

Childhood Injury Deaths: National Analysis and Geographic Variations

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Abstract: Twenty-three causes of injury mortality in children ages 0–14 in the United States were analyzed by age, race, sex, and state of residence for the years 1980–85. Motor vehicles caused 37 per cent of all injury-related deaths and were the leading cause of injury mortality in every group except children younger than one year, for whom homicide was the leading cause. Male death rates were at least four times female rates for suicide, unintentional firearm injury, and

injuries related to farm machinery or motorcycles. The drowning rate among Whites was almost twice that of Blacks for ages 1–4, but in the 10–14 year age group the drowning rate for Blacks was over three times that of Whites. In general, the highest injury death rates were in the mountain states and the south. Between 1980 and 1985, the suicide rate in the 10–14 year age group more than doubled. (*Am J Public Health* 1989; 79:310–315.)

Introduction

Injury is the leading cause of death among children above nine months of age in the United States. Injuries cause approximately 44 per cent of all deaths in children ages 1–4, 51 per cent at ages 5–9, and 58 per cent at ages 10–14.¹ The importance of injury deaths in children and young adults is reflected in the fact that injury surpasses all major disease groups as the leading cause of premature years of life lost in this country.^{2–5}

We examined 23 categories of fatal childhood injury in the United States, analyzing age, sex, race, and state of residence for the six years 1980–85.

Methods

Mortality tapes for the years 1980 through 1985 were obtained from the National Center for Health Statistics (NCHS). Deaths of children ages 0–14 years, where the underlying event was injury (i.e., coded E800–E999), were analyzed. The 1982 Census Bureau population estimates, multiplied by six, were used as the denominators for calculating the average annual death rates.

Injury deaths were categorized into 23 causes of death based on ICD E-codes. The *expected* number of deaths for each state, based on the death rate for the United States as a whole, was calculated by multiplying the six-year population estimate for the state by the total US death rate for each injury cause. For example, to calculate the expected number of motor vehicle occupant deaths in Alabama, the six-year population estimate of 5,538,000 (the 1982 estimate of 923,000 times six) was multiplied by 3.17/100,000/year (the US motor vehicle occupant death rate) to get 176 expected deaths for 1980 through 1985. As injury death is a relatively rare event in this population, a Poisson distribution was assumed, and 99 per cent confidence limits were calculated for the number of *observed* deaths in each state. In Alabama, the observed number of motor vehicle occupant deaths was 268 with a 99 per cent confidence interval ranging from 226 to 310. If the *expected* number of deaths fell outside the confidence interval set around the *observed* number of death, the state's observed number of deaths was determined to be either

significantly high or significantly low. For Alabama, the expected number of motor vehicle occupant deaths, 176, fell well below the lower 99 per cent confidence limit of 226 so Alabama had a significantly high number of observed motor vehicle occupant deaths.

When a state's *observed number of deaths* was significantly high or low, the state was so depicted on a map. In addition, any state whose death *rate* ranked in the top 10 death rates for a given cause but whose expected deaths fell within the 99 per cent confidence interval of the observed deaths (due to small numbers) were depicted in a separate group called "top ten". All other states were depicted as "average". Sometimes all of the states with the top 10 death rates from a given cause also had significantly high observed numbers of deaths in which case no "top ten" group appears on the map.

Results

National Analysis

During the six-year period 1980–85, almost 10,000 US children ages 0–14 years died of injuries *each year* (Table 1). Thirty-seven per cent of these deaths were related to motor vehicles; this figure includes bicyclist and pedestrian deaths involving motor vehicles. The other leading causes of death were drowning (14 per cent of injury deaths), house fires (12 per cent), and homicide (10 per cent).

When motor vehicle deaths were separated into the subcategories shown in Table 1, the five leading causes of injury death were motor vehicle occupant, drowning, pedestrian, house fire, and homicide. These five causes, in varying order, were consistently the top five in each age, sex, and racial group, with two exceptions: for children less than one year old, suffocation and food aspiration replaced drowning and pedestrian deaths; and for children ages 10–14, bicycles replaced house fires among the top five causes of injury death.

Age: US children ages 0–14 years experienced an average annual death rate of 19.3/100,000 for all injury causes combined during the years 1980–85. The injury death rate was 33.9/100,000/year for children less than one year old, 25.4 for ages 1–4, 14.4 for ages 5–9, and 16.2 for ages 10–14. The relative importance of specific causes of death varied with age (Figure 1). Motor vehicle-related injuries were the largest category for all ages except children less than one year old, for whom homicide accounted for even more deaths than motor vehicles.

The overall death rate from motor vehicles varied less among age groups than most other causes of injury, ranging from 5.5/100,000/year below one year of age to 7.8 for ages 1–

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TABLE 1—Injury Deaths by Cause, Ages 0–14, US, 1980–85

| Injury Cause | Number of Deaths 1980–85 | Average Annual Death Rate per 100,000 Population |
|------------------------------|--------------------------|--|
| Motor vehicle-related, total | 22,174 | 7.2 |
| Motor vehicle occupant | 9,796 | 3.2 |
| Pedestrian, traffic | 7,489 | 2.4 |
| Bicycle | 2,194 | 0.7 |
| Pedestrian, non-traffic | 1,276 | 0.4 |
| Motorcycle | 690 | 0.2 |
| Other motor vehicle-related | 729 | 0.2 |
| Drowning | 8,568 | 2.8 |
| House fire | 7,021 | 2.3 |
| Homicide | 5,722 | 1.9 |
| Suffocation | 2,279 | 0.7 |
| Firearm, unintentional | 1,700 | 0.6 |
| Fall | 1,332 | 0.4 |
| Aspiration, food | 1,248 | 0.4 |
| Suicide | 1,214 | 0.4 |
| Aspiration, other | 983 | 0.3 |
| Poison, solid/liquid | 539 | 0.2 |
| Farm machinery | 508 | 0.2 |
| Electric current | 432 | 0.1 |
| Poison, vapor | 384 | 0.1 |
| Airplane crash | 348 | 0.1 |
| Other unintentional | 3,473 | 1.1 |
| Unknown intent | 1,237 | 0.4 |
| Medical/surgical | 539 | 0.2 |
| All injury (E800–E999) | 59,711 | 19.3 |

4 years. Differences emerged, however, when motor vehicle deaths were separated into the six subcategories.

Occupant deaths accounted for 90 per cent of motor vehicle-related deaths prior to age 1 and were also the largest subcategory for ages 1–4 (43 per cent) and 10–14 (46 per cent), but pedestrian deaths were paramount at ages 5–9 (47 per cent). Pedestrian non-traffic deaths, which involve a vehicle striking a child in a driveway or on other private property,

comprised 17 per cent of motor vehicle-related deaths in children ages 1–4 years. Annually, an average of 212 children died this way, 83 per cent of them 1–4 years of age.

Bicyclist deaths accounted for 12 per cent of the motor vehicle-related deaths in the 5–9 year age group, and 16 per cent for ages 10–14. Sixty per cent of all childhood bicyclist deaths occurred among 10–14 year old children.

Approximately 115 motorcyclist deaths occurred each year, primarily in the 10–14 year age group. Sixty-seven per cent of these children were identified as the driver of the motorcycle. Some deaths in which the vehicle was classified as a motorcycle may have involved miscoded off-road vehicles, such as all-terrain vehicles and minibikes, which should have been included in the category “other motor vehicle.”

Sex: The male-to-female ratio of death rates was 1.7 to 1 for all injury causes combined. Male death rates were over four times the female rates for suicide, unintentional firearm injury, and injury related to motorcycles or farm machinery. For males ages 10–14, unintentional firearm deaths were surpassed only by deaths related to motor vehicles and drowning.

Race: Among the four major racial groups, injury death rates were lowest for Orientals and Whites and highest for Native Americans (Table 2). Causes of injury with exceptionally high death rates for Native Americans were pedestrian non-traffic deaths (3.9 times the rate for all children), poisoning by solid or liquid (3.5 times), aspiration of non-food materials (2.6 times), and motor vehicle occupants (2.2 times).

For Oriental children, the death rate from falls was more than twice the rate for all US children. In contrast, the death rate among Oriental children for unintentional firearm deaths was one-eleventh the US rate and their motorcycle death rate was one-seventh the US rate.

Differences between Blacks and Whites in overall death rates decreased with increasing age. The rate for Blacks was 2.5 times the rate among Whites for children less than one

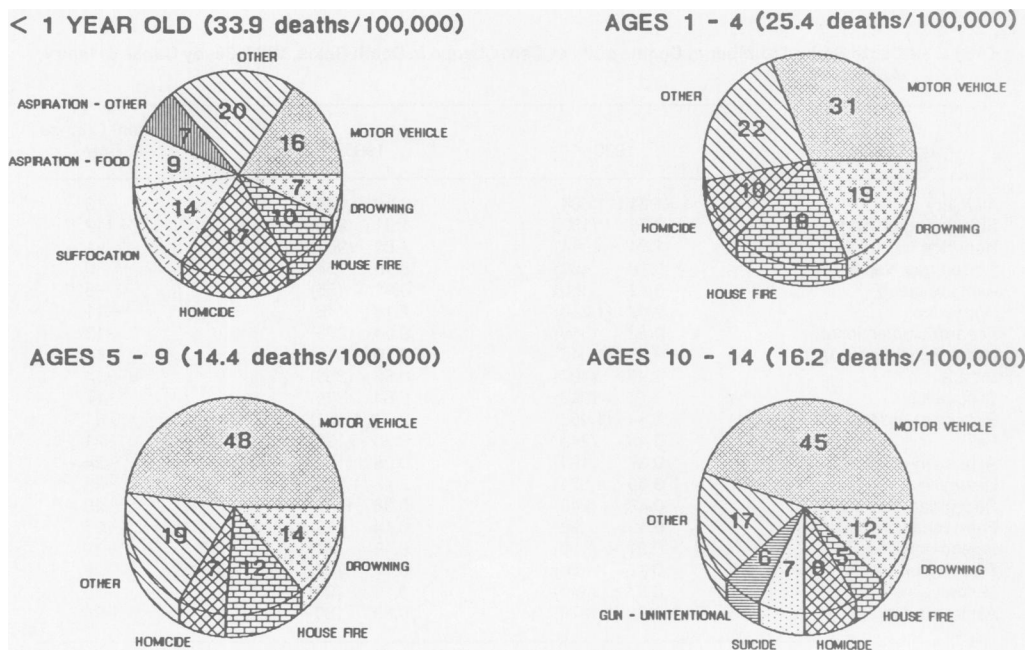


FIGURE 1—Childhood Injury Deaths, Percentage by Cause, US 1980–85

TABLE 2—Average Annual Death Rates* by Leading Causes and Race, Ages 0–14, US, 1980–85

| Injury Cause | White | Black | Native American | Oriental | All Races† |
|------------------------|------------------|------------------|-----------------|---------------|------------------|
| All Injuries | 17.5 (44,217) | 29.3 (13,634) | 33.9 (918) | 17.5 (917) | 19.3 (59,711) |
| Motor vehicle occupant | 3.3 (8,224) | 2.6 (1,217) | 6.9 (186) | 3.1 (162) | 3.2 (9,796) |
| Pedestrian, traffic | 2.2 (5,487) | 3.8 (1,748) | 3.6 (98) | 2.9 (153) | 2.4 (7,489) |
| Drowning | 2.6 (6,438) | 3.9 (1,814) | 4.8 (131) | 3.4 (180) | 2.8 (8,568) |
| House fire | 1.6 (4,080) | 6.0 (2,795) | 3.3 (90) | 1.0 (51) | 2.3 (7,021) |
| Fall | 0.4 (933) | 0.7 (333) | 0.6 (17) | 0.9 (49) | 0.4 (1,332) |
| Homicide | 1.3 (3,355) | 4.7 (2,191) | 2.7 (72) | 1.9 (101) | 1.9 (5,722) |

*Rate/100,000/year (total deaths over six-year period in parentheses)

†All Races column includes cases where race was unknown.

year old, 1.8 times for ages 1–4, 1.7 for ages 5–9, and 1.2 for ages 10–14.

House fire and homicide rates for Blacks were more than three times the rates for Whites in all age groups below 10 years. Pedestrian death rates were more than twice as high in Blacks as in Whites for ages 1–4 and 5–9 years. In contrast, the drowning rate among Whites ages 1–4 was almost double that of Blacks. At ages 10–14 years, the most pronounced racial difference was the high death rate from drowning in Blacks (3.4 times the rate for Whites). Black children ages 10–14 continued to experience high homicide and house fire death rates compared to Whites, while White children in this age group had substantially higher death rates than Blacks for

motor vehicle occupants, suicide, unintentional firearm deaths, motorcycles, and suffocation.

Time Trends: The injury death rate for the US population ages 0–14 decreased by 16 per cent between 1980 and 1985, from 21.6 to 18.2/100,000/year (Table 3). The greatest decreases occurred in the youngest children: 25 per cent for children less than 1 year old, 21 per cent for ages 1–4, and 19 per cent for ages 5–9, compared to 7 per cent for ages 10–14.

Death rates declined for almost all causes of injury during this time period (Table 3). Among the leading causes of fatal injury, the greatest decreases were seen in rates of drowning and pedestrian deaths. The motor vehicle occupant death rate declined by 14 per cent for all ages combined, with dramatic differences among age groups. Children under 1 year experienced a 32 per cent decrease, ages 1–4 years a 22 per cent decrease, ages 5–9 years an 11 per cent decrease, and ages 10–14 only a 3 per cent decrease. The suicide rate for ages 10–14 more than doubled.

Geographic Variations

Analysis at the state level found more than a three-fold difference among the states with the highest and lowest injury death rates. Injury death rates for all children ages 0–14 ranged from 11.2/100,000/year in Massachusetts to 35.0/100,000/year in Alaska. In general, the highest rates were in the mountain states and in the south, and the lowest rates were in New England, the mid-Atlantic states, and the midwest.

In every state, total motor vehicle deaths surpassed deaths from any other injury cause. Furthermore, in 26 states, the subcategory of motor vehicle occupants outranked deaths from any other category (Appendix). Deaths due to house fires outnumbered those from any other specific injury cause in 11 states, while drowning was the leading injury cause of death in 10 states. Pedestrian deaths ranked first in three states, as did homicide in Washington, DC.

Motor vehicle occupant deaths (Figure 2) were high in the south and southwest. The highest rates were in Idaho (7.4/100,000/year), New Mexico (6.6), and Wyoming (6.5), which

TABLE 3—Death Rates,* Number of Deaths and Per Cent Change in Death Rates, 1980–85, by Cause of Injury, Ages 0–14, US

| Injury Cause | 1980 | 1985 | Percent Change in Rates |
|------------------------|----------------|---------------|-------------------------|
| All Injury | 21.61 (11,084) | 18.19 (9,449) | -16 |
| Suicide (ages 10–14) | 0.76 (139) | 1.61 (275) | +112 |
| Homicide | 1.84 (944) | 1.86 (967) | +1 |
| Poison-gas, vapor | 0.10 (52) | 0.10 (54) | 0 |
| Airplane crash | 0.12 (60) | 0.11 (55) | -8 |
| House fire | 2.42 (1,240) | 2.15 (1,118) | -11 |
| Firearm-unintentional | 0.62 (316) | 0.54 (278) | -13 |
| Motor vehicle-occupant | 3.60 (1,846) | 3.10 (1,610) | -14 |
| Bicycle | 0.79 (407) | 0.68 (353) | -14 |
| Suffocation | 0.77 (393) | 0.64 (335) | -17 |
| Pedestrian-traffic | 2.84 (1,456) | 2.24 (1,161) | -21 |
| Fall | 0.48 (245) | 0.38 (198) | -21 |
| Aspiration-other | 0.37 (191) | 0.28 (144) | -24 |
| Drowning | 3.60 (1,671) | 2.43 (1,263) | -25 |
| Pedestrian-non-traffic | 0.48 (248) | 0.36 (187) | -25 |
| Farm machinery | 0.19 (98) | 0.14 (72) | -26 |
| Poison-solid, liquid | 0.21 (106) | 0.15 (80) | -29 |
| Electric current | 0.17 (85) | 0.12 (64) | -29 |
| Motorcycle | 0.27 (140) | 0.19 (98) | -30 |
| Aspiration-food | 0.53 (274) | 0.35 (180) | -34 |

*Rate/100,000/year
Number of Deaths in parentheses.

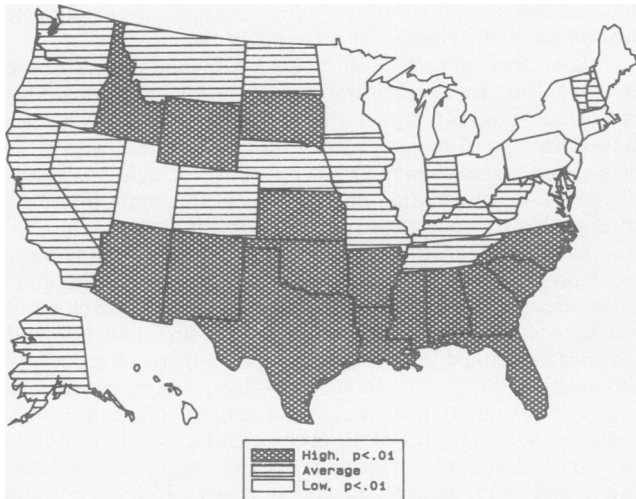


FIGURE 2—Motor Vehicle Occupant Deaths by State, Ages 0-14 Years, US 1980-85

contrasted sharply with the relatively low rate in nearby Utah (2.4).

House fire deaths (Figure 3) showed a distinct geographic pattern, with high rates in the east, especially the southeast, and low rates in the west.

Drowning rates (Figure 4) ranged from 0.8/100,000/year in Rhode Island to 6.8 in Alaska. California, Oregon, and Utah are among the states with significantly high numbers of drowning deaths, although they do not have significantly high numbers of deaths for most other causes.

Death rates from unintentional firearm injury ranged from zero in Rhode Island to 2.1/100,000/year in Alaska. The rates were highest in the south and in the northern mountain states (Figure 5).

Farm machinery death rates were highest in northern farm states: Idaho, South Dakota, Wisconsin, Vermont, Iowa, and Minnesota had rates ranging from 0.6 to 0.9/100,000/year. Deaths from farm machinery had the highest rates among 1-4 year olds and occurred predominantly (80 per cent) among White males. In Wisconsin children ages 1-

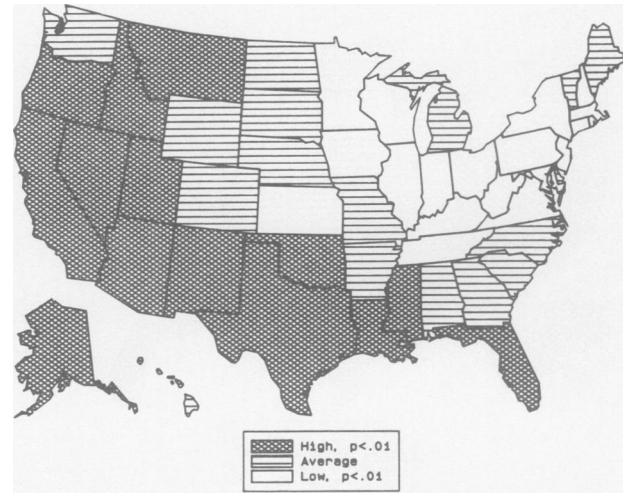


FIGURE 4—Drowning Deaths by State, Ages 0-14 Years, US 1980-85

4, farm machinery deaths were surpassed only by deaths due to motor vehicles, house fires, and drowning (data not shown).

Homicide rates ranged from 0.7/100,000/year in New Hampshire to 3.0 in Delaware and 4.6 in Washington, DC. High homicide rates were seen throughout the southwest as well as in states with large urban populations (Figure 6).

Suicide rates (Figure 7) are mapped for the 10-14 year age group because only 2 per cent of the childhood suicides occurred in younger children. Suicide rates were generally highest in the northern and mountain states; they ranged from a low of 0.3/100,000/year in North Dakota to 2.1 or higher in Wyoming (3.3), New Mexico (2.7), Idaho (2.4), and Colorado (2.1).

Discussion

Childhood injury death rates have been decreasing for decades^{3,6} and it is encouraging that both the frequency and the rate of death from all injuries combined have continued

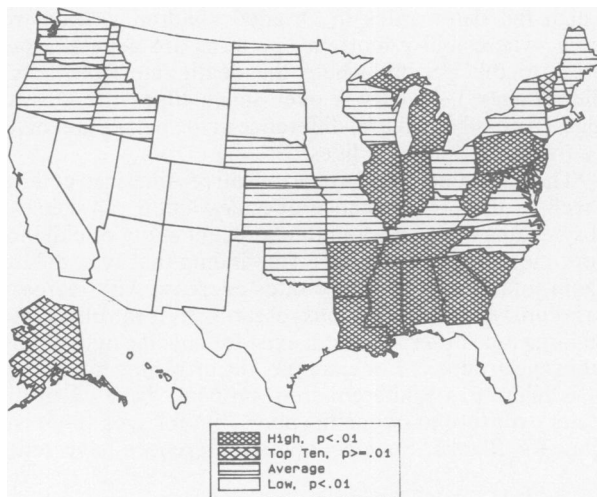


FIGURE 3—House Fire Deaths by State, Ages 0-14 Years, US 1980-85

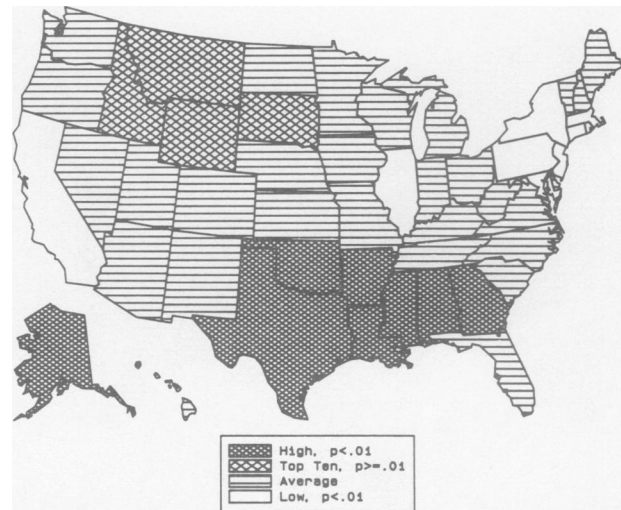


FIGURE 5—Unintentional Firearm Deaths by State, Ages 0-14 Years, US 1980-85

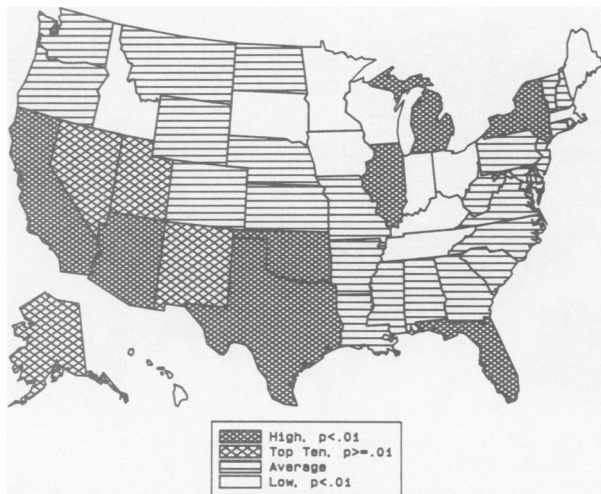


FIGURE 6—Homicides by State, Ages 0–14 Years, US 1980–85

to decrease in recent years. Major causes of unintentional injury death continue to be motor vehicle occupants, pedestrians, drowning, and house fires. The importance of homicide during the first year of life—often representing lethal cases of child abuse—and the increasing rates of juvenile suicide are matters of special concern because they reflect personal, family, and social disruption.

Identifying states with the highest rates of a specific injury cause of death may suggest a likely causal factor. For example, the high house fire death rates in the south and east suggest that the older and/or wooden houses, more commonly found in these regions^{3,7} may be a contributing factor. In addition, the National Fire Data Center suggests that low income and education levels and large numbers of families living in poverty, particularly prevalent in the southeast, may contribute to high fire death rates.⁸ Similarly, an especially low death rate may be revealing. For example, the low rate of motor vehicle occupant deaths in Utah suggests a beneficial effect on children of social policies (reflecting, in this instance, religious tenets) that reduce alcohol use by adults. The motor vehicle occupant death rate per billion vehicle

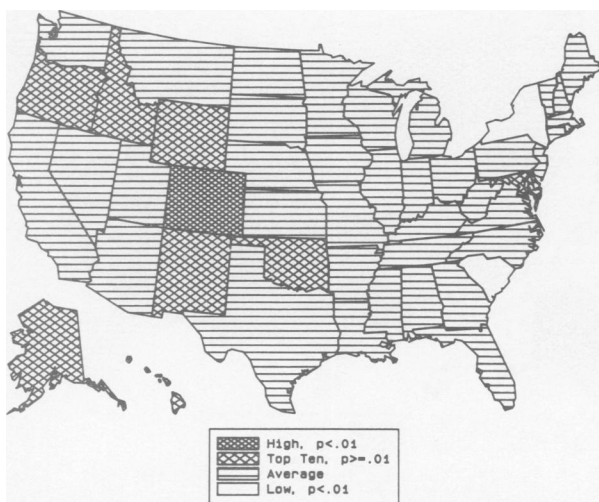


FIGURE 7—Suicides by State, Ages 0–14 Years, US 1980–85

miles is also low in Utah³ as well as the per capita consumption of alcohol, which is the lowest in the country.⁹

It is also important to look at the rankings of causes *within* a state. In Maine and Virginia, the house fire death rate is not substantially higher than in the US as a whole—yet house fires are a major problem in these states, with death rates even higher than the rates for motor vehicle occupants. This type of information can be helpful to a state interested in targeting its own most serious problems.*

Limitations of this study include possible coding variations among states. It is unlikely that different coding practices affected the major causes of injury death, since motor vehicle-related injury, drowning, house fire, and homicide are clearly defined and recognizable throughout the country. However, coding of some less prominent injury causes may vary. For example, mechanical suffocation and aspiration, to which about one-third of all injury deaths in children under one year of age are attributed, may be confused with each other and may include miscoded cases of Sudden Infant Death Syndrome (SIDS). More accurate coding of SIDS in recent years may, in part, account for the decrease in deaths coded to aspiration in children less than one year old.

The use of data from a six-year period made it possible to examine causes of death and population subgroups that are rarely considered. For example, pedestrian deaths in non-traffic locations such as driveways and parking lots comprise only 2 per cent of all injury deaths, but 17 per cent of all motor vehicle-related deaths in 1–4 year olds. An examination of pedestrian deaths for this age group in Washington State indicates that fatalities occurring in non-traffic situations may often be misclassified as traffic-related.¹⁰ From 1979 to 1983, one-third of the pedestrian traffic deaths to children under five years of age in Washington State were re-classified as non-traffic deaths when additional information from different data sources was considered. Thus, non-traffic pedestrian deaths may be an even more important cause of death for young children than national data indicate.

The differences observed among racial groups indicate the need for prevention efforts focused on the particular injury problems of certain subpopulations. Falls cause 5 per cent of injury deaths in Oriental children, compared to only 2 per cent in all other children. Falls from or out of buildings are overrepresented among fall deaths in Oriental children when compared to fall deaths in children of other races, suggesting that an urban living environment may contribute to high fall death rates in Oriental children.¹¹ Data from Korea, where injury mortality patterns are generally quite similar to the US but where the death rate from falls in children ages 1–4 years is over seven times the US rate, suggest a possible cultural difference in the perception of falls as a threat to children's lives.¹²

The high injury death rates in Native American children, as well as the predominance of males among all causes of injury death, were also found in a recent study of childhood injury mortality in Canada.¹³ The finding that race differentials in total injury mortality rates decrease with increasing age is consistent with previous research, as is the observation that large race differences still exist for specific injury causes within age groups.¹⁴ For example, the drowning rate for ages 1–4 is highest in White children, probably because of their greater exposure to swimming pools, but for ages 10–14 is far higher for Blacks. Socioeconomic differences have repeat-

*Detailed data for each state are available from the authors.

edly been shown to be related to differences in injury occurrence as well as injury prevention understanding and behaviors.¹⁵⁻¹⁷ The racial differences revealed by this study most likely reflect differences in income, education, and other aspects of socioeconomic status among racial groups in the US.

This study indicates that in certain geographic areas or for specific population subgroups it is possible to identify injury problems that are often masked in larger, less specific categories. Such identification increases the likelihood that specific injury problems will be targeted and given higher priority in prevention programs, eventually leading to a reduction in injury mortality.

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APPENDIX

Leading Cause of Injury Death* by State, Ages 0-14, US 1980-85

| Motor Vehicle Occupant | House Fire | Drowning | Pedestrian | Homicide |
|------------------------|----------------|------------|---------------|----------------------|
| Alabama | Delaware | Alaska | Massachusetts | District of Columbia |
| Arkansas | Illinois | Arizona | New York | |
| Colorado | Maine | California | Rhode Island | |
| Connecticut | Maryland | Florida | | |
| Georgia | Michigan | Hawaii | | |
| Idaho | New Jersey | Montana | | |
| Indiana | Pennsylvania | Nevada | | |
| Iowa | South Carolina | Oregon | | |
| Kansas | Vermont | Utah | | |
| Kentucky | Virginia | Washington | | |
| Louisiana | West Virginia | | | |
| Minnesota | | | | |
| Mississippi | | | | |
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| Nebraska | | | | |
| New Hampshire | | | | |
| New Mexico | | | | |
| North Carolina | | | | |
| North Dakota | | | | |
| Ohio | | | | |
| Oklahoma | | | | |
| South Dakota | | | | |
| Tennessee | | | | |
| Texas | | | | |
| Wisconsin | | | | |
| Wyoming | | | | |

*When all categories of motor vehicle-related deaths are combined, Total Motor Vehicle is the leading cause in every state.