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Injury Fatalities Among Young Children

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Injuries and violence are the primary causes of death among young children in the United States. In particular, in 1982-84 motor vehicle injuries, fires, drowning, and homicide were the leading external causes of death at ages 1-4 years and 5-9 years, accounting for nearly 80 percent of all deaths from external causes. The purpose of this article is to analyze race and sex differentials in injury fatalities among young children. Race and sex differentials in injury mortality were measured in terms of relative risks, that is, race (black to white) and sex (male to female) mortality ratios. Race ratios for external causes ranged from 1.7 to 1.9 for children 1-4 and 5-9, while sex ratios were

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somewhat lower, 1.4 to 1.8. Although race and sex ratios were relatively small for passenger-related motor vehicle fatalities (0.8 to 1.2) the ratios for pedestrian-related injuries were considerably greater (1.5 to 2.0). Race ratios for deaths caused by fires and homicide were particularly large (3.4 to 4.3).

Mortality differences were also measured in terms of excess mortality. For each age-race group more than 65 percent of the overall excess deaths among males were due to external causes of death. Pedestrian-related motor vehicle injuries and drownings accounted for the largest proportion of excess deaths among males. At ages 1-4, 53 percent of the overall excess deaths among blacks were due to external causes. Deaths caused by fires and homicide accounted for more than two-fifths of the excess in this age group. At ages 5-9, 81 percent of excess mortality among black males and 69 percent among black females were accounted for by external causes. Fires, pedestrian-related motor vehicle fatalities, and homicides accounted for nearly 65 percent of excess mortality among black children.

There has been a 30 percent decline in death rates from all external causes between 1972–74 and 1982–84. Pedestrian-related motor vehicle death rates declined the most in both age groups. Mortality also declined in each age-race-sex group for passenger-related motor vehicle injuries, for drownings, and for fires except among black males ages 5–9. Homicide, in contrast, increased in both age groups. There has been little change, however, in the incidence of injuries among children. Thus, it appears that declines in fatalities accounted for a major portion of the mortality reduction.

HE RELATIONSHIP BETWEEN a child's health and his or her physical and social environment has received increasing attention as a public health issue (1). These environmental factors play an especially important role in the incidence of and mortality from injuries. Previous research has considered both broad overviews of injury fatalities (2-4) for all age groups and narrowly focused analyses of particular injuries (5-8). In this article we analyze race and sex differentials in injury fatalities among young children. In particular, there are three major objectives of this paper: (a) to assess race and sex differentials in mortality from external causes of death (intentional and unintentional injuries) among children ages 1-9; (b) to assess the contribution of external causes of death to race and sex differentials in overall mortality for young children, and (c) to assess secular changes in mortality from these external causes among young children.

We have focused our analyses on children ages 1-9 for two reasons. First, deaths to children under age 1—infant mortality—result from a very different set of causes. External causes of death account for only 3 percent of infants' deaths compared to 47 percent for 1-9-year-olds. Second, children ages 10-14 years are often exposed to different risks than are younger children. For example, in 1982-84, nearly 10 percent of the motor vehicle deaths of 10-14-year-olds were driver related. Furthermore, for an additional 14 percent of motor vehicle accident deaths in this age group, the death certificate did not indicate whether the victim was the driver or a passenger.

Methods

Mortality data for the United States are reported for two periods—1982-84 and 1972-74. Although these periods cover two revisions of the International Classification of Diseases (ICD), the change in classifications does not introduce serious discontinuities for the causes of death under investigation (9). Death rates were calculated from unpublished tabulations compiled by the Division of Vital Statistics, National Center for Health Statistics, and from population estimates of the Bureau of the Census.

Natural causes of death (ICD 9th revision codes 001 to 799) are distinguished from external causes (ICD E800 to E999). For boys and girls ages 1-4 and 5-9, the specific causes of death analyzed include motor vehicle injuries (ICD 9th revision

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codes E810-E825 and 8th revision codes E810-E823) with particular attention to differences between "pedestrian" fatalities that include pedal cycles (4th digit ICD codes .6 and .7) and "passenger" fatalities (4th digit ICD code .1). These two components of motor vehicle injuries account for about 90 percent of all motor vehiclerelated fatalities in these two age groups. The remainder primarily include "unspecified persons" (4th digit ICD code .9).

In addition, we analyzed deaths from homicide (8th and 9th revision ICD codes E960-E969); fire and flames (8th and 9th revision ICD codes E890-E899), and from accidental drowning and submersion (8th and 9th revision ICD code E910). Water transport accidents causing submersion or drowning (E830 and E832) were excluded from the latter category because they are not readily available in tabular form for the 1970s. It should be noted, however, that in 1983 there were only five deaths among 1-4-year-olds coded to E830 and E832 in contrast with 655 deaths coded to E830 and E832 in contrast with 321 coded to E910.

Race and sex differentials were measured in two ways. First, sex ratios (male to female relative risks) were calculated for each age-race group and cause of death. Similarly race ratios (black to white relative risks) were calculated for each age-sex group and cause. Although the causespecific mortality ratios are informative, they do not illustrate the extent to which overall mortality among blacks or among males can be reduced by eliminating the excess mortality for that cause. In order to do this, we calculated the race or sex difference in death rates for a particular cause as a percent of the corresponding difference in the all causes death rates.

Results

Race-sex differentials. In 1982–84, there were 23,083 deaths among children ages 1–4 and 12,913 deaths among children ages 5–9. Table 1 shows the age-race-sex-specific death rates for all causes of death, natural causes, and the leading external causes of death. There is substantial variation in death rates across these groups and causes. In both age groups, death rates for external causes were higher among males than females and among blacks than whites.

In addition, external causes of death accounted for 44 percent of all deaths among children ages

Table 1. Deaths per 100,000 population among children ages 1-4 and 5-9 by race and sex for leading external causes of death: United States, 1982-84

		1-4 years					5–9 years				
			W	hite	BI	ack		White		Bl	ack
Cause of death	9th revision ICD code	Tot a l ¹	Male	Female	Male	Female	Total ¹	Male	Female	Male	Female
All causes		55.1	55.8	44.2	91.8	74.1	26.6	29.1	20.4	42.6	31.2
Natural causes	001-799	30.8	30.1	26.9	47.2	41.1	13.1	13.8	11.7	16.3	15.0
External causes	E800-E999	24.3	25.7	17.3	44.6	33.0	13.5	15.3	8.7	26.3	16.2
Motor vehicle	E810-E825	7.4	8.0	6.1	10.6	7.6	6.3	7.4	4.6	10.3	6.2
Pedestrian, cvclist	² .6–.7	3.9	4.3	2.9	6.9	4.6	3.8	4.5	2.2	7.9	4.2
Passenger	² .1	2.8	3.0	2.7	2.8	2.3	1.7	1.8	1.8	1.4	1.6
Fire	E890-E899	4.5	3.7	2.6	12.8	11.0	1.8	1.5	1.1	5.1	4.5
Drowning	E910	4.4	6.2	3.2	3.9	1.7	1.8	2.2	0.7	5.1	1.4
Homicide	E960-E969	2.5	1.8	1.5	7.0	6.5	1.0	0.7	0.7	2.5	2.2

¹ Includes other races not shown separately.

² Fourth digit ICD codes for use with categories E810-E825 to identify the injured person.

Table 2. Sex and race mortality ratios among children ages 1–4 and 5–9 for leading external causes of death: United States, 1982–84

		1-4	years		5–9 years				
	Sex	ratio ²	Race ratio ³		Sex ratio ²		Race ratio ³		
Cause of death'	White	Black	Male	Female	White	Black	Male	Female	
All causes	1.26	1.24	1.65	1.68	1.43	1.37	1.46	1.53	
Natural causes	1.12	1.15	1.57	1.53	1.18	1.09	1.18	1.28	
External causes	1.49	1.35	1.74	1.91	1.76	1.62	1.72	1.86	
Motor vehicle	1.31	1.39	1.33	1.25	1.61	1.66	1.39	1.35	
Pedestrian, cyclist	1.48	1.50	1.60	1.59	2.05	1.88	1.76	1.91	
Passenger	1.11	1.22	0.93	0.85	1.00	0.88	0.78	0.89	
Fire	1.42	1.16	3.46	4.23	1.36	1.13	3.40	4.09	
Drowning	1.94	2.29	0.63	0.53	3.14	3.64	2.32	2.00	
Homicide	1.20	1.08	3.89	4.33	1.00	1.14	3.57	3.14	

¹ See table 1 for ICD codes.

² Ratio of race-specific death rate for males to race-specific death rate for females.

³ Ratio of sex-specific death rate for blacks to sex-specific death rate for whites.

1-4 and for 51 percent of all deaths among children ages 5-9. These proportions differ markedly by race and sex, ranging from 39 percent and 43 percent among white females ages 1-4 and 5-9 respectively, to 49 percent and 62 percent among black males ages 1-4 and 5-9 respectively.

Motor vehicle injuries, fires, drowning, and homicide were the leading external causes of deaths at ages 1-4 and 5-9 (table 1), accounting for almost 80 percent of the externally caused deaths in these two age groups. No other single external cause amounted to more than 4 percent. For example, deaths associated with unintentional poisoning, with falls, and with choking each accounted for only 3-4 percent of externally caused deaths among 1-4-year-olds (data not shown).

Motor vehicle injuries were the leading cause of

death for white children ages 1-4 and for all children ages 5-9 (table 1). One-half (54 percent) of all motor vehicle injury fatalities among children 1-4 and 3 out of 5 among children 5-9 occurred as a result of their being struck and killed by a motor vehicle as pedestrians or pedal cyclists.

Sex and race ratios for motor vehicle injury death rates associated with pedestrians were considerably greater than for death rates associated with passengers (table 2). The sex ratio for pedestrian fatalities ranged from 1.48 to 2.05 compared with 0.88 to 1.22 for passenger fatalities. Similarly, the race ratio for pedestrian fatalities ranged from 1.59 to 1.91 compared with 0.78 to 0.93 for passenger fatalities.

The race ratios for deaths caused by fires were among the largest of any cause (3.40 to 4.23, table 2). In addition, the sex ratios for fires were larger

Table 3. Percent of excess deaths attributable to specific causes of death: United States, 1982-84

		1-4	vears		5–9 years			
	Male e	excess	Black excess		Male excess		Black excess	
Cause of death	White	Black	Male	Female	White	Black	Male	Female
All causes	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Natural causes	27.6	34.5	47.5	47.5	24.1	11.4	18.5	30.6
External causes	72.4	65.5	52.5	52.5	75.9	88.6	81.5	69.4
Motor vehicle	16.4	16.9	7.2	5.0	32.2	36.0	21.5	14.8
Pedestrian, cyclist	12.1	13.0	7.2	5.7	26.4	32.5	25.2	18.5
Passenger	2.6	2.8	(1)	(1)	0	(2)	(1)	(1)
Fire	9.5	10.2	25.3	28.1	4.6	5.3	26.7	31.5
Drowning	25.9	12.4	(1)	(1)	17.2	32.5	21.5	6.5
Homicide	2.6	2.8	14.4	16.7	0	2.6	13.3	13.9

¹ The death rate for white children was higher than for black children.

² The death rate for females was higher than for males.

Table 4. Percent change in death rates between 1972–74 and 1982–84 among children ages 1–4 and 5–9 for leading external causes of death by race and sex: United States

			1-4 years			5–9 years				
		W	nite	Bla	ick		W	hite	Ble	ick
Cause of death ¹	Total ²	Male	Female	Male	Female	Total ²	Male	Female	Male	Female
All causes	- 29.0	- 29.0	- 27.7	- 30.8	- 31.4	- 33.0	- 33.3	- 34.6	- 32.5	- 27.1
Natural causes	- 29.2	- 28.7	- 27.5	- 33.0	- 32.1	- 31.8	- 31.3	- 34.3	- 27.6	- 26.1
External causes	- 28.7	- 29.4	- 27.9	- 28.4	- 30.5	- 34.1	- 34.9	- 35.1	- 35.2	- 28.0
Motor vehicle	- 33.9	- 30.4	- 34.4	- 43.0	- 37.2	- 38.2	- 35.1	- 38.7	- 42.8	- 44.1
Pedestrian, cyclist	- 35.5	- 36.8	- 31.0	- 46.1	- 34.3	- 44.1	- 40.8	- 50.0	- 44.8	- 49.4
Passenger	- 20.0	- 6.3	- 22.9	- 30.0	- 45.2	- 19.0	- 18.2	- 14.3	- 26.3	- 20.0
Fire	- 10.0	- 14.0	- 16.1	- 3.0	- 5.2	- 14.3	- 11.8	- 31.3	10.9	-2.2
Drowning	- 26.7	- 30.3	- 15.8	- 18.8	- 34.6	- 43.8	- 50.0	- 46.2	- 40.0	- 22.2
Homicide	13.6	12.5	7.1	11.1	18.2	42.9	40.0	40.0	31.6	46.7

¹ See table 1 for 9th revision ICD codes: 1972-74 death rates based on 8th revision ICDA, the codes for motor vehicle injuries are E810-E823; the fourth digit codes are the same as in the 9th revision; for fire E890-E899; for

among whites (about 1.4) than blacks (about 1.1).

Race ratios for homicide mortality were as large as those for mortality caused by fires: black children, ages 1-4, were four times as likely as white children to die from homicide (table 2). Although homicide death rates were lower among 5-9-year-olds than among those aged 1-4, large race differences persist (race ratios above 3).

Among those ages 5-9, the race ratio for drowning was just over 2.0. For the 1-4 year olds, however, the race ratios were reversed (table 2); young white children were twice as likely as black children to drown.

Table 3 shows the proportion of overall excess deaths attributable to each cause. For each agerace group more than 65 percent of excess deaths among males are due to external causes. Pedestrian-related motor vehicle injuries account for 12-13 percent of the excess among 1-4-yeardrowning E910; and for homicide, E960-E978.

² Includes other races not shown separately.

olds and 26-33 percent among 5-9-year-olds. Drowning also accounts for a substantial portion of excess deaths among males.

External causes accounted for just over half the excess deaths among black children ages 1-4 but 81 percent of the excess among males and 69 percent of the excess among females ages 5-9. Fires accounted for the greatest proportion of overall excess deaths of black children: 25-30 percent among males and females in both age groups. Homicide accounted for 13-17 percent of the excess deaths in both age groups. Pedestrian-related motor vehicle injuries accounted for 25 percent of the excess among males and 19 percent among females ages 5-9 but less than 10 percent among 1-4-year-olds.

Secular changes. The 1982-84 death rates for children 1-9 years represented 30 percent declines

from the 1972-74 rates. Although the declines were similar for natural and external causes, there were some interesting differences by specific cause, age, race, and sex (table 4) as follows:

• Natural causes. Death rates from natural causes declined by about 30 percent in both age groups. For 1-4-year-olds declines were somewhat greater for blacks than for whites, while the reverse was true for 5-9-year-olds.

• Pedestrian-related death rates. These showed the largest declines of all rates in both age groups (35 percent for 1-4-year-olds and 44 percent for 5-9-year-olds). Among 1-4-year-olds black males had a somewhat greater decline than the other three race-sex groups. Among 5-9-year-olds these death rates declined more for females than males, but they declined by about the same amount for blacks and whites.

• Passenger-related death rates. There was a 20 percent decline in this category for both age groups. Among 1-4-year-olds the decline was greater among blacks than whites and among females than males. For children ages 5-9 the percentage declines were only slightly greater among blacks than whites and among males than females.

• Fire and flames. Mortality from fire showed the smallest declines (10 percent among 1-4-year-olds and 14 percent among 5-9-year-olds). In both age groups death rates for whites declined more than for blacks. For black males 5-9, the death rate increased by 11 percent.

• Drowning. Death rates from drowning showed among the largest declines for 5-9-year-olds (44 percent) and a moderate decline for 1-4-year-olds (27 percent). Among children 1-4, there was no consistent pattern among the four groups. White males and black females experienced larger declines than white females and black males. For children 5-9, death rates fell more for whites than for blacks.

• Homicide. Death rates from homicide at ages 1-4 and 5-9 increased in all age-race-sex groups. The increases were larger among 5-9-year-olds (32-47 percent) than 1-4-year-olds (7-18 percent).

Discussion

Although there have been considerable decreases in childhood mortality over the last decade, there remain appreciable differences by race and sex in mortality from injuries and violence. In 1982-84, external causes of death accounted for more than two-thirds of the male-female differences in overall death rates for 1-4-year-olds and more than three-fourths of the difference among 5-9-yearolds. Furthermore, external causes accounted for half of the black-white differences in overall death rates for children 1-4 and three-fourths for those ages 5-9. In particular, deaths from two causes (homicide and fire) were responsible for two-fifths of the excess mortality among black children 1-4 years old. Among 5-9-year-olds nearly 65 percent of the excess mortality of black children was accounted for by fires, pedestrian-related motor vehicle injuries, and homicide.

Two causes of death showed higher rates among white than black children (passenger-related motor vehicle accidents and drowning among 1-4-yearolds). A possible explanation for the low race ratio for passenger-related motor vehicle accidents is that fewer black children than white children are "exposed to the risk" of being a motor vehicle passenger. Data from the 1980 census on occupied housing units showed that 33 percent of blacks compared with 10 percent of whites had no motor vehicle (10). If it were possible to adjust the passenger death rates for exposure to risk (that is, miles driven) it is possible that the passenger death rates for blacks would be higher than those for whites.

The explanation for the low race ratio for drowning among 1-4-year-olds may also be related to differences in exposure to risk. After dividing the drownings into two components ("in the bathtub" and "while swimming") we noted that 23 percent of black compared with 15 percent of white children ages 1-4 drowned in the bathtub. Nevertheless, most of the drownings occurred as a result of a swimming accident, even among blacks. It is possible that young white children swim more frequently than young black children, so that their exposure to risk of drownings may be higher.

Other studies of fatal injuries among children generally show higher rates among boys than girls and minorities compared with other children. For example, MacWilliam and co-workers presented results on mortality from pedestrian and nonpedestrian motor vehicle accidents, drownings, and fires among Canadian children. As in the United States, death rates from injuries in Canada were much higher for males than females and for minority (native children on Indian reserves) than for nonminority children. The authors concluded that the "alarming excess mortality among native children attributable to drowning and to fire may be related to complex factors such as lifestyle... and socioeconomic conditions...."(11)

Table 5. Death rates for injuries, incidence of injuries, and hospital discharge rates associated with injuries among children: United States 1970–84

Year	Deaths per 100,000 persons under 15'	Injuries per 100 persons under 17 ²	Discharges per 10,000 persons under 15 ³
1984	15.4	31.2	84.7
1983	16.1	32.7	87.4
1982	16.7	32.9	90.4
1981	17.6	39.1	94.2
1980	19.0	38.7	94.2
1979	19.7	38.4	98.5
1978	20.9	37.7	97.4
1977	20.5	44.4	103.2
1976	20.6	37.0	107.8
1975	21.6	45.7	104.2
1974	22.4	36.7	105.9
1973	25.2	37.6	100.2
1972	25.2	40.2	101.1
1971	25.3	40.4	95.0
1970	25.5	35.6	94.4

¹ 8th and 9th revision ICD codes include E800-E949.

² Annual estimates from the National Health Interview Survey

³ Annual estimates from the National Hospital Discharge Survey; 8th and 9th revision ICD codes 800-999.

SOURCE: National Center for Health Statistics.

It should be noted that there are substantial racial differences in socioeconomic status. For example, in 1984, 51 percent of black children under age 6 were living in families with incomes below the poverty level compared to 18 percent of white children (12). Thus, racial differences in mortality probably reflect socioeconomic differentials. Unfortunately, however, it is difficult to investigate socioeconomic differentials in mortality because U.S. death certificates contain no socio-economic information about the child.

Based on retrospective data from the 1975 Current Population Survey, Mare (13) found substantial socioeconomic differentials in all-cause childhood mortality. He had no cause of death data available but hypothesized that injury mortality is a major determinant of socioeconomic differentials in overall childhood mortality, "suggesting that differences in access to safe recreational areas, in exposure to hazardous driving conditions, and, for the younger children, in parental vigilance are important sources of child mortality variation among socioeconomic groups." Fox (14) also concluded from cause-specific data in England and Wales that the "inadequacies of supervision and education, and the environmental hazards confronting" children in the lowest social class are clearly demonstrated by their significantly higher death rates for accidents.

Rivara and Barber (6) analyzed pedestrian injury

data from Memphis, TN, and concluded that the socioeconomic background of the child as well as the characteristics of the neighborhood were important determinants of the risk of pedestrian injury. Similarly, Nersesian and coworkers (15) examined childhood mortality and poverty in Maine and found that death rates from accidents were higher among poor children than the nonpoor, citing as contributing factors substandard housing and less parental supervision.

We also found that there were substantial declines between 1972-74 and 1982-84 in death rates from all external causes except homicide and fires among black children. It is of interest to consider whether these declines in unintentional injury mortality were attributable to changes in the incidence of injuries or changes in case-fatality rates. Although data to address this issue definitively are not available, it is possible to use survey data in broader age groups to gain some insight on this question (survey data are unavailable for the specific age groups used previously). Hospital discharge rates (based on annual estimates from the National Hospital Discharge Survey) associated with fatal and nonfatal injuries among children under age 15 increased about 14 percent during the first half of the 1970s to 108 per 10,000 and then declined gradually but continually through 1984 to 85 per 10,000 (table 5). Unfortunately, it is unclear whether the decline is due to increased use of outpatient services or decreased incidence of severe iniuries.

However, annual estimates from the National Health Interview Survey (NHIS) show that the overall incidence of injuries for children under 17 remained relatively stable (at an average of about 37-39 per 100 per year) between 1970 and 1981. A questionnaire change in 1982 resulted in a discontinuity in the series, but the rate remained fairly stable between 1982 and 1984 (table 5). Similarly, the number of school-loss days due to injury per 100 children 6-16 years remained unchanged (34 in 1971-72 versus 36 in 1981-82).

In order to compare the incidence data with injury mortality data, death rates from injuries (E800-E949) among children under age 15 were calculated for 1970-84 (table 5). From 1970 to 1973 the death rate for injuries among children under 15 remained stable at about 25 per 100,000 followed by steady declines from 1973-76. The rate plateaued again between 1976 and 1978. In 1979 the death rate began to drop steadily and by 1984 the rate was 40 percent below the 1970 rate. This somewhat erratic trend masks the steady downward trend experienced by infants under 1 year of age (65 percent decline over the 14 years). Although the hospital discharge data are somewhat ambiguous, the implication of the three trends in table 5 suggests that case-fatality declines accounted for a major portion of the mortality reduction.

The large declines over the past decade in childhood mortality from both natural and external causes are even more notable in view of adverse changes in socioeconomic conditions of children. For example, there has been a marked increase in the proportion of children under 6 living in single-parent families, from 10 percent (1974) to 15 percent (1984) among whites and from 38 percent to 58 percent among blacks (16,17). In addition, the proportion of children under age 6 living in families with incomes below the poverty level has risen among both whites (from 13 percent in 1974 to 18 percent in 1984) and blacks (from 40 percent to 51 percent) (12,18). Had mortality increased during this period, it is likely that these same socioeconomic changes would have been pointed to as contributing factors.

Homicide mortality stands out as the only major cause showing an increase for all age-race-sex groups. Whether the rise in homicide death rates is due to increased incidence or better reporting is unclear. Further, it is unclear whether reporting practices differ by race or socioeconomic status. The available data show higher homicide rates for younger than older children and much higher rates for black than white children. Writing on the public health impact of child homicide, Christoffel (7) focuses attention on environmental risks to the victim (rather than the state of mind of the offender). She suggests increased community supports for families under stress and programs to raise the awareness of child caretakers concerning the need for supervision of children.

The 1980 Public Health Service report, "Promoting Health/Preventing Disease: Objectives for the Nation" identified 15 broad areas, including injury prevention, to be given priority attention toward the goal of further improvements through health promotion and disease prevention strategies. While the 1990 objectives for injury related mortality for all children appear likely to be met (19), there remain appreciable differences in mortality by race and sex which the targets do not address. Reduction of these differentials in external cause mortality could have a substantial impact on reducing race and sex differences in overall death rates.

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