Chapter 5

ACCIDENTAL INJURIES: PREVENTION AND SERVICES

Contents

Figures

Tables

Chapter 5

ACCIDENTAL INJURIES: PREVENTION AND SERVICES[1]

Introduction

Broadly speaking, injuries to adolescents are of two general types, accidental (or unintentional) injuries[2] and nonaccidental injuries such as those inflicted in suicide attempts or assaults.[3] Accidental injuries are responsible for more deaths to American adolescents than any other problem, causing more than half of all deaths to persons ages 10 to 19[4] (see figure 5-l). In 1987, 55 percent of all deaths to persons ages 10 to 19 were due to accidental injuries (93). That year, 10,658 U.S. adolescents ages 10 to 19 died from accidental injuries (93). Many more adolescents experienced accidental injuries that caused visits to physicians' offices or hospital emergency rooms, temporary or permanent disability, restricted-activity and school-loss days, and other problems. This chapter reviews information on the problem of accidental injuries for U.S. adolescents, the factors associated with accidental injuries among adolescents, consequences of accidental injuries, and the effectiveness of different strategies to prevent accidental injury. The chapter also describes major Federal Government policies and programs pertaining to accidental injuries.

Background on Accidental Injuries Among Adolescents

Sources of Data on Accidental Injuries

No single source of information provides comprehensive data on the cause, nature, and severity of injuries among the U.S. population (58). Particularly lacking are detailed data on injuries that do not result in death.[5][6]

National data on injuries currently have to be gathered from the National Center for Health Statistics in the U.S. Department of Health and Human Services (DHHS), the National Highway Traffic Safety Administration (NHTSA) in the U.S. Department of Transportation, and other sources. These sources offer data that include:

- mortality data based on death certificates,
- national, population based, health survey data,

[1]This chapter is based, in part, on a background paper on unintentional injuries prepared for OTA (66). O'IA, however, takes full responsibility for the use of information in this chapter, and for the use of the phrase "accidental injuries" rather than "unintentional injuries. "

[2]To make this Report more accessible to the lay reader and for other reasons, OTA has chosen to use the term accidental injury in this Report. The term preferred by those in the injury prevention community, however, is unintentional injury (e.g., 66).-Those who prefer the term unintentional injury believe that the term accidental injury implies that injuries cannot be prevented, whereas the term unintentional injury implies that while an individual may not have consciously intended to hurt him or herself, some action taken or not taken may have prevented the injury. Perhaps to overstate this perspective somewhat, all injuries are avoidable. The position that true "accidents' do not occur (i.e., by chance, entirely without cause) correctly brings attention to injuries as a public health problem to which additional preventive interventions can and should be applied, but it seems to be unprovable. Use of the term unintentional also may have the unfortunate effect of placing the onus of causation (and responsibility for precautions) exclusively on the person who is injured, although in fact unintentional injuries may be caused unintentionally, by persons, organizations, or systems other than the victim.

[3]Information on adolescent suicide is presented in ch. 11, "Mental Health Problems: Prevention and Services,'' in this volume. Information in homicide among U.S. adolescents is presented inch. 13, "Delinquency: Prevention and Services," in this volume, and inch. 18, "Issues in the Delivery of Services to Selected Groups of Adolescents, ' in Vol. III.

[4]The focus of this OTA Report is on adolescents ages 10 through 18. There is no single agreed-upon definition of adolescents, however, and much of the data reported in this chapter is for individuals ages 10 through 19, because data obtained from the National Center for Health Statistics on causes of death for adolescents are reported using age breaks of 10 to 14 and 15 to 19. Differences in Federal agencies' definitions of adolescence are discussed inch. 19, "The Role of Federal Agencies in Adolescent Health,'' in Vol. III.

[5]There are relatively more data available on injuries related to motor vehicle crashes because of the efforts of the National Highway Traffic Safety Administration (NHTSA) and the Insurance Institute for Highway Safety, both of which have a mandate to study automobile injuries (47).

[6]The National Center for Health Statistics is currently working on merging and expanding its health care surveys (87a). Designed to include a patient followup component and linkage with the household interview survey, the new National Health Care Survey will generate data that will permit analysis of patient outcomes, the relationship between uses of health services and health characteristics, and the use of health care at the local level (87b). As discussed further in app. C, "Issues Related to the Lack of Information About Adolescent Health and Health and Related Services, " in Vol. I of this Report (76a), oversampling of adolescents and their use of health services is also *required to* improve the Nation's knowledge base about adolescent health.

- health care services utilization data (e.g., hospital discharge abstracts, hospital emergency room reports, and surveys of office-based physicians), and
- traffic accident data (78).[7]

In addition to national sources of data on injuries, there are a number of smaller, local or regional studies that provide data on injuries. The generalizability of data from these smaller studies is limited. In the aggregate, however, these studies do provide some useful information about accidental injuries among adolescents.

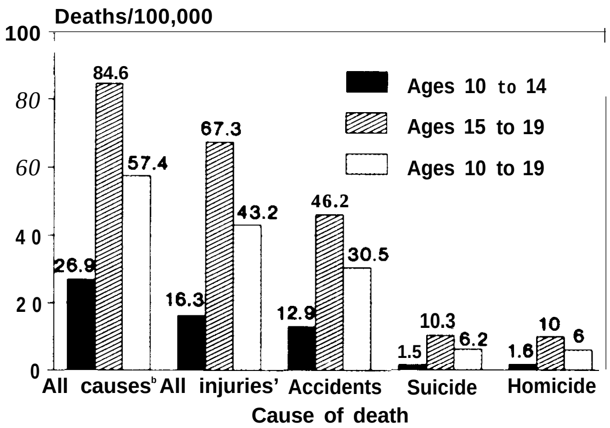
Trends in the Incidence and Prevalence of Accidental Injuries Among Adolescents

Injury Deaths and Death Rates

Over time, the prominence of accidental and other injuries as a cause of death for young people has increased, in part because of the significant decrease in the numbers of deaths associated with infectious disease (78,88). *Injury death rates* for adolescents ages 10 to 14 decreased from 23.6 deaths per 100,000 in 1950 to 16.3 per 100,000 in 1987, but the rates for adolescents ages 15 to 19 actually increased over the same period, from 55.6 deaths per 100,000 to 67.3 per 100,000 (65,93). *Accidental injury death rates* for adolescents declined between 1970 and the mid-1980s. But between 1986 and 1987, they leveled off for 10- to 14-year-olds and increased for 15- to 19-year-olds (see figure 5-2).

In 1987, approximately half of *all* deaths-and more than two-thirds (70 percent) of *injury* deaths-among U.S. adolescents ages 10 to 19 were due to accidental injuries (see figure 5-1 and table 5-l). The percentage of injury deaths that are accidental changes during adolescence. In 1987, for example, 79 percent of *injury* deaths among adolescents ages 10 to 14 were accidental, but 69 percent of the injury deaths for adolescents ages 15 to 19 were accidental.

Figure 5-l-Death Rates Among U.S. Adolescents Ages 10 to 14 and Ages 15 to 19, by All Causes and External Causes of Death, 1987



[a]Although this OTA Report focuses on adolescents ages 10 to 18, the data here are for 5-year age groups and therefore include 19-year-olds.
[b]"All causes" includes injuries and diseases. The rates at which causes of death other than injuries occurs in the adolescent population are relatively small-e. g., malignant neopfasms, the next highest cause of death after injuries, occurs in 10- to 19-year-olds at a rate of 3.7 per 100,000 adolescents ages 10 to 19.
[c]"All injuries" includes accidents, suicide, homidde, and other injuries.

SOURCE: Office of Technology Assessment, 1991, based on U.S. Department of Health and Human Services, Public Health service, Centers for Disease Control, National Center for Health Statistics, unpublished 1987 mortality rates, Hyattsville, MD, 1990,

Health Survey Data on Injuries

Data on injuries available from the National Health Interview Survey[8] (NHIS) conducted by the National Center for Health Statistics in DHHS indicate that each year about 30 percent of U.S. children and adolescents ages 5 to 17 experience an injury (92), NHIS does not provide separate breakdowns for accidental and intentional injuries.

Data from the 1988 NHIS indicate that injuries accounted for 18 percent of restricted-activity days[9] reported for adolescents ages 10 to 18 in 1988 (93). Adolescent males had more injury-related restricted-activity per 100 adolescents than adolescent females.[10]

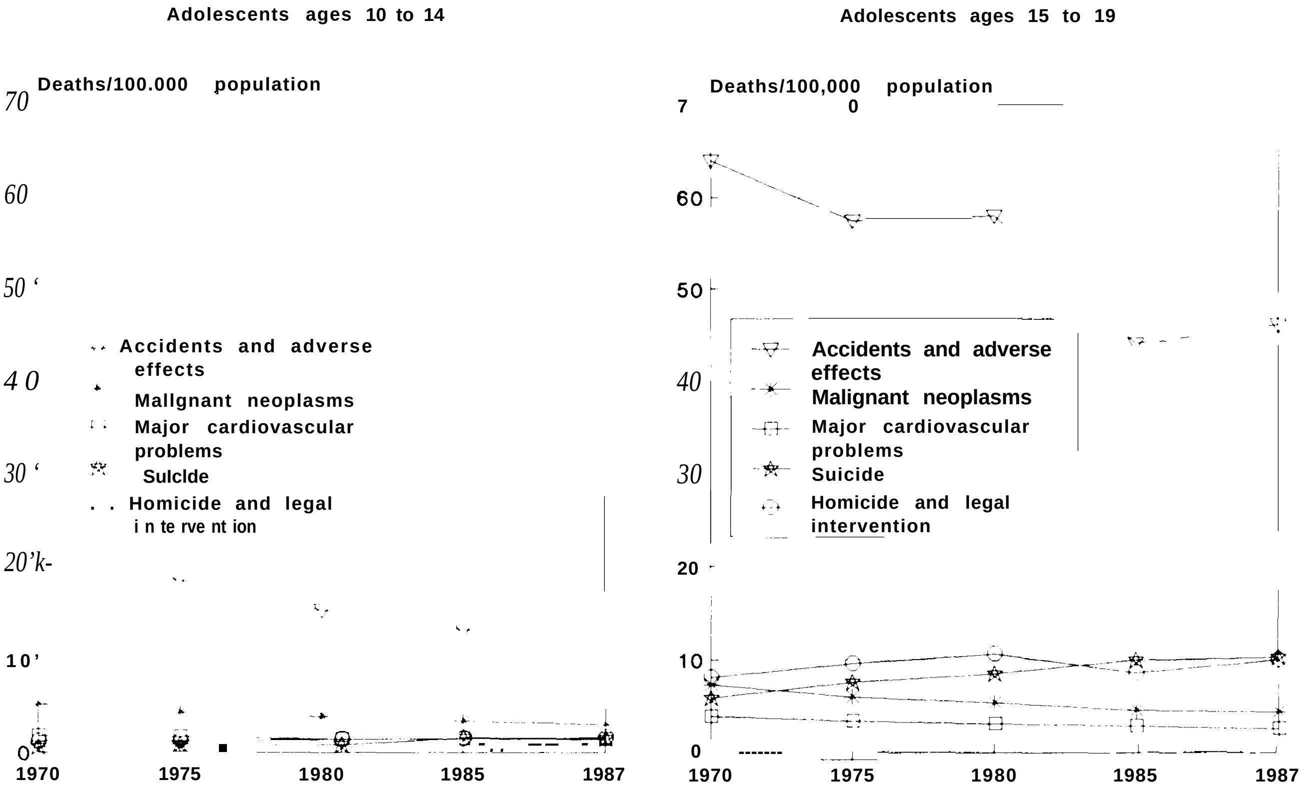
[7]Several Federal sources of &h on physical health of U.S. adolescents are described in box 6-B in ch. 6, "Chronic Physical Illnesses: Prevention and Services," in this volume.

[8]The National Health Interview Survey collects data on children and adolescents up to age 17 from their parents, usually their mothers.

[9]As defined by the National Health Interview Survey conducted by DHHS, a *restricted-activity day* is any day on which a person cut her usual activities for more than one-half day because of an illness or an injury. Restricted-activity days are unduplicated counts of bed-disability days, work-loss days, and school-loss days, and other days on which a person cuts down on his or her usual activity (92).

[10]See table 6-5 in ch. 6, "chronic Physical Illnesses: Prevention and Services," in this volume for data on restricted-activity days associated with injuries.

Figure 5-2—Death Rates for the Five Leading Causes of Death Among U.S. Adolescents Ages 10 to 14 and Ages 15 to 19, 1970-87



SOURCE: Office of Technology Assessment, 1981, based on U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Center for Health Statistics, *Vital Statistics of the United States 1970, Vol. II—Mortality* (Washington, DC: U.S. Government Printing Office, 1974); U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Center for Health Statistics, *Vital Statistics of the United States 1975, Vol. II—Mortality* (Washington, DC: U.S. Government Printing Office, 1979); U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Center for Health Statistics, *Vital Statistics of the United States 1980, Vol. II—Mortality*, Pub. No. (PHS) 85-1101 (Washington, DC: U.S. Government Printing Office, 1985); U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Center for Health Statistics, *Vital Statistics of the United States 1985, Vol. II—Mortality*, Pub. No. (PHS) 88-1102 (Washington, DC: U.S. Government Printing Office, 1987); and U.S Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Center for Health Statistics, unpublished 1987 mortality data, Hyattsville, MD, 1990.

School-loss days are a subset of restricted-activity days *(92).*[11] *NHIS* data indicate that injuries were responsible for 8.5 percent of school-loss days associated with acute conditions among adolescents ages 10 to 17 in 1988 (93).[12] Again, adolescent males had higher rates of school-loss days associated with injuries than adolescent females.

Injury-Related **Health Services Utilization**

According to data from the 1985 National Ambulatory Medical Care Survey conducted by the National Center for Health Statistics in DHHS, some 8,177,000 visits to private office-based physicians' offices by adolescents ages 10 to 18 in 1985 were for a diagnosis of injury or poisoning, accounting for

[11] As defined by the National Health Interview Survey conducted by DHHS, a *school-loss day* is any day on which a child did not attend school for at least half of his or her normal school day because of a specific illness or injury (92). School-loss days are determined only for children 5 to 17 years of age, beginning in 1982.

[12] See table 6.6 in ch. 6, "Chronic Physical Illness: Prevention and Services," in this volume for data on school-loss days associated with injuries.

Table 5-l-Average Annual Accidental Injury Deaths and Death Rates Among U.S. Adolescents Ages 10 to 14 and Ages 15 to 19, 1984-86

	Ages 10 to 14		Ages 15 to 19	
	Deaths	Rate (per 100,000)	Deaths	Rate (per 100,000)
Vehicle-related:				
Motor vehicle occupant	458	2.69	3,770	20.18
Drivers	56	0.33	2,094	11.21
Passengers	402	2.36	1,676	8.97
Motorcycles	87	0.51	639	3.42
Pedestrians	294	1.72	515	2.76
Bicycles	219	1.28	142	0.76
Other &vehicle unspecified	203	1.19	1,526	8.17
Other:				
Drowning	280	1.64	566	3.03
Firearms	169	0.99	248	1.33
Fires/burns	174	1.02	238	1.27
Falls	39	0.23	143	0.77
Other accidental	324	1.90	752	4.02
Total accidental	2,248	13.18	8,537	45.69

SOURCES: U.S. Department of Commerce, Bureau of the Census, *Current Population Reports, Series P-25, No. 1000, Estimates* of the *Population of the United States by Age, Sex, and Race: 1980 to 1986* (Washington, DC: U.S. Government Printing Office, 1987); U.S. Department of Health and Human Services, Public Health Service, National Center for Health Statistics, *Vita/ Statistics of the United States, Volume //, 1984-1986 Mortality, Part A* (Washington, DC: U.S. Government Printing Office).

16.3 percent of adolescents' visits to physicians' offices (89).[13] Presumably, many adolescents with injuries are treated at home, in clinics, by athletic trainers, or in emergency rooms. Data from hospital emergency rooms on visits associated with a range of consumer products are discussed below (79,80, 81).[14]

The National Hospital Discharge Survey, also conducted by the National Center for Health Statistics within DHHS, reports that in 1987 injuries and poisonings together were the most frequent reasons for adolescents' hospitalizations (91).[15] In 1988, injuries and poisonings accounted for approximately 31 percent of hospitalizations of adolescent males ages 10 to 14 and 42 percent of hospitalizations of males ages 15 to 18 (91). The percentage of hospitalizations due to injuries for adolescent females that year was lower; injuries accounted for approximately 26 percent of hospitalizations of 10- to 14-year-old females and 9 percent of hospitalizations of 15- to 18-year-old females. It is not possible to distinguish accidental from nonaccidental injuries in hospital discharge data (91).[16]

Specific Types of Injuries Among Adolescents

Information on the causes of *fatal injuries* to adolescents is available from the Vital Statistics System of the National Center for Health Statistics in DHHS. As shown in figure 5-3, about three-fourths of accidental injury deaths among U.S. adolescents ages 10 to 19 in 1984 to 1986 resulted from vehicle-related accidents (99,100,101). Deaths from vehicle-related accidents include deaths among drivers and passengers in cars, all-terrain vehicles (ATVs), and bicycles. Drowning is also a significant cause of accidental death among adolescents, ac-

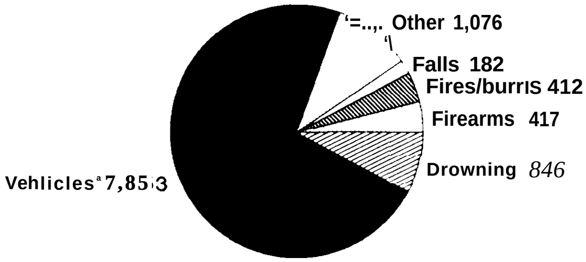
[13]See table 6.3 inch. 6, "Chronic Physical Illnesses: Prevention and Services, " in this volume for data on office visits to physicians associated with injury and poisoning. The National Ambulatory Medical Care Survey does not provide a breakdown of visits by type of injury (i.e., accidental or intentional), Furthermore, the number of visits for injury is undoubtedly higher than the number of individual patients, making a count of individual adolescents difficult.

[14]See section below entitled "Specific Causes of Injury Among Adolescents."

[15]See table 6-2 in ch. 6, "Chronic Physical Illnesses: Prevention and Services, " for data on hospital discharges associated with injuries among adolescents.

[16]More complete information on the diagnoses involved in adolescents' visits to physicians' offices and hospitalizations can be found in ch. 6, "Chronic Physical Illnesses: Prevention and Services," in this volume.

Figure 5-3-Accidental Injury Deaths by Cause Among U.S. Adolescents Ages 10 to 19, 1984-86



[a]This category includes deaths among drivers, passengers, and pedestrians; and includes cars, trucks, all-terrain vehicles, motorcycles, bicycles, and other and unspecified motor vehicles. Differences by type of vehicle and age are reported in table 5-1.

SOURCE: Office of Technology Assessment, 1991, based on U.S. Department of Health and Human Services, Public Health Service, National Center for Health Statistics, *Vital Statistics of the United States—Vol. II, Mortality* (Washington, DC: U.S. Government Printing Office, various years).

counting for nearly 8 percent of accidental injury deaths (see figure 5-3). Other important causes of accidental injury deaths among adolescents are firearm accidents, fires/burns, and falls.

Comprehensive national data on *nonfatal* accidental injuries are not available. Neither NHIS nor the National Hospital Discharge Survey nor the National Ambulatory Medical Care Survey obtains information on the causes of such injuries.

One source of cause-specific data on health services utilization related to injuries is the U.S. Consumer Product Safety Commission's National Electronic Injury Surveillance System, conducted in U.S. emergency rooms (80). This survey is limited, however, in that it excludes motor vehicles and firearms from its purview. Data from a review by the U.S. Consumer Product Safety Commission of the top 20 leading consumer products associated with accidental injuries resulting in emergency room treatment for adolescents ages 10 to 18 in 1988 reveals that the vast majority of such injuries are associated with recreational activities (see table 5-2) (80). Among the leading categories of products are those involved in basketball, football, baseball, skateboarding, wrestling, roller skating, or bicycling. Injuries are reported both for organized and informal activities (80).

Photo credit: Education Week

Sports, including organized sports, are a leading cause of nonfatal injuries among adolescents. According to data from the U.S. Consumer Product Safety Commission's surveillance system, football accounted for nearly 236,000 visits to hospital emergency rooms in 1988.

Local studies provide additional information about the causes of nonfatal injury to adolescents. In a statewide study in Massachusetts,[17] sports injuries accounted for the greatest number of injuries in adolescents ages 13 to 19 that resulted in medical treatment (32). This study estimated that 1 in 14 adolescents ages 13 to 19 required hospital treatment for sports injury and 20 percent of these injuries were from football (32). The authors suggest that because of the methodological limitations of their study, these figures should be considered minimal injury rates.

A more detailed discussion of motor-vehicle-related injuries, drowning, firearm-related injuries, and injuries associated with sports and recreational activities (e.g., football, bicycling) is presented below.

Motor-Vehicle-Related Injuries

National data indicate that vehicle-related injuries are the leading cause of accidental injury deaths among U.S. adolescents ages 10 to 19. Fatal motor vehicle injuries account for the largest proportion of

[17]This study collected data on fatal and nonfatal unintentional injuries to a sample of over 5,000 children and adolescents ages 0 to 19 in Massachusetts over a 1-year period as part of the Massachusetts Statewide Childhood Injury Prevention Program Surveillance System (32). Adolescents ages 13 to 19 made up about half of the sample.

Table 5-2—Top 14 Consumer Products[a] Related to Accidents Leading to Hospital Emergency Room Visits Among U.S. Adolescents Ages 10 to 18, 1988

Consumer product	Number of emergency room visits
Basketball..	244,166
Organized	81,176
Informal	26,850
Not specified	136,140
Football	235,853
Organized	110,253
Informal	28,174
Not specified	97,426
Bicycles or accessories	182,031
Baseball	109,920
Organized	47,463
Other	62,457
Stairs or steps	102,297
Knives, not elsewhere classified	57,774
Soccer	54,820
Organized	27,025
Other..	27,795
Skateboards	50,095
Floors or flooring materials	46,846
Nails, screws, carpet tacks, or thumbtacks	43,600
Doors, not specified	41,738
Ceiling and walls	37,301
Roller skating (activity, apparel or equipment)	31,729
Wrestling (activity, apparel, or equipment)	30,990

[a]The U.S. Consumer Products safety Commission keeps track of injuries associated with activities that involve the use of consumer products, although every injury is not directly caused by the product. They do not collect data on accidents involving motor vehicles orfirearms.

SOURCE: U.S. Consumer Product Safety Commission, unpublished 1988 data from the National Electronic Injury Surveillance System, 1989.

Photo credit: Bethesda Chevy Chase Rescue Squad

Drowning is the second leading cause of accidental injury deaths for adolescents; black adolescent males are particularly at risk.

fatal vehicle-related injuries among U.S. adolescents, especially 15- to 19-year-olds (table 5-1).[18] Drivers ages 16 to 19 represent only 6 percent of licensed drivers but account for 13 percent of all fatal motor vehicle crashes (110). Adolescent drivers are at greatest risk of becoming involved in a motor vehicle crash when they drive at night. Although adolescent drivers do only 20 percent of their driving at night, they suffer more than half their crash fatalities during nighttime hours (42,123). In 1988, half of all fatal crashes involving drivers ages 15 to 17 took place between the hours of 4 p.m. and midnight (1 10).[19] The nighttime fatality rates for adolescent males exceed those for females by more than two to one (122,123). Most motor vehicle crashes involving adolescents take place on the weekend. In 1988, adolescent drivers ages 15 to 17 were most frequently involved in fatal crashes on Fridays or Saturdays; 40 percent of fatal crashes took place on one of these days. Another 16 percent took place on Sunday (110).

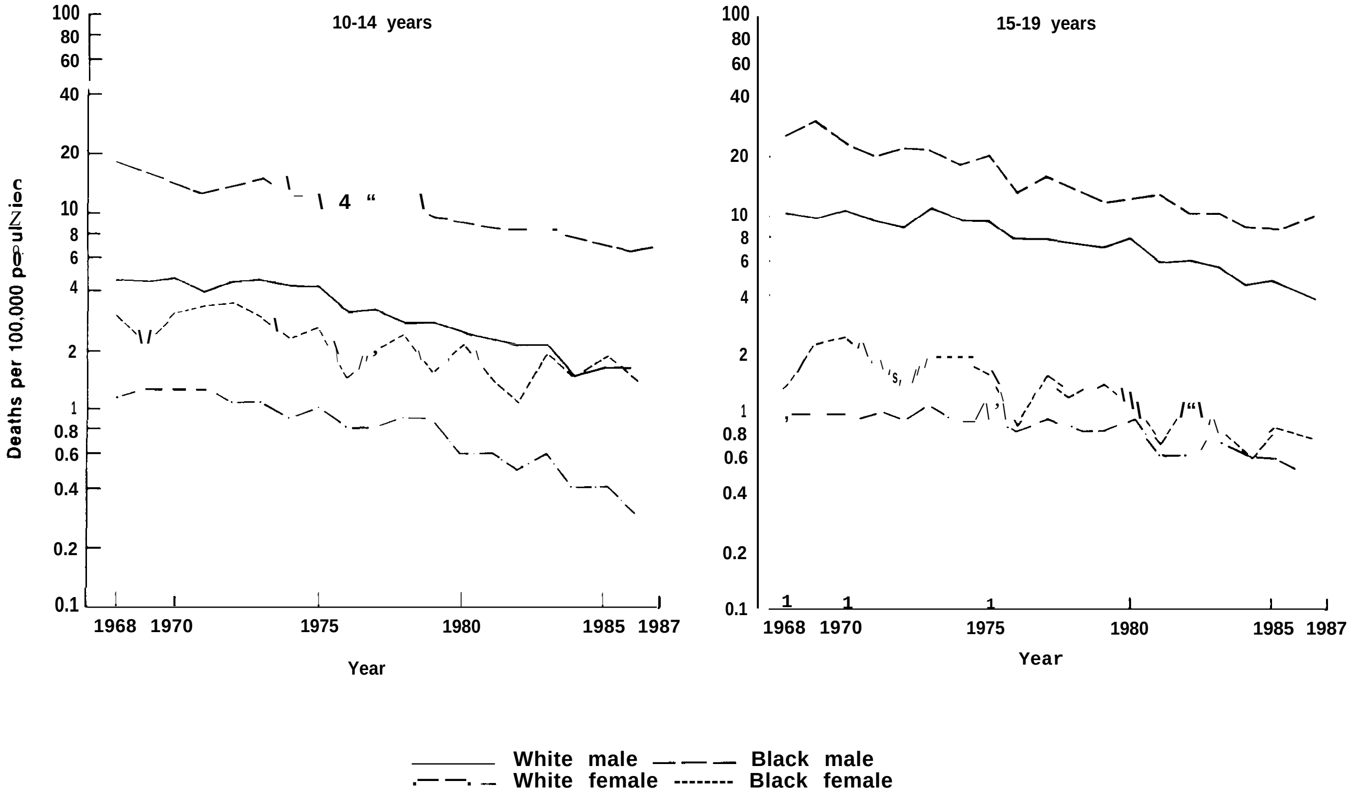
Alcohol consumption is a risk factor for automobile crashes for persons of all ages, but it appears that adolescents may be at even greater risk than adults of becoming involved in a motor vehicle crash if they drive after consuming alcohol (42). The National Highway Traffic Safety Administration (NHTSA) in the U.S. Department of Transportation reports that about half of the motor vehicle crash fatalities among adolescents ages 15 to 19 are related to alcohol, and about a quarter of fatally injured drivers ages 15 to 19 are intoxicated at the time of their accident (116). Interestingly, however, drivers ages 16 to 19 are less likely than older drivers (e.g., those ages 20 to 24) to have consumed alcohol prior to involvement in a crash. Furthermore, in alcohol-related crashes, the average blood alcohol content is lower for the fatally injured adolescent driver than for the fatally injured adult driver (42,1 10). This suggests that it takes less alcohol for the adolescent driver to be at risk for a serious or fatal motor vehicle crash (42,104,1 17,1 18).[20]

[18]Bicycle and ATV-related injuries are discussed in the section below on sports and recreational injuries.

[19]Another 18 percent of fatal crashes took place between the hours of noonand 4 p.m. (110).

[20]Risk factors, prevention and treatment for alcohol and other drug abuse are discussed in ch. 12, "Alcohol, Tobacco, and Drug Abuse: Prevention and Services," in this volume.

Figure 5-4-Drowning Deaths Among U.S. Adolescents Ages 10 to 14 and Ages 15 to 19, by Race and Gender, 1968-87



SOURCES: 1968-85 data: U.S. Department of Health and Human Services, Public Health Service, National Center for Health Statistics, 'Trends and Current Status in Childhood Mortality: United States, 1900-85," Vitaland *Health Statistics, Series* 3, No. 26, DHHS Pub. No. (PHS) 89-1410 (Washington, DC: U.S. Government Printing Office, 1989). 1987 data: U.S. Department of Health and Human Services, Public Health Service, National Center for Health Statistics, unpublished mortality data, Washington, DC, 1990.

Passengers of adolescent drivers are also at increased risk of being involved in a motor vehicle crash. The majority of adolescents killed as passengers are in vehicles driven by other adolescents (124). In addition, adolescents have been found to be disproportionately involved in the vehicle-related deaths of other nonadolescent drivers, passengers, and pedestrians (122,124).

Drowning

National data indicate that drowning is the second leading cause of accidental injury death among U.S. adolescents ages 10 to 19 (88,90). A review of national drowning rates indicates that the risk of drowning increases substantially during adolescence, before peaking during the early- to mid-twenties (84). Similar patterns have been reported in local studies in North Carolina (54) and in Maryland (25).

Death rates from drownin g are higher for adolescent males than for adolescent females. Furthermore, according to data from the National Center for Health Statistics in DHHS, black adolescents (particularly males) are at greater risk of drowning than their white counterparts (see figure 5-4).

The site of adolescent drowning is usually a lake, river, stream, pond, or canal rather than an ocean or swimming pool (54,126). This finding may reflect greater exposure time near these bodies of water or lower levels of supervision. Interestingly, however, the 10 to 19 age group accounted for half of all drownings in public or motel pools in a North Carolina study (54).

Alcohol is involved in close to 40 percent of adolescent drownings (39,53,54,126). Alcohol may impair judgment of the adolescent in a dangerous situation. It also may decrease the likelihood of struggling to get out of the water, thus increasing the chances of drowning (71).

Accidental Firearm Injuries

Accidental firearm injuries follow drownings as a cause of accidental injury death among adolescents ages 10 to 19 (see table 5-1 and figure 5-3). It is encouraging to note that death rates for accidental firearm-related injuries among adolescents ages 15 to 19 have recently been decreasing.[21] Accidental firearm-related death rates for adolescents ages 15 to 19 peaked in 1972 at a rate of 2.5 deaths per 100,000 population but declined to a low of 1,2 deaths per 100,000 in 1987 (29).

Accidental firearm deaths occur primarily among adolescent males. Accidental firearm-related death rates for adolescent males exceed rates for adolescent females by almost 8 to 1. Males ages 15 to 19 have the highest accidental firearm death rate (1.33 deaths per 100,000) of all other age groups. Adolescent males ages 10 to 14 have the third highest accidental firearm death rate (0.99 deaths per 100,000) (99,100,101). Racial differences among adolescent males vary somewhat by age. For males ages 10 to 14, the accidental firearm death rate is nearly twice as high for whites as for blacks (1.93 deaths per 100,000 v. 0.97 deaths per 100,000). Among 15- to 19-year-old males, rates are slightly higher among blacks than whites (2.56 deaths per 100,000 v. 2.31 deaths per 100,000) (29,99,100,101).

National data on nonfatal accidental firearm injuries among U.S. adolescents are unavailable (5).[22] A Massachusetts study found that accidental firearm injuries were a less common type of accidental injury among adolescents ages 13 to 19 presenting to hospital emergency rooms, with a rank order of 15 among all injuries (32).

Little is known about risk factors associated with accidental firearm injuries among U.S. adolescents, but adolescents' exposure to firearms appears to be quite high. Over 40 percent of the 8th and 10th graders surveyed in the National Adolescent Student Health Survey in 1987 reported that they had used a gun during the past year; of these, over 40 percent had used a gun more than 10 times (6). In general, the source of these firearms is unknown. However, the National School Safety Center reports that the overwhelming majority of weapons that have been confiscated in schools were obtained legitimately (e.g., from parents) (50a). About half the American households reported having a gun in 1989 (76).

Information on when and where accidental firearm-related deaths occur among U.S. adolescents is quite limited. In 1984, more than 30 percent of the fatalities of adolescents ages 10 to 14 that occurred in the home resulted from firearm injuries; this was a significantly higher percentage than for children in younger age groups (85). A study of a limited sample of 88 accidental firearm deaths among children through age 14 in California indicated that most of these deaths occurred while children were playing with a gun (127).

In rural areas, accidental firearm injuries may be associated with hunting. A study of accidental firearm fatalities in North Carolina indicated that 28 percent of accidental firearms deaths to adolescents ages 15 to 19 occurred while hunting (45). Another study of hunting-related accidental firearm injuries revealed that younger victims (ages 8 to 19) of hunting injuries were more likely than older hunters to engage in unsafe hunting practices, including carrying the gun incorrectly (21).

Sports and Recreational Injuries[23]

As noted above, sports and recreational activities appear to be a leading source of nonfatal adolescent injury. The U.S. Consumer Product Safety Commission has reported that, in fiscal year 1987, sports and recreational activities and equipment were responsible for nearly $2 billion in costs of hospital emergency room treatment for injuries to persons

[21] Unfortunately, however, adolescent death rates for homicide and suicide involving the use of firearms have continued to increase. See ch. 11, "Mental Health Problems: Prevention and Treatment" (suicides), and ch. 13, "Delinquency: Prevention and Treatment" (homicides), in this volume.

[22] Because firearms are not under the jurisdiction of the U.S. Consumer Product Safety Commission, data on firearm-related injuries are not included in the Commission's National Electronic Injury Surveillance System (78).

[23] For a general discussion of adolescent fitness, see ch. 7, "Nutrition and Fitness Problems: Prevention and Services," in this volume.

ages **5** to **24,** more than any other class of consumer products[24] (79).

Data from limited samples suggest that injury rates vary considerably by type of sport or recreational activity. A l-year study of 1,283 student athletes in grades 9 through 12 found that 22 percent sustained injuries during the year (43). Students playing football were most likely to experience an injury (61 percent of those participating), followed by females participating in gymnastics (46 percent), males participating in gymnastics (40 percent), wrestling (40 percent), and males' basketball (37 percent), Males, who made up 58 percent of the sample of student athletes, experienced nearly three-quarters of the injuries.

A study of sports injuries treated at the University of Rochester Section of Sports Medicine over a 7-year period found that these injuries peaked during ages 16 to 19; this age group was responsible for 45 percent of the cases seen (24). Overall, football was responsible for the greatest number of injuries. Knee injuries were most common for all sports.

Although the relationship between physical fitness and risk of injury has not been well studied, a limited study of 124 young men and 186 young women undergoing basic military training indicated that higher physical fitness may reduce the risk of certain types of less serious sports injuries. The authors conclude, however, that fitness probably has no effect on reducing severe or catastrophic injury (22).

Football-Related Injuries--Football is one of the most hazardous interscholastic athletic activities, accounting for 28 injuries per 100 participants per year in national samples (46,74).[25] In 1988, football-related injuries were responsible for nearly 236,000 visits to emergency rooms by adolescents ages 10 to 19[26] (see table 5-2) (80). About a third of high school football players experience an injury that keeps them out of practice or a game (20).

Between 1973 and 1980, 260 high school and college players died from football-related injuries. Improvements in helmet design reduced the frequency of head trauma during the late 1960s and early 1970s but resulted in greater use of the head for blocking. As a result, in the early 1970s there was an increased incidence of neck injuries, including injuries resulting in quadriplegic. In 1976, the National College Athletic Association and the National Federation of State High School Athletic Associations ruled to prohibit ' 'spearing' (using the head to strike an opponent while tackling), which poses particular risks for cranial and spinal cord injuries. Subsequently, the incidence of permanent quadriplegic resulting from football injuries declined from an average of 35 cases per year in 1971 to fewer than 10 per year as of 1986 (46,74).

A study examining the injury experience of 5,128 males ages 8 to 15 participating in 208 youth football teams found that 5 percent of the males sustained injuries during the football season (33). Of these, 61.4 percent were classified as moderate injuries, and 38.9 percent were classified as major injuries. Males on the oldest and heaviest teams in this age group (Junior Bantam teams) had the highest rates of injury (9.6 percent of males), and males on the smallest and youngest teams (Junior Pee Wee teams) had the lowest rate of injury (1.9 percent of males). About a third of the males experienced a fracture, the most common type of injury; another quarter sustained sprains. Most injuries (88.3 percent) resulted from contact with another player; 41 percent of injuries occurred during tackling. Over two-thirds of the injuries occurred during games or scrimmages as opposed to practices, and more injuries occurred at away games than home games. A higher prevalence of injury during practice as opposed to games has been reported by other researchers. For example, a study of 1,283 high school athletes, 179 of whom played football, indicated that about two-thirds of the football-related injuries occurred during practice. However, given the much greater amount of exposure experienced in practice rather than game episodes, it was calculated that game situations were actually more likely to produce an injury per unit of exposure (43).

It has been suggested that the elimination of kickoffs and punt returns could reduce the football-related injury rate because of the high incidence of

[24]The U.S. Consumer Product Safety Commission keeps track of injuries associated with activities that involve the use of consumer produc the injuries may not be caused directly by the consumer product.

[25]Higher rates have been reported in studies using more limited samples. For example, 61 percent of students playing football were reported to have sustained an injury in one study (43).

[26]This figure includes organized as well as informal football; organized football accounted for 110,253 visits to emergency rooms.

major injuries sustained during these plays (33). In addition, improvements could be made in the teaching methods for blocking and tackling to reduce the numbers of injuries caused by direct impact by helmets; this was a cause of 18 percent of football-related injuries in a study of injuries experienced by males ages 8 to 15 participating in youth football (33).

Bicycle-Related Injuries-Adolescents ages 10 to 17 accounted for 30 percent of all fatal bicycle accidents in the United States in 1988 (1 10). The majority of fatal bicycle accidents in 1988 (91 percent) occurred on roadways rather than at intersections or other locations (1 10). Among adolescents, the older the bicycle rider, the more likely it is that an injury will be the result of a collision with a motor vehicle; as many as 90 percent of all bicycling fatalities involve motor vehicles, and they are largely the result of head injuries sustained in the accident (41). For bicycle-related injuries requiring hospital admission, the injury is five times more likely to be the result of collision with a motor vehicle than the result of some other type of event (e.g., collision with another bicycle or falling off of a bike) (31).

Figures indicating alcohol involvement among adolescent bicyclists, specifically, do not exist. Alcohol testing is not done uniformly in the case of bicycle accidents, and little information exists about exposure to alcohol among noninjured bicyclists.

All-Terrain-Vehicle (ATV)-Related Injuries--ATVs have become a source of considerable controversy since their introduction in the United States in the 1980s. Originally designed as tractors for use in the flat, wet rice paddies of the Orient, these 3- or 4-wheel vehicles have been adopted for off-road recreational use in rough terrain (66). Instability of ATVs, some of which are capable of speeds as high as 70 miles per hour, is a major problem (66). In 1985, there were 238 documented deaths attributed to ATVs among persons of all ages (2,51). In 1988, ATVs were associated with 27,000 visits to emergency rooms by adolescents ages 10 to 18 (80).

Injuries from ATVs are primarily a consequence of hitting an obstacle or tipping over. Among all age groups, head injuries are responsible for 70 percent of the deaths involving ATVs and are the major cause of hospitalization (19,70). Helmets are used by less than 20 percent of the victims, despite clear evidence of their potential to reduce the incidence and severity of head injury (27,63,73,120).

Adolescents ages 12 to 15 account for 27 percent of accidents involving 3-wheel ATVs and 42 percent of those involving 4-wheel ATVs; adolescents and young adults ages 16 to 24 account for 35 percent of accidents involving 3-wheel ATVs and 19 percent of those involving 4-wheel ATVs (1,51). Males are involved in close to 80 percent of the cases, most likely a function of their greater exposure time relative to females.

As of March 1988, the U.S. Consumer Product Safety Commission had instituted a ban on the sale of 3-wheel ATVs and ruled that the sale of 4-wheel vehicles to minors be more closely controlled[27] (75). Nonetheless, because many previously purchased 3-wheel ATVs are still being used, nearly half of the emergency room visits by adolescents ages 10 to 18 in 1988 that were associated with ATVs occurred with 3-wheel ATVs (80).

Factors Associated With Accidental Injuries Among Adolescents

Factors associated with accidental injuries can be categorized as demographic factors, risk-taking behaviors, and stressful life events.

Demographic Characteristics

Demographic characteristics of adolescents that appear to be associated with differing rates of accidental injuries among adolescents include age, gender, and race/ethnicity. While these characteristics are not amenable to change and thus cannot be the targets of intervention or prevention efforts, this information is useful to identify groups at highest risk.

Age~Children at different developmental stages experience different types of injuries (59). Thus, adolescents can be expected to have different patterns of experience with injury than younger children or adults, and older adolescents experience different patterns of injury than younger adolescents. For example, adolescents experience much higher rates of motor vehicle occupant injuries, bicycle injuries, and sports injuries than younger

[27] *U.S.A. v. Polaris Industries,* **LP.** *87-3525* **GAG (108).**

children, but young children are more likely to experience pedestrian accidents (32,59).

In addition, dramatic increases in the rates of accidental injury deaths occur during adolescence and early adulthood. For example, although the rate of death due to accidents in a recent year was 15.7 deaths per 100,000 population for adolescents ages 12 to 14, it was 55.8 deaths per 100,000 for those ages 15 to 17, and 93.3 deaths per 100,000 for those ages 18 to 19 (40). An evaluation of Massachusetts data also revealed differences between injury patterns for younger adolescents ages 13 to 15 and older adolescents ages 16 to 19 (9).[28] The older adolescents experienced higher rates of injury and more severe injuries than the younger ones; the older adolescents' rates of admission to hospitals due to injuries were 1.26 times higher than the younger adolescents' rates, and their death rates due to injuries were 1.50 times higher, Although the younger adolescents experienced more bicycle-related injuries, older adolescents experienced more injuries of other types, including motor vehicle occupant injuries, motorcycle injuries, burns, and deaths due to overexertion. Because 19-year-olds are likely to disproportionately contribute to the totals of injuries or deaths due to some types of accidents (e.g., motor vehicle crashes or accidents involving alcohol), figures presented in this chapter that include 19-year-olds may actually be higher than if 19-year-olds were excluded.

Gender—Adolescent males are at considerably higher risk of death from injury than adolescent females. Although there is some variation by cause of injury, total rates of injury death for males ages 10 to 19 exceed those for females by as much as 9 to 1 (see table 5-3). The magnitude of this difference is greater for older adolescents ages 15 to 19 than for those ages 10 to 14 (65). For example, the male-to-female ratio of deaths due to motor vehicle occupant injury for the years 1984 to 1986 was 1.3:1 for ages 10 to 14, compared with 2.1:1 for those ages 15 to 19; similarly, the male-to-female ratio for drowning deaths increases from 4.4: 1 forages 10 to 14, to 9.9:1 for ages 15 to 19.

Table 5-3-Male-to-Female Ratios of Injury Deaths Among U.S. Adolescents Ages 10 to 14 and Ages 15 to 19, by Selected Causes, 1984-86

	Age group	
Cause	10 to 14	15 to 19
Motor vehicle occupant	1.3:1	2.1 :1
Motorcycles	4.4:1	8.2:1
Pedestrians	1.7:1	2.4:1
Fires and burns	1.5:1	2.7:1
Falls	4.8:1	5.9:1
Drowning	4.4:1	9.9:1
Firearms-accidental	8.9:1	8.9:1
Suicide	3.2:1	4.4:1
Firearms..	3.6:1	5.8:1
Homicide	1.5:1	3.2:1
Firearms..	2.6:1	5.0:1

SOURCE: U.S. Department of Health and Human Services, Public Health Service, National Center for Health Statistics, *Vital Statistics of the United States, Volume II—Mortality, Part A* (Washington, DC: U.S. Government Printing Office, various years).

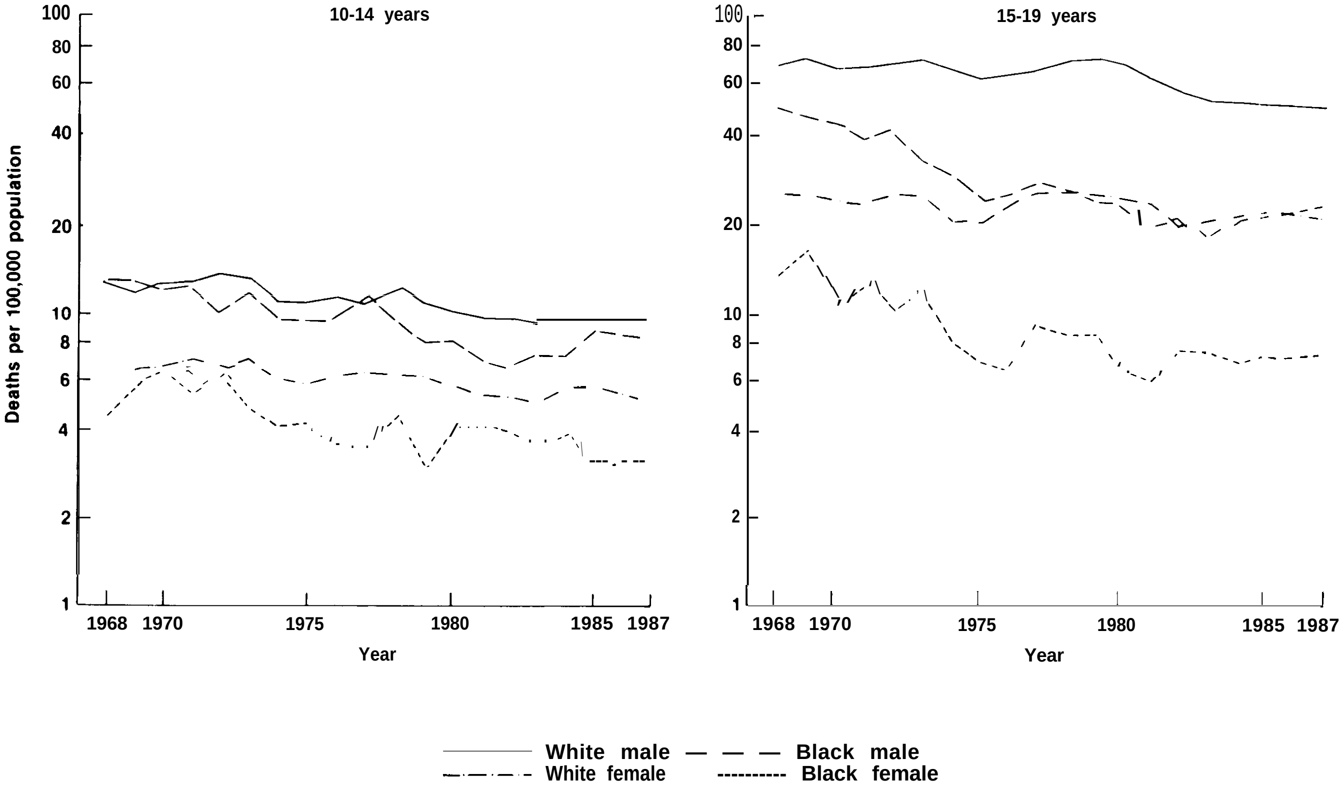
It is impossible, because appropriate data are not systematically collected, to determine the extent to which differences between adolescent males and females in accidental injury rates are a function of differing exposure to situations where injuries may occur, or to differing susceptibility based on some other factor. There is some evidence that males tend to engage more in behaviors that put them at higher risk of injury. For example, the 1987 National Adolescent Student Health Survey of 8th and 10th graders found that 71 percent of males v. 48 percent of females rode a motorcycle or minibike during the past year; 32 percent of males v. 20 percent of females swam alone; 71 percent of males v. 46 percent of females drove or rode a go-cart, snowmobile, or ATV; and 64 percent of males v. 19 percent of females used a gun during the past year (6). These data suggest that adolescent males, and the high risk activities that males engage in, should be prime targets of preventive interventions.

Race and Ethnicity—Race and ethnicity are sometimes, but not always, differentially associated with accidental injury deaths among U.S. adolescents.[29] For example, the 1986 rate of accidental injury death for black adolescents ages 10 to 14 was 14.7 deaths per 100,000, as compared with 13.0 deaths per 100,000 for white adolescents ages 10 to 14 (40). The 1986 rate of accidental injury death for black adolescents ages 15 to 19 was 27.9 deaths per 100,000, as compared with 52.6 deaths per 100,000 for whites (40). These overall rates consist largely of

[28] Data reported by Bass and colleagues *(9)* were collected from Sept. 1, 1979 through Aug. 31, 1982.

[29] The extent to which racial and ethnic differences reflect factors associated with socioeconomic status is not known. See ch. 18, "Issues in the Delivery of Services to Selected Groups of Adolescents," in Vol. III for discussion.

Figure 5-5-Motor Vehicle Accident Deaths Among U.S. Adolescents Ages 10 to 14 and Ages 15 to 19, by Race and Gender, 1968-87



SOURCES: 1966-85data: U.S. Department of Health and Human Services, Public Health Service, National Center for Health Statistics, 'Trends and Current Status in Childhood Mortality: United States, 1900-85," *Vital and Health Statistics*, Series 3, No. 26, DHHS Pub. No. (PHS) 89-1410 (Washington, DC: U.S. Government Printing Office, 1989). 1987 data: U.S. Department of Health and Human Services, Public Health Service, National Center for Health Statistics, unpublished mortality data, Washington, DC, 1990.

motor vehicle accident-related deaths. As noted above, black adolescents are somewhat more likely than white adolescents to die as a result of drowning. As shown in figure 5-5, motor vehicle accident deaths declined somewhat for black male and female adolescents between 1968 and 1987, although recently, death rates have leveled off.

Native American adolescents ages 10 to 19 are at particularly high risk for injury, experiencing death from accidental injury at over twice the rate of blacks or whites. In 1986, Native American adolescents ages 10 to 14 experienced injury deaths at a rate of 33.2 per 100,000; Native Americans ages 15 to 19 experienced injury deaths at a rate of 108.4 per 100,000 (12). There are several explanations for the higher rates of injury among Native Americans (77). Because a high proportion of Native Americans live in rural areas, they are less likely to be discovered quickly if they crash, and, once injured, they may not have speedy access to trauma centers for treating emergencies. Also, because alcohol cannot be legally purchased on reservations, many Native Americans travel some distance in order to drink, thus increasing the number of miles that they drive under the influence of alcohol if they drive home after consuming alcohol.

There are few data on injuries among other racial and ethnic groups of adolescents. According to *The Injury Fact Book*, when all ages are considered together, Asians have the lowest rates of injury (8a). A recent analysis of childhood injury deaths found that Asians ages O to 14 had an overall injury death rate equivalent to that of white children ages O to 1430 (117a). However, Asian children ages 0 to 14 were found to have higher death rates than average for pedestrian traffic deaths, drownings, and deaths resulting from falls (117a).

Other Demographic Factors--In the aggregate, both social class and rural v. urban locale have been shown to be associated with many types of injuries, but many of the specific relationships between these factors and injury among adolescents have not been well-investigated. Adolescents in rural areas have been found to be at higher risk of accidental injuries, in part because of work with farm equipment (43a). People who live in poverty, whether in rural or urban environments, are at greater risk for drowning, residential fires, and motor-vehicle-related deaths (8a). As noted elsewhere in this Report, existing data on the health status of poor adolescents and research on the health effects of poverty have severe limitations.[31]

Risk-Taking Behavior

Some adolescents engage in behaviors that potentially increase their risk of accidental injury. These include unsafe driving or bicycling practices (e.g., driving after consuming alcohol, not wearing safety belts, not wearing a helmet), participating in football or other contact sports, and not following water safety rules (e.g., swimming alone).[32]

Three types of risk-taking behaviors known to increase the risk of accidental death or injury are discussed below: alcohol or drug use, failure to use safety belts, and failure to use bicycle or motorcycle helmets.

Alcohol or Drug Abuse-Alcohol use is a major risk factor for all types of injury.[33] Alcohol affects the injury process in at least three ways. First, it impairs judgment, increasing the chances that the user wilI become involved in a potentially injury-producing situation (e.g., driving too fast, diving into shallow water); second, alcohol impairs the ability of the user to perform tasks necessary to avoid injury (e.g., negotiating a slippery curve while driving, Swimming to shore); and third, alcohol exacerbates the severity of injuries by inhibiting the ability of the body to withstand trauma (1 19).

In 1988, 3,158 adolescents ages 15 to 19 died in alcohol-related motor vehicle crashes (1 13). Data from the U.S. Department of Transportation's Fatal Accident Reporting System indicate that there have been significant decreases in driver alcohol involvement in fatal motor vehicle crashes since the early 1980s (116). In 1988, 12.1 percent of drivers under age 18 involved in fatal motor vehicle crashes had a blood alcohol content of 0.10 percent or greater, compared with 18.6 percent of drivers of that age in 1982 (1 10). Another 9.5 percent of the fatally injured drivers under age 18 in 1988 (and 11.4 percent in 1982) had a blood alcohol content between 0.01 and 0.09, suggesting that alcohol use below the usual legal limit is also associated with fatal accidents.

Alcohol is also frequently involved in fatal pedestrian and bicycle accidents; in 1988, 23.6 percent of victims of fatal pedestrian *or* bicycle accidents had a blood alcohol content of 0.10 percent or greater (1 10).

A review of blood alcohol levels measured in 41 adolescents ages 16 to 18 admitted to a trauma center following motor vehicle, bicycle, or pedestrian accidents in North Carolina revealed that 29 percent had measurable (although not legally prohibited) levels of blood alcohol (55).[35] Males were much more likely to test positive for alcohol than females; 32 percent of males had measurable levels of blood alcohol, compared with only 18 percent of females.

[30] No further age breakdowns were provided.

[31] See ch. 18, "Issues in the Delivery of Health and Related Services to Selected Groups of Adolescents," in Vol. III.

[32] In 1987, for e-pie, over a third of 8th and 10th graders participating in the National Student Health Survey reported that they swam alone during the previous year, 26.4 percent that they swam in a restricted or unsupervised area, and 28.4 percent that they dove into water of unknown depth (6).

[33] For a general discussion of the use of alcohol and other drugs by adolescents, see ch. 12, "Alcohol, Tobacco, and Drug Abuse: Prevention and Services," in this volume.

[34] NHTSA within the U.S. Department of Transportation defines a motor vehicle crash as being related to alcohol if the driver or nonoccupant (e.g, pedestrian) has a blood alcohol concentration of 0.10 percent or greater. Persons with a blood alcohol content of 0.10 percent or greater are considered to be intoxicated (1 16).

[35] The study also included 34 individuals ages 19 and 20. Blood alcohol content (BAC) determina tions were made for only 50 of the total 86 patients admitted to the hospital during the survey period. Unfortunately, the authors do not indicate the ages of the patients for whom BAC readings were not obtained; rather they report the numbers of patients of each age with positive BAC relative to the total number of patients of each age who were admitted to the hospital.

Less information is available on the possible link between alcohol consumption and other types of accidental injuries (47). Also, other drugs, such as marijuana or cocaine, may elevate risk of injury, though no systematic epidemiologic studies have been conducted to identify the role these other drugs may play in accidental injuries.

Failure To Use Safety Belts-There is substantial evidence that the use of safety belts in cars reduces the chances of experiencing serious injury in the event of a crash. For example, although about the same proportion of restrained and unrestrained passenger car occupants involved in fatal crashes in 1988 sustained nonfatal injuries (42 percent of restrained occupants v. 40 percent of unrestrained occupants), nearly twice as many unrestrained occupants as restrained occupants were killed as a result of injuries (49 v. 26 percent) (112).[36]

Surveys of U.S. adolescents indicate that most adolescents do not wear safety belts (35). In the 1987 National Adolescent Student Health Survey of 8th and 10th graders, only 41.2 percent reported that they had worn a safety belt the last time they were in a car (6).

U.S. adolescents do report, however, that protection in a crash is one of the most important factors in their deciding to wear a safety belt; 81.2 percent of adolescents surveyed in the National Adolescent Student Health Survey reported that this was a very important factor; in comparison, only 12.1 percent said that friends' use was a very important factor, and over half reported that friends' use was not important at all (6). Riccio-Howe found that safety belt use by family and friends was an important factor in adolescents' safety belt use (57a). Laws were also found to be an important factor. Riccio-Howe found that adolescents reported higher safety belt use when a law mandating such use was in effect than when it was repealed, and that adolescents who had learned to drive during the period the law was in effect continued to report higher safety belt use (57a). The law was more predictive of adolescents' safety belt use than were the adolescents' health beliefs and perceived locus of contro1[37] (57a).

Failure To **Use Bicycle or Motorcycle** Helmets-Evidence suggests that very few adolescents wear bicycle helmets and that adolescents are less likely than bicycle riders in older age groups to wear helmets (120). Only 3.7 percent of over 200 bicyclists ages 11 to 19 interviewed in one study were found to be wearing helmets; this compared with 16.2 percent of those age 30 or older (120). In the 1987 National Adolescent Student Health Survey of 8th and 10th graders, fewer than 10 percent said that they *ever* wore a bicycle helmet, and less than 1 percent reported that they always wore a helmet (6). A review of bicycle-riding-related accidents to children ages 1 to 18 (80 percent of whom were between ages 5 and 14) found that less than 1 percent (ages not specified) had been wearing protective equipment at the time of their injury (68).

Peer influence appears to play a role in whether U.S. adolescents wear bicycle helmets. Over 60 percent of the 8th and 10th graders surveyed in the National Adolescent Student Health Survey reported that they thought that their friends would think that wearing a bicycle helmet was a "silly thing to do" (6). Anecdotal evidence suggests that some young adolescents distinguish between casual neighborhood riding of bicycles and longer bicycle trips and are more likely to wear helmets during the latter activity.

Use of helmets among adolescents riding minibikes or motorcycles is also low. As of April 1990, only 23 States required use of motorcycle helmets for riders of all ages (44). Another 23 States required use under a specified age, usually 18 (although in some States the maximum age is as low as 15 years old). Data on crashes in States where only minors are required to wear motorcycle helmets indicate that fewer than 40 percent of fatally injured minors were wearing helmets, even though the law required them to do so (1 14). Enforcement of helmet wearing among minors is difficult, as it can be difficult to distinguish them from older riders. Nearly 60 percent of 8th and 10th graders participating in the 1987 National Adolescent Student Health Survey reported that they sometimes rode a motorcycle or

[36]These data are for all ages combined.

[37]A person's perceived locus of control is his o, her general sense tithe or she either controls or is controlled by events (63a). Riccio-Howe used a locus of control scale specifically related to the occurrence of accidents (57a).

38 Students were not asked directly whether, or how frequently, they rode a motorcycle or minibike. Rather, they were asked how frequently they wore a helmet when they did ride a motorcycle or minibike. Thus, it is not possible tdetermine frequency of riding from the survey responses.

minibike; however, only a third of those reported that they always wore a helmet when riding (6).[38]

Stressful Life Events

In a study that compared ill and injured hospitalized adolescents on a variety of measures including demographics, impulse control, emotional tone, and alcohol and other drug use, Slap and her colleagues found that the occurrence of stressful life events was, along with gender and previous hospitalization for an injury, a reliable characteristic distinguishing the injured from the ill adolescents (68a). The stressful life events most associated with hospitalization for an injury included suspension from school, failing a grade level, difficulty getting a summer job, breaking up with a boyfriend or girlfriend, and the death of a grandparent (68a). However, Slap and her colleagues note that their study sample was small and otherwise somewhat limited methodologically and that a prospective study to confirm the results is needed (68a). It is also important to note that 28 percent of the injured patients in the Slap et al. sample had been victims of assault; thus, the study's findings may be applicable to violent as well as accidental injuries. Nonetheless, Slap and her colleagues' results suggested that stresses that may be minimized by adults are important risk factors for injury during the adolescent years (68a). In an article directed at school nurses, Lee and colleagues also noted that high school is a stressful time for adolescents, and that there is a potential relationship between high levels of stress and accidental injury (41a).

Consequences of Accidental Injuries Among Adolescents

In general, the total dollar costs associated with injuries, both accidental and intentional, in the United States are enormous. An estimated $158 billion in aggregate lifetime direct and indirect costs[39] is imposed annually by injuries in this country (58).[40] About a quarter of those costs (around ***$39.4*** billion) can be attributed to injuries incurred by persons ages 15 to 24 (58). It is important to note, however, that costs have not been estimated separately for 10- to 18-year-olds. Thus, it is difficult to infer the actual proportion of costs attributable to accidental injuries among 10- to 18-year-olds.

For the 15- to 24-year-old age group, motor-vehicle-related injuries are responsible for the greatest lifetime costs, followed by falls, firearms, burns and frees, drownings and near drownings, and poisonings (58). Overall, males, who experience greater mortality and morbidity due to accidental injuries, also account for more mortality and morbidity costs.

According to a study based on data gathered in the 1980 National Medical Care Utilization and Expenditure Survey, injuries and poisonings are responsible for the third greatest proportion of direct medical costs to persons under age 17,[41] accounting for $1.9 billion in 1980 dollars[42] (36).

Anecdotal evidence from case studies indicates that injuries have a tremendous impact on injured adolescents, their families, and society (58). Along with lost productivity, school absenteeism, and health care expenses, injuries can have long-term or permanent effects including disfigurement and loss of ability to perform social roles.[43] However, data on injury-related disabilities are surprisingly sparse. No national data are available to examine injury-related disability in a systematic manner. Little information is available on the long-term consequences of injuries, particularly those that are less severe (47). As a result, it is very difficult to document the impact of injury survival beyond the acute phases of treatment for injuries.

Data on the health consequences of accidents for adolescents in terms of restricted-activity days, as mentioned earlier, are available through NHIS (93). In 1988, injuries (accidental and intentional

---

[39] *Direct costs* are "amounts paid for personal health care . . . (and) for home modification, vocational rehabilitation and overhead and administrative costs for automobile and health insurance' for those injured (58). *Indirect costs can be* divided into morbidity and mortality costs; morbidity costs include the value of goods and services not produced because of injury-related illness and disability, while mortality costs constitute the value of lifetime earnings lost by all who die prematurely as a result of injury.

[40] Estimates are based on the lifetime costs for the 57 million persons injured in 1985 (58).

[41] Includes children underage 10.

[42] However, injuries and poisonings accounted for a lower proportion of direct medical care costs for injury for the under 17 age group than it did fo 17- to #-year-olds.

[43] See ch. (j, "Chronic Physical Illnesses: Prevention and Services," in this volume for additional discussion of disabilities among adolescents.

combined) were responsible for 18 percent of restricted-activity days and 8.5 percent of school-loss days for acute conditions (93).[44] Injuries were responsible for 133.5 restricted-activity days and 38.9 bed-disability days per 100 males, and 104.9 restricted-activity days and 26.1 bed-disability days for females (92). Injuries accounted for 32.3 school-loss days for every 100 students ages 10 to 17. For adolescents ages 15 to 17, injuries accounted for 55 school-loss days per 100 students.

Prevention of Accidental Injuries Among Adolescents

Accidental injury prevention efforts can focus either on reducing or eliminating the occurrence of accidents or on minimizing the effects of accidents—i.e., reducing the severity of the injuries that might result from the accident.

Three basic approaches have been used for the prevention of accidental injuries: 1) persuasion or education, 2) legislation and regulation, and 3) automatic protection (47,58). The provision of direct incentives or other tangible support, sometimes combined with education, is another prevention strategy (18,26).

Although results of evaluation efforts are not definitive, there appears to be some consensus that, in general, automatic protection is the most effective strategy for injury protection, followed by laws and regulation, and that education and persuasion is the least effective strategy for injury prevention (9,47, 58,128). The use of direct incentives, sometimes combined with education, has not been evaluated as an overall strategy, but results of some programs suggest that it too is promising (18,26). As with other adolescent health problems, it is likely that no single approach to prevention is sufficient (see also 12a).

Rivara has estimated that 29 percent of deaths from trauma to U.S. children ages 1 to 14 could be prevented if only 12 currently available prevention strategies were implemented (60). Some of these strategies (e.g., use of infant restraint seats) are not applicable to adolescents ages 10 to 18. Nonetheless, Rivara's approach could be used to develop estimates of the numbers of preventable adolescent injury deaths.

Injury prevention approaches targeted to individuals (education and incentives), regulation and legislation, and automatic protection are discussed below, along with specific examples of injury prevention efforts.

Educational and Incentive Approaches

Educational strategies are some of the most widely used approaches to preventing injury; they tend to be relatively inexpensive and have a high level of community acceptance (78). The success of educational efforts, however, has been mixed, and there appears to be some consensus in the injury field that, as mentioned above, education and persuasion alone has been the least effective means of accident prevention (9,47,58,128). OTA agrees with this finding.

There are a number of reasons why educational efforts may be unsuccessful. First, the change in behavior advocated by the educational effort maybe too complex (e.g., executing safe turns on a 3-wheel ATV may be quite difficult 'for a 13-year-old). Second, complete compliance may be required for the behavior to be effective (e.g., safety belts must be worn every time the adolescent rides in a car). Third, the required behavior may be unpleasant (e.g., adolescents may feel that wearing a bicycle helmet is hot and uncomfortable or socially unacceptable). And last, there may be other external barriers to compliance (e.g., bicycle helmets may be unafforda-ble or unavailable; there maybe cultural, literacy, or language barriers to receiving or responding to the educational message). Thus, some interventions have offered positive incentives to adolescents to help increase health-enhancing behaviors such as the use of safety belts and bicycle helmets.

Some education may help adolescents avoid accidents. Educational efforts can be directed at many different audiences including adolesents, parents, teachers, manufacturers, and policymakers. For example, educational efforts can be directed toward convincing adolescents to use safety belts, parents can be taught how to discuss safety belt use with their children, manufacturers can be educated about public views regarding safety belt design, and policymakers can be educated about the effectiveness of a law requiring safety belt use.

[44] Restricted-activity days are calculated for 10- to 18-year-olds. School-loss days are calculated for 10- to 17-year-olds (92).

Examples of education and incentive efforts targeted at changing the behavior of adolescents are discussed below.

Driver Education

The lack of evaluation information on injury-prevention interventions has resulted in the implementation of programs that are ineffective, or that even have adverse effects. A good example of this is high school driver education programs (47,128). Driver education had long been endorsed as an intervention to reduce adolescent morbidity and mortality due to motor vehicle crashes, Subsequent research, however, has not supported the use of driver education as it is currently delivered as a strategy to reduce motor vehicle crashes (47,78).

A driver education study, involving random assignment of students to an extensive driver education course, a shortened version of the course, or no course at all, found that although students in the shortened class experienced slightly fewer crashes than those who had not taken a class, no reduction in crashes was found for those who completed the longer version of the class (69). Other research indicates that driver education programs may actually result in higher rates of accidents among adolescent drivers, in part because they make it possible for adolescent drivers to obtain a license at a younger age, when they may be more likely to be in motor vehicle crashes (47,78). This occurs in States where taking driver education is a prerequisite for license at an earlier age (e.g., at age 16 instead of 17) (78). Another explanation of the low impact of high school driver education courses is that such courses provide novice drivers with inadequate behind-the-wheel experience (72,105). In response, some States have developed resource materials to assist parents in providing behind-the-wheel practice (72). An additional response, of course, would be for schools themselves to increase the amount of behind-the-wheel experience provided to students learning to drive.

Incentives

Safety restraints in automobiles have gained increasing acceptance over the past decade as a means of preventing or limiting the severity of injuries associated with motor vehicle crashes.[45] However, because adolescents have lower rates of use of safety belts than other age groups, special approaches to encourage adolescents to use safety belts seem to be necessary (6,47,109).

One such program, which used cash incentives to increase voluntary safety belt use, was implemented in Chapel Hill, North Carolina (18). Students' cars, identified by bumper stickers, were stopped randomly by study personnel as they entered the school parking lot and, if the occupants were wearing their safety belts, they were rewarded with $5 in cash. For students not driving to school, family cars were identified by bumper stickers. When the occupants were observed anywhere in the community to be wearing safety belts, the adolescent was rewarded with $5 the next day in school. The program involved soliciting donations from parents and private businesses, paired with extensive publicity at the high school (18). The program succeeded in increasing observed use of safety belts among adolescent males from just under 20 percent to close to 39 percent, and among adolescent females from 21 percent to 44 percent. The long-term effects of this program have not been assessed, so it is unknown whether increases in safety belt use by adolescents were maintained over time.

Combining Education and Incentives

The use of bicycle helmets has the potential to reduce head injury among cyclists. Helmets are relatively ineffective in most crashes that result in fatalities but have considerable potential for reducing the severity of injury in nonfatal crashes. Several studies have indicated that hardshell bicycle helmets are associated with as much as a tenfold reduction in the incidence of significant injuries to cyclists (27,64,120). Despite its demonstrated effectiveness in reducing the severity of injury, helmet use among adolescent bicyclists is low (6,73,120).

In Seattle, a communitywide education campaign was implemented in an effort to increase the use of bicycle helmets (26). The campaign included efforts to increase parental awareness of the need for helmets, to promote the use of helmets by children, and to reduce financial barriers to the purchase of helmets. To increase parental awareness of the need for helmets, the campaign included the use of a variety of media to promote the use of bicycle helmets, such as public service announcements on television and radio, press conferences, informa-

[45] Airbags are discussed in the section on "Automatic Protection" below.

tional pamphlets distributed through physicians and health departments, and presentations to community groups. Efforts to promote use of helmets included the implementation of a bicycle safety program in public elementary schools, distribution of stickers promoting helmets to school and youth groups and at bicycling events, and the provision of incentives, such as baseball tickets, to children who wore helmets at bicycling events. Finally, in order to reduce financial barriers to the purchase of bicycle helmets, more than 100,000 discount coupons that lowered the cost of helmets to about $25 were distributed through physicians' offices, schools, youth groups, and community events; 1,300 helmets were sold at cost through the Parent-Teacher Association; and 1,300 helmets were donated to youth groups serving low-income children.

The effectiveness of the campaign was evaluated by comparing observed use of bicycle helmets before the campaign with observed use at various intervals after the start of the campaign. Observations were made at a variety of sites, including schools, bike trails, parks or playgrounds, and streets. To control for intervening events not related to the helmet campaign, observations of helmet use were also made in a demographically similar city (Portland, Oregon), where no organized effort to increase helmet use occurred during the study period. A total of 9,871 observations were made in the two cities of children estimated to be ages 5 to 15.

Results of the evaluation indicated significantly greater increases in the use of bicycle helmets in Seattle as compared with Portland (26). Use of helmets in Seattle increased from 4.6 to 14.0 percent 16 months after the campaign commenced, compared with an increase from 1.0 to 3.6 percent in Portland.[46] Both before and after the campaign, use was associated with race (whites were most likely to wear helmets), bicycle type (riders of geared bikes were more likely to use helmets), and site type (riders on bicycle paths were more likely to use helmets). In addition, children riding with companions (either other children or adults) who wore helmets were much more likely to wear helmets themselves, suggesting that peer and parental pressure may have an effect on use of helmets. Like other multifaceted prevention efforts described throughout this Report, it is difficult to disaggregate the effects of different elements of the Seattle prevention program. An evaluation that could disaggregate the effects of education from helmet distribution and other incentives, as well as assess the effectiveness of both strategies used together, would be useful, particularly if compared with a multifaceted intervention such as Seattle's.

Legislation

Another strategy for preventing or controlling accidental injuries is through legislation. Legislative measures are usually directed at changing either the environment or mandating specific behaviors. Examples include the motorcycle helmet and safety belt laws currently in effect in most States, or through local ordinances. In the first such effort in the country, for example, bicycle helmets were recently made mandatory for all bicycle riders in Howard County, Maryland, riding on county paths and streets (13,14). After pressure, however, the Howard County Council subsequently voted to amend the law to exempt riders over age 15 (14).

Laws and regulations can also be limited in their effectiveness and may be least effective for those who are at highest risk. For example, although 35 States plus the District of Columbia now have safety belt-use laws[47] (44,112), adolescents still have lower use of safety belts than adults or younger children (47,112). In 19 cities surveyed by the U.S. Department of Transportation's NHTSA, safety belt use by passengers ages 5 to 12 averaged 37 percent, with a range from 24 to 60 percent, while usage for passengers ages 13 to 19 averaged only 24 percent (112). As noted previously, in States where only minors are required to wear motorcycle helmets, many adolescents do not wear them.

Special Driver Licensing Restrictions for Adolescents

Nighttime driving curfews for adolescents, and changes in the minimum driving age have been shown to be effective in reducing adolescent vehicle crashes. States with nighttime curfews for 16-year-

[46] These figures were adjusted for a variety of confounding variables, including race, type of bicycle, where bicyclist was observed riding, and with whom (if anyone) bicyclist rode. The unadjusted rates for Seattle were 5.5 percent use of helmets before the campaign, and 15.7 percent use after the campaign; unadjusted rates for Portland were 1.0 and 2.9 percent during the same period (26).

[47] All States have laws requiring that younger children be restrained by a child safety seat or (for older children) safety belt, but most of these laws affect only children under the age of 6 (1 12).

old drivers have reduced the fatalities in this age group by as much as 69 percent (122). Since half of fatal crashes involving 16- to 19-year-olds occur between 9 p.m. and 6 a.m., this measure has considerable potential for reducing injury.

It has also been suggested that the age for obtaining a driver license be raised so that adolescents would be more mature before taking on the complex task of driving. This approach is a response to data demonstrating a disproportionate involvement of young drivers in severe and fatal crashes. However, the approach does not account for the fact that it takes time and practice to become a proficient driver, even at older ages. Another strategy that has been proposed is to develop a "graduated driver licensing system" whereby adolescents could actually start driving as early as age 14 under close parental supervision (11 1). The privileges of driving at night, and without parents present, would be phased in over the course of several years. This would allow a period of time for adolescents to gradually master the task of driving. Because this approach has yet to be tested, no conclusions can be drawn about the potential effectiveness of the approach in reducing adolescent involvement in motor vehicle crashes.

Requirements for School Bus Safety Belts

A number of school districts have moved to require safety belts in school buses, although the ratio of effectiveness to costs has been of concern[48] (1 1), As part of a cost-benefit analysis of safety belts in Texas school buses, estimates of the numbers of preventable school bus injuries and fatalities were calculated. It was calculated that 13 percent of serious injuries[49] to children ages 5 to 14 were preventable with the use of safety belts, as were 52 percent of injuries to adolescents ages 15 to 18.[50] Based on their analyses, the authors concluded that installation of safety belts in Texas was not cost-beneficial because the anticipated savings in direct medical care and legal costs and indirect costs (e.g., foregone earnings) did not offset the significant costs involved in retrofitting old buses and equipping new buses with safety belts.

A more recent and comprehensive study on school bus safety was conducted by the Transportation Research Board of the National Research Council (48). The analysis examined the effectiveness of safety belts in buses in preventing injury, assuming that only one-half of all students would actually wear the safety belts. It was estimated that, if all large school buses in the United States were equipped with safety belts, up to 1 life, 48 incapacitating injuries, 238 nonincapacitating injuries, and 665 injuries could be saved each year for a total annual cost of $43 million to equip the buses and maintain the safety belts. Based on these findings, the Committee concluded that a Federal standard mandating safety belts was unwarranted. Data from the U.S. Department of Transportation's NHTSA show that far more children are injured or killed in the process of boarding or leaving school buses than in school buses themselves. The Transportation Research Board recommended that, rather than equipping large school buses with safety belts, the safety of children riding school buses could be more effectively improved through driver training, pupil education, school bus monitors, safer school bus routing, improved mirrors, and improved signaling devices.

Automatic Protection

In contrast to voluntary efforts that rely on education to promote compliance, automatic protection measures typically are directed at changing consumer products or the environment. These efforts are frequently intended to provide protection by making changes that do not require individual action. Efforts may be voluntary, or required as the result of legislation or regulation. For example, Federal regulations now require a wide array of safety features on cars designed to reduce risks of injury. These include shatterproof windshields, energy-absorbing steering columns, and automatic safety belts or airbags. Environmental improvements, such as better street design, improved lighting, and installation of energy-absorbing materials at roadside sites where crashes are likely to occur, are also

[48]Small, van-type school buses are currently required t. have safety belts due to their similarity to cars and the lack of other protective features are found in the larger buses (44).

[49]*Serious injuries* were defined as those receiving a score of 3 or greater on the Maximum Abbreviated Injury Scale (lMAIS), a commonly used trauma severity scale (11). A MAIS score of 3 would reflect injuries such as major nerve laceration multiple rib fracture; abdominal organ contusion; or hand, foot, or arm crush or amputation. AMAIS score of 6 would indicate that the injury was potentially fatal.

[50]Overall, however, children ages 5 to 14 received 84 percent of all injuries, and 83 percent of serious injuries.

Photo credit: Bethesda-Chevy Chase Rescue Squad

In general, automatic safety features such as airbags have been found to be more effective than education-based preventive measures in preventing injuries. Airbags are not yet required standard equipment in cars sold in the United States and are unlikely to be found in the older cars that adolescents apparently tend to use.

examples of efforts to provide automatic protection (2a,78).

In automobiles, passive restraint devices such as airbags or automatic safety belts are becoming increasingly available as a result of Federal regulation. These devices are each limited in ways different from standard shoulder-lap safety belts. Airbags, as they are currently constructed, are most effective in frontal collisions, which make up about 35 percent of all fatal car crashes (106). However, airbags are designed to supplement the use of safety belts. In order to enhance protection in frontal crashes, and to provide protection in other types of crashes, manually operated safety belts must be worn in conjunction with airbags. While the effectiveness of automatic safety belts is believed to be slightly less than traditional lap and shoulder belts, the use of automatic safety belts could have a substantial impact on injury reduction because, like airbags, they do not rely upon active compliance. In addition, the effectiveness of some automatic safety belts can be enhanced by the simultaneous use of a manually operated lap belt.

Federal Motor Vehicle Rule 208 required that all new cars sold in the United States after September 1989 must have an automatic crash protection system as standard equipment (28,1 13). However, this system could be either airbags or automatic safety belts. Some observers have noted that more expensive model cars have been the first to use airbags (121). (Honda, for example, will not make airbags standard until late 1993, and even then ''a few low-priced, stripped cars may not have standard airbags" (121)). Anecdotal evidence suggests that adolescent drivers tend to use older, less expensive cars.

Treatment of Accidental Injuries Among Adolescents

Health service needs for acute and short-term treatment of accidental injuries differ by the type and severity of the injury sustained and, to a lesser degree, the developmental characteristics of the injured person.

Adolescents may present some special concerns for treatment. For example, medical personnel may have difficulty dealing with adolescents (22).[51] In addition, adolescents may have a need for additional types of services beyond the immediate medical treatment of the injury.

National data are not available, but there is some evidence reported in smaller studies that the treatment needs of adolescents differ from those of younger children. A study of persons under age 18 residing in upper Manhattan who sustained severe injuries that resulted in hospitalization, for' example, found differences in the need for nonmedical services identified at the time of treatment. Adolescents ages 10 to 16 were more likely than younger children to have a need for psychological services,[52] and less likely to need child welfare services, according to information recorded on hospital charts (52).

There is also evidence that the pattern of injury differs by age. Data from emergency departments in Massachusetts indicated that adolescents ages 16 to 19 sustain more severe injuries than adolescents ages 13 to 15 (9). Adolescents ages 16 to 19 had

[51]Also see ch. 15, ''Major Issues Pertaining to the Delivery of Primary and Comprehensive Services to Adolescents, " in Vol. III for a discussion Of issues in the delivery of health services to adolescents.

[52]Adolescents were more likely to have received gun shot wounds or to be referred for ingestions of toxic substances.

more injuries requiring treatment in emergency rooms and higher rates of hospital admission. Data from 88 Los Angeles County emergency departments indicate that 28 percent of all trauma cases involved children and adolescents ages 1 to 19; adolescents ages 13 to 19 had twice the number of injuries requiring emergency services as children under the age of 13 (67). In addition, head injuries and abdominal injuries were found to be more common among children and adolescents ages 1 to 19 than among adults.

The immediate treatment goal for all victims of moderate to severe injury is timely and appropriate prehospital and hospital care, regardless of age. Guidelines specific to the treatment of adolescents sustaining an injury do not exist; neither the American College of Emergency Medicine nor the American College of Surgery has a special protocol for adolescents who sustain injury. Because extremes of age are a factor in the initial management of a severely injured person, however, guidelines for the very young (under 8 years of age) and the elderly have been developed (4).

The issue of pediatric trauma care has received increased attention over the past decade (37,38). The American Pediatric Surgical Association and the American College of Surgeons, for example, have endorsed standards of care for critically injured pediatric patients (3,57). These standards of care recognize that children may have different treatment needs from adults. Children tend to sustain different types of injuries (e.g., head injuries), some types of injuries need to be managed differently (e.g., growth plate fractures must be properly managed to prevent limb shortening or deformity), children have smaller nutritional reserves and have different metabolic requirements, and there is a need for providing psychological support. There are no special guidelines for adolescent patients, however.

Following a 1987 conference on unintentional injury among adolescents, the American Medical Association's (AMA) Council on Scientific Affairs reviewed issues surrounding the use of emergency room services by adolescents (15). The review was prompted by the concern that the unique health needs of adolescents might be neglected when it comes to procedures and training of personnel involved with emergency services. Unfortunately, the AMA review was limited by a lack of current

Photo credit: Bethesda-Chevy Chase Rescue Squad

After a committee of the American Medical Association's Council of Scientific Affairs found that there was an insufficient body of scientific knowledge relating to the specific needs of adolescents in emergency rooms to warrant a full report, the committee planned to monitor the issue.

data on adolescent use of emergency room services. Their analysis of clinical and developmental issues suggested that adolescents in emergency rooms had several requirements that might not be recognized by emergency room personnel: the need for confidential services; the need for physicians to identify hidden agendas (e.g., suicidal ideation in an 18-year-old male who has had a motorcycle accident); and the need for followup services. These needs were believed to apply to adolescents in all clinical settings, not just in emergency facilities, and the report suggested that "as more family practice, pediatric, and internal medicine programs include training in adolescent medicine, the care of adolescents in emergency rooms should improve' (15). It is not clear why specialists in emergency care were not included in this group. The most important conclusion seemed to be that the body of scientific knowledge relating to the specific needs of adolescents in emergency rooms ''is not large enough currently to support a full [Council of Scientific Affairs] report. The Committee pledged to monitor the issue.

Major Federal Policies and Programs Pertaining to Accidental Injuries Among Adolescents

Wide-ranging injury prevention and control activities, related to both accidental and intentional injury, are conducted by the Federal Government. These activities involve a number of different agencies, each focusing on different aspects of the injury problem. The involvement of many agencies and activities has meant that attention has been given to many injury-related issues, but the overall Federal response has been fragmented (16).[53]

Some efforts have been made by DHHS and other agencies to coordinate Federal injury prevention and control efforts. Within the Centers for Disease Control's (CDC) Center for Environmental Health and Injury Epidemiology and Control, a Division of Injury Epidemiology and Control has been established to carry out a program of injury prevention research in conjunction with the U.S. Department of Transportation's NHTSA, with half of the funding to be directed to prevention and control of motor-vehicle-related injury (16,30,108). In fiscal year 1989, a Federal advisory committee for Injury Prevention and Control was established through the Bureau of Maternal and Child Health and CDC within DHHS, and NHTSA within the U.S. Department of Transportation (50). The charge of the Advisory Committee is to report on the state of injury prevention and set priorities for injury-related research; the first meeting of the advisory committee took place in September 1989 (50,87).

Various injury prevention and control activities of the Federal Government that include a focus on adolescents are described below.

U.S. Department of Health and Human Services

Centers for Disease Control

The Division of Injury Epidemiology and Control (DIEC) in CDC was created in 1986 through funding from NHTSA in an effort to better coordinate Federal efforts in the area of injury control. Prior to this, no central agency had Federal responsibility for reducing the incidence of injuries (47).

Funding for injury research activities at CDC has increased substantially over the past several years, although it is still quite low in comparison with the funding appropriated for heart disease or cancer. Appropriations for fiscal year 1989 were over $23 million, more than twice the budget for 1988 (103). Some programs that are funded through DIEC specifically target accidental and intentional injury among adolescents (e.g., motor-vehicle-related injuries, adolescent suicide or homicide); however, most do not. Although there is no budget line item specific to adolescents at DIEC, an estimated 15 percent of their funding, $3.3 million, is directed at adolescent issues (87).

The priorities of DIEC are to support intramural and extramural injury research and to support State and local injury prevention and control programs (87). Funded activities include the development of injury surveillance systems; collection and analysis of data; professional education and training; and research in acute care, biomechanics, epidemiology, and prevention (87,103). In addition, several multidisciplinary, injury prevention academic research centers are funded; these centers provide injury-related research, training, and technical assistance (87).

Health Resources and Services Administration

The Bureau of Maternal and Child Health in the Health Resources and Services Administration of DHHS has provided grants for injury prevention projects through the special projects of regional and national significance (SPRANS) program authorized under Title V of the Social Security Act. In fiscal year 1988, 23 SPRANS projects dealt with injury prevention among adolescents.[54] Children and adolescents are targeted through these programs. Projects have been funded to implement injury prevention programs in States, provide injury prevention services to Native American adolescents, and reduce drinking and driving among adolescents (49,94). Also funded through the Bureau of Maternal and Child Health are 12 demonstration projects designed to improve emergency medical services for children, including adolescents, although adolescents are not specifically targeted (95).

[53] The general problem of fragmentation in the Federal approach to adolescent health is discussed at length in ch. 19, "T'he Role of Federal Agencies in Adolescent Health," in Vol. III.

[54] For further discussion, see ch. 19, "The Role of Federal Agencies in Adolescent Health," in Vol. III.

National Institute for Child Health and Human Development

The National Institute of Child Health and Human Development (NICHD) within the National Institutes of Health identifies the prevention of childhood injury as one of its priorities. In 1987, NICHD developed a plan for the development of research on the prevention of childhood injury (102). Initially funded projects focus on the prevention of injury among younger children rather than adolescents.

U.S. Department of Transportation's National Highway Traffic Safety Administration

NHTSA was established within the U.S. Department of Transportation in 1970 by the Highway Safety Act of 1970 (108). The mandate of NHTSA is to reduce deaths, injuries, and economic costs resulting from motor vehicle crashes. NHTSA's activities and research include efforts to stimulate activities to improve occupant protection, improve traffic law enforcement, improve the quality of emergency medical services, and establish and maintain a computerized traffic recordkeeping system (109).

Adolescents and young adults ages 15 to 24 are a major focus of the efforts of NHTSA to increase safety belt use and to reduce drunk and drugged driving-related traffic fatalities (109). NHTSA annually awards four to five research and demonstration grants targeted at 15- to 24-year-olds. Most of the past research conducted through NHTSA has focused on programs to educate young people about the risks of drinking and driving, and about safety belt usage.

Although most efforts of NHTSA are not age-specific, some efforts are directed at adolescents and young adults under the age of21. In fiscal year 1988, NHTSA focused over $1 million on research and program activities designed to address highway safety problems of individuals ages 15 to 24 (109). The majority of programs have targeted high-school age adolescents. These include media campaigns addressing the issue of drunk driving, the development of high school assembly programs, and training programs for teachers to enhance their abilities to discuss alcohol and drug abuse issues with their students. In January 1990, NHTSA issued a report on a "Young Adult Highway Safety Plan," which focuses on the involvement of 15- to 24-year-olds in motor vehicle crashes (1 15). Areas of emphasis in the plan include adjudication, supervision, enforcement, legislation, licensing, school-based and extracurricular programs, and community- and work-based programs.

NHSTA also funds activities aimed at younger children which affect adolescents in the 10- to 14-year-old age group. These activities include Pedestrian Safety Programs that teach children ages 9 to 12 to deal with a complex traffic environment (44,56). In 1990, a Bicycle Education Program directed at children in grades 5 and 6 was in the planning stages; and a new instructional kit providing information on occupant protection to junior and middle school students, ''The Car Club," was under development (44).

NHTSA also administers the Fatal Accident Reporting System, which gathers data on fatal vehicle accidents, and the National Accident Sampling System, which reports on fatal and nonfatal traffic crashes based on a sample of cases.

U.S. Consumer Product Safety Commission

The U.S. Consumer Product Safety Commission, in operation since 1973, is responsible for overseeing a wide range of consumer products to ensure that they are not hazardous to consumers (79). The commission uses several strategies for correcting consumer hazards, including issuing and enforcing mandatory standards, working with industry to develop voluntary standards, banning products, recalling products, conducting research on potential hazards of products, encouraging the development of new or improved voluntary standards, and conducting consumer information programs. For example, the commission was responsible for banning the sale of 3-wheel ATVs, and the request that industry develop a voluntary standard for 4-wheel ATV safety.

The commission also oversees the National Electronic Injury Surveillance System, which maintains information on emergency room visits for injuries that are related to consumer products (excluding motor vehicle, firearms, and several other classes of consumer products that are not under the jurisdiction of the commission).

Conclusions and Policy Implications

Accidental injuries are responsible for more deaths among U.S. adolescents than any other problem. In 1987, 10,658 U.S. adolescents ages 10 to 19 died as a result of accidental injury. Nearly two-thirds of these deaths resulted from motor vehicle crashes. U.S. adolescents are particularly susceptible to being involved in a motor vehicle crash when driving at night, or when driving after consuming alcohol.

Accidental injury *deaths,* however, represent just the "tip of the iceberg" of problems resulting from accidental injuries (58). Such injuries also cause temporary or permanent disabilities,[55] utilization of health care, school loss, and other problems. Sports and recreational activities, such as basketball and football, are a leading cause of nonfatal injuries among adolescents.

Three basic approaches have been used for the prevention of accidental injuries. These are persuasion or education, legislation and regulation, and automatic protection. Positive incentives to encourage the use of protective equipment have also been tried and evaluated. Although results are not definitive, there appears to be some consensus that automatic protection (e.g., airbags in cars) is the most effective strategy for injury prevention, followed by laws and regulation, and that education and persuasion is the least effective strategy for injury prevention. In a few evaluations, however, programs that provide incentives to use protective devices (e.g., safety belts, bicycle helmets) have shown promise.

Over the past few years, there has been a significant increase in the amount of attention paid to injury research (62). Nonetheless, few reliable data exist on the causes of accidental injuries among adolescents, or on the effectiveness of interventions to prevent accidental injuries or limit their severity. Studies have primarily been descriptive in nature; rigorous effectiveness evaluations of prevention programs are particularly needed, as well as studies that seek to identify causal relationships so interventions may be developed (62).

There is little information on the long-term economic and other costs of injury (58). Neither the long-term monetary costs of injuries nor the sometimes devastating effects on families of seriously injured adolescents (e.g., financial and emotional stress) have been extensively assessed.[56]

The lack of comprehensive national data on accidental injuries among adolescents ages 10 to 18 makes it difficult to reach conclusions about which groups of adolescents are most at risk, and about the environmental characteristics that increase risk for accidental injury (17). This lack of data inhibits the development of a national strategy to address the problem of accidental injury. At the same time, it is critical that local jurisdictions have adequate injury surveillance systems so they can effectively identify problem areas, develop community responses that address their unique injury problems, and evaluate the effectiveness of their efforts (86).[57]

Evidence about the cause of injury is essential for determining appropriate interventions. While diagnostic information helps to distinguish skull fractures from concussions or lacerations from contusions, it does not identify factors pertinent to the prevention of the injury. Data about injury causation are essential to differentiate, for example, whether the skull fracture resulted from a fall, a motorcycle crash, or from playing football. Each of these causal factors implies the need for different preventive strategies (e.g., installation of a secure railing on a bridge, passage of motorcycle helmet laws, or changes in the design of football helmets). Inclusion in medical records of information on the causes of injuries would greatly enhance the utility of injury-related diagnostic information.

Data on the full spectrum of injuries, including those that do not result in hospitalization or death, are necessary to monitor the injury problem adequately, and to define appropriate countermeasures. Focusing only on injuries with the most severe outcomes results in a biased view of the injury problem. For example, although motor vehicle crashes are clearly the most important cause of severe injuries and death among adolescents, sports and recreational injuries actually account for many more injuries and are experienced by many more adolescents. A review of mortality data alone would not reveal the important role that sports and recreational activities play in adolescent injuries.

[55]See ch. 6, "Chronic Physical Illnesses: Prevention and Services," in this volume for a discussion of the effects of chronic physical illnesses and disabilities on adolescents.

[56]Some of the effects of adolescent disability on families are discussed in ch. 6, "Chronic Physical Illnesses: Prevention and Services," in this volume.

[57]For example, a @@ number of pedestrian injuries along a particular stretch of road might indicate a need for better lighting, the need for a pedestrian walkway, or a need for warning signs, depending on the circumstances.

Another type of information that is lacking is the measurement of exposure. This is a difficult task that typically requires collection of data outside the health care delivery system. For example, in drawing appropriate conclusions about the risk of motor vehicle crashes involving adolescent drivers, it is important to document both the numbers of adolescent drivers and the extent to which they drive. This kind of exposure information serves as the denominator in calculating rates. It allows comparisons that take into account whether adolescents contribute disproportionately to motor vehicle crashes, or become involved in crashes at rates (per mile driven or time spent driving) that are no different from their parents or other adults. Some estimates of miles driven by adolescents can be obtained by transportation or insurance authorities; however, this kind of exposure information is not available for other types of injuries. Thus, for example, information on how many miles adolescents log on bicycles or ATVs or on how many adolescents know how to swim or swim well is not available.

Few good evaluation studies have been conducted on the effectiveness of specific injury prevention programs or intervention approaches. Although there appear to be many good ideas among injury prevention efforts, few have been well evaluated (50). It is critical that adolescent attitudes and beliefs about injury problems and various modes of injury prevention be considered when developing injury prevention interventions (65).

Although there is some evidence that adolescents with injuries may require some specialized treatment (e.g., psychological services, education on injury prevention) after injury, there is little information available on these needs, or on whether there is a need to train medical personnel in the special care of adolescents with injuries. Information is also lacking on long-term outcomes of accidental injury and the costs associated with injury. This requires a recordkeeping system with the ability to track injury victims over time and through various systems of health care, rehabilitation, and education services.

Funding for injury prevention research is scarce and has not been sufficient to permit well-designed intervention trials or solid evaluation studies. The new initiatives within CDC to fund research and intervention programs are directed, in part, at meeting this need. In proportion to the magnitude of the problem and funding of programs for other health problems, however, funding for these injury prevention programs is minimal. For example, despite the significant costs of injuries, both monetary and personal, overall finding for injury prevention and control is significantly less than that for cancer and cardiovascular diseases (58).

There is a critical need for a focus by Federal and local governments on the problem of accidental injury, including support for prevention research and programming g, and for data systems to provide the information necessary to develop informed policies.

Chapter 5 References

1. American Academy of Pediatrics, "ATV Fact Sheets, " Elk Grove Village, IL, 1989.
2. American Academy of Pediatrics, Committee on Accident and Poison Prevention "Skateboard Injuries, ' *Pediatrics* 83(6):1070 1071, 1989.
3. American College of Surgeons, "Planning Pediatric Trauma Care,' *Hospital and Prehospital Resources for Optimal Care of the Injured Patient (Chicago,* IL: February 1987).
4. American Heart Association% *Textbook of Advanced Cardiac Life Support,* 2nd. ed. (Dallas, TX: 1987).
5. American Medical Association, Council on Scientific Affairs, "Firearm Injuries and Deaths: A Critical Public Health Issue," *Public Health Reports* 104(2):1 *11-120, 1989.*
6. *American* School Health Association, Association for the Advancement of Health Education, Society for Public Health Education, Inc., *The National Adolescent Student Health Survey: A Report on the Health of America's Youth* (Oakland, CA: Third Party Publishing Co., 1989).
7. Armstrong, K., Director, Healthy People Programs, Western Consortium for PublicHealth, Berkeley, CA, personal communication to theOffice of Technology Assessment, U.S. Congress, Washington, DC, June 18, 1990.
8. Baker, S.P., and Li, G., "The Risk of Drowning: Males in Maryland Rivers" (letter to the editor),*Journal of the American MedicalAssociation* 265(3):356, 1991.

8a. Baker, S. P., O'Neill, B., and Karpf, R., *The Injury Fact Book* (Lexington, *MA:* Lexington Books, 1984).

9. Bass, J., Gallagher, S., andMehta, K., "InJuries to Adolescents and Young Adults,' ' *Pediatric Clinics ofNorth America 32(1):3 1-39, 1985.*
10. Bass, J.,Mehta, K., and Eppes, B., "What School Children Need to Learn About Injury Prevention" *Public Health Reports* 104(4):385-388, *1989.*
11. Begley, C., and Biddle, A., "Cost-Benefit Analysis of Safety Belts in Texas School Buses, " *Public Health Reports 103(5):479-485, 1988.*
12. Bergeisen, L., "physical Health of Indian Adolescents, " paper prepared for the Office of Technology Assessment, U.S. Congress, November 1989.

12a. Bergman, A.B., and Rivara, F. P., "Sweden's Experience in Reducing Childhood Injuries,"*Pediatrics* 88(1):69-74,1991.

13. Beyers, D., "Howard Mandates Helmets," *Washington Post,* p. Al, May 8, 1990.
14. Beyers, D., "Howard Council To Vote on Limiting Helmet Law," *Washington Post,* p. D1, July 30, 1990.
15. Bohigian, G. M., "Emergency Room Services for Adolescents," background report of the Council on Scientific Affairs, American Medical Association% Evanston, IL, 1989.
16. Brown, S., "Federal Funding,' *Public Health Reports lCT2(6):659-662, 1987.*

17. Butler, J.A., and Mitrovich, K.A., "The Select Panel for the Promotion of Child Health: Injury Recommendations in Retrospect," *Journal of Social Issues* 43(2):119-133, 1987.
18. Campbell, B.J., Hunter, W.W., Stewart, J.R., et al., *Increasing Safety Belt Use Through an Incentive Program* (Chapel Hill, NC: Highway Safety Research Center, 1982).
19. Cogbill, T.H., Landercasper, J., Strutt, P.J., et al., "'l'he New Three-Wheeled Motorcycle--A New Mechanism of Serious Injury," *Wisconsin Medical Journal* 85:18-20, 1986.
20. Colburn, D., "Serious Injuries Up in High School Football," *Washington Post,* Health Section, p. 7, Feb. 21, 1989.
21. Cole, T.B., and Patetta, M.J., "Hunting Firearm Injuries, North Carolina," *American Journal of Public Health* 78:1585-1586, 1988.
22. Cowart, V., "Adolescent Patients Pose Particular Problems; Physical Fitness May Help Prevent Injuries," *Journal of the American Medical Association* 259(23):3380-3381, 1988.
23. Cowart, V., "Policy Recommendations Expected From Meeting on Unintentional Injuries in Adolescents," *Journal of the American Medical Association* 259(23):3381, 1988.
24. DeHaven, K., and Lintner, D., "Athletic Injuries: Comparison by Age, Sport, and Gender," *American Journal of Sports Medicine* 14(3):218-224, 1986.
25. Dietz, P., and Baker, S., "Drowning: Epidemiology and Prevention," *American Journal of Public Health* 64(4):303-312, 1974.
26. DiGuiseppi, C., Rivara, F., Koepsell, T., et al., "Bicycle Helmet Use by Children: Evaluation of a Community-Wide Helmet Campaign," *Journal of the American Medical Association* 262(16):2256-2261, 1989.
27. Dorsch, M.M., Woodward, A.J., and Somers, R.L., "Effects of Helmet Use in Reducing Head Injury in Bicycle Accidents," presented at the 28th Annual Meeting of the American Association for Automotive Medicine, Denver, CO, Oct. 8-10, 1984.
28. Faigin, B., Economist, Office of Plans and Policy, National Highway Traffic Safety Administration, Department of Transportation, Washington, DC, personal communications, Sept. 24, 1990.
29. Fingerhut, L.A., and Kleinman, J.C., "Firearm Mortality Among Children and Youth," *Advance Data From Vital and Health Statistics of the National Center for Health Statistics, No. 178,* National Center for Health Statistics, Centers for Disease Control, Public Health Service, U.S. Department of Health and Human Services (Hyattsville, MD: Nov. 3, 1989).
30. Finklea, J.F., "Injury prevention Research and Demonstration Grants: An Overview of the Process," *Public Health Reports* 102(6):648-651, 1987.
31. Friede, A. M., Azzara, C. V., Gallagher, S. S., et al., "The Epidemiology of Injuries to Bicycle Riders," *Pediatric Clinics of North America* 32(l): 141-151, 1985.
32. Gallagher, S., FinisOn, K., Guyer, B., et al., "The Incidence of Injuries Among 87,000 Massachusetts Children and Adolescents: Results of the 1980-81 Statewide childhood Injury Prevention Program Surveillance System," *American Journal of Public Health* 74(12):1340-1347, 1984.
33. Goldberg, B., Rosenthal, P., Robertson, L., et al., "Injuries in Youth Football," *Pediatrics* 81(2):255-261, 1988.
34. Guyer, B., Talbot, A., and Pless, I.B., "Pedestrian Injuries to Children and Youth," *Pediatric Clinics of North America* 32(1):163-174, 1985.
35. Halperin, S., Bass, J., Mehta, K., et al., "Unintentional Injuries Among Adolescents and Young Adults: A Review and Analysis," *Journal of Adolescent Health Care* 4(4):275-281, 1983.
36. Harlan, L., Harlan, W., and Parsons, P.E., "The Economic Impact of Injuries: A Major Source of Medical Costs," *American Journal of Public Health* 80:453-459, 1990.
37. Harris, B., "Pediatric Care in Hospitals," *Emergency Care Quarterly* 3(1):65-72, 1987.
38. Harris, B., and Latchaw, L., "The Best Is Yet lb Come," *Emergency Care Quarterly* 3(1):73-75, 1987.
39. Howland, J., and Hingson, R, "Alcohol as a Risk Factor for Drownings: A Review of the Literature (19501985)," *Accident Analysis and Prevention* 20(1):19-71, 1988.
40. Kovar, M.G., U.S. Department of Health and Human Services, Public Health Service, National Center for Health Statistics, unpublished mortality data, Washington, DC, 1989.
41. Kraus, J.F., Fife, D., and Conroy, C., "Incidence, Severity and Outcomes of Brain Injuries Involving Bicycles," *American Journal of Public Health* 77:76-78, 1987.
41a. Lee, E.J., Jacobson, J.M., and Levanas, V., "Stressful Life Events and Accidents at Schools," *Pediatric Nursing* 15:140-142, 1989.
42. Lewis, C., "Preventing Traffic Casualties Among Youth: What Is Our Knowledge Base?" *Alcohol, Drugs and Driving* 4(l): 1-7, 1988.
42a. Maron, D.J., Telch, M.J., Killen, J.D., et al., "Correlate of Seat Belt Use by Adolescents: Implications for Health Promotion," *Preventive Medicine* 15:614-23, 1986.
43, McLain, L.G., and Reynolds, S., "Sports Injuries in a High School," *Pediatrics* 84(3):446-450, 1989.
43a. Melton, G.B., and Oberlander, L.B., "Health of Rural Adolescents," contract paper prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, September 1989.
44. Miller, J.R., Deputy Adminitrator, National Highway Traffic Safety Administration, U.S. Department of Transportation, written comments to the Office of Technology Assessment U.S. Congress, Washington, DC, June 21, 1990.
45, Morrow, P.L., and Hudson, P., "Accidental Firearm Fatalities in North Carolina," *American Journal of Public Health 76:1120-1123, 1986.*
46. Mueller, F.O., and Schindler, R.D., "Annual Survey of Football Injury Research, 1931 -1986," monograph prepared for the American Football Coaches Association, and the National Federation of State High School Association Orlando, FL, Kansas City, MO, 1987.
47. National Academy of Sciences, National Research Council, Institute of Medicine, Coremission on Life Sciences, Committee on Trauma Research, *Injury in America* (Washington, DC: National Academy Press, 1985).
48. National Academy of Sciences, National Research Council, Transportation Research Board, *Improving School Bus Safety* (W-01% DC: National Academy of Sciences, 1989).
49. National Center for Education in Maternal and Child Health, Georgetown University, "Adolescent Health: SPRANS Abstracts FY 1989," Washington DC, 1989.
50. National Committee for Injury Prevention and Control and Education Development Center, Injury *Prevention: Meeting the Challenge,* report to the Bureau of Maternal and Child Health and Resources Development, Centers for Disease Control, U.S. Department of Health and Human Services, and the National Highway Traffic Safety Administration, U.S. Department of Transportation (New York, NY: Oxford University Press, 1989).
50a. National School Safety Center, "Safety Is Priority, Say Urban School Chiefs," *School Safety* (Encino, CA: Pepperdine University, Spring 1988).
51. Newman, R., *Analysis of All Terrain Vehicles, Related Injuries, and Deaths* (Washington, DC: U.S. Consumer Product Safety Commission, September 1987).
52. O'Connor, P., Davidson, L., Durkin, M., et al., "Prevention Strategies: An Approach to Changing the Outcomes of Severe Injuries to Children," paper presented at the Second Biennial Conference on Community Research and Action, East Lansing, MI, June 23, 1989.
53. Orlowski, J.P., "Adolescent Drownings: Swimming, Boating, Diving, rind Scuba Accidents," *Pediatric sAnnals 17(2): 125-132, 1988,*
54. Patetta, M., and Biddinger, P., "Characteristics of Drowning Deaths in North Carolina," *Public Health Reports* 103(4):406-411, 1988.

55. Pipkin, N., Walker, L., and Thomason, M., "Alcohol and Vehicular Injuries in Adolescents,' *Journal of Adolescent Health Care* 19:119-121, *1989.*
56. Preusser, D., and Lund, A., "And Keep on Looking: A Film to Reduce Pedestrian Crashes Among 9-to 12-Year-Olds,'' *Journal of Safety Research 19:177-185, 1988.*
57. Ramenofsky, M., and Morse, T., "Standards of Care for the Critically Injured Pediatric Patient' *'Journal of Trauma* 22(11):92 1-933, 1982.
57a. Riccio-Howe, L.A., "Health Values, Locus of Control and Cues to Action as Predictors of Adolescent Safety Belt Use, " *Journal of Adolescent Health Care* 12:256-262, *1991.*
58. *Rice,* D., MacKenzie, E., et al.,*Cost of Injury in the United States: A Report to Congress 1989 (San* Francisco, CA: Institute for Health and Aging, Injury Prevention Center, University of California, Johns Hopkins University, 1989).
59. Rivara, F.P., "Epidemiology of Childhood Injuries," *Preventing Childhood Injuries,* A.B. Bergman (cd.) (Columbus, OH: Ross Laboratories, 1982).
60. Rivara, F. P., "Traumatic Deaths of Children in the United States: Currently Available Prevention Strategies, '*Pediatrics* 75(3):456-*462, 1985.*
61. Rivara, F.P., and Barber, M., "Demographic Analysis of childhood Pedestrian Injuries," *Pediatrics* 76(3):375-381, *1985.*
62. Rivara, F. P., and Wolf, M.E., "Injury Research: Where Should We Go From Here?" *Pediatrics* 84(1):180-181, *1989.*
63. Rodgers, G. B., "The Effect of Helmets in Reducing All-Terrain Vehicle Injuries and Deaths, ' *Accident Analysis and Prevention* 22(1):47-58, 1990.
63a. Rotter, J., "Some Problems and Misconceptions Related to the Constructs of Internal Versus External Control of Reinforcement,'' *Journal of Consulting and Clinical Psychology* 43:56-67, *1975.*
64. Runyan, C. W., Earp, J. A., and Reese R.P., "Injury Experiences, Bicycle Helmets and Beliefs About Mandated Helmet Use in a National Sample of Competitive Cyclists," unpublished manuscript, Chapel Hill, NC, 1990.
65. Runyan, C.W., and Gerken, E., "Epidemiology and Prevention of Adolescent Injury: A Review and Research Agenda, '*Journal of the Amen"can Medical Association* 262(16):2273-2279, *1989.*
66. Runyan, C.W., Gerken, E., and Sadowski, L. S., "Unintentional Injury Among Adolescents, " paper prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, January 1990.
67. Seidel, J. S., Hornbein, M., Yoshiyama, K., et al., "Emergency Medical Services and the Pediatric Patient: Are the Needs Being Met?'' *Pediatrics* 73:769-772, *1984.*
68. Selbst, S., Alexander, D., and Ruddy, R., "Bicycle-Related Injuries," *American Journal of Diseases of Children* 141:140-144, 1987.
68a. Slap, G.B., Chaudhuri, S., and Vorters, D. F., "Risk Factors for Injury During Adolescence,' *Journal of Adolescent Health Care* 12:263-268, *1991.*
69. Smith, M.F., "Follow-Up Evaluation: Safe Performance Curriculum Driver Education Project, ' written comments to J.R. Miller, National Highway Traffic Safety Administration, U.S. Department of Transportation Washington DC, August 1987.
70. Smith, S. M., and Middaugh, J.P., "Injuries Associated With Three-Wheeled, All Terrain Vehicles, Alaska, 1983 and 1984," *Journal of the American Medical Association* 255:2454-2458, 1986.
71. Spyker, D.A., "Submersion Injury: Epidemiology, Prevention, and Management," *Pediatric Clinics of* North *America* 32:1 13-125, 1985.
72. Sweedler, B. M., "Strategies To Reduce Youth Drinking and Driving," *Alcohol Health and Research World* 14(1):76-80, *1990.*
73. Thompson, R. S., Rivara, F. P., and Thompson, D. C., "A Case-Control Study of the Effectiveness of Bicycle Safety Helmets, " *New England Journal of Medicine* 320(21):1361-1367, 1989.
74. Torg, J. S., Vegso, J.J., and Sennett, B., "The National Football Head and Neck Injury Registry: 14-Year Report on Cervical Quadriplegic (1971 -1984),' *Clinics in Sports Medicine* 6:61-73, *1987.*
75. U.S. Congress, House of Representatives, Committee on Government Operations, Subcommittee of Commerce, ConSumers, and Monetary Affairs, *Consumer Product Safety Commission's Oversight of Consent Decree Regarding Hazards of All-Terrain Vehicles (ATV's),* hearing, Feb. 28, 1990, serial No. 101-2 (Washington DC: U.S. Government Printing Office, 1990).
76. U.S. Congress, Library of Congress, Congressional Research Service, "Guns and Gun Control: National Public Opinion Polls," prepared by R. Shinn, Nov. 26, 1990.
76a. U.S. Congress, Office of Technology Assessment, *Adolescent Health-Volume I: Summary and Policy Options, OTA-H-468 (-Washington DC:* Us. Government Printing Office, April 1991).
77. U.S. Congress, Office of Technology Assessment, *Indian Health Care,* OTA-H-291 (Washington, DC: U.S. Government Printing Office, April 1986).
78. U.S. Congress, Office of Technology Assessment, *Healthy Children: Investing in the Future, OTA-H-345* (Washington, *DC:* U.S. Government Printing Office, February 1988).
79. Us. Consumer Product Safety Commission, *1987 Annual Report* (Washington, DC: 1988).
80. U.S. Consumer Product Safety Commission, unpublished 1988 data from the National Electronic Injury Surveillance System, Washington DC, 1989.
81. U.S. Consumer Product Safety Commission Division of Hazard and Injury Data Systems, "The National Electronic Injury Surveillance System: A Description of its Role in the U.S. Consumer Product Safety Commission' Washington DC, April 1989.
82. U.S. Department of Commerce, Bureau of the Census,*Estimates of the Population of the United States by Age, Sex, and Race: 1980 to 1986,* Current Populations Reports, Series P-25, No. 1000 (Washington, DC: U.S. Government Printing Office, 1987).
83. U.S. Department of Health and Human Services, Office of the Secretary, Task Force on Black and MinorityHealth, *Report of the Secretary's Task Force on Black and Minority Health, Volume V, Homicide, Suicide, and Unintentional Injuries* (Washington, DC: U.S. Government Printing Office, January *1986).*
84. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, "Drowning in the United States, 1978 -1984," *Morbidity and Mortality Weekly Report,* prepared by J.A. Gulaid and R.W. Sattin, 37(SS-1):26-32, February 1988.
85. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, "Deaths Due to Injury in the Home Among Persons Under 15 Years Of Age, 1970- 1984," *Morbidity and Mortality Weekly Report,* prepared by D.A. Pollock, D.L. McGee, and J.G. Rodriguez, 37(SS-1):13-20, February 1988.
86. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, "Introduction: Moving From the 1990 Injury Control Objectives to State and Local Surveillance Systems,' *Morbidity and Mortality Weekly Report,* prepared by M.L. Rosenberg, P.L. Graitcer, and R.J. Waxweiler, 37(SS-1):1-4, February 1988.
87. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, response to 1989 Office of Technology Assessment questionnaire regarding adolescent health initiatives, Washington, DC, 1989.
87a. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Center for Health Statistics, *Health, United States, 1989* (Washington, DC: U.S. Government Printing Office, 1990).
87b. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Center for Health

Statistics, *National Center for Health Statistics: Organization and Activities,* DHHS Pub. No. (PHS) 88-1200 (Hyattsville, MD: 1988).

88. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Center for Health Statistics, "Trends and Current Status in Childhood Mortality: United States, 1900-85," *Vital and Health Statistics, Series 3, No. 26,* DHHS Pub. No. (PHS) 89-1410 (Washington, DC: U.S. Government Printing Office, 1989).

89. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Center for Health Statistics, unpublished 1985 data from the National Ambulatory Medical Care Survey, Hyattsville, MD, 1989.

90. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Center for Health Statistics, unpublished 1987 mortality data, Washington, DC, 1990.

91. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Center for Health Statistics, unpublished 1987 data from the National Hospital Discharge Survey, Washington DC, 1989.

92. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Center for Health Statistics, *Vital and Health Statistics: Current Estimates From the National Health Interview Survey, 1988,* DHHS Pub. No. (PHS) 89-1501 (Washington, DC: U.S. Government Printing Office, 1990).

93. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Center for Health Statistics, unpublished 1988 data from the National Health Interview Survey, Hyattsville, MD, 1990.

94. U.S. Department of Health and Human Services, Public Health Service, Health Resources and Services Administration, Bureau of Health Care Delivery and Assistance, Office of Maternal and Child Health, *Abstracts of Active Projects, FY 1986* (Rockville, MD: 1986).

95. U.S. Department of Health and Human Services, Public Health Service, Health Resources and Services Administration, Bureau of Maternal and Child Health and Resources Development, Emergency Medical Services for Children Program, "Emergency Medical Services for Children-The Federal Initiative," Rockville, MD, no date.

%. U.S. Department of Health, Education, and Welfare, Public Health Service, National Center for Health Statistics, *Vital Statistics of the United States, 1970, Vol. II-Mortality* (Washington, DC: U.S. Government Printing Office, 1975).

97. U.S. Department of Health, Education, and Welfare, Public Health Service, National Center for Health Statistics, *Vital Statistics of the United States, 1975, Vol. II-Mortality* (Washington, DC: U.S. Government Printing Office, 1980).

98. U.S. Department of Health and Human Services, Public Health Service, National Center for Health Statistics, *Vital Statistics of the United States, 1980, Vol. II—Mortality* (Washington DC: U.S. Government Printing Office, 1985).

99. U.S. Department of Health and Human Services, Public Health Service, National Center for Health Statistics, *Vital Statistics of the United States, 1984, Vol. II—Mortality* (Washington DC: U.S. Government Printing Office, 1989).

100. U.S. Department of Health and Human Services, Public Health Service, National Center for Health Statistics, *Vital Statistics of the United States, 1985, Vol. II-Mortality* (Washington DC: U.S. Government Printing Office, 1988).

101. U.S. Department of Health and Human Services, Public Health Service, National Center for Health Statistics, *Vital Statistics of the United States, 1986, Vol. II-Mortality* (Washington, DC: U.S. Government Printing Office, *1989).*

102. U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, National Institute of Child Health and Human Development, response to Office of Technology Assessment questionnaire regarding adolescent health initiatives, Washington, DC, 1989.

103. U.S. Department of Health and Human Services, Public Health Service, Office of Disease Prevention and Health Promotion, "Prevention Report," Washington, DC, December 1988.

104. U.S. Department of Transportation, National Highway Traffic Safety Administration, "Alcohol in Fatal Accidents for Various Driver Age Groups,' research notes, J.C. Fell, Washington DC, 1982.

105. U.S. Department of Transportation National Highway Traffic Safety Administration *Provisional Driver Licensing System for Young Novice Drivers,* DOT HS 806-891 (Washington, DC: 1985).

106. U.S. Department of Transportation, National Highway Traffic Safety Administration *Fatal Accident Reporting System* (Washington, DC: 1987).

107. U.S. Department of Transportation National Highway Traffic Safety Administration, *Traffic Safety '87: A Report on the Activities Under the National Traffic and Motor Vehicle Safety Act of 1966, as Amended and the Motor Vehicle Information and Cost Savings Act, as Amended January 1, 1987-December 31, 1987* (Washington, DC: 1988).

108. U.S. Department of Transportation, National Highway Traffic Safety Administration, *Status Report on Priority Programs,* DOT HS *807-265* (Washington, DC: April 1988).

109. U.S. Department of Transportation% National Highway Traffic Safety Administration, response to 1989 Office of Technology Assessment questionnaire regarding adolescent health initiatives, Washington, DC, 1989.

110. U.S. Department of Transportation, National Highway Traffic Safety Administration *Fatal Accident Reporting System 1988: A Review of Information on Fatal Traffic Crashes in the United States in 1988* (Washington, *DC: 1989).*

111. U.S. Department of Transportation, National Highway Traffic Safety Administration "Provisional Licensing Programs for Young Drivers," DOT HS 807-375, prepared by P.F. Wailer (Washington, DC: February 1989).

112. U.S. Department of Transportation, National Highway Traffic Safety Administration, *Restraint System Usage in Traffic Population 1988, Annual Report,* DOT HS *807-447* (Washington, *DC:* June 1989).

113. U.S. Department of Transportation National Highway Traffic Safety Administration "Consumer Information" Washington DC, November 1989.

114. U.S. Department of Transportation National Highway Traffic Safety Administration, *Facts About Motorcycle Crashes and Safety Helmet Use, NTS-23/4* (Washington, DC: 1990).

115. U.S. Department of Transportation, National Highway Traffic Safety Administration, *Young Adult Highway Safety Plan* (Washington, DC: January 1990).

116. U.S. Department of Transportation, National Highway Traffic Safety Administration, National Center for Statistics and Analysis, *Drunk Driving Facts* (Washington DC: July 1989).

117. Wagenaar, A. C., *Alcohol, Young Drivers, and Traffic Accidents* (Lexington, MA: Lexington Books, 1983).

1 17a. Wailer, A.E., Baker, S.P., and Szocka, A., "Childhood Injury Deaths: National Analysis and Geographic Variations," *American Journal of Public Health* 79(3):310-315, *1989.*

118. Wailer, P.F., Runyan, C. W., and Perry, P.E., "Assessing the Impact of Increasing the Drinking Age on Motor Vehicle Injuries: An Injury Control Case Study," Centers for Disease Control, Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA, 1986.

119. Wailer, P.F., Stewart, J.R., Hansen, A.R., et al., "The Potentiating Effects of Alcohol on Driver Injury,' *Journal of the American Medical Association* 256:1461-1466, *1986.*

120. Wasserman, R., Walk, J., Monty, M., et al., "Bicyclists, Helmets and Head Injuries: A Rider-Based Study of Helmet Use

and Effectiveness,'' *American Journal of Public Health* 78(9):1220 1221, 1988.

121. White, J.B., "Honda Follows Lead of U.S. On Air Bags," *Wall Street Journal,* p. Bl, Sept. 25, 1990.
122. Williams, A.F., "Fatal Motor Vehicle Crashes Involving Teenagers,'' *Pediatrician* 12:37-40, 1985.
123. Williams, A.F., "Nighttime Driving and Fatal Crash Involvement of Teenagers,'' *Accidents* Analysis *and* Prevention 17:1-5, 1985.
124. Williams, A.F., and Karpf, R. S., "Deaths of Teenagers as Passengers in Motor Vehicles, ' Accidents Analysis and Prevention 15:49-54, 1983.
125. Williams, A.F., Wells, J.K., and Lund, A.K., "Voluntary Belt Use Among High School Students," Accidents Analysis *and* Prevention 15:161-165, 1983.
126. Wintemute, G.J., Kraus, J.F., Teret, S.P., et al., "Drowning in Childhood and Adolescence: A Population Based Study," *American Journal of Public Health* 77:830-832, 1987.
127. Wintemute, G.J., Teret, S.P., Kraus, J.F., et al., "When Children Shoot Children,'' *Journal of the American Medical Association* 257:3107-3109, 1987.
128. Withers, B., and Baker, S., "Epidemiology and Prevention of Injuries," *Emergency Medicine Clinics of North America* 2(4):701-715, 1984.