts as passengers (34, 48). Nonuse was more prevalent in males than females and among black students than white students, and 85.1% of high-school students had rarely or never worn a bicycle helmet. Significantly more males than females never or rarely wore a helmet (34, 48). Peer pressure, negative modeling by family members, and community climate are some of the factors related to nonuse (50, 54). Building a culture of safety for seat belts and helmet-wearing among adolescents will be one of the future challenges (86). Legislation mandating seat belt and helmet use, together with enforcement and education, has proven to be the most effective strategy (67, 108, 113).

To complement efforts to increase helmet use globally, the World Health Organization’s Helmets: A Road Safety Manual for Decision-Makers and Practitioners (110) explains why helmets are needed, how to assess the problem of nonuse, how to design and implement a helmet program, and how to evaluate a program to determine whether it is working.

HOME AND RECREATION INJURIES
Adolescent injuries occurring in the home and in recreation, such as those from drowning, poisoning, and fires, represent a significant burden in health care costs, injuries, and deaths.

Drowning
In 2006, there were 426 fatal unintentional adolescent drownings in the United States (24). Alcohol involvement was the leading contributing factor in boating fatalities, contributing to about one in five reported boating deaths (43, 97). Nonfatal drownings can cause brain damage that may result in long-term disabilities including memory problems, learning disabilities, and permanent loss of basic functioning (a permanent vegetative state).

African American youth had the highest rate of drowning in 2006 (1.73 per 100,000),
whereas white youth had the lowest (0.87 per 100,000). Between 2004 and 2006, the fatal unintentional drowning rate for African Americans ages 10–19 was 2.2 times that of whites. For AI/AN, the rate was 1.6 times that of whites, and for Asians and Pacific Islanders it was 1.5 times (24).

Factors such as the physical environment (access to swimming pools) and a combination of social and cultural issues (developing swimming skills and choosing safe water recreation) may contribute to the racial differences in drowning rates (13). The percent of drownings in natural water settings increases with age. Most drownings in those over 15 years of age occur in natural water settings (19). In survey research, men of all ages, races, and educational levels consistently reported greater swimming ability than women, yet men have much higher drowning rates (39).

Poisonings
Unintentional poisoning death rates have been rising steadily since 1992 (20) and are a growing problem among adolescents. Poisoning was second only to motor vehicle crashes as a cause of unintentional injury death in adolescents in 2006 (24).

Prescription drug use can easily escalate into unintentional poisoning overdose. In 2006, 40 adolescents ages 10–14 and 738 adolescents ages 15–19 died from unintentional poisoning death rates were highest in young children and older adults, 137 adolescents lost their lives in house fires in 2006, and 54,397 were treated in emergency departments, of which 569 were hospitalized (24).

Death rates for black and Native American adolescents are more than twice the rate for whites (106, 107). House fire deaths occur disproportionately in the Southeast United States and in December through February, when more than one-third of house fires occur (102). The most common causes of residential fires are cooking and heating equipment, and the most common cause of fire-related deaths is cigarette smoking (2).

Fires
In 2006, fires and burns were the fifth leading cause of unintentional injury death among adolescents. House fires accounted for 93% of all fire- and burn-related deaths. Although house fire death rates are highest in young children and older adults, 137 adolescents lost their lives in house fires in 2006, and 54,397 were treated in emergency departments, of which 569 were hospitalized (24).

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STRATEGIES FOR REDUCING HOME AND RECREATION INJURIES
Many interventions directed at the home and recreational environments work to prevent injuries; however, many of these strategies have not gained wide acceptance or use. Although these strategies will work to protect adolescents,
they will likely protect other age groups from injury, as well.

**Drowning Prevention**

To reduce the risk of drowning, environmental protections (such as isolation pool fences and lifeguards) should be adopted. Alcohol use should be avoided while swimming, boating, waterskiing, or supervising children. All participants, caregivers, and supervisors should know water safety skills, be trained in cardiopulmonary resuscitation (CPR), and have access to 911 emergency calls (19). Adolescents should be supervised when they are in or near water and use personal flotation devices while boating (76). An estimated 423 lives could have been saved in 2006 if all boaters had worn life jackets or personal flotation devices (97).

**Poisoning Prevention**

Keeping prescription drugs away from adolescents and properly disposing of all pain medications will help reduce unintentional drug overdoses in teens. As of November 2008, 32 states had operational prescription drug monitoring programs (PDMP), and an additional 6 states are in the start-up phase (100). These programs are designed to deter and identify illegal activity such as prescription forgery, indiscriminate prescribing, and “doctor shopping.” PDMPs may hold promise to decrease the incidence of prescription drug overdose by electronic monitoring of prescriptions written and filled.

Proper maintenance of potential sources of carbon monoxide (CO) poisoning in the home is the best way to avoid CO poisoning. CO alarms offer an additional layer of protection by sounding a loud noise (much like a smoke alarm) when CO concentrations reach dangerous levels.

The nationwide U.S. toll-free number for Poison Control Centers, 1-800-222-1222, is available 24 hours a day, 7 days a week. The centers provide assistance with poisoning emergencies, answer questions about specific poisons, and provide poison prevention tips.

**Fire Prevention**

Smoking carries a particularly high risk for fires in the home; therefore, restrictions on smoking in the home, or quitting altogether, are good prevention strategies. In case of a fire, having a working smoke alarm can reduce the risk of death in a house fire by ~50%, and it is very cost-effective. An estimated 94% of U.S. households have at least one smoke alarm. However, ~25% of these alarms do not work because of battery removal or because the batteries are not replaced each year (107).

Working smoke alarms outside every habitable floor and outside every sleeping area give adolescents and other residents in a burning home enough advance warning to escape nearly all types of fires. Smoke alarms should be tested twice a year and, if possible, equipped with a ten-year, long-life lithium battery. In new construction, smoke alarms can be hardwired and sprinkler systems can be installed for additional protection. Fire escape plans should be a part of every family’s disaster plan and should be practiced at least once a year (17).

Examples of potential interventions to reduce motor vehicle and home and recreational injuries can be found on Table 2. This table identifies potential interventions that can be used to preventing sports-related injuries, work-related injuries, motor vehicle injuries, and home and recreational injuries such as those related to drowning, poisoning, and fire.

**ALCOHOL AS A CONTRIBUTING FACTOR IN UNINTENTIONAL INJURY**

Alcohol is the most commonly used drug among adolescents, and more young people drink alcohol than smoke tobacco or use marijuana (44). In 2001, there were 40,933 injury-related deaths associated with excessive alcohol use or binge drinking among all ages. Of these, more than half were unintentional deaths [13,878 traffic deaths and 12,233 nontraffic deaths; (18)]. AI/AN are reported to have the highest alcohol-related motor
Table 2  Potential interventions for adolescent injury prevention

<table>
<thead>
<tr>
<th>Causes of adolescent injury</th>
<th>Potential intervention</th>
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<tbody>
<tr>
<td><strong>Sports-related injuries</strong></td>
<td>Rule changes</td>
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<td>Physical conditioning</td>
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<td>Safer equipment designs</td>
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<td>Coaching and trainer education</td>
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<td>Use of protective gear and clothing</td>
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<td></td>
<td>Reduction in personal risk behaviors</td>
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<tr>
<td></td>
<td>Environmental change to playing surfaces, breakaway goal posts and bases</td>
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<tr>
<td><strong>Work-related injuries</strong></td>
<td>The Fair Labor Standards Act (FLSA): protects youth under age 18 from hazardous work conditions and specifies minimum ages for different types of work, prohibits work during hazardous times (such as at night), and dictates maximum daily hours worked</td>
</tr>
<tr>
<td></td>
<td>The Teen Drive for Employment Act (Public Law 105–334): prohibits all on-the-job driving for 16-year-olds and limits the amount of driving permitted for 17-year-olds</td>
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<tr>
<td><strong>Motor vehicle injuries</strong></td>
<td>Graduated driver licensing law</td>
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<tr>
<td></td>
<td>Safety belt use</td>
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<td></td>
<td>Helmet use on bicycles and motorcycles/mopeds</td>
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<td>Safe speeds</td>
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<td></td>
<td>Elimination of distractions caused by talking or texting on a cell phone</td>
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<td>Reduction in the number of teen passengers</td>
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<td></td>
<td>Restrictions on the hours and times of driving, and reducing unsupervised driving exposure</td>
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<td>Zero alcohol tolerance when driving</td>
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<tr>
<td><strong>Home and recreational injuries</strong></td>
<td>Drowning prevention:</td>
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<td>Environmental protections (such as isolation pool fences, lifeguards)</td>
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<td>Use of life jackets</td>
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<td>Avoiding alcohol use during aquatic activities</td>
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<td>Access to make 911 emergency calls</td>
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<td>Training in cardiopulmonary resuscitation (CPR)</td>
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<td><strong>Poisoning prevention:</strong></td>
<td>Keeping prescription drugs away from adolescents</td>
</tr>
<tr>
<td><strong>Fire Prevention:</strong></td>
<td>Properly disposing of all pain medications</td>
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<tr>
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<td>Working smoke alarms on every floor of the home and outside every sleeping area</td>
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<tr>
<td></td>
<td>Developing fire escape planning, with practice at least once per year</td>
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</tbody>
</table>

Vehicle–mortality rates among all racial/ethnic populations (105).

People ages 12 to 20 years drink 11% of all alcohol consumed in the United States. More than 90% of this alcohol is used in the form of binge drinks (72), in which men consume 5 or more drinks and women consume 4 or more drinks within 2 hours (68). In 2007, 75% of students in grades 9 through 12 had consumed alcohol in their lifetime, and 44.7% reported having at least one drink during the past month. In the past 30 days, more than 10% reported driving a motor vehicle after drinking alcohol, 29% reported riding with a drinking driver, and 26% consuming five or more drinks on a single occasion (34, 48). Underage drinking is not a problem just among older teens: nearly 1 in 5 eighth graders report recent use (44).

Alcohol use is associated with 36% of fatalities among those ages 15–20 and 20% of fatalities among those under age 15 years (15). Alcohol use is a factor in more than 30% of all drowning deaths (30), 14%–27% of all boating-related deaths (56), 34% of all pedestrian deaths (16), 40% of deaths in house fires (91), and 51% of adolescent traumatic brain injuries (52). Alcohol is implicated in deaths due to falls, fires, hypothermia, occupational work,
Evidence-based strategies to reduce or prevent binge drinking and to reduce underage drinking include increasing alcoholic beverage costs and excise taxes, limiting the number of retail alcohol outlets that sell alcoholic beverages in a given area, enforcing laws against underage drinking and alcohol-impaired driving, restricting Internet sales of alcohol, enforcing random breath testing, and implementing screening and brief interventions for alcohol misuse (4, 28, 42, 71, 89, 99, 104).

**APPROACHES TO CONTROLLING INJURIES**

Controlling injuries involves changing the environment, individual behavior, products, social norms, legislation, policy, and ecology related to injury. Figure 7 illustrates how these different approaches are reflected in preventing injuries, and how each can converge with the others to amplify their effects.

**Structural Approaches**

Although structural strategies that require little or no action on the part of individuals are often preferred (109), these strategies are not always affordable or feasible to implement. Product modifications (such as machinery guards) and environmental changes (such as adding lifeguarding to pools and oceans, and building bike lanes, pool fencing) often afford the greatest protection to the population, but an adolescent's individual choices and behaviors can, and often do, override these protections (35, 37).

**Behavioral Approaches**

Behavioral change should be seen as a necessary component of even the most effective structural, automatic, environmental, or engineering protections (36, 87). For example, bicycle and motorcycle helmets protect against head injury, but they must be fitted properly and used consistently. Life jackets can prevent drowning, but must be worn. Strong laws against speeding and drunk driving must be adopted, enforced, and adhered to by drivers. Effective injury prevention always involves both behavioral (active) and environmental (passive) countermeasures—it is never an either/or proposition (81, 87).

**Legislation and Policy Approaches**

Although adolescent behaviors can be changed by introducing a law or policy that mandates compliance—such as requiring protection when operating industrial machinery or requiring helmet use (31, 84)—legislation must be supported by the public and enforced by local authorities (82). Other policy approaches that have proven effective for preventing motor vehicle injuries among adolescents as well as other drivers include primary seat belt use laws (where one can be cited for nonuse as a primary offense), enhanced police enforcement, 0.08 blood alcohol level laws, minimum legal drinking age 21 laws, sobriety checkpoints, and zero tolerance laws for young and inexperienced drivers (113). Policy changes that discourage early adolescent driving, such as rising insurance costs, expensive driving schools, and GDL laws, have already reduced the proportion of 16-year-olds who hold a driver’s license from nearly 43.8% in 1998 to 29.8% in 2006 (25).

**Ecological Approaches**

The most effective injury prevention efforts are structured within an ecological framework, focusing on individual modifiable factors and family, peer group, work site, and community and sociocultural factors simultaneously (3, 62, 88). For example, legislation requiring bicycle helmet use should be accompanied by an educational campaign for children and parents, police enforcement in the community, and discounted sales of helmets by local merchants (1, 41). Programs addressing the safety of employees can also be extended to focus on the safety of other family members such as adolescents on and off the job. Ecological approaches
emphasize tailoring specific interventions to the cognitive and physical skills of adolescents and to the social world in which they live (9). Local enforcement of laws designed to protect adolescents is an important ecological factor in prevention. Significant overlap exists among these strategies, as depicted in Figure 7. Ecological changes have an influence on legislation and behavior; structural changes have an effect on behavior and ecology. Legislative changes affect behavior, structures, and ecology. There is no single strategy to resolve this problem. Strategies work best when combined.

SUMMARY
Unintentional injuries are the largest source of premature morbidity and mortality among adolescents and are the leading cause of death. Motor vehicle injury represents the biggest injury burden to young people. Other major causes of unintentional injuries include drowning, poisonings, and fire and burns. Alcohol is an important cross-cutting predisposer. School, sports, and work are important settings where injuries to adolescents commonly occur.

No single solution exists to prevent adolescent injuries. Ecological, structural, behavioral legislative, and policy approaches that consider the interactions between people and their environments are necessary. Injury policy development, education and skill building, laws and regulation, family, school, community, workplace, home-based strategies, and enforcement are all important elements of a comprehensive approach to prevent unintentional injuries. Families and schools, adolescents themselves, community organizations and agencies, and businesses can collaborate to develop, implement, and evaluate interventions to reduce the major sources of injuries among adolescents.

Implementing known and effective prevention strategies such as using seat belts and bicycle and motorcycle helmets, installing residential smoke alarms, reducing misuse of alcohol, strengthening GDL laws, promoting policy change, using safety equipment in sports and leisure, and protecting adolescents at work will all contribute to reducing injuries. The frequency, severity, potential for death and disability, and costs of these injuries, together with the high success potential of prevention strategies, make injury prevention a key public health goal to improve adolescent health in the future.

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Figure 1
Leading causes of unintentional injury deaths (number and percent), ages 10–14, all races, both sexes, United States, 2006. Total percentage will not add to 100 because 6.2% of deaths were due to other injuries (not included in this graph). Other injury deaths include natural/environmental, struck by or against an object, other pedal cyclist, machinery, cut or pierce, other specified (classifiable or not elsewhere classified), and unspecified deaths. Source: CDC (24)

Figure 2
Leading causes of unintentional injury deaths (number and percent), ages 15–19, all races, both sexes, United States, 2006. Total percentage will not add to 100 because 3.1% of deaths were due to other injuries (not included in this graph). Other injury deaths include natural/environmental, struck by or against an object, other pedal cyclist, machinery, cut or pierce, other specified (classifiable or not elsewhere classified), and unspecified deaths. Source: CDC (24)
Figure 5
Average annual number of deaths due to motor vehicle traffic and all unintentional injuries among adolescents by age in years, United States, 2000–2006. Source: CDC (24).
Figure 6
Coverage and quality ratings of state graduated driver licensing (GDL) systems for young drivers, as of April 2009. From the Insurance Institute for Highway Safety (46).
Figure 7

Approaches to controlling adolescent injuries.

- Graduated driver licensing laws
- Zero alcohol tolerance for young drivers
- Good driver insurance discounts
- Helmet laws
- Workplace safety regulations

- Community standards
- Social and cultural norms
- Peer relations
- Family and workplace practices
- Law enforcement

- Using sport safety equipment
- Putting on seat belts and helmets
- Wearing life jackets
- Not using cell phone or texting while driving

- Rollover protection on tractors
- Swimming pool fencing
- Sidewalks and bike lanes
- Machine guards and automatic shut-off devices

- Structural
- Ecological
- Behavioral
- Legislation/policy
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