Medical-Examiner-Reported Fatal Occupational Injuries, North Carolina, 1978–1984

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Fatal occupational injuries are a major public health problem in the U.S. Utilizing a medical examiner database from North Carolina, 1,233 fatal work-related injuries were identified in a 7-year time period. Twelve percent of these deaths were in out-of-state residents. For men, highest risk industries were forestry/fishery, agriculture, trade, and transportation/public utilities/communications. Only 4% of deaths occurred in women. The most common manner of death in women was homicide. Highest-risk industries for women were agriculture, trade, and transportation/public utilities/communications. Of 902 decedents tested, alcohol was found in 11%, and 7% had levels at or above 100 mg%. Because of its completeness, the North Carolina Medical Examiner System is a useful tool to use in the surveillance of fatal occupational injuries.

Key words: work-related fatalities, homicide, surveillance data

INTRODUCTION

Work-related injuries are a major public health problem in the United States. Estimates of the number of people killed on the job each year vary greatly among surveys because of different inclusion criteria and reporting sources [Suruda and Emmett, 1988]. The Bureau of Labor Statistics reported 3,750 work-related deaths in 1985 [U.S. Department of Labor, 1986]. A recent study by the National Institute for Occupational Safety and Health (NIOSH) reported 32,342 deaths occurring over a 5-year period (approximately 6,468 deaths per year) [Centers for Disease Control, 1987a]. A recent report on occupational safety and health statistics concluded that there is no agreed-upon method to estimate the magnitude of traumatic death in the workplace [Panel on Occupational Safety and Health Statistics, 1987].

Several studies have described fatal occupational injuries in some detail, utilizing several different reporting sources for case identification [Baker et al., 1982; Centers for Disease Control, 1985; Parkinson et al., 1986]. Detailed epidemiologic

descriptions of these injuries are needed in order to identify high-risk groups more precisely so that intervention strategies can be developed, implemented, and evaluated.

This study was undertaken to identify and describe fatal occupational injuries utilizing a medical examiner (ME) database and to assess the utility of this database as part of a surveillance system for fatal occupational injuries.

MATERIALS AND METHODS

Deaths were identified by utilizing records maintained by the Office of the Chief Medical Examiner in Chapel Hill, North Carolina. North Carolina law requires that homicides, suicides, accidental deaths, deaths due to trauma, deaths due to disaster or violence, and any death with unknown, unnatural, or suspicious circumstances be reported to the North Carolina Medical Examiner System (NCME). The NCME consists of approximately 600 County Medical Examiners (licensed physicians) and 100 pathologists throughout the state. The primary role of the County Medical Examiner is to detect, analyze, and document the medical aspects of investigated deaths. Specimens for toxicologic testing are forwarded to the Chief Medical Examiner for analysis. Autopsies are performed when deemed necessary. Data from medical examiner cases are assembled into one central, computerized database maintained at the Office of the Chief Medical Examiner [North Carolina Department of Human Resources, 1985]. Reports from County Medical Examiners and pathologists must be received within 3 weeks of death in order for monetary compensation to be paid (L. Parker, Office of the Chief Medical Examiner, Chapel Hill, NC, personal communication, March, 1986).

Cases included in this study met the following criteria:

1. Death resulted from traumatic injury while at work in North Carolina.
2. The injury must have occurred in the 7-year time period of January 1, 1978, through December 31, 1984.
3. Age at injury was 16 years or greater.
4. Manner of death was determined to be "accident" or homicide by the investigating medical examiner.
5. Occupation/industry was not recorded as student/student (N = 10), housewife/housewife (N = 2), or retired/retired (N = 1).
6. Industry was not recorded as military (N = 67).

Suicides (N = 31) were not included. Also, homicides where the victim and perpetrator were known to each other (N = 13) were not included because it was felt these deaths may have little to do with workplace circumstances. The medical examiner reports for 13 deaths were reviewed where death occurred on the job but the manner of death was reported as unknown. One of these was a duplicate record and was deleted from this study. The authors reviewed the original narrative report of the remaining 12 deaths where manner was reported as unknown: two were thought to be natural and deleted, three were not on the job and deleted, three were deleted because manner of death was unable to be determined, and four were recoded to manner of death as "accident" and included in this study.

Denominator data were obtained from the *1980 Census of the Population,* Bureau of the Census. The 1980 U.S. census for North Carolina reported a civilian

employed population of 2,607,925 [U.S. Department of Commerce, 1983a,b]. Census civilian employment figures were multiplied by seven to obtain the number of employed-person years at risk for the 7-year time period of this study. Rates were calculated for in-state residents only. Out-of-state residents are not included in the calculations of rates because they are not represented in the denominator. Rates were age-adjusted or industry-adjusted to the age of industry distribution of North Carolina using the direct method. Rates are expressed per 100,000 employed-person years (EPY).

Descriptions relating to time, place, and alcohol or other drug involvement include both in-state and out-of-state residents.

Analysis of toxicology data for blood alcohol was limited to those cases where survival time was known and was less than 6 hours. Since alcohol is metabolized in those surviving past the time of injury, alcohol testing in those surviving more than 6 hours after injury has less meaning.

Occupation and industry categories used by the North Carolina Medical Examiner System were developed specifically for that system and do not match existing Bureau of the Census categories. It was possible to group NCME industry categories to match existing Bureau of the Census industry categories; however, this was not possible for occupation categories. Means of death categories (external cause of death) used by the North Carolina Medical Examiner System are also unique to the system.

RESULTS

Over the 7-year period of this study, 1,233 deaths met the case criteria. In-state residents accounted for 1,091 (88%) of these deaths. Homicide accounted for 181 (17%) of 1,091 deaths in North Carolina residents.

Person Characteristics: Sex, Race, and Age

Women accounted for 44 (4%) of all injury deaths in in-state residents. The distribution of manner of death differed markedly by sex. The most frequent manner of death in women was homicide, accounting for 25 (57%) of all female deaths. In contrast, homicide represented 15% of all injury deaths in men. Homicide and unintentional injury death rates were, respectively, 5.6 and 23 times higher in men as compared to women (Table I).

In 1980, the North Carolina labor force was approximately 80% white, and 827 (76%) of the deaths occurred in whites. The unintentional injury rate was higher in nonwhites (5.9/100,000 employed person years [EPY]) than in whites (4.3/100,000 EPY). The homicide rate was also marginally higher in nonwhites (1.1/100,000 EPY vs. 0.9/100,000 EPY).

There is a general increase in fatal injury rates in older age groups (Fig. 1). The highest fatal unintentional injury rates are found in the over-65 age group for males and in the 60–64 age group for females. The highest homicide rates are in the over-65 age group for both males and females. In females, all fatal injuries in this age group were homicides.

Industry

For women, the industry having the highest overall rate for fatal injury was agriculture; the trade industry had the highest homicide rate. For men, the highest

TABLE I. Distribution and Sex-Specific, Industry-Adjusted Rates by Manner: Fatal Occupational Injuries, North Carolina, 1978–1984

Sex	N	(%)	Rate[a]
Male			
Unintentional injuries	891		7.0
Homicides	156		1.7
All injuries	1,047	(96)	8.7
Female			
Unintentional injuries	19		0.3
Homicides	25		0.3
All injuries	44	(4)	0.6
Total	1,091	(100)	6.0

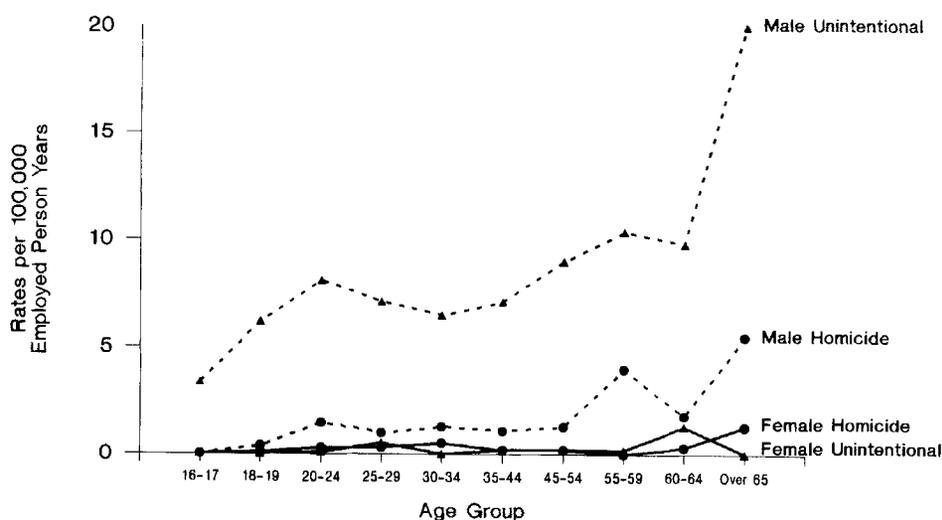[a]Rates are expressed per 100,000 employed-person years.

Fig. 1. Age-specific, industry-adjusted rates (by sex and manner) of fatal occupational injuries in North Carolina, 1978 to 1984.

fatality rates were in forestry/fishery, agriculture, construction, and transportation/ public utilities/communications; the highest homicide rate was in trade (Table II).

Time

There was a decrease in the number of fatal injuries occurring over the 7-year study period (Fig. 2).

The greatest number of fatal unintentional injuries occurred in the warm-weather months. This increase was almost entirely accounted for by an increase in the number of injuries in agriculture and construction. Homicide was more evenly distributed over all months.

Most (88%) unintentional fatal injuries occurred Monday through Friday, reflecting employment patterns; the fewest number occurred on Sunday (3%). Homicides were more evenly distributed over all days of the week than unintentional injury deaths. Data on the hour of injury were missing in 102 of the 1,233 cases. The

TABLE II. Industry-Specific, Age-Adjusted Rates by Sex and Manner: Fatal Occupational Injuries, North Carolina, 1978–1984

Industry group	Rate[a] (N)					
	Unintentional		Homicide		All injuries	
Female						
Agriculture	2.9	(3)	0.4	(1)	3.3	(4)
Trade	0.2	(3)	1.1	(16)	1.3	(19)
T/PU/C[b]	0.7	(2)			0.7	(2)
F/I/RE[c]	0.4	(1)	0.2	(1)	0.6	(2)
Manufacturing	0.2	(5)	0.1	(2)	0.3	(7)
Services	0.1	(4)	0.1	(4)	0.3	(8)
Male						
Forestry/fishery	35.4	(13)			35.4	(13)
Agriculture	19.7	(110)	1.2	(7)	20.9	(117)
T/PU/C	17.2	(148)	1.1	(9)	18.2	(157)
Construction	17.3	(181)	0.3	(4)	17.6	(185)
Services	4.7	(74)	3.1	(49)	7.8	(123)
Trade	4.1	(74)	3.6	(65)	7.8	(139)
Manufacturing	6.5	(214)	0.5	(16)	7.0	(230)
Mining	5.0	(2)			5.0	(2)
Public admin	1.3	(7)			1.3	(7)
F/I/RE	0.7	(2)	0.3	(1)	1.0	(3)

[a]Rates are expressed per 100,000 employed person years.
[b]Transportation/public utilities/communication.
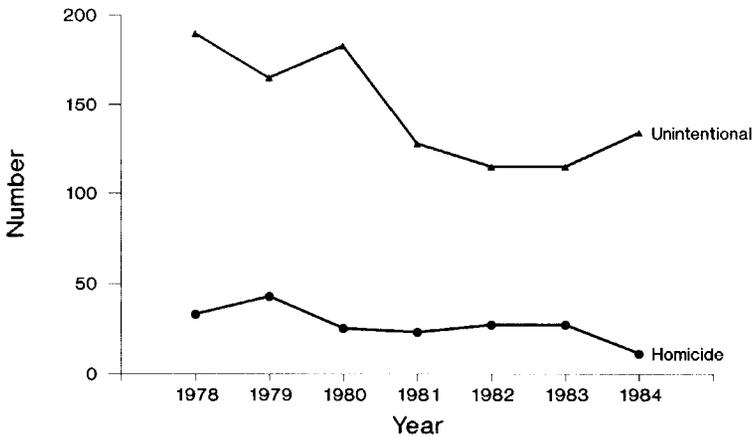[c]Finance/insurance/real estate.

Fig. 2. Distribution of fatal occupational injuries (by year and manner) in North Carolina, 1978 to 1984.

majority of unintentional injury deaths occurred between the hours of 8 A.M. and 4 P.M. (60%); 13% occurred between 4 P.M. and midnight; and 11% occurred between midnight and 8 A.M. Homicides were more evenly distributed over the day but occurred most frequently between 4 P.M. and midnight (44%). Twenty-seven percent of the homicides occurred between midnight and 8 A.M.; 29% occurred between 8 A.M. and 4 P.M.

TABLE III. Distribution of Fatal Occupational Injuries by Means of Death: In-State and Out-of-State Residents, North Carolina, 1978–1984

Means of death	N (%)		
	In-state	Out-of-state	Total
Motor vehicle	200 (18)	61 (43)	261 (21)
Gun	138 (13)	7 (5)	145 (12)
Fall	112 (10)	20 (14)	132 (11)
Falling object	116 (11)	12 (8)	128 (10)
Machinery, other[a]	98 (9)	5 (4)	103 (8)
Electrocution	88 (8)	5 (4)	93 (8)
Tractor	85 (8)	4 (3)	89 (7)
Explosion	41 (4)	0	41 (3)
Fire	32 (3)	1 (<1)	33 (3)
Drowning	25 (2)	2 (<1)	27 (2)
Blunt instrument	24 (2)	2 (<1)	26 (2)
Sharp, cutting instrument	20 (2)	1 (<1)	21 (2)

[a]Nontractor machinery.

Means of Death

The leading means (cause) of death was motor vehicle incidents (21%). In addition, 30 deaths were identified in which motor vehicles were involved, even though another means of death (such as fire or fall) was recorded. Guns were the second-most-frequent means of death, followed by falls and falling objects (Table III).

For men, the most frequent causes of death were motor vehicle incidents (21%), falls (11%), guns (11%), and falling objects (11%). For women, the most frequent means of death were guns (39%), motor vehicle incidents (16%), and sharp, cutting instruments (12%). The most common means of death among whites were motor vehicle incidents (21%), guns (12%), falls (10%), and falling objects (10%); for nonwhites, motor vehicle incidents (20%), falling objects (13%), falls (11%), and guns (10%) were the most common means.

Motor vehicles were the leading means of death in the transportation/public utility/communication industry (58%). Guns were the leading means of death in the trade (40%) and services (31%) industry groups. Falls and electrocution were the most common means of death in construction, accounting for 28 and 19% of deaths, respectively. Falling objects caused the most deaths in manufacturing (24%). Water transport (46%), drowning (31%), and exposure (24%) were the means of death for the forestry/fishery industry. The leading means of death in agriculture were tractors (43%), nontractor machinery (13%), and motor vehicles (9%).

Alcohol

Alcohol testing was done in 813 or 90% of the 902 deaths where survival time is known and was less than 6 hours. Of those tested, 89% were negative for alcohol. Fifty-three cases (7% of those tested) had a blood alcohol concentration greater than or equal to 100 mg%.

DISCUSSION

The overall fatal occupational injury rate during the 7-year period of this study was 6.0/100,000 employed-person years (EPY). This is less than the crude annual rate of 8.8/100,000 workers reported for North Carolina in the recent *National Traumatic Occupational Fatalities* study (NTOF) done by NIOSH [Centers for Disease Control, 1987b]. This lower rate may be due to differences in reporting sources, inclusion criteria, or the sensitivity of each system. The NTOF study identified fatal occupational injuries with death certificates and included military personnel, housewives, students, the retired, and out-of-state residents. Homicides where the victim and perpetrator were known to each other and suicides were also included in the NTOF study. If these cases included in the NTOF study were also included in our medical examiner study, the crude rate would have been 7.3/100,000 EPY. In addition, this medical examiner study does not include those North Carolina residents who sustained a fatal occupational injury out of state. These would also be included in the NTOF study. Further comparison of medical examiner and death certificate cases is needed to account for the difference in rates.

In this study, as in others, the fatal occupational injury rate was higher in men than women and in nonwhites than whites [Baker et al., 1982]. This difference may be explained by employment patterns in which men and nonwhites are involved in more hazardous occupations and activities. Interestingly, homicide was the most common fatal occupational injury for women, as was shown in Texas [Davis et al., 1987]. The homicide rate for men in this study (1.7/100,000 EPY) was lower than rates found in death certificate studies in Texas (2.1/100,000 male workers) and California (2.23/100,000 workers) [Davis, 1987; Kraus, 1987].

The NTOF study ranked the highest-risk industries in North Carolina as construction (23.0/100,000 workers per year); agriculture, including forestry/fishery (18.6/100,000); and transportation/public utilities/communication (17.4/100,000) [Centers for Disease Control, 1987b]. This study ranked forestry/fishery, agriculture, transportation/public utilities/communications, and construction as high-risk industries. The differences in ranking may be due to different selection criteria or misclassification of industry. When examining all causes of death on death certificates, the accuracy of industry coding has been shown to be 70% in long-term workers [Steenland and Beaumont, 1984]. The accuracy of industry information on medical examiners reports has not been evaluated. This information may be more accurate on medical examiner reports since cases are individually investigated.

There was a general decrease in the number of fatal occupational injuries occurring over the 7-year time period of this study. Employment figures from the Employment Security Commission of North Carolina show an increase in employment each year except for 1982 and 1983, when employment decreased slightly [Employment Security Commission of North Carolina, 1985]. The greatest number of people were employed in 1984. Therefore, the fatal occupational injury rate probably decreased over the study period. This apparent decrease may reflect, in part, changes in the size of high risk populations. More fatal injuries occurred in the warm-weather months. The increase in the number of deaths occurring in agriculture and construction may be accounted for by an increase in the number of workers at risk in these industry groups.

The role of alcohol in fatal work-related injuries is not clear. This study found

only 7% of appropriately tested fatalities had a level at or exceeding 100 mg%, the level generally accepted as evidence of legal intoxication. Lower levels of alcohol might, however, adversely effect job performance and ability to avoid injury. A range of values, varying from 1.6 to 22%, has been found in other studies [Baker et al., 1982; Copeland, 1985; Berkelman et al., 1985]. No information is available about alcohol use in co-workers who may be involved in the sequence of events leading to the fatal incident. Better data are needed about alcohol, prescription drug, and other drug usage, both in the victim and in co-workers, at those workplaces where occupational injuries occur in order to better define the role of alcohol. The data from this study suggest that alcohol plays less of a role in fatal occupational injuries than in nonoccupational motor-vehicle-related fatal injuries. Further analysis of these data is planned.

The leading means of death, as shown in other studies, was motor vehicle incidents [Baker et al., 1982; Centers for Disease Control, 1985]. More information is needed on the circumstances surrounding these fatalities in order to develop interventions directed toward decreasing on-the-job motor-vehicle-related fatalities. Guns were the second-most-common means of death. Prevention efforts should be directed toward those who are likely to be assaulted (e.g., trade industry employees working between the hours of 4 P.M. and midnight). Suggested interventions include the use of bulletproof vests and partitions and limiting hours of public contact in trade industry workers [Kraus, 1987]. Falls were a major cause of death in the construction industry. Although the Occupational Safety and Health Administration (OSHA) has specific standards for fall protection equipment used by laborers working at elevations, more than 80% of those injured in falls may not have fall protection in the work area [U.S. Department of Labor, 1984]. Stricter enforcement of existing standards may reduce this preventable cause of occupational mortality and morbidity.

The NC Medical Examiner System is a useful surveillance tool with which to study fatal occupational injuries and can identify cases and monitor trends. This system possesses many characteristics that make it especially useful for the surveillance of fatal occupational injuries:

1. Case ascertainment is more complete. Most sudden deaths occurring in the workplace are reported to the NC Medical Examiner System. Traumatic deaths are mandated by law to be investigated by the Medical Examiner System. Deaths in which work-relatedness is not readily apparent, such as motor vehicle incidents, are ascertained during the case investigation.
2. The information gathered is detailed and relevant for the study of fatal occupational injury. Meaningful recording of the current occupation and industry of the decedent is assured. Death certificate information on occupation and industry may reflect usual occupation and usual industry and not the occupation and industry at the time of the injury.
3. The system is timely. The NCME requires submission of reports to the Office of the Chief Medical Examiner within 3 weeks of death in order for compensation to be paid to the investigating County Medical Examiner. The system can be especially useful for identifying pretargeted types of workplace fatalities. This allows further investigation of the workplace to be done while it is still possible to adequately gather more detailed, relevant information.

Several problems with the data were identified. Coding schemes for occupation and

industry do not match available denominator information. With the exception of the forestry/fishery category, it was possible to group industry categories to match census denominators. On the other hand, it was not possible to separate manufacturing/wood product deaths from forestry deaths. Thus, some deaths occurring in the forestry industry were included in manufacturing. Adopting a coding mechanism matching Bureau of the Census categories would eliminate this problem. Industry information was missing in 6% of the cases. Information on restraint use in motor vehicle incidents was missing in almost all cases.

Medical examiner systems vary in completeness of coverage and availability of data (computerization) in different states. However, medical examiner systems and databases have great potential for the study of fatal occupational injuries. The investigation of traumatic on-the-job fatalities by a medical examiner allows information to be collected on external causes of death and other circumstances surrounding the fatal event. This study identified motor vehicle incidents and falls as major causes of death. More complete data are needed on these potentially preventable fatal injuries, such as the presence and use of personal protective equipment (e.g., safety belts). In this study, alcohol was associated with a small proportion of fatal occupational injuries. Appropriate prevention strategies should, therefore, focus more on other factors associated with fatal occupational injury. Preventive efforts also need to focus on homicide in the workplace.

ACKNOWLEDGMENTS

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