The Incidence of Injuries Among 87,000 Massachusetts Children and Adolescents: Results of the 1980–81 Statewide Childhood Injury Prevention Program Surveillance System

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Abstract: This study describes the incidence of fatal and nonfatal injuries occurring in 87,022 Massachusetts children and adolescents during a one-year period. A surveillance system for injuries at 23 hospitals captured 93 per cent of all discharges for ages 0–19 in the 14 communities under study. Sample data were collected on emergency room visits, hospital admissions, and deaths for all but a few causes of unintentional injuries. The overall incidence was 2,239 per 10,000. The true incidence rates are probably higher than those reported. The ratio of emergency room visits to admissions to deaths was 1,300 to 45 to 1. Injury rates varied considerably by age, sex, cause, and level of severity. Age-specific injury rates were lowest for infants and elementary school age children and highest for toddlers and adolescents. The overall ratio of male to female injury rates was 1.66 to 1. Injuries from falls, sports, and cutting and piercing instruments had a high incidence and low severity. Injuries from motor vehicles, burns, and drownings had lower incidence, but greater severity. Results provide evidence that both morbidity and mortality must be considered when determining priorities for injury prevention. Current prevention efforts must be expanded to target injuries of higher incidence and within the adolescent population. (*Am J Public Health* 1984; 74:1340–1347.)

Introduction

Injuries have been recognized as the leading cause of death in children for nearly 40 years.[1] However, most epidemiological studies of injuries have not been community-based[2] and are limited either to a single type of injury, such as head injuries[3] or burns,[4,5] or to a specific cause of injury, such as consumer products.[6,7] In addition, many studies examine deaths only,[8,9] without attention to the many non-fatal injuries serious enough to require hospital treatment.

In 1966, Manheimer and co-authors calculated incidence rates for non-fatal, medically-attended injuries in a population of 8,874 children enrolled in a prepaid health plan.[10] They also examined accident repeatedness and severity of injuries, and studied behavioral and personality characteristics of the population. Dickson and Schlesinger reported the rate of medically-attended injuries among children under seven years of age living in a suburban housing development as part of a community-based child injury prevention project.[11,12] A recent study of the incidence of hospital treated trauma in a well-defined population was comprehensive, but did not report injury data by age.[13] Under a grant from the Office of Maternal and Child Health,[14] the Massachusetts Department of Public Health developed the Statewide Childhood Injury Prevention Program (SCIPP).[15]

This paper provides descriptive epidemiological analyses of the incidence of fatal and nonfatal injuries occurring in 87,022 Massachusetts children and adolescents, under 20 years of age, during a one-year period.

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Methods

A surveillance system was established to collect data for three levels of injury severity [death, hospitalization, and emergency room (ER) treatment and release] from a defined geographic population. Data were collected for residents of 14 Massachusetts cities and towns, selected to participate in the SCIPP demonstration project because they represent the state's older urban centers, Boston suburbs, and small rural towns. Table 1 summarizes the population characteristics of the study sites and compares them with the state as a whole.[16]

Twenty-three hospitals were recruited into the surveillance system, accounting for 93 per cent of all pediatric discharges for the 14 communities under study.[17] The inclusion of five referral, teaching hospitals minimized the possibility that serious cases requiring transfer for specialized treatment were missed.*

Case Definition

Cases were defined as children and adolescents (ages 0–19 years), living in one of the 14 communities, who had an injury diagnosed between September 1, 1980 and August 31, 1981. Injuries to residents of other communities using the same hospitals were not included.

The surveillance system recorded all injury cases requiring hospital admission or resulting in death, as well as all cases of burns and poisonings treated and released in the ER. ER visit for injuries other than burns or poisonings were abstracted on a 25 per cent sample basis by case-finding for five days, skipping 15 days, then repeating this process. Ninety ER days were sampled during the one-year period.

All unintentional injury cases were recorded except animal and insect bites, sunburns, food poisonings, and contact dermatitis not caused by a drug or product. Homicides, suicides, and intentionally self-destructive actions

*A group of 33 other hospitals admitted from one to eight patients from a study community per year; however, it was logistically impossible to collect data from these hospitals.

TABLE 1—Demographic Characteristics of Study Population Compared with Massachusetts Population

Characteristics	SCIPP Communities		Statewide Total	
	Number	Per Cent	Number	Per Cent
Communities	14	—	351	—
Population	286,676	—	5,737,037	—
Ages 0–5	22,221	7.8	404,764	7.1
Ages 6–12	30,256	10.6	576,555	10.0
Ages 13–19	34,545	12.0	740,201	12.9
Ages 0–19 combined	87,022	30.4	1,721,520	30.0
Families	74,867	—	1,438,062	—
With children less than age 18	37,037	49.5	713,686	49.6
Black families with children less than age 18	539	1.5	32,645	4.6
Spanish origin families with children less than age 18	2,270	6.1	22,850	3.2
Household Units	103,430	—	2,032,717	—
Rental Units	50,023	48.4	862,898	42.5
Dwellings built prior to 1940		53.8		47.3
Mean per capita income	$7,239	—	$7,459	—
Below poverty level	—	9.9	—	9.6
Age 25 and over with four years of high school or more	—	73.9	—	72.2

SOURCE: 1980 US Census[16]

were recorded, but are not included in the incidence rates reported here. Cases of child abuse, which were medically diagnosed and recorded as such in the hospital record, are also excluded from this report. Both the clinical nature of the injury (N codes 800–994), and a supplemental classification of external cause of injury and poisoning (E codes 800–989) were coded according to the International Classification of Diseases, ninth edition (ICD-9-CM).[18]

To facilitate analysis, E codes were grouped into 19 categories (Appendix A), and N codes into six categories (Appendix B). Pedal cycle riding injuries were divided into two categories to distinguish motor vehicle involvement. The term "falls" refers to non-sports-related and non-vehicular-related causes. Sports injuries are not distinguished in the ICD coding scheme; therefore, a separate coding scheme was developed for this category.

Data Collection

Two data collectors were trained to perform all case-finding and abstraction from medical records. ER cases were identified by scanning daily ER log sheets and pulling the medical records of all suspected cases of injury to confirm whether study criteria were met. Hospitalized cases were obtained from computerized printouts of inpatient discharge listings, which specify N codes. Repeat visits for treatment of the same injury were eliminated, cases seen in the ER and admitted were counted only once as admissions, and those resulting in death were counted only once, as deaths. Because accidental injuries resulting in immediate death may never reach a hospital, fatal cases of residents were also ascertained from death certificates.

The data collectors recorded all data on a standardized form and assigned a primary cause (E code) after reviewing the medical record. Cases with two or more possible causes of injury were coded according to the first harmful event. The ICD N code was usually available from the hospital discharge sheet. For multiple injuries, the most serious diagnosis was used for coding.

Quality control measures included an initial training period for data collectors, weekly problem solving meetings, use of a coding manual, updated data resolutions, selected duplicate coding by the study coordinator, and manual scanning of of all completed forms. Keypunching of coded data was double-verified and automatically checked for range and consistency errors during transmission through a computer edit/update program. Other checks were performed at six-month intervals to ensure uniformity between data collectors in casefinding and abstraction procedures. Neither systemic errors nor discrepancies in identifying cases were discovered. Nevertheless, an average of 7.5 per cent of injury cases were found to have been missed during casefinding.** These appeared to be randomly distributed.

Injury rates were calculated per 10,000 children per year with the ER sample extrapolated. Denominators for rates were derived from the 1980 US Census.[16] Standard errors were calculated from unadjusted counts of ER injury cases.

Results

In the population of 87,022 children and adolescents under surveillance, 5,953 cases met the study criteria. We observed 15 deaths, 668 hospital admissions, and 5,270 ER visits within the sampling periods, yielding an estimated 19,483 separate injury events (Table 2). The overall incidence rate was 2,239 per 10,000 with a standard error of 31. Of the estimated total number of events, 96.5 per cent were treated and released from an ER, 3.4 per cent were admitted to a hospital, and less than 0.1 per cent resulted in death. The ratio of ER visits to admissions to deaths was 1,300 to 45 to 1.

Injury rates varied considerably by age, sex, and level of severity. Infants and older teenagers experienced the highest injury rates (Figure 1). For both ER visits and admissions, males had a greater injury rate than females, sustaining 63.4 per cent of all injuries. The overall ratio of male to female injury rates was 1.66 : 1. Only among infants

**Supervisors of casefinders went back to the same hospitals and reviewed the complete logs for surveillance days more carefully and slowly and in a systematic fashion and thus found the missed cases.

TABLE 2—One-Year Injury Rates per 10,000, According to Age Grouping by Sex and Severity, 1980–81

Age Group in Years*	Sex	Total Incidence			Emergency Room			Admissions			Deaths		
		N[1]	Rate	SE[2]	N[3]	Rate	SE	N	Rate	SE	N	Rate	SE
0–5	Male	2257	1986	81	2161	1901	80	93	82	8	3	2.6	1.5
	Female	1674	1542	74	1616	1489	73	56	52	7	2	1.8	1.3
	Both	3931	1769	55	3777	1700	54	149	67	6	5	2.2	1.0
6–12	Male	3938	2565	78	3814	2484	78	123	80	7	1	0.6	0.7
	Female	2226	1494	62	2157	1448	62	68	46	6	1	0.7	0.7
	Both	6164	2037	50	5971	1974	50	191	63	5	2	0.7	0.5
13–19	Male	6149	3494	84	5903	3354	84	240	136	9	6	3.4	1.4
	Female	3239	1911	65	3149	1858	65	88	52	6	2	1.2	0.8
	Both	9388	2718	53	9052	2620	44	328	95	5	8	2.3	0.8
0–19	Male	12344	2785	48	11878	2680	48	456	103	5	10	2.2	0.7
	Female	7139	1672	38	6922	1621	38	212	50	3	5	1.2	0.5
	Both	19483	2239	31	18800	2160	31	668	77	3	15	1.7	0.4

*The population for each age/sex combination is as follows: 0–5 includes 11,367 males and 10,854 females
6–12 includes 15,355 males and 14,901 females
13–19 includes 17,598 males and 16,947 females

1) N = number of injuries
2) SE = standard error
3) Actual observed events = 5,270, 25% sample of injuries × 4 + 100% sample of burns and poisonings.

and two-year olds was the injury rate for females slightly greater than that for males. For all levels of severity this ratio increases with age, particularly for male teenagers. It is highest for injuries requiring hospital admission (2.06 : 1).

Cause of Injury

For all ages combined, falls (most often on stairs) were the most common cause of injury, followed by sports, being struck by an object, and cutting or piercing from instruments or machinery (Table 3).

In general, males were at greater risk than females of the same age group for most injury causes. For preschoolers, however, females were injured as often or more by foreign bodies, burns, chokings, electric shocks, overexertion, or as occupants of motor vehicles; females aged 6–12 were as or more likely to be injured by electric shock or as occupants of motor vehicles; teenage females required hospital treatment for poisonings or chokings more often than males. Each age and sex group displays a unique pattern of injuries as described below.

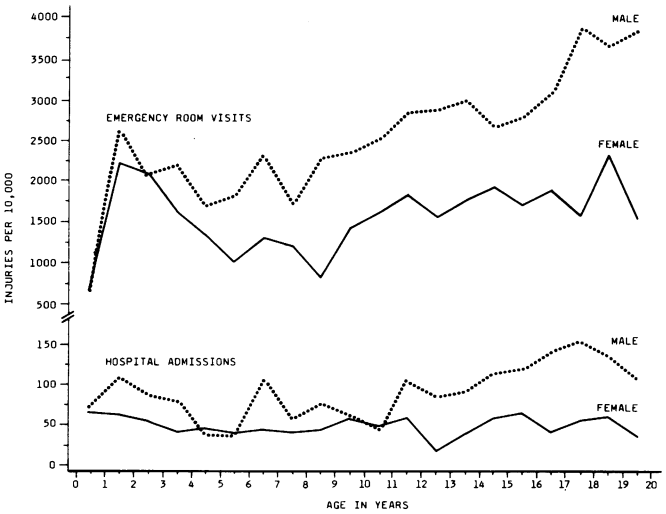

FIGURE 1—Age and Sex Rates for Injuries Resulting in Emergency Room Visits and Hospital Admissions,* 1980–81, Massachusetts

*15 cases resulting in death are not included in this figure.

Preschool Age Children (0–5 years)

The overall injury rate for preschoolers was 1,769 per 10,000, with a male to female ratio of 1.29. Preschool age children suffered fall injuries (non-sports related) at a rate one and one-half to two times greater than older children. One of every 12 children under the age of six required hospital treatment for a fall, with falls occurring most frequently in the home and usually associated with furniture and stairs. Outside the home, most falls were associated with playground equipment or baby carriages and strollers.

Preschoolers experienced a poisoning 10 times more often than children of elementary school age. They also had the highest incidence of burn injuries, most of which occurred in the kitchen and were caused by scalds from heated food and water, or contact with hot surfaces on stoves, radiators, and irons. Only two children received tap water scalds.

The high incidence of foreign body injuries resulted primarily from swallowing or inserting small objects in the nose or ear. Although the incidence of choking was low, preschoolers were 14 times more likely than elementary school children and seven times more likely than teenagers to choke on an object. While drownings were rare in these communities, preschoolers had three times the risk of older children. Preschool age children had the lowest injury rates as motor vehicle occupants or pedestrians when compared to older children.

Infants, it should be noted, differed somewhat from one- to five-year olds; their injury rate was substantially lower (695 per 10,000). The lower rate holds for all causes except choking and burns. There were no motor vehicle occupant injuries to infants in our population and sex differentials were not evident. Finally, infants had a higher rate of hospitalization for injuries (75.5 per 10,000); 9.6 per cent of their injuries required hospital admission.

Elementary School Age Children (6–12 years)

The overall injury rate for elementary school age children was 2,037 per 10,000 with a male to female ratio of 1.72. More than one of every 80 elementary school age children

TABLE 3—One-Year Injury Rates per 10,000 for Male and Female Residents of 14 Massachusetts Communities by Age Group, External Cause 1980–81

	All Ages Combined			0–5 Years			6–12 Years			13–19 Years		
External Cause*	Both Sexes	Male	Female	Both	Male	Female	Both	Male	Female	Both	Male	Female
Falls	548	609	484	810	876	741	568	661	473	361	391	330
Sports	402	536	264	15	18	12	344	436	249	703	959	438
Struck by Object	370	485	252	279	378	175	396	518	269	407	524	286
Cutting, Piercing	300	420	176	155	189	120	278	380	172	413	605	214
Other	147	172	121	126	139	112	130	159	99	176	205	146
MV-Occupant	98	101	96	33	29	37	37	32	42	194	207	181
Overexertion	88	94	81	53	29	77	49	52	46	144	174	114
Pedal Cycle Non-MV	73	111	34	31	46	15	125	186	61	55	88	22
Foreign Body	53	66	40	72	71	73	28	39	16	63	86	39
Burns	50	55	44	82	79	86	21	23	19	54	68	40
Poisonings	33	35	31	64	76	52	6	7	5	36	34	40
Other Transport	32	42	22	22	33	11	17	18	16	52	69	34
Pedestrian	16	22	10	9	9	8	21	29	12	16	23	9
MV-Pedal Cycle	14	19	7	1	3	0	13	14	12	22	35	8
Choking	5	2	7	14	6	21	1	3	0	2	0	5
Explosives, Arms	4	6	1	.5	1	0	4	6	1	7	10	3
Motorcycle	4	6	1	0	0	0	0	0	0	10	16	4
Electricity	1	1	1	2	2	2	1	1	1	1	1	0
Drowning	1	1	0	1	3	0	.3	1	0	.3	1	0
TOTALS	2239	2785	1672	1769	1986	1542	2037	2565	1494	2718	3494	1911

*Definitions appear in Appendix A

required hospital treatment for a non-motor vehicle involved bicycle accident—twice the rate for teenagers and four times that of preschoolers. Burns and poisoning rates were lowest for elementary school age children.

Teenagers (13–19 years)

The overall injury rate for teenagers was 2,718 per 10,000 with a male to female ratio of 1.83. One of every 14 teenagers required hospital treatment for a sports injury. The largest proportion of sports injuries were from football (19.9 per cent), basketball (17.4 per cent), rollerskating (13.4 per cent), and baseball (9.4 per cent). While contributing smaller proportions of injuries, soccer, ice hockey, sledding, skiing, horseback riding, skateboarding, and lacrosse produced a higher ratio of injuries requiring hospital admission.

Teenagers had a rate of motor vehicle occupant injuries six times that of younger children; one of every 50 teenagers is injured as a motor vehicle occupant per year. Teenagers also have the greatest risk of colliding with a motor vehicle while riding a bicycle—a rate 20 times that of preschool age children and twice that of elementary school age children.

The majority of burns to teenagers resulted from contact and flame burns that were work-related. Males frequently received chemical burns caused by substances used in automotive repair and maintenance (e.g., battery acid). A substantial number of leg burns were reported for motorcycle drivers.

The most common poison ingestions involved alcohol or drug abuse. Particles in the eye accounted for the majority of foreign body injuries.

Level of Severity

Deaths—Six of the 15 deaths never reached a participating hospital and were detected by review of death certificates. Five deaths (four in children under six years of age) resulted from house fires; playing with matches caused two of these deaths. Motor vehicles were involved in five deaths—one elementary school aged pedestrian and four teenaged occupants. There were three fatal drownings, one in each age group. One child died as the result of an accidental discharge of a weapon. Finally, a 14-year old male died from an electrocution received at an electric company substation.

Teenagers had the highest death rate per 10,000 (2.3), followed by preschool age children (2.2) and elementary school age children (0.7). Case-fatality ratios have not been compiled because there were only 15 deaths in the 19,483 cases of injury.

Hospitalizations—The causes of non-fatal injury by level of care are listed in Table 4. More than 20 per cent of motorcycle, drowning, and pedestrian-related injuries were hospitalized. While only 3 per cent of all falls resulted in hospitalizations, these 159 injuries accounted for 24 per cent of all admissions. Sports and motor vehicle occupant injuries accounted for 17 per cent and 14 per cent of hospitalizations, respectively.

The 668 hospital admissions resulted in a total of 3,076 bed days. The median length of stay was 1.9 days with a range of one to 42 days, varying considerably with injury type and age. Burns (8.5 days), pedestrian (5.5 days), explosives (4.5 days), and motorcycle injuries (4.3 days) required the longest median length of hospitalization. Median length of stay tended to be greater among teenagers (2.4 days) than among preschoolers (1.8 days) or elementary-schoolers (1.6 days).

Nature of Injury

Table 5 relates injury cause to clinical nature for all ages combined. The largest proportion of injuries (39.1 per cent) were less severe ones, such as sprains, strains, and contusions. Lacerations were the second most common diagnosis (35.4 per cent). More serious injuries included fractures to body parts other than the head (12 per cent) and intracranial injuries (4.7 per cent). Twenty-four per cent of these intracranial injuries were skull fractures. Hospitalization was required in 8 per cent of fractures, 25 percent of intracranial injuries, and 78 per cent of internal injuries.

Motor vehicle accidents caused the largest proportion of intracranial and internal injuries. Intracranial injuries oc-

TABLE 4—Selected External Causes of Injury by Level of Care, Percentage of Total Incidence

Injury Type	Total Number*	Emergency Room		Admissions	
		No.	%	No.	%
Motorcycle	34	20	59	14	41
Drowning	5 (3)	0	0	2	40
Pedestrian	138 (1)	104	75	33	24
Explosives, Arms	35 (1)	28	80	6	17
MV-Pedal Cycle	118	100	85	18	15
Choking	42	36	86	6	14
Poisoning	287	247	86	40	14
MV-Occupant	855 (4)	760	89	91	11
Electricity	8 (1)	6	75	1	12
Pedal Cycle Non-MV	636	592	93	44	7
Other Transport	278	264	95	14	5
Burns	433 (5)	408	94	20	5
Sports	3502	3388	97	114	3
Falls	4767	4608	97	159	3
Foreign Body	462	454	98	8	2
Other	1281	1261	98	20	2
Struck by Object	3224	3184	99	40	1
Cutting, Piercing	2613	2580	99	33	1
Overexertion	765	760	99	5	1
TOTAL	19483 (15)	18800	96.5	668	3.4

*Number of deaths are in parentheses of the related injury type.

curred in 24 per cent of pedestrian accidents, 14 per cent of motor vehicle/bicycle collisions, 15 per cent of occupant accidents, and 10 per cent of motorcycle accidents. Six intracranial injuries resulted in death—four cases were occupants and two were pedestrians.

Discussion

This paper, describing a year of injury surveillance data in Massachusetts, is the largest and most comprehensive community-based study, to date, of childhood and adolescent injuries reported for a defined geographic population. However, because of the many unresolved methodological issues in the field of injury epidemiology, we wish to review the study's strengths, weaknesses, and relationship to other published reports.

Incidence Rates for Defined Injuries: Validity and Bias

Because we reviewed medical records in detail and coded all cases independently, we are confident about the

TABLE 5—External Cause of Injury and Resulting Nature of Injury for All Ages Combined

Cause of Injury*	Nature of Injury**													
	Internal		Intracranial[1]		Fractures other than skull		Lacerations		Sprains		Other[2]		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Pedestrian	3	2	33	24	18	13	12	9	68	49	4	3	138	100
MV-Pedal Cycle	3	2	16	14	26	22	13	11	56	48	4	3	118	100
MV-Occupant	3	0.4	130	15	61	7	171	20	424	50	66	8	855	100.4
Pedal Cycle Non-MV	6	1	63	10	100	16	265	42	202	32	0	—	636	101
Motorcycle	2	6	3	9	8	24	8	24	13	38	0	—	34	101
Fall	2	0.04	393	8	663	14	1817	38	1826	38	66	1	4767	99.04
Struck by Object	6	0.2	143	4	355	11	1165	36	1470	46	85	3	3224	100.2
Sports	14	0.4	108	3	747	21	333	10	2197	63	103	3	3502	100.4
Overexertion	0	—	0	—	151	20	4	0.5	586	77	24	3	765	100.5
Other[3]	0	—	32	2	193	9	511	25	743	36	584	28	2063	100
Explosives, Arms	1	3	0	—	1	3	16	46	1	3	16	46	35	101
Cutting, Piercing	0	—	0	—	8	0.3	2571	98	28	1	6	0.2	2613	99.5
Drowning	0	—	0	—	0	—	0	—	0	—	5	100	5	100
Poisoning	0	—	0	—	0	—	0	—	0	—	287	100	287	100
Burns[4]	0	—	0	—	0	—	6	1	0	—	435	99	441	100
TOTALS	40	0.2	921	4.7	2331	12.0	6892	35.4	7614	39.1	1685	8.6	19483	100

*Definitions appear in Appendix A.
**Definitions appear in Appendix B.
1) Includes 222 skull fractures.
2) Includes burns, poisonings, and foreign bodies.
3) Includes chokings, foreign bodies and other transport.
4) Includes electricity.

accuracy of case inclusion, ICD coding, and other recorded characteristics. However, several factors caused the incidence rates for the defined injuries in this population to be underestimated.

First, we estimate that our surveillance system captured only 93 per cent of injury-related hospitalizations for residents of the study communities.[17] Because of resource limitations, we lack data on the other 7 per cent of admissions distributed among 33 hospitals within and outside the state. Estimates of ER visits for residents seen and released at non-participating hospitals also are not available.

Second, our data collectors missed 7.5 per cent of cases because of unclear logs and records or unavoidable human error due to eye strain and fatigue. This error was random and not associated with any age group or cause of injury.

Third, the ER rates presented here may differ from rates calculated from a complete case census. The sampling plan for ER cases introduced sampling error that was assessed partly by calculating variance measures for the actual number of observed events. Rates derived from the sampling strategy were compared with rates calculated from casefinding on both sample and non-sample days for two injuries: burns and poisonings. The incidence rate for burns from the complete case census was 49.7 (S.E. = 2.3). Using the 25 per cent sample, it was 48.4 (S.E. = 4.6). For poisonings, the complete census rate was 33.0 (S.E. = 2.9), while the sampling method produced a higher rate of 41.4 (S.E. = 4.1).

We conclude that our overall incidence rate for unintentional injuries to children and adolescents may be underestimated by 7.5 to 14.5 per cent and should be viewed as a minimal injury rate for this population. The methodology, definitions of injury cases, and known sources of bias have been described in detail to facilitate future comparisons by other researchers.

Injuries Not Measured by the Surveillance System

While the incidence rates reported here are probably the most comprehensive morbidity data available for injuries to children and adolescents, the SCIPP surveillance system did not record all injuries to this population. Because cases were ascertained through hospitals only, injuries treated at physicians' offices, freestanding clinics, HMOs, or dentists' offices were missed. The size of this missed segment of cases will depend on the communities' utilization of available ambulatory care sites and local practice patterns, but can be estimated from the National Health Interview Survey (NHIS). Their case definition includes all injuries leading to restricted activity days (e.g., stayed in bed or missed school), requiring medical attention, or resulting from certain intentional violence. In 1981, NHIS reported an injury rate for children under six years of age of 3,620 per 10,000 and for those aged six to 16 years, 3,820 per 10,000.[19] This expanded definition results in an estimate of injury incidence nearly twice that of the SCIPP rates.

We excluded certain types of injuries, including sunburns, and insect and dog bites, from the surveillance system. However, Manheimer found dog bites to be the fourth most common type of injury in his population of children age 0–15 years, accounting for 5.4 per cent of all injuries.[10]

The focus of this report is unintentional injuries: all medically diagnosed cases of child abuse, suicide, and homicide were excluded. However, we recognize that intentionally inflicted injuries are an important component of injury epidemiology.

This study does not attempt to estimate secondary causes or diagnoses. For example, injuries resulting from a vehicle crash that ignites were designated only as motor vehicle occupant. In reality, few such cases occurred. In a similar manner, we have reported only the most serious diagnosis when multiple injuries occurred.

Each case was treated as an independent event at the highest level of severity. Nor were attempts made to identify repeated injuries to the same individual. While recognizing the importance of accident repeaters, the magnitude of the data set, the problems of cross-checking names between hospitals, and the need to maintain confidentiality made it difficult to address this issue.

When compared to the rest of Massachusetts, our study population underrepresents Blacks and overrepresents Hispanics.[16] Injury rates for specific racial and ethnic groups were not calculated because these designations are not routinely listed in the medical record. Therefore, extrapolation of SCIPP injury rates to other populations must be done with caution.

Comparison between SCIPP Data and Other Incidence Studies

Comparisons with other injury studies must also be done cautiously because of conflicting definitions of injury cases and missing details. Our overall injury rate for a population 19 years of age or younger was approximately 10 per cent lower than that found by Manheimer (2,461 per 10,000) in a population 15 years of age or younger.[10] This difference may be due to the special characteristics of his health care facility-based population, our underreporting, our exclusion of certain types of injuries, or an overall decline in injury rates since the 1960s.[20]

Dickson reported a lower injury rate (1,240 per 10,000) for suburban New York children under seven years of age, based on data obtained from the offices of physicians and dentists as well as hospitals.[11] We found lower injury rates in our suburban population also (1,450 per 10,000), but the difference may be due partly to underreporting of his data furnished by providers.

SCIPP's injury incidence rate for a complete year of ER visits is 9.5 per cent greater than our previously reported rate for six months (September to February) of the same year.[15] This difference may be attributed to the seasonality of some injuries. However, even this one-year study cannot examine seasonality because of the sampling methodology used.

Implications for Improving Injury Data Gathering and Guiding Prevention Efforts

Our efforts to collect injury data were hampered by the characteristics of hospital medical record-keeping. Published hospital discharge data and ER logs often failed to identify the cause of injury. Complete descriptions of the circumstances surrounding the injury (e.g., location of accident) were missing from many records. When complete information was available, ICD coding had to be supplemented with more detailed schemes to eliminate gaps; for example, to distinguish injuries resulting from an individual sport or product.

Providers must be encouraged to supplement the clinical report of an injured patient. In addition, hospitals could begin to perform ICD coding for external cause of injury (E code), thereby facilitating surveillance. These efforts are needed to reduce the cost of surveillance and to improve the epidemiological study of injury.

The SCIPP findings have direct implications for the prevention of childhood and adolescent injuries. For exam-

ple, health care providers currently put much emphasis on preventing such injuries as electrical burns, tap water scalds, and motor vehicle occupant injuries in preschool age children. While these are important efforts, they must be expanded to target injuries of higher incidence and, in particular, injuries to adolescents.

It must also be recognized that injury morbidity is an important health status indicator. For each death, we found 45 hospitalizations and 1,300 ER visits. Given the magnitude of non-fatal injuries and the observed differences for each level of injury severity, a consideration of both morbidity and mortality is warranted in setting priorities for prevention efforts.

The impact of injuries is staggering when our rates are used as a basis for estimating the statewide incidence of childhood injuries. The 1,721,000 children and adolescents living in Massachusetts can be expected to suffer 377,000 injuries requiring hospital treatment annually. More attention by health professionals to causal factors, the development and use of uniform definitions and coding schemes by researchers, integration and expansion of existing national data bases, and appropriate funding are needed to facilitate further research and identify prevention measures. Policy makers must be encouraged to direct the necessary resources toward injury prevention.

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APPENDIX A
Definition of Injury Terms and ICD-9-CM E Coding System

	External Cause of Injury	
Injury Type	ICD-9-CM E Code	Definition
MV-Occupant	810–819 (.0, .1, .8, .9)	Operator or passenger of car, bus, truck, jeep, tractor, van
Pedestrian	810–819 (.7)	Struck by motor vehicle
MV-Pedal Cycle	810–819 (.6)	Collision with motor vehicle
Motorcycle	810–819 (.2, .3)	Operator or passenger; includes mopeds and dirt bikes
Pedal Cycle Non-MV	826	Collision with object or pedestrian; fall from pedal cycle
Other Transport	800–807	Railway
	810–819 (.4, .5)	Occupant of streetcar; rider of animal or drawn vehicle
	820–829 (excludes 826)	Nontraffic accidents; includes while boarding/alighting vehicle, non-collision, falls and off-road vehicles such as snowmobiles
	830–845	Air and water transport vehicle
Poisonings	850–869	Excludes ingestion with suicidal or homicidal intent and poisoning due to drugs in therapeutic use
Falls	880–888	Excludes falls from motor vehicle, pedal cycle and during sports activity; includes falls from stairs, building, ladder, bed and level ground
Foreign Body	914–915	Object in eye or other orifice; inhalation/ingestion of object not resulting in choking or suffocation
Struck by Object	916–918	Struck by falling object; striking against object; caught between objects
Cutting, Piercing	920	Powered and unpowered hand tools, household appliances, knives, and other sharp objects (e.g., broken glass, nail, splinter)
	919	Agricultural, lifting, woodworking, and manufacturing machinery
Explosives, Arms	921–923	Explosions of pressured vessels; firearms; fireworks and explosive materials
Electricity	925	Electric shock or electrocution from wiring, power lines, and appliances
Overexertion	927	Strenuous movements from lifting, pulling, twisting
Other, unspecified	870–879	Misadventures of care and late effects of surgery
	900–909	Natural environment; primarily effects of excessive heat or cold; includes exposure and lightning
	928	Other and unspecified environmental and accidental causes
	929	Late effects of accidental injury
	930–949	Poisoning due to drugs in therapeutic use
Sports	100–299*	Sports activities due to falls, collision with players, contact with equipment and strenuous movements; excludes sports activities resulting in drowning
Burns	890–899	Fires, flames, smoke inhalation
	924	Hot substances, corrosive liquids, steam
	926	Radiation; includes infra-red and ultra-violet lamps, electrical welders; excludes sunburns
Drowning	910	Submersions
Choking	911–913	Choking on food or object; mechanical suffocation due to crib, plastic, refrigerator and accidental strangulation

*Our coding scheme

APPENDIX B
Definition of Injury Terms and ICD-9-CM N Coding System

	Nature of Injury	
Injury Type	ICD-9-CM N Code	Definition
Internal	860–869	Internal injury of chest, abdomen and pelvis
Intracranial	800–804	Fracture of skull and facial bones; nose, jaw and orbit
	850–854	Concussions, brain lacerations, contusion and hemorrhage
Fractures other than Skull	805–829, 830–839	All other fractures and dislocations
Lacerations	870–897	Open wounds and traumatic amputations
	900–904	Injury to blood vessels
	910–919	Superficial injuries; abrasions, blisters and splinters
Sprains	840–848	Sprains and strains
	920–924	Contusions
	925–929	Crushing injuries
Other	905–909	Late effects of injury
	930–939	Effects of foreign body entering through orifice
	940–949	Burns
	950–957	Injury to nerves and spinal cord
	958–959	Other and unspecified injury
	960–979	Poisonings by drugs, medicinals and biological substances
	980–989	Toxic effects of non-medicinal substances
	990–995	Includes effects of radiation, heat/cold, drowning and electrocution