

Northeastern Ohio Trauma Study: II. Injury Rates by Age, Sex, and Cause

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Abstract: Using a 1977 sample of emergency department visits in five northeastern Ohio counties, population-based injury rates are tabulated by age, sex, and cause. Case fatality ratios are estimated by comparing these injury rates with population-based mortality rates for 1976–1978. For all age and sex groups, injuries are a major cause of emergency department visits. Falls, striking, cuts, and motor vehicle crashes are the leading causes of injury. Case fatality

ratios for motor vehicle crash injuries are considerably higher than those for non-transport injuries. Injury rates and case fatality ratios for males exceed those for females except among the elderly. With increasing age, injury rates decline but the fraction of injuries leading to hospital admission or to fatality rises sharply. (*Am J Public Health* 1984; 74:473–478.)

Introduction

In the United States, injuries are the leading cause of death during the first four decades of life,¹ and are responsible for half of all visits to hospital emergency departments.² Although some causes of fatal injuries are tabulated by age and sex in *Vital Statistics of the United States*, population-based data on non-fatal injuries, which are far more numerous than fatal ones, have not been readily available.^{3–6}

This report presents population-based rates for injuries—non-fatal as well as fatal—treated in emergency departments of hospitals serving a large midwestern United States population during 1977. These injury rates are tabulated and analyzed by cause, age, and sex. The findings are discussed and related to mortality data for the same region from 1976 through 1978.

Methods

The Northeastern Ohio Trauma Study² collected a 1.9 per cent, time-stratified random sample of all visits during 1977 to the emergency departments of 41 of the 42 acute care hospitals in the study region. This 2,014 square mile region (Cuyahoga, Geauga, Lake, Lorain and Medina counties) coincides with the Cleveland and Lorain-Elyria Standard Metropolitan Statistical Areas. It includes rural and urban areas. The estimated population in 1977 was 2,200,000 with 72 per cent living in Cuyahoga County, the site of Cleveland, the major urban center.²

This report is based on the same sample of emergency department visits and follows the same general methods used in the previous report² which examined injury rates for all age and sex groups combined. The injuries tabulated were all injuries defined in the eighth revision of the *International Classification of Diseases Adapted*⁷ under the heading “Accidents, poisonings and violence.” For this report, tabulation was restricted to visits by residents of the study region and only the first hospital visit for each injurious event was tabulated. Estimates for the 1977 population of the study

region were made by linear interpolation between the 1970 and 1980 census counts for each age and sex group.^{8,9}

The 41 participating hospitals accounted for 97.6 per cent of all 1977 emergency department visits in the study area.² No adjustment was made for injuries not treated in hospital emergency departments, the small fraction of visits occurring at the non-participating hospital, visits by area residents to emergency departments outside the study area, or visits excluded because of the patient’s unknown age or sex. The overall incidence rates in this report differ slightly from those in the previous report because of the age and sex exclusions and because this report utilizes final 1980 census data previously available only as preliminary estimates.

To simplify the presentation of the results, no error estimates were included in Tables 1–3. Information necessary to calculate these estimates is provided in the Appendix. The annual numbers of deaths from motor vehicle crashes and “non-transport accidents” are tabulated by residency, age, and sex by the National Center For Health Statistics.¹⁰ These counts for all residents of the study area were converted into average annual death rates per 100,000 persons. Mortality data for the three years 1976–1978 were used because data for 1977 alone provided too few fatalities to allow stable age and sex specific case fatality ratios to be calculated. For consistency with the injury data, which only tabulated injuries occurring within the study region, deaths occurring outside the study region were excluded. This exclusion reduced the motor vehicle death rate by 18 per cent and the non-transport death rate by 7 per cent.

The statistical significance of group-to-group differences was calculated using a chi-square test with appropriate degrees of freedom. Group-to-group differences, when described, are statistically significant differences at a p value less than 0.01. When differences are termed non-significant, the p value is greater than 0.05.

Results

The sample contained 8,369 visits to emergency departments for injuries by residents of the northeastern Ohio region. The age or sex of the patient was unknown for 192 visits (2 per cent). Thus, tabulations were based on 8,177 cases.

The overall annual rate of emergency visits for injuries was 194 per 1,000 residents. Total injury rates for each sex and both combined were highest in the 15–24 year old group and declined with age thereafter (Figure 1). In this age group, the major causes of injury were motor vehicle crashes, striking, cutting, falls, overexertion, and assault (Table 1).

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TABLE 1—Age- and Cause-Specific Injury Rates[‡] per 1,000 Residents at Risk, Five Northeastern Ohio Counties, 1977

Cause	Age (years)	Age (years)										All Ages
		0-4	5-9	10-14	15-24	25-34	35-44	45-54	55-64	65-74	75+	
Falls	880-887	90	68	65	47	33	33	32	35	40	69	47
Striking/Struck/Caught	916-918	26	37	40	48	30	22	16	11	3	4	27
Cut	920	18	32	36	48	35	27	17	14	8	3	28
Motor Vehicle Crash	810-823	12	16	14	49	32	18	14	13	11	9	23
Other Road Vehicle	825-827	4	13	15	3	1	1	0*	1*	0*	1*	4
Overexertion (Strains)	919	4	4	23	35	23	14	10	7	3	1*	16
Insect/Animal Bite	905-906	10	18	16	10	6	6	6	6	2	2*	8
Assault	960-968	1*	3	7	19	14	10	4	2	2	3	8
Foreign Body	914-915	8	5	2	11	10	7	4	3	1*	1*	6
Hot or Corrosive Fluid	924	6	2	2	4	5	2	2	2	1*	1*	3
Undetermined Intent	980-988	3	2	1	9	8	5	3	2	2	1*	5
Infrequent Causes	**	13	3	3	7	8	6	4	2	4	2*	6
Other		10	8	32	31	13	10	9	4	3	3	14
TOTAL	800-999	205	211	255	321	217	162	121	102	80	100	194

‡ Based on 8,177 emergency department visits.

‡‡ Reference 7.

* Indicates rate based on fewer than five counted events.

** Rail, water and air transportation (E800-807, 830-838, 840-845), poisoning (E850-877), fires and flames (E890-899), heat or cold exposure (E900-901), surgical and medical misadventure (E930-936) and self-inflicted (E950-959). These causes were described separately in a previous paper² but combined here.

Injury rates from falls were highest among the very young (0-4 years) and the very old (75+). Falls were unique in having their peak injury rates at the extremes of age (Table 1).

Injury rates for males (Table 2) were higher than those for females (Table 3) in each age group until age 55. For those aged 55 and older, the rates for males and females were

not significantly different. Male injury rates from falls exceeded female rates in each age group up to 25 years. In the age groups from 25-54, male and female injury rates from falls were not significantly different. Among persons aged 55-64, and among all persons 55 or older, female injury rates from falls exceeded male rates.

The 1976-1978 Northeastern Ohio age and sex-specific

TABLE 2—Age- and Cause-Specific Injury Rates[‡] per 1,000 Residents at Risk, for Males in Five Northeastern Ohio Counties, 1977

Cause	Age (years)	Age (years)										All Ages
		0-4	5-9	10-14	15-24	25-34	35-44	45-54	55-64	65-74	75+	
Falls	880-887	110	80	72	56	37	31	30	22	35	56	50
Striking/Struck/Caught	916-918	31	45	49	72	41	30	22	13	4	5*	37
Cut	920	19	41	48	71	49	39	23	19	7	3*	39
Motor Vehicle Crash	810-823	15	20	20	60	41	17	13	11	8	7*	27
Other Road Vehicle	825-827	5	17	18	2	1*	1*	0*	0*	0*	2*	4
Overexertion (Strains)	919	5	6	28	52	30	20	12	9	3*	3*	22
Insect/Animal Bite	905-906	13	23	18	12	6	7	8	6	0*	2*	10
Assault	960-968	1*	4	8	22	15	9	4	2	2*	7*	9
Foreign Body	914-915	10	6	2*	18	13	14	4	5	3*	2*	9
Hot or Corrosive Fluid	924	5	3	3	6	6	2	2*	3	1*	0*	4
Undetermined Intent	980-988	3*	1*	2*	11	9	4	3	2*	3*	3*	5
Infrequent Causes	**	13	3	4	9	10	7	6	2	5	3*	7
Other		12	10	45	46	18	14	13	6	5	2*	21
TOTAL	800-999	241	259	317	435	278	194	139	102	74	94	244

‡ Based on 4,938 emergency department visits.

‡‡ Reference 7.

* Indicates rate based on fewer than five counted events.

** Rail, water and air transportation (E800-807, 830-838, 840-845), poisoning (E850-877), fires and flames (E890-899), heat or cold exposure (E900-901), surgical and medical misadventure (E930-936) and self-inflicted (E950-959). These causes were described separately in a previous paper² but combined here.

TABLE 3—Age- and Cause-Specific Injury Rates* per 1,000 Residents at Risk, for Females in Five Northeastern Ohio Counties, 1977

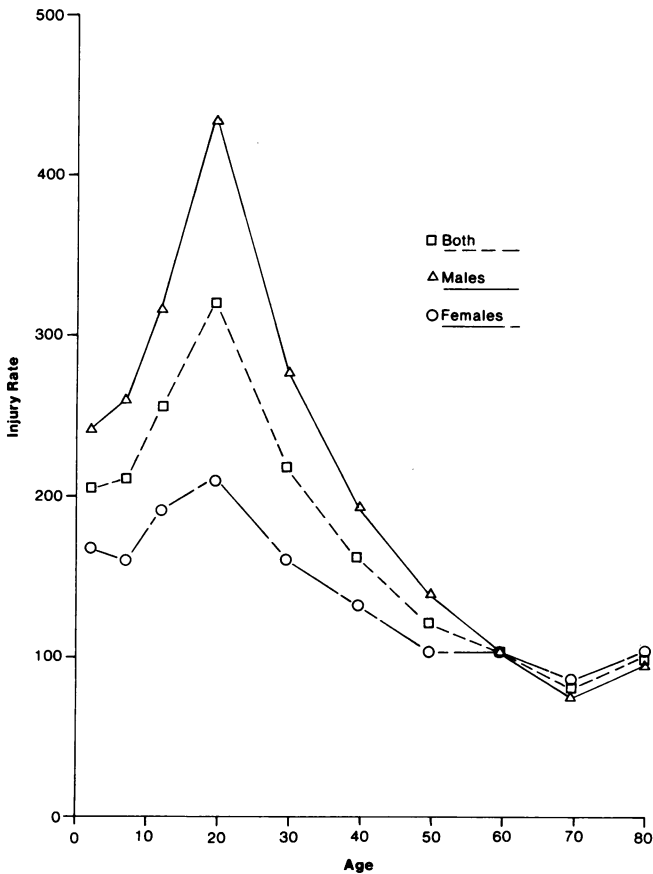
Cause	E-Code††	Age (years)										All Ages
		0-4	5-9	10-14	15-24	25-34	35-44	45-54	55-64	65-74	75+	
Falls	880-887	68	56	57	39	29	34	34	47	44	77	44
Striking/Struck/Caught	916-918	21	28	31	25	19	14	10	9	3*	3*	17
Cut	920	17	22	24	25	22	17	13	9	8	3*	17
Motor Vehicle Crash	810-823	9	12	7	38	23	18	14	15	13	10	19
Other Road Vehicle	823-827	2*	8	11	5	1*	1*	0*	1*	0*	0*	3
Overexertion (Strains)	919	3	3	17	19	16	9	8	6	4	0*	10
Insect/Animal Bite	905-906	7	12	13	8	6	6	4	6	4	3*	7
Assault	960-968	0*	2*	6	16	13	12	4	3	2*	1*	8
Foreign Body	914-915	7	5	2*	5	7	1*	3	1*	1*	1*	3
Hot or Corrosive Fluid	924	7	2*	1*	3	3	2	2*	1*	1*	2*	2
Undetermined Intent	980-988	3*	3	1*	8	7	6	3	1*	2*	0*	4
Infrequent Causes	**	13	2*	3	5	6	5	3	1*	3	1*	4
Other		9	5	18	16	9	6	5	3	2*	4*	8
TOTAL	800-999	167	159	191	211	160	132	103	103	85	103	148

‡Based on 3,239 emergency department visits.

††Reference 7.

*Indicates rate based on fewer than five counted events.

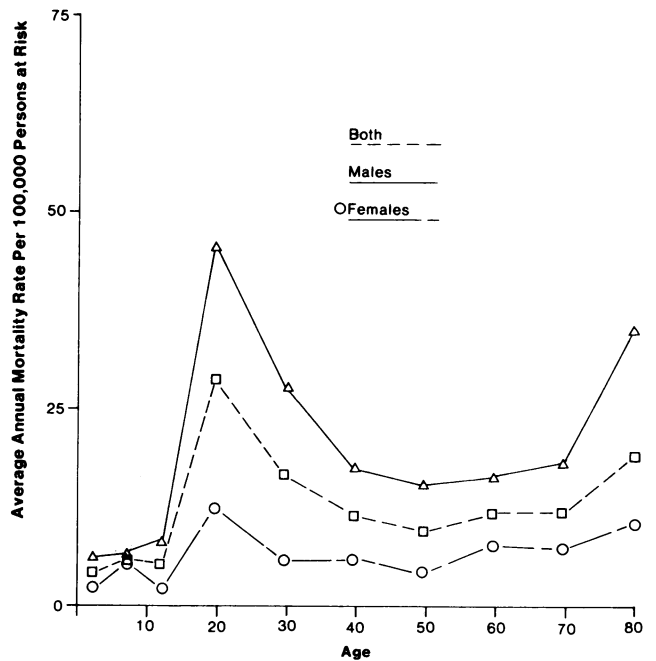
**Rail, water and air transportation (E800-807, 830-838, 840-845), poisoning (E850-877), fires and flames (E890-899), heat or cold exposure (E900-901), surgical and medical misadventure (E930-936) and self-inflicted (E950-959). These causes were described separately in a previous paper² but combined here.



Age groups are represented by their mid values and have the same ranges as in Tables 1-3. Age 75 and older is plotted at 80 years. Overall annual rates per 1,000 persons at risk are 244 for males, 148 for females, and 194 for both sexes.

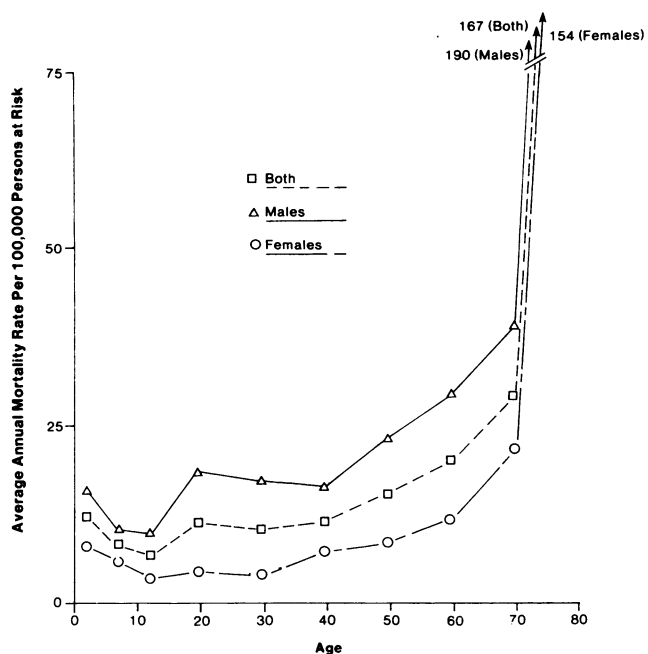
FIGURE 1—Age- and Sex-Specific Injury Rates per 1,000 Persons at Risk per Year in Five Northeastern Ohio Counties, 1977

death rates from motor vehicle crashes (Figure 2) differed sharply from those for "non-transport accidents" (Figure 3). The age and sex-specific ratio of deaths to injuries (estimated case fatality ratios) age are shown in Figures 4 and 5, respectively. Case fatality ratios for motor vehicle crashes were considerably higher than those for non-transport inju-



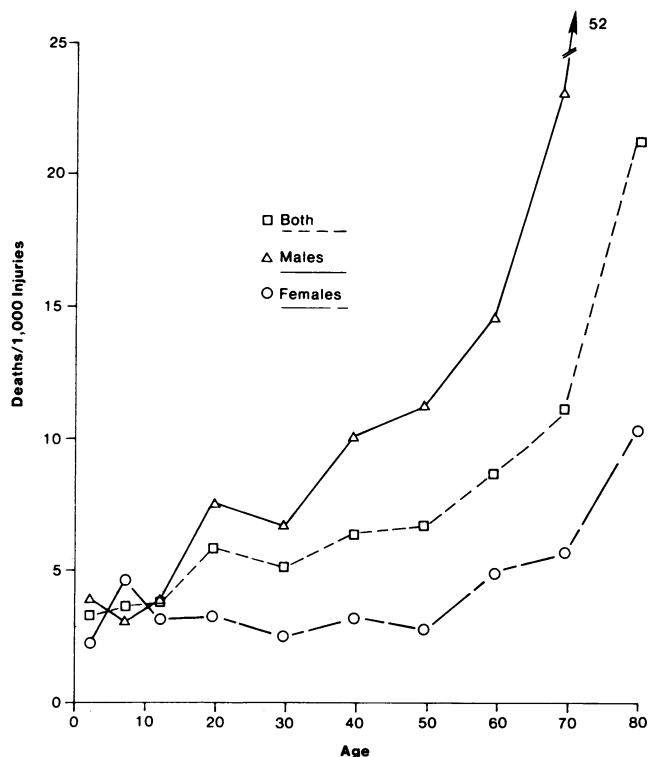
Only deaths occurring in the study region are tabulated. Age groups are represented by their mid values and have the same ranges as in Tables 1-3. Age 75 and older is plotted at 80 years. Overall average (1976-1978) annual rates per 100,000 persons at risk are 21 for males, 7 for females and 14 for both sexes. Data are derived from U.S. vital statistics.

FIGURE 2—Age- and Sex-Specific Average Annual Mortality Rates (1976-78) from Motor Vehicle Crashes in Five Northeastern Ohio Counties



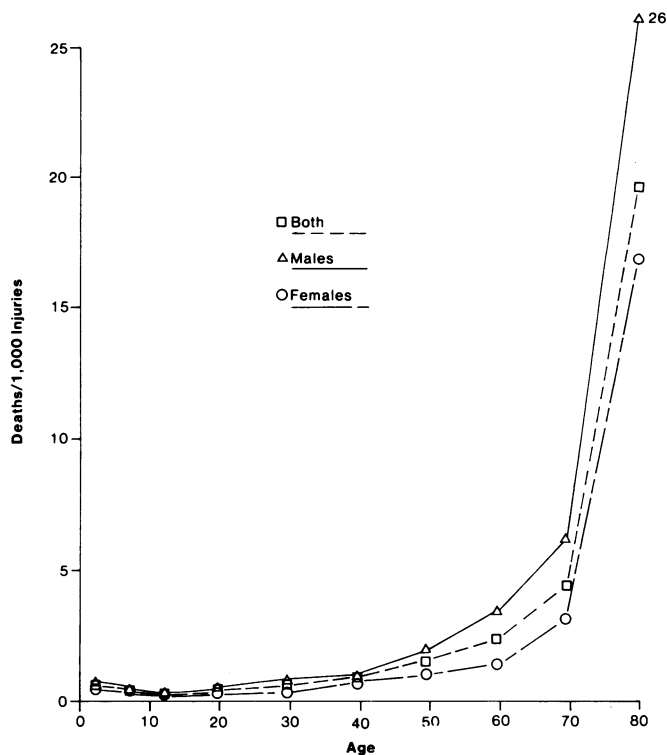
The injuries tabulated correspond to the ICDA codes E850 - E929. Only deaths occurring in the study region are tabulated. Age groups are represented by their mid values and have the same ranges as in Tables 1-3. Age 75 and older is plotted at 80 years. Overall average (1976-1978) annual rates per 100,000 persons at risk are 24 for males, 15 for females and 19 for both sexes. Data are derived from U.S. vital statistics.

FIGURE 3—Age- and Sex-Specific Average Annual Mortality Rates (1976-78) from Non-Transport Injuries in Five Northeastern Ohio Counties



These are the ratios of the Northeastern Ohio mortality rates (Figure 2) to the Northeastern Ohio motor vehicular injury rates (Tables 1-3) scaled to give deaths per 1,000 injuries. The ratio for the oldest males is based on only four cases of motor vehicle injury. Age groups are represented by their mid values and have the same ranges as in Tables 1-3. Overall fatality ratios per 1,000 cases are 8 for males, 4 for females, and 6 for both sexes.

FIGURE 4—Age- and Sex-Specific Average (1976-78) Deaths per 1,000 Motor Vehicle Crash Injuries in Five Northeastern Ohio Counties



These are the ratios of the Northeastern Ohio mortality rates (Figure 3) to the Northeastern Ohio injury rates (Tables 1-3) for non-transport injury scaled to give deaths per 1,000 injuries. The appropriate "infrequent causes" of Tables 1-3 were included in the denominators. Age groups are represented by their mid values and have the same ranges as in Tables 1-3. Overall fatality ratios per 1,000 cases are 1.2 for males, 1.3 for females, and 1.3 for both sexes.

FIGURE 5—Age- and Sex-Specific Average (1976-78) Deaths per 1,000 Non-Transport Injuries in Five Northeastern Ohio Counties

ries for all age and sex groups up to age 65. Case fatality ratios for motor vehicle crash injuries were considerably higher among males than among females. For each sex, case fatality ratios increased with age, sharply so after middle age (Figures 4, 5).

The per cent of emergency visits leading to hospital admission rose markedly after age 65 (Table 4) and was similar for males and females. While 5 per cent of all visits for injuries led to hospital admission, 21 per cent did so among persons aged 65 to 74, and 34 per cent among those 75 years or older. The per cent of emergency visits leading to hospital admission was higher for motor vehicle crash injuries than for non-transport injuries overall and up to age 35; no significant difference was present among those aged 35-64; the per cent leading to hospital admission was higher for non-transport injuries (p = 0.02) among those aged 65 or older.

The per cent of injuries occurring at school or work, near or at home, and elsewhere is shown for each age group and sex in Table 5. For each sex, below age 10 and above age 64, the vast majority of injuries occurred at or near the place of residence. In the age range 10-64, injuries occurring remote from the place of residence were relatively frequent. For males 10-64 years old, injuries at school or work accounted for nearly half of all injuries. While females 10-64 years old also received many injuries at school or work, most of their injuries occurred elsewhere, often near or at home.

TABLE 4—Per Cent of Emergency Department Trauma Visits* Resulting in Hospital Admission by Age, Sex, and Causal Group in Five Northeastern Ohio Counties, 1977

Age (Years)	Motor Vehicle Crash Injuries	Non-Transport** Injuries	All Causes of Injury
0-4	6	3	4
5-9	11	2	2
10-14	8	2	3
15-24	9	3	5
25-34	4	2	3
35-44	4	5	6
45-54	6	5	7
55-64	5	6	7
65-74	7	24	21
75+	21	36	34
All ages	7	4	5

*This tabulation is based on 7,854 patients discharged, admitted, or transferred alive with complete records from the emergency departments.

**All patients with ICDA external cause of injury codes from E850 through E929.

Discussion

The injury rates presented here are population rates for five northeastern Ohio counties obtained by sampling the records of essentially all emergency departments serving this area. Thus, they are not subject to errors which may be present in data obtained through interviews, or to the selection biases which may be present in data obtained from hospital samples not bearing a known relationship to definable populations at risk.

The rates tabulated are slightly conservative due to several exclusions: emergency department visits at the non-participating hospital (2 per cent), patients of unknown age or sex (2 per cent), patients with unknown addresses (2 per cent), and visits to outside emergency departments by residents of the study region. Six per cent of all emergency visits for injury were made by non-residents.² Since the study region contained the major urban center for northeastern Ohio, it is reasonable to assume that the outward mobility of residents was no greater than the inward mobility of non-residents who received emergency care in the study

region. An alternative estimate is obtained by noting that among residents of the study region, 8 per cent of deaths due to injuries occurred outside the study region.

The data in this report are limited to patients visiting hospital emergency departments for injury. They exclude patients who received care entirely through other providers and those who died of injuries without being registered at an emergency department.

The calculation of case fatality ratios was subject to three sources of error:

- To the extent that the number of injury cases was underestimated, the case fatality ratio was overestimated.

- Injury data for 1977 were compared to mortality data for the three-year period 1976-1978, an approach which assumed that 1977 did not differ radically from 1976 and 1978. Examination of the mortality data supported this view.

- The case fatality ratio is the ratio of all deaths to all cases (surviving or dying). In the present study, cases dying without reaching a hospital were not tabulated in the denominator. Thus, the denominator was slightly underestimated. The number of fatalities omitted from the denominator was less than the total number of fatalities, and this was less than 6 per cent of all cases (Figures 4, 5). Thus, the observed ratio of deaths to cases provided a good estimate of the case fatality ratio.

In all age groups, injury was a major cause of emergency department visits, hospital admission, and death. Although age-specific injury rates declined after age 15-24 (Tables 1-3), the clinical implications of these injuries were far more serious among the old than among the young. The per cent of emergency visits leading to hospital admission, the population-based mortality rates, and the case fatality ratios all increased sharply among the elderly. For motor vehicle crash injuries overall, 0.6 per cent of the cases were fatal but, for persons aged 65 or older, 1.5 per cent were fatal (Figure 4). For non-transport injuries, one-tenth of a per cent of cases were fatal overall, but among persons aged 65 to 74 half a per cent were fatal, and among those 75 or older 2 per cent were fatal (Figure 5). These case fatality ratios far exceed the case fatality ratios observed among younger people.

TABLE 5—Persons Injured by Place of Occurrence, Age, and, Sex in Five Northeastern Ohio Counties, 1977

Age Group (years)	Males			Females			Both Sexes			Total Number of Cases
	Per Cent* at School or Work	Per Cent* Near or at Home‡	Per Cent* Elsewhere	Per Cent* at School or Work	Per Cent* Near or at Home‡	Per Cent* Elsewhere	Per Cent* at School or Work	Per Cent* Near or at Home‡	Per Cent* Elsewhere	
0-4	2	89	8	3	88	9	2	89	9	404
5-9	11	70	19	11	71	18	11	71	19	417
10-14	30	48	22	33	48	18	31	48	21	578
15-24	50	22	28	28	39	33	43	27	30	1533
25-34	50	28	22	23	56	21	40	38	22	937
35-44	48	33	19	17	60	22	35	44	21	539
45-54	50	34	16	20	50	30	37	41	22	415
55-64	45	37	19	18	52	30	31	45	25	336
65-74	6	73	21	3	71	25	4	72	24	143
75+	6	88	6	1	87	12	3	87	10	117
All Ages	40	39	22	20	56	24	32	45	23	5419**

*Difference from 100 in the totals is due to rounding.

**Tabulation is based on 5,419 events; it excludes 2,758 events with unknown or unspecified location.

‡Includes resident institutions.

Population-based mortality rates due to non-transport injury were also high among the elderly. The overall annual death rate from non-transport injuries was 19 per 100,000 persons, but among persons aged 65 to 74 it was 29, and for those aged 75 and older, 167 (Figure 3). Mortality from motor vehicle crashes was greatest at age 15 to 24 years with an annual death rate of 29 per 100,000 persons at risk (Figure 2). For ages 35-64, the rate fell to 11. A second peak was seen in the elderly with 14 deaths per 100,000 persons per year in those aged 65, and still higher values for those aged 75 and older.

In conclusion, this is the first report of comprehensive, population-based injury statistics by cause, age, and sex. Not all of the observations presented here are new. For example, adverse prognoses have been associated with burn injuries in older patients¹¹ and with head injuries from motor vehicle crashes.¹² The great burden that injuries impose upon emergency care facilities is also well known. Since this report provides previously unavailable estimates of injury rates in a well defined population, the findings should be useful to many of those concerned with trauma, specifically, and with the provision of medical care, generally. Subsequent reports will present more specialized analyses based on the same data.

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APPENDIX

Calculation of confidence limits for the injury rates presented in this study can be performed if the number of observed visits and the number of persons at risk are known. To facilitate such calculations, the number of persons at risk for each age and sex group is shown in the following table.

APPENDIX TABLE—Estimated* 1977 Population by Age and Sex (Thousands of Persons). Five-County Northeastern Ohio Trauma Study Region

Age (Years)	Males	Females	Both Sexes
0-4	83.4	79.9	163.3
5-9	90.5	86.8	177.3
10-14	100.2	97.0	197.1
15-24	188.1	196.3	384.4
25-34	157.4	167.0	324.4
35-44	120.0	130.7	250.7
45-54	121.6	132.2	253.8
55-64	109.3	123.1	232.4
65-74	61.6	83.6	145.2
75+	31.2	58.2	89.4
All ages	1,063.2	1,154.7	2,218.0

* Each population estimate was generated from the corresponding estimates for 1970 and 1980 using linear interpolation. Some combined estimates differ slightly from the separate estimates because of rounding.

**NIOSH/NCI Cosponsor Conference
On Workplace Screening, Monitoring**

The National Institute for Occupational Safety and Health (NIOSH) and the National Cancer Institute (NCI) will jointly sponsor a conference on Medical Screening and Biological Monitoring for the Effects of Exposure in the Workplace, July 10-13, 1984, Cincinnati, Ohio. For details and to submit papers, contact Dr. Joseph Kielman, Technical Resources, Inc., Suite 408, 10215 Fernwood Road, Bethesda, MD 20817. Tel: 301/493-5300.