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### Work-Related and Non-Work-Related Injury Deaths in the U.S.: A Comparative Study

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## Work-Related and Non-Work-Related Injury Deaths in the U.S.: A Comparative Study

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### ABSTRACT

This study assesses the percentage of traumatic fatalities attributable to work-related causes in the US, by cause of death and population demographics. The 1993-1998 Vital Statistics Mortality data from the National Center for Health Statistics were used. There were 848,945 traumatic fatalities (E800-E999) among the general population 16 years or older in the US during this time; of these, 32,044 were work-related accounting for 3.8% of all the fatalities. The work-related percentage varied from 62.7% for machine-related deaths to 0.7% for suicides, from 4.9% for males to 1.0% for females, from 9.8% in Alaska to 1.5% in Arizona, from 4.2% for decedents with 1 to 4 year college educations to 2.9% for decedents with high school or less, from 4.4% for races other than white and black to 2.6% for black. Mean age-at-death was 42 years for work-related vs. 48 years for non-work-related fatalities. This difference is more pronounced for deaths from falls (45 years vs. 78 years). Conversely, victims of work-related homicide were older than non-work-related (41 years vs. 33 years). A more complete understanding of the burden of traumatic fatalities attributable to work-related causes requires consideration of the total work-related percentage, causes of death, and population demographics.

**Key Words:** injury mortality, fatality, occupational injury mortality, mortality surveillance, etiologic fraction.

### INTRODUCTION

Work-related diseases and injuries have killed people from the beginning of history, although few studies have assessed the work-related share of disease and injury mortality at a national level. Hernberg (2001) stated, "This deficiency is understandable, since the task is heroic. Very often crucial data are lacking, either because work-related mortality has not been studied at all or because the quality of the studies available is poor." This

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question is so important that the *Scandinavian Journal of Work, Environment, and Health* devoted an entire issue to a study (Nurminen and Karjalainen 2001) that tried to assess the work-related percentage of disease and injury mortality in Finland in 1996. While it is difficult to assess work-related shares of disease mortality, it is relatively easier to assess work-related shares of injury mortality. Such opportunity exists in the United States. In the US, there are three national surveillance data sets that contain information on work-related injury deaths. These are the Census of Fatal Occupational Injury (CFOI) (Toscano and Windau 1998; BLS 2001), the National Traumatic Occupational Fatalities (NTOF) surveillance system (Bell *et al.* 1990; Jenkins *et al.* 1993), and the Vital Statistics Mortality (VSM) data (NCHS 2001). VSM contains all reported deaths in the US, including all disease and injury deaths. Differences and similarities between CFOI and NTOF were well discussed in previous studies (Marsh and Layne 2001; CDC 1998; Myers *et al.* 1998; Chen and Fosbroke 1998). Both NTOF and VSM are death certificate-based data systems. However, NTOF is unique in that the data contain narrative information from death certificates for the injury descriptions and the immediate, underlying, and contributory causes of death. NTOF also contains codes for industry and occupation (Fosbroke *et al.* 1997), but only work-related deaths are included. For the purpose of identifying both work-related and non-work-related injury deaths, this study used VSM data to assess work-related percentages of all traumatic fatalities in the United States during a six-year period from 1993 to 1998.

## METHODS

In this study, injury deaths were drawn from the National Center for Health Statistics (NCHS) Vital Statistics Mortality data from all 50 states, the District of Columbia, and New York City. Decedents aged 16 years or older who died in the US from 1993 to 1998 with the "underlying cause of death" coded as "external" were included in the study. The "external" causes are defined based on the International Classification of Diseases, Ninth Revision, External Causes of Injury and Poisoning codes (ICD-9 E-codes, from E800 to E999) (WHO 1977). Work-related injury deaths in this study were identified by the "injury at work?" item on the death certificate. The Operational Guidelines for Determination of Injury at Work were developed jointly by the Association for Vital Records and Health Statistics, the National Institute for Occupational Safety and Health (NIOSH), the National Center for Health Statistics, and the National Center for Environmental Health and Injury Control (Jenkins *et al.* 1993). In general, a work-related injury death was defined as any injury death sustained while: (1) performing work for compensation, (2) performing volunteer work for an organized group, or (3) performing work on a farm. Injuries during commuting to or from a work site are not counted as work related.

The work-related percentage of all injury deaths is calculated as the number of work-related injury deaths over the number of all injury deaths (includes both work and non-work-related deaths)  $\times 100\%$ . Work-related percentages were calculated by cause of death, gender, sex, race, education, and state.

## RESULTS

Overall, 3.8% of all traumatic fatalities among the general population 16 years or older in the US were attributed to injuries at work. But work-related percentages

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varied: (1) by cause of death from 62.7% of machine-related deaths to 0.7% suicides and intent undetermined (see Table 1); (2) by state from 9.8% in Alaska to 1.5% in Arizona (see Table 2.); (3) by county population size from 4.7% (county of population less than 100,000) to 3.4% (county population of 100,000 and more) (see Table 3.); (4) by gender from 4.9% in male to 1.0% in female; (5) by education level from 4.2% (1 to 4 year college education) to 2.9% (high school or less); (6) by age-group from 6.4% among decedents 46 to 65 years old to 1.1% among decedents more than 65 years old; and (7) by race from 4.4% (races other than white and black) to 2.6% (black). In general, mean age-at-death was younger in work-related than non-work-related traumatic fatalities (42 years for work-related deaths vs. 48 years for non-work-related deaths) (see Table 4.). This difference is more pronounced for deaths from falls, suffocation, natural/environmental exposure, and machine-related injuries; for example, 78.6% of non-work-related fall deaths occurred to persons aged 70 years or older, while only 7.4% of work-related fall deaths occurred to persons in that age group. Conversely, for homicide deaths, work-related cases were older than non-work-related. Decedents 16 to 19 years of age accounted for 49.3% of non-work-related homicide deaths, while decedents of the same age group accounted for 22.9% of work-related homicide deaths.

**Table 1. Work-related and non-work-related injury deaths by cause of death.**

Cause of death categories (ICD-9)	Non-work-related		Work-related		Work-related percentage <sup>a</sup>
	N	%	N	%	%
Machine (E919)	2118	0.3	3558	11.1	62.7
Electrocution (E925)	1370	0.2	1644	5.1	54.5
Explosion (E921, E923)	502	0.1	591	1.8	54.1
Struck by falling objects (E916)	2148	0.3	1793	5.6	45.5
Struck by flying objects/caught in (E917-E918)	1017	0.1	629	2.0	38.2
Air transport (E840-E845)	4053	0.5	1267	4.0	23.8
Water transport (E830-E838)	3731	0.5	449	1.4	10.7
Railway transport (E800-E807)	3074	0.4	216	0.7	6.6
Homicide (E960-E969)	116391	14.2	5016	15.7	4.1
Falls (E880-E888)	83140	10.2	3468	10.8	4.0
Nature/Environment (E900-E909, E928)	24066	2.9	991	3.1	4.0
Motor vehicles (E810-E829, E846-E848)	231924	28.4	8353	26.1	3.5
Drowning (E910)	15488	1.9	479	1.5	3.0
Suffocation (E911-E913)	21286	2.6	544	1.7	2.5
Fire (E890-E899)	16741	2.0	396	1.2	2.3
Other incidents	33049	4.0	657	2.1	1.9
Poisoning (E850-E869)	55982	6.9	496	1.5	0.9
Suicide (E950-E959)	181113	22.2	1366	4.3	0.7
Intent undetermined (E980-E989)	19708	2.4	131	0.4	0.7
All causes of injury (E800-E999)	816901	100.0	32044	100.0	3.8

<sup>a</sup> Work-related percentage=(Number of work-related injury deaths/number of all injury deaths) X 100%.

Table 2. Work-related and non-work-related injury deaths by state.

State	Non-work-related		Work-related		Work-related percentage <sup>a</sup>
	N	%	N	%	%
Alabama	17974	2.2	684	2.1	3.7
Alaska	2505	0.3	271	0.8	9.8
Arizona	18687	2.3	283	0.9	1.5
Arkansas	9792	1.2	498	1.6	4.8
California	89298	10.9	3352	10.5	3.6
Colorado	12759	1.6	508	1.6	3.8
Connecticut	8335	1.0	174	0.5	2.0
D.C.	3847	0.5	109	0.3	2.8
Delaware	2153	0.3	74	0.2	3.3
Florida	49174	6.0	2028	6.3	4.0
Georgia	24721	3.0	1230	3.8	4.7
Hawaii	3223	0.4	96	0.3	2.9
Idaho	3997	0.5	302	0.9	7.0
Illinois	32282	4.0	1153	3.6	3.4
Indiana	17679	2.2	712	2.2	3.9
Iowa	7891	1.0	400	1.2	4.8
Kansas	7822	1.0	407	1.3	4.9
Kentucky	13350	1.6	697	2.2	5.0
Louisiana	17278	2.1	979	3.1	5.4
Maine	3466	0.4	99	0.3	2.8
Maryland	16114	2.0	408	1.3	2.5
Massachusetts	13195	1.6	310	1.0	2.3
Michigan	27175	3.3	849	2.6	3.0
Minnesota	12610	1.5	428	1.3	3.3
Mississippi	12209	1.5	617	1.9	4.8
Missouri	20259	2.5	777	2.4	3.7
Montana	3551	0.4	214	0.7	5.7
Nebraska	4715	0.6	329	1.0	6.5
Nevada	7212	0.9	319	1.0	4.2
New Jersey	17829	2.2	560	1.7	3.0
New York	43486	5.3	1633	5.1	3.6
New Mexico	8112	1.0	312	1.0	3.7
New Hampshire	2659	0.3	91	0.3	3.3
North Dakota	1898	0.2	136	0.4	6.7

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**Table 2. (continued)**

North Carolina	25888	3.2	1051	3.3	3.9
Ohio	27055	3.3	823	2.6	3.0
Oklahoma	12203	1.5	526	1.6	4.1
Oregon	11189	1.4	462	1.4	4.0
Pennsylvania	37510	4.6	1323	4.1	3.4
Rhode Island	2226	0.3	69	0.2	3.0
South Dakota	2428	0.3	160	0.5	6.2
South Carolina	13496	1.7	581	1.8	4.1
Tennessee	22474	2.8	734	2.3	3.2
Texas	58958	7.2	2690	8.4	4.4
Utah	5965	0.7	359	1.1	5.7
Vermont	1689	0.2	55	0.2	3.2
Virginia	19538	2.4	635	2.0	3.1
Washington	15984	2.0	610	1.9	3.7
West Virginia	6449	0.8	339	1.1	5.0
Wisconsin	14629	1.8	426	1.3	2.8
Wyoming	1966	0.2	162	0.5	7.6

<sup>a</sup> Work-related percentage=(Number of work-related injury deaths/number of all injury deaths) X 100%.

Leading causes of death for non-work-related fatalities were motor vehicle crashes, suicides, homicides, and falls. Leading causes of death for work-related fatalities were motor vehicle crashes, homicides, machinery-related incidents, and falls. Injury events and sources of work-related fatalities differed from overall fatalities within the same cause of death. Motor vehicle crashes in the workplace were more likely to be non-traffic related and more likely to involve pedestrians, compared with those outside the workplace. The major cause of poisoning deaths outside the workplace was drug related, while the major cause of poisoning in the workplace was other substance related. The common causes of falls in the workplace were falls from ladders or scaffolding and falls from buildings or other structures, while the common causes of falls outside the workplace were falls from stairs or steps and other falls from one level to another (mostly falls from chair and bed—E884.2).

## DISCUSSION

This is the first report on work-related percentages of all injury mortality by cause of death and population demographics at the national level in the United States. The overall work-related share of all injury mortality—3.8%, which is reported in this study, likely understates the significance and important impact of work-related injury mortality. There are several important issues relevant to the interpretation of these findings. Death certificates under-report work-related injury deaths. Death certificates capture an average of 81% of all work-related injuries (Stout and Bell 1991; Russell and Conroy 1991). Work-related percentages were higher than the overall 3.8% in certain population demographics, such as those 26 to 65 years of age, males, whites, and people of races other than white and black. Work-related percent-



**Table 3. Work-related and non-work-related injury deaths by year, county population size, gender, race, and age group.**

Population demographics	Non-work-related		Work-related		Work-related percentage <sup>a</sup>
	N	%	N	%	%
<b>Year</b>					
1993	135854	16.6	5385	16.8	3.8
1994	135683	16.6	5542	17.3	3.9
1995	136063	16.7	5396	16.8	3.8
1996	136068	16.7	5381	16.8	3.8
1997	136072	16.7	5243	16.4	3.7
1998	137161	16.8	5097	15.9	3.6
<b>County Population Size</b>					
less than 100,000	240899	29.5	11887	37.1	4.7
100,000 or more	576002	70.5	20157	62.9	3.4
<b>Gender</b>					
Male	573595	70.2	29510	92.1	4.9
Female	243306	29.8	2534	7.9	1.0
<b>Race</b>					
White	654081	80.1	27280	85.1	4.0
Black	138905	17.0	3676	11.5	2.6
Others	23915	2.9	1088	3.4	4.4
<b>Age group (in years)</b>					
16-19	61676	7.5	863	2.7	1.4
20-29	154176	18.9	5936	18.5	3.7
30-39	154226	18.9	8017	25.0	4.9
40-49	124214	15.2	7522	23.5	5.7
50-59	71160	8.7	5248	16.4	6.9
60-69	62272	7.6	2863	8.9	4.4
70-75	79923	9.8	1243	3.9	1.5
76+	109254	13.4	352	1.1	0.3
<b>Education</b>					
High school or less	232302	28.4	6839	21.3	2.9
1-4 year college	476989	58.4	21123	65.9	4.2
Graduate school	30255	3.7	1025	3.2	3.3
Not recorded	77355	9.5	3057	9.5	3.8

<sup>a</sup> Work-related percentage=(Number of work-related injury deaths/number of all injury deaths) X 100%.

ages were also higher than 3.8% in half of the 50 states. The mean age-at-death is younger in work-related injury deaths than in non-work-related injury deaths, so on average more potential years of life lost result from a work-related fatality than from a non-work-related fatality (Gilbert *et al.* 1998), demonstrating a disproportionate impact on people of working age who are the nation's productive work force and income earners for their families. Some injury deaths in non-workplace settings may also have been influenced by work-related factors, such as suicides and injuries occurring during commuting to or from a work site. The percentages presented

**Table 4. Mean age-at-death for work-related and non work-related injury death by cause of death.**

Cause of death categories (ICD-9)	Mean age-at-death (in years)	
	Non-work-related	Work-related
Machine (E919)	60	48
Electrocution (E925)	42	34
Explosion (E921, E923)	50	37
Struck by falling objects (E916)	51	43
Struck by flying objects/caught in (E917-E918)	50	42
Air transport (E840-E845)	45	39
Water transport (E830-E838)	41	38
Railway transport (E800-E807)	38	47
Homicide (E960-E969)	33	41
Falls (E880-E888)	78	45
Nature/Environment (E900-E909, E928)	66	44
Motor vehicles (E810-E829, E846-E848)	43	43
Drowning (E910)	41	38
Suffocation (E911-E913)	70	41
Fire (E890-E899)	57	43
Other incidents	59	47
Poisoning (E850-E869)	41	40
Suicide (E950-E959)	45	43
Intent undetermined (E980-E989)	41	40
All causes of injury (E800-E999)	48	42

here are for injury mortality only. The percentage might be different for injury morbidity (McCaig *et al.* 1998). Finally, it is worth noting that the 3.8% identified in this study is close to the 3% identified in the Finnish Study (Nurminen and Karjalainen 2001). The United States and Finland are well-developed countries; the percentage would likely be much higher in less developed countries (Stout *et al.* 1990; Leigh *et al.* 1999).

Assessments of the burden of traumatic fatalities attributable to work-related causes are needed to plan the allocation of resources for injury research and prevention (Coggon 2001). But the most appropriate way to allocate resources may not be simply based on the total percentage of work-related versus non-work-related deaths. A more complete understanding of the role of work-related issues in injury deaths requires consideration of specific factors, such as, causes of death, population demographics (age, race, location, etc.), and social and economic impacts (Leigh *et al.* 1997).

Opportunities for prevention are an important reason for examining the work-related percentage of all injury deaths. Modern workplace safety legislation and resulting changes in safety management practices have demonstrated that workplaces are relatively more controllable than non-work environments. Safety hazards are relatively easier to predict and control in the workplace than in non-work environments. The preventability has been supported by the encouraging fact that



during the past two decades (from 1980 to 1998), the number of work-related injuries decreased (CDC 1998), while the number of non-work-related injury fatalities did not change much (NCHS 2001). Although the number of work-related injury deaths in 1998 was lower than it had been 20 years ago, at least 5097 workers were killed on the job that year. Thus, the modern workplace still poses a number of challenges in the area of occupational safety.

Fatalities may be grouped into three general categories: (1) fatalities that are common both in the workplace and non-workplace (*i.e.*, motor-vehicle crashes, homicides, and falls); (2) fatalities that are unique to the workplace (*i.e.*, machine-related deaths and electrocutions); and (3) fatalities that are common in non-workplace settings but not so common in the workplace (*i.e.*, suicides and poisonings). For fatalities common in both work and non-work places, prevention can be achieved through exchange of information about prevention strategies between workplace and non-workplace. For example, the policy of non-resistance during a robbery, which has been developed and used in the convenience store industry, is also applicable to the non-workplace (Faulkner *et al.* 1998). Workplaces provide unique opportunities to study injuries and prevention strategies in relatively controlled environments (CDC 1994). For example, collision warning system technologies, which are designed to help drivers avoid forward-moving collisions, are now being tested in the trucking industry (Woll 1998; NHTSA 1999). If demonstrated to be effective, such technologies could be introduced to passenger cars. For fatalities that are unique to the workplace, the Occupational Safety and Health Administration and NIOSH have developed regulations or recommendations for prevention (Pratt *et al.* 2001; NIOSH 2000; OSHA 2001). The National Center for Injury Prevention and Control (NCIPC) plays an important role in research and prevention of fatalities that are common in non-workplace settings (NCIPC 2001). NCIPC conducts research on a range of non-occupational injury issues and funds a network of academic-based injury prevention and control research centers.

This paper describes work-related fractions of overall traumatic fatalities: the number of work-related injury deaths divided by the number of work-related and non-work-related injury deaths. The percentage is an etiologic fraction or attributable risk (Kleinbaum *et al.* 1982). It is different from the proportionate mortality ratio (Chen *et al.* 2000). The work-related percentage was higher for persons with a college education than for persons with less than a college education. This suggests that persons with a college education who died from an injury were more likely to have died at work than less educated persons. This could be a reflection that persons with a college education had a higher prevalence of employment than less educated persons. It could also be a reflection of higher educated persons living in safer communities, having safer overall life styles, and thus having fewer non-work-related injury deaths. This study did not have information on employment, life style or community of the decedents.

A more complete understanding of the burden of traumatic fatalities attributable to work-related causes requires consideration of the total work-related percentage as well as specific factors, such as, causes of death, population demographics (age, race, location, etc.), and social and economic impacts. This study was unable to assess the burden by occupation and industry because the VSM data do not include this information for all states. This study also did not calculate rates for work-related

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and non-work-related fatal injuries. Such analyses would be useful to identify potential risk factors and populations at differential risk of work-related or non-work-related fatal injuries.

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