
Fatal Injuries to Workers in the United States, 1980-1989: A Decade of Surveillance

INTRODUCTION

The Occupational Safety and Health Act of 1970 was enacted "to assure so far as possible every working man and woman in the nation safe and healthful working conditions."¹ Death from injuries at work is a major public health problem. A number of studies have estimated the extent of occupational injury deaths occurring in the U.S. each year.²⁻⁵ The results have varied widely and have provided limited information about the injuries or their circumstances. The National Traumatic Occupational Fatalities (NTOF) surveillance system was developed by the National Institute for Occupational Safety and Health (NIOSH), to fill gaps in the knowledge of work-related injury deaths in the U.S. by providing a census of occupational injury deaths for all U.S. workers.

Analysis of occupational injury deaths by demographic, employment, and injury characteristics facilitates effective use of resources aimed at preventing injuries in the workplace. Surveillance data such as those gathered through the NTOF system allow the description of the nature and magnitude of the occupational injury problem in the U.S., the identification of potential risk factors, the generation of hypotheses for further research, and the setting of research and prevention priorities. Ongoing surveillance systems also enable the monitoring of trends over time and offer the potential to evaluate prevention efforts. A report on occupational injury mortality in the U.S. for the years 1980-1985, based on data collected by the NTOF system, has previously been

published.⁶ The present document extends the period of analysis to a decade, and provides a more comprehensive summary of fatal occupational injuries for the U.S., as a whole; and examines for the first time, the patterns of work-related injury fatalities in every state.

METHODS

Death Certificates

Information in the NTOF surveillance system is taken directly from death certificates. To gather data for the system, NIOSH collects and automates death certificates from the 52 vital statistics reporting units in the 50 states, New York City, and the District of Columbia for workers 16 years of age or older for whom an external cause of death (International Classification of Diseases, Ninth Revision;⁷ E800-E999) was noted, and for whom the certifier entered a positive response to the "Injury at Work?" item.

The NTOF data contain variables useful for describing characteristics of victims as well as injury circumstances—including demographic, employment, and cause of death variables. In addition to coded data, narrative text from the death certificate for industry, occupation, causes of death, and injury description is entered and maintained.

Death certificates were utilized for this surveillance system because they are available for all workers who died during the period, regardless of size or nature of employment, coverage by workers' compensation

systems, or other jurisdictional restrictions. State-based studies show that death certificates identify a greater proportion of occupational trauma fatalities than any other single source. Although these studies did not include NTOF per se, they indicate that death certificates capture 67% to 90% of all fatal work injuries.⁸

The limitations of death certificates as a source of occupational injury fatality surveillance have been discussed by several authors.^{2,6,9,10} The primary issues of concern in the use of death certificates are the ability to identify and to retrieve the certificates that meet the study criteria. Studies indicate that motor vehicle crashes and homicides are the external causes of death most likely to be missed in death certificate surveillance of occupational injuries.^{9,10} For the period 1980 through 1984, data on work-related homicides and suicides were not available from four states—Louisiana, Nebraska, New York, and Oklahoma. In subsequent years, data were obtained from those states as procedures were altered to allow retrieval of this information. All tables and figures reflect actual data obtained from the states; denominator data were not adjusted to reflect years for which some data were missing.

Each vital statistics reporting unit is responsible for identifying and providing cases that meet the NTOF criteria. For the period of data analyzed in this report, there were no standardized guidelines for the completion of the “Injury at Work?” item on the death certificate. Thus, this item on the death certificate, which is one of the three criteria for inclusion in the NTOF surveillance system, was subject to certifier interpretation. Although the lack of standardized reporting of this item may result in both false positives—if a liberal definition of injury “at work” was used—and false negatives—if a very restrictive definition was used or the item was left blank, the numbers reported here are apt to represent the minimum number of work-related deaths that occurred in

the U.S. during the period.

To improve the quality of occupational injury fatality reporting, national guidelines for completing the “Injury at Work?” item were developed and disseminated in 1992 by the Association for Vital Records and Health Statistics, NIOSH, the National Center for Health Statistics, and the National Center for Environmental Health. These guidelines have been distributed nationally to medical examiners and coroners through state Vital Registrars and should improve future death certificate surveillance of fatal occupational injuries (See Appendix I).

Occupation, Industry, and Cause of Death Coding

Employment information was coded from the usual industry and occupation narratives from the death certificate using software developed by NIOSH; cases which could not be assigned a code by the software were hand-coded by the Bureau of the Census. Occupation narratives were coded into 11 major divisions of occupation according to the 1980 Bureau of the Census classification scheme;¹¹ industry narratives were coded into the 10 standard industrial divisions according to the Standard Industrial Classification Manual, 1987.¹² Death certificates for which no occupation or industry entry was present or for which the entry was too vague were coded into the “not classified” group. Certificates which had entries such as “housewife” or “student” were also coded into the “not classified” group. Appendix II provides explanations of the abbreviations for occupation and industry divisions on figures and tables.

Death certificates query for the “usual” occupation and industry of the person who died, which may not necessarily reflect the occupation or industry engaged in at the time of the fatal injury. Studies comparing death certificate entries for usual occu-

pation and industry to employment information for occupation and industry at the time of death, found agreement for occupation to be 64% to 74% of the cases,¹³⁻¹⁸ and for industry to be 60% to 76% of the cases.¹³⁻¹⁸ Though the query on death certificates is for "usual" occupation and industry, some studies indicate that the death certificate entries may actually better reflect occupation or industry at time of death than usual, lifetime employment.¹⁶⁻¹⁸

Cause of death codes are assigned based upon the ICD-9 supplementary chapter for the classification of external causes of injury and poisoning.⁷ The codes from this chapter, denoted with a preceding "E," cover the spectrum of unintentional and intentional causes of death. The grouping of the E-Codes for these analyses followed the rubrics established in the ICD-9. A table which provides the actual E-code rubrics included in each of the groupings is shown in Appendix III.

Employment Data

Because no single source of employment data provides information by state, industry, occupation, and demographic characteristics, employment estimates used in calculating occupational injury fatality rates were derived from several sources. Employment data used to calculate rates for the total civilian workforce, by industry division, by cause, by state, and by year were taken from County Business Patterns (CBP), an establishment-based census of employers.¹⁹ CBP data do not include agricultural production, public administration, the self-employed, or workers in managerial occupations. The employment data for agricultural production were derived from the 1982 Census of Agriculture, Bureau of the Census,²⁰ and the data for public administration from annual average employment data from the Bureau of Labor Statistics (BLS) household surveys.²¹ Denominators for the calculation of rates by occupation divisions, age, race, and gender were also taken from the BLS annual average employment data from house-

hold surveys. Rates for occupation divisions by age groups are presented for 1983 through 1989 only, due to the availability of comparable denominator data.

Fatality rates were calculated as average annual deaths per 100,000 workers. Rates were not calculated for cells with less than three cases due to the instability of rates based on small numbers. Frequencies and rates are presented for the civilian workforce only, because denominator data were not available for military personnel. State-specific rates were calculated for private sector employment only; public administration as well as the military were excluded due to the lack of comparable denominator data.

The numbers and rates presented here are based on data that are consistent across the U.S., to facilitate comparisons between states. These numbers may differ from numbers generated by other surveillance or data collection systems. Within states, workers' compensation systems, departments of employment security, medical examiners' offices, or other agencies may collect occupational injury information or employment information which may result in different rate calculations or tabulations for causes of work-related injury deaths and other demographic and employment characteristics. Within the present analysis, rates calculated using establishment-based employment data will differ from those generated using employment data from household surveys.

Mapping

To map geographic distributions of work-related fatality rates for the U.S., for high-risk industries, and for the leading causes of death, the fatality rates for the 50 states and the District of Columbia were grouped into five categories based on the population standard deviation of the overall U.S. occupational fatality rate (or the rate for that industry or cause of death):

Very high—fatality rates more than two standard deviations (s.d.) above the average rate;

High—fatality rates greater than one s.d., but less than two s.d. above the average;

Moderately high—fatality rates greater than the average rate but less than one s.d. above the average;

Moderately low—fatality rates less than the average rate but less than one s.d. below the average;

Low—fatality rates more than one s.d. below the average rate but greater than zero.

Rates for the 51 reporting entities generally do not exhibit distributions that are normal and do not constitute a sample. Therefore, implications based on the probabilities of the standard normal distribution are not valid for these five categories. For mapping purposes, this method of categorizing states identifies those states with extreme values better than defining categories based on percentiles.

It should be noted that all tabulations and calculations by state are provided for state of death, and therefore may not represent either state of residence, state of employment, or state where the injury occurred.

Years of Potential Life Lost

The years of potential life lost (YPLL) before age 65 were calculated for the 10-year period. Although several methods are available for calculating YPLL,²² the method used in this report is based on years of potential employment. The YPLL for each fatal case was determined by subtracting the victim's age at the time of death from potential retirement age of 65 years. The YPLL rates for 1980 through 1989 were calculated as the sum of the YPLL for a given year divided by the sum of the workers for that year, then multiplied by 100,000. YPLL rates were calculated only for civilian workers.

RESULTS

For the 10-year period from 1980 through 1989, 63,589 workers died from injuries sustained at work; an average of 6,359 deaths per year. Of the total, 62,289 (98%) occupational injury deaths involved workers in the civilian labor force. The average annual occupational fatality rate for the U.S. civilian work force was 7.0 per 100,000 workers.

During the decade, the number of civilian fatal occupational injuries decreased, although not consistently, from a high of 7,405 in 1980 to 5,714 in 1989 (**Figure US-1**); this represents a 23% decrease in the number of occupational deaths over the 10-year period. The annual fatality rate per 100,000 civilian workers (**Figure US-1**) also decreased from the maximum in 1980 (8.9 per 100,000 workers) to a minimum in 1989 (5.6 per 100,000 workers)—a 37% decrease.

The civilian YPLL rates decreased from the maximum of 231.2 per 100,000 workers in 1980, to a minimum of 135.8 per 100,000 workers in 1989, representing a 41% decrease (**Figure US-2**).

Gender, Race and Age Groups

Although males accounted for 56% of the civilian workforce for the period,²¹ males accounted for 94% of the fatal occupational injuries reported in NTOF. The fatality rate for males (9.8 per 100,000 workers) was 12 times higher than for females (0.8 per 100,000 workers). Unintentional injuries, defined as all deaths with external cause of death codes E800 through E949, accounted for 85% of the male injury deaths and 53% of female injury deaths. In contrast, the proportion of injury deaths by homicide (E960-E969) and suicide (E950-E959) were higher for females, with homicide accounting for 41% and suicide for 4% of the female injury deaths, compared to homicide (10%) and suicide (3%) for males. However, as

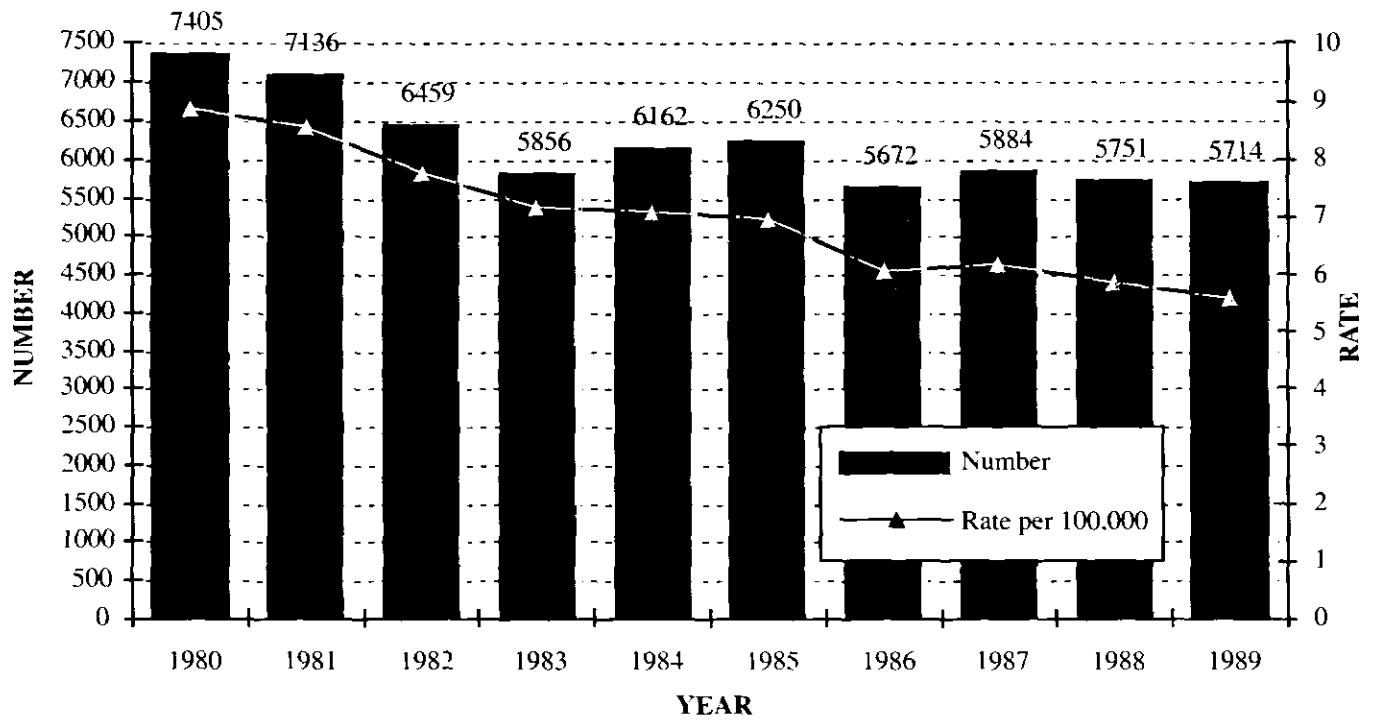


Figure US-1. Distribution and Rate of Traumatic Occupational Fatalities by Year, US, 1980-1989.

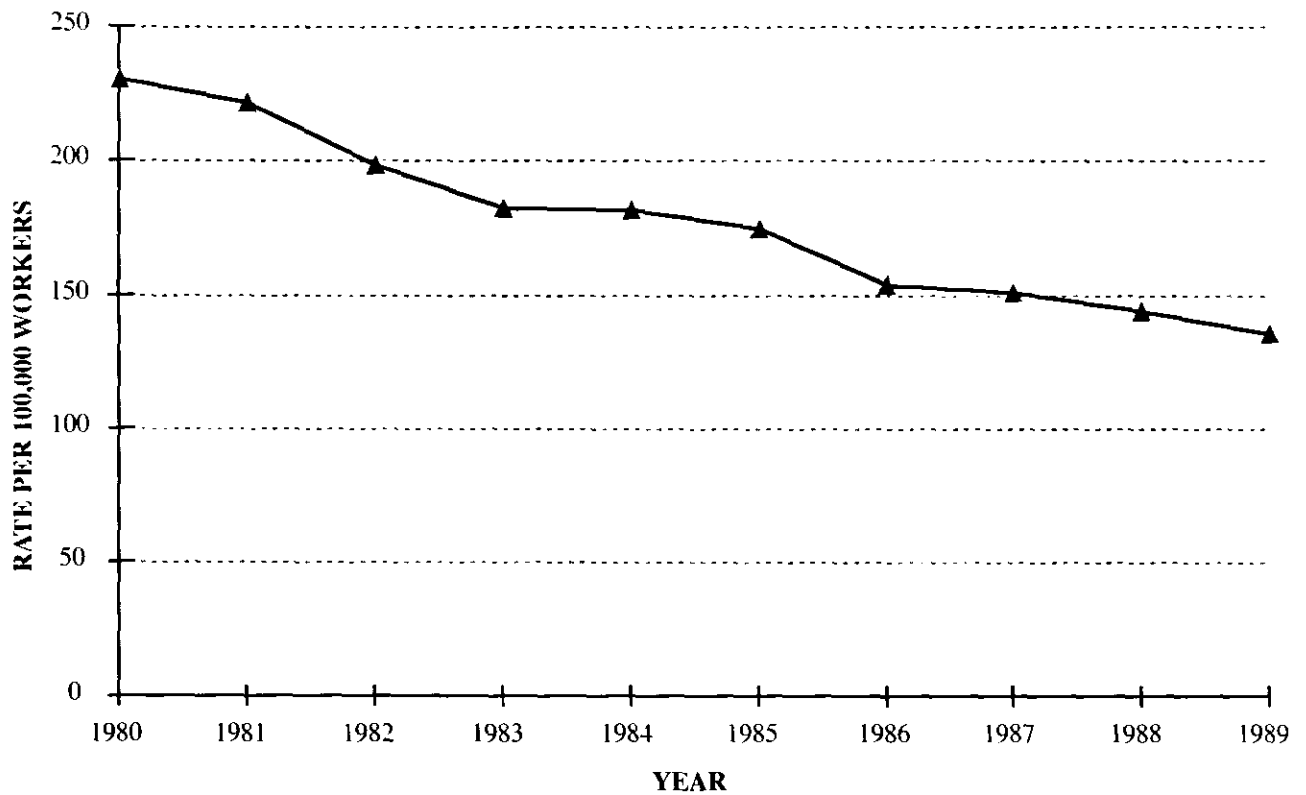


Figure US-2. Rate of Years of Potential Life Lost (YPLL) to Traumatic Occupational Fatalities by Year, US, 1980-1989.

can be seen in **Table US-1**, males had higher fatality rates for all three manners of death.

Table US-1. Average Annual Rate (per 100,000 workers) of Traumatic Occupational Fatalities by Manner of Death and Gender, US, 1980-1989.

Manner of Death	Male	Female
Unintentional	8.34	0.43
Homicide	1.02	0.33
Suicide	0.30	0.04

The distribution of occupational injury deaths by **race/ethnicity** indicates that 49,837 were White (80%), 6,739 were Black (11%), 3,830 were Hispanic (6%), 919 were Asian and Pacific Islanders (2%), 307 were American Indians/Alaska Natives (0.5%), and 654 of the cases were of other or unknown race/ethnicity (1%) (**Figure US-3**). Fatality rates were calculated

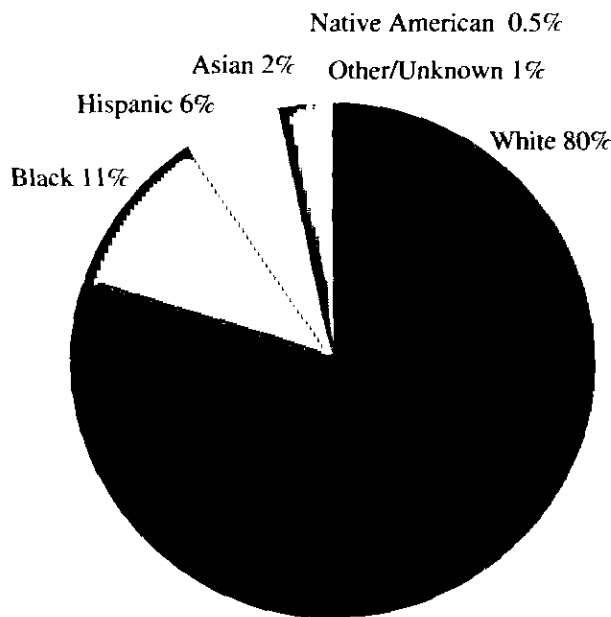


Figure US-3. Distribution of Traumatic Occupational Fatalities by Race/Ethnicity, US, 1980-1989.

for the race categories, White (including Hispanics), Black, and Other, for which corresponding denominator data were available. The highest fatality rate by race was for Blacks (6.5 per 100,000 workers), followed by Whites (5.8 per 100,000 workers), and workers of Other races (4.9 per 100,000 workers).

Workers of Other races had the highest homicide rate (1.6 per 100,000 workers), followed by Blacks (1.4 per 100,000 workers), and Whites (0.6 per 100,000 workers). Blacks had the lowest suicide rate at 0.1 per 100,000 workers, which was nearly half the rate of the other two race categories.

Figure US-4 shows the average annual rate of occupational injury deaths by year and race category. The rate of occupational injury deaths per 100,000 workers generally decreased over the period of the study, with rates for Black workers consistently higher than the rates for Whites and workers of Other races.

The frequency and rate of occupational injury deaths by **age group** is presented in **Figure US-5**. The age group that accounted for the largest number of occupational fatalities was the 25-29 year old age group (14%), followed by the 30-34 year old age group (13%), and the 20-24 year old age group (12%). The age group 65 years and older had the highest fatality rate with 14.6 deaths per 100,000 workers, followed by the 60-64 year old age group (7.9 per 100,000 workers), and the 55-59 year old age group (7.3 per 100,000 workers). In comparison, the 16-19 year old age group had the lowest fatality rate with 3.9 per 100,000 workers.

As with the overall fatality rate, the rates for homicide and suicide increased with age. The highest homicide and suicide rates per 100,000 workers were reported for the age group 65 years and older (2.0 for homicide and 0.4 for suicide); followed by the 60-64 year old age group for homicide (1.0) and the 55-59 year old age group for suicide (0.3).

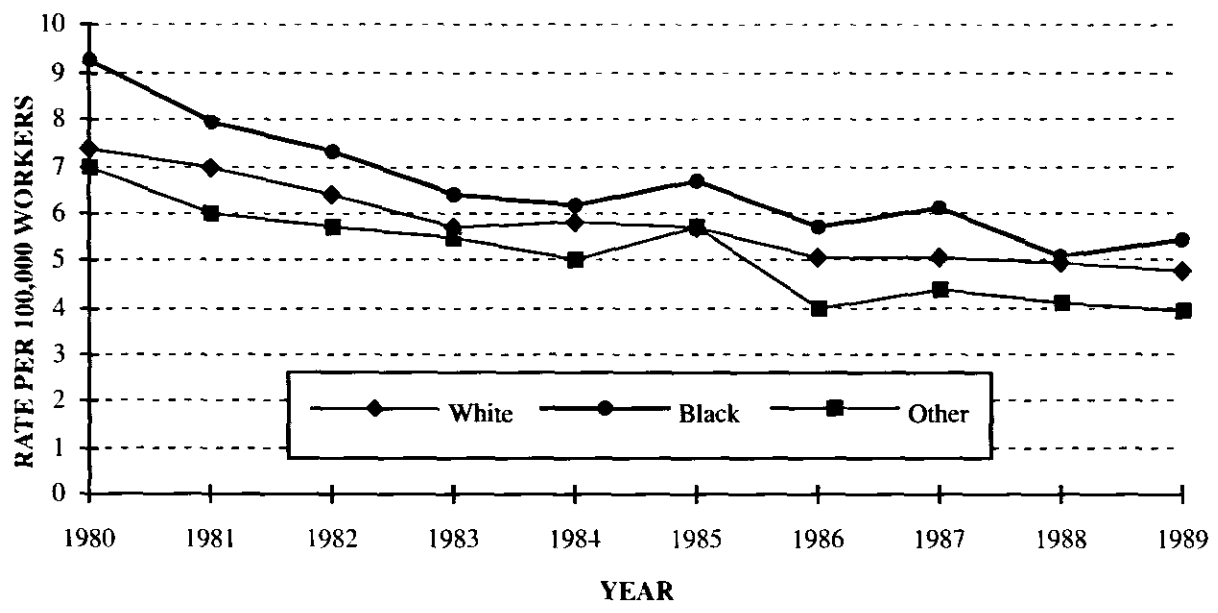


Figure US-4. Rate of Traumatic Occupational Fatalities by Race and Year, US, 1980-1989.

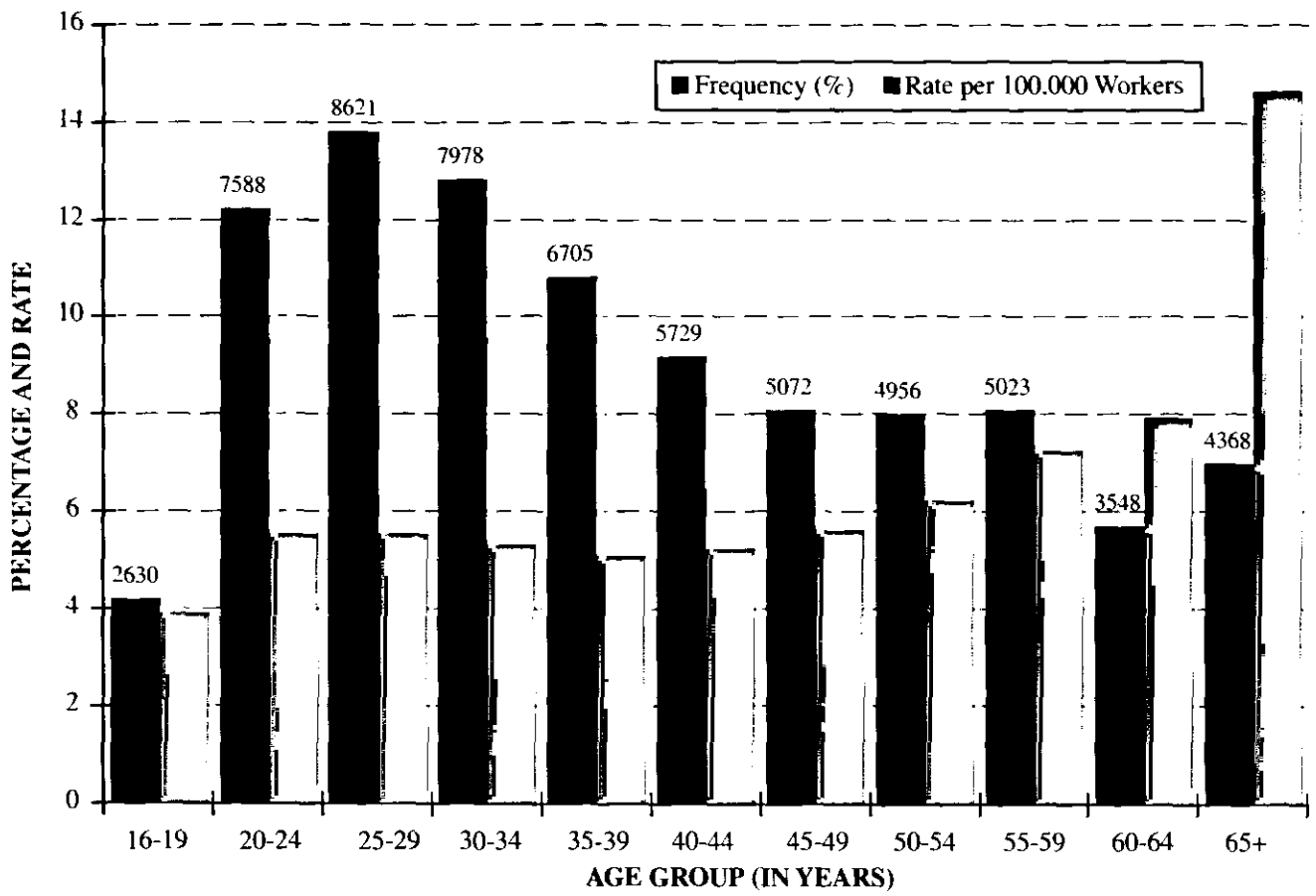


Figure US-5. Distribution and Average Annual Rate of Traumatic Occupational Fatalities by Age Group, US, 1980-1989.

Age group-specific rates for males and females are shown in **Figure US-6**. Males have consistently higher rates than females in every age group. The highest fatality rates occur in the age group 65 years and older for both males and females.

Figure US-7 shows the average annual rate of occupational injury death by year and age group. Rates were consistently highest for workers aged 65 years and older. The rates generally decreased over time, although the pattern is not as clear for workers in the age groups 55-64 years and 65 years and older.

Cause of Death

The leading causes of occupational injury death in the United States were motor vehicle crashes (23%), machine-related incidents (14%), homicides (12%), falls (10%), electrocutions (7%) and being struck by falling objects (7%).

To calculate the fatality rates by cause of death, the same denominator was used for all causes of death—the total employed civilian population; therefore, the relative magnitude of the fatality rates is the same as

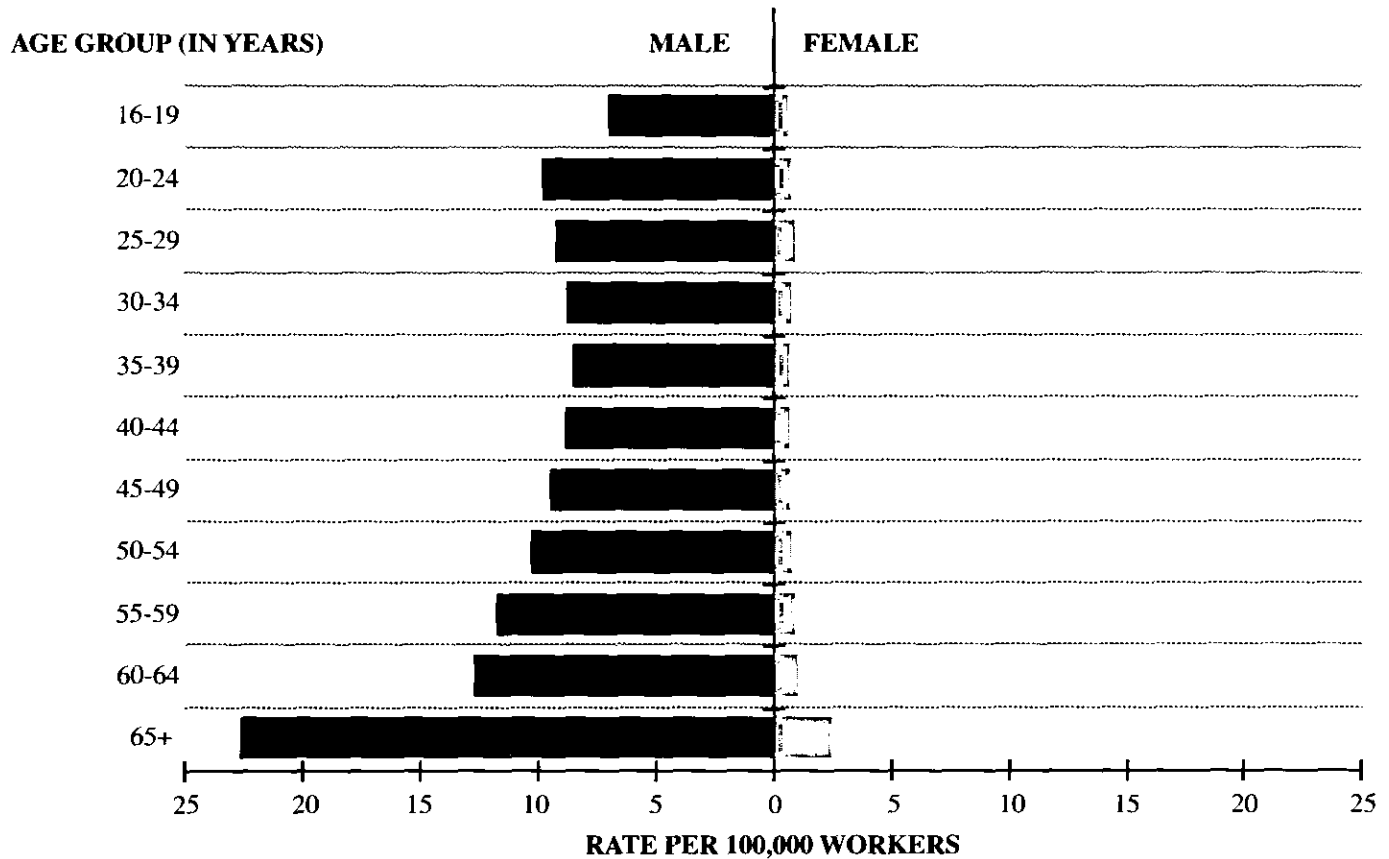


Figure US-6. Average Annual Rate of Traumatic Occupational Fatalities by Age Group and Gender, US, 1980-1989.

RATE PER 100,000 WORKERS

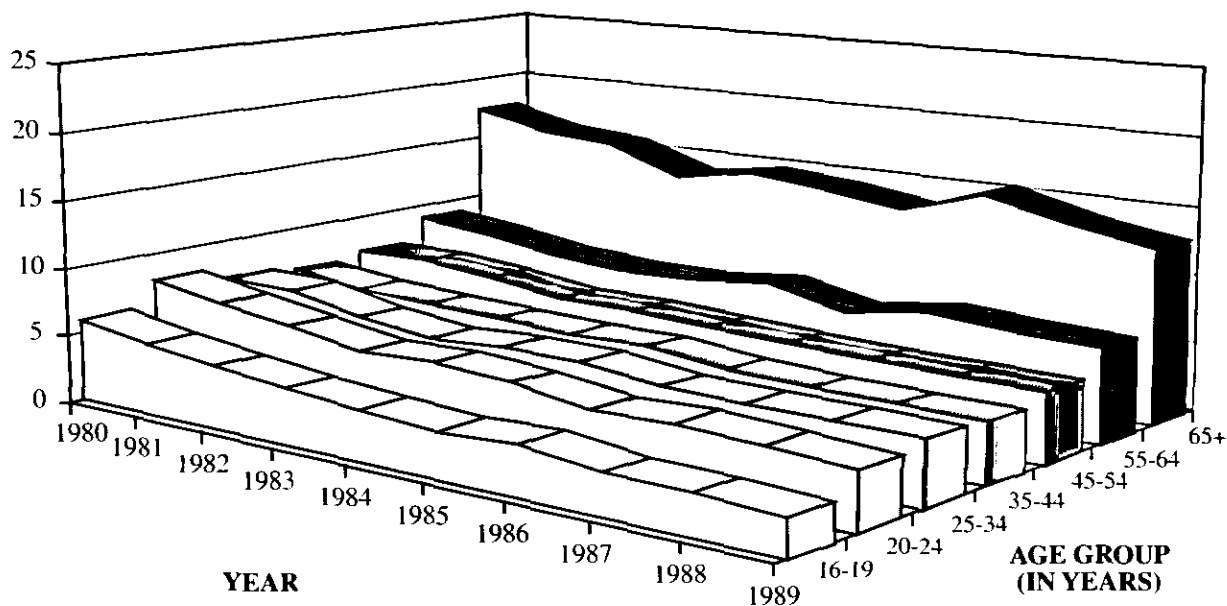


Figure US-7. Rate of Traumatic Occupational Fatalities by Age Group and Year, US, 1980-1989.

that for the distribution (percent of total) of fatalities by cause of death. **Table US-2** depicts the average annual rate of fatalities by cause of death and industry division. The fatality rates per 100,000 workers for the six leading causes of death were: motor vehicle-related incidents, 1.6; machine-related incidents, 1.0; homicides, 0.9; falls, 0.7; electrocutions, 0.5; and struck by falling object incidents, 0.5.

Fatality rates for each of the leading causes of work-related injury death were examined by state of death. **Figures US-8** through **US-13** show the geographic distribution (by state) of rates for work-related motor vehicle deaths, machine-related deaths, homicides, fatal falls, electrocution fatalities, and deaths as a result of being struck by a falling object, respectively.

Industry Divisions

Figure US-14 shows both the proportion and rate of

work-related injury deaths by industry division. The industry divisions in the U.S. with the largest number of fatalities were construction (18%), transportation/communication/public utilities (18%), manufacturing (14%), and agriculture/forestry/fishing (12%). The mining industry had the highest average annual fatality rate per 100,000 workers at 31.9; this was followed by construction (25.6), transportation/communication/public utilities (23.3), and agriculture/forestry/fishing (18.3).

Motor vehicle-related incidents accounted for the highest fatality rate per 100,000 workers in three industry divisions (**Table US-2**): transportation/communication/public utilities (11.4), public administration (1.9), and wholesale trade (0.9). Homicide was one of the four leading causes of death for each of these industry divisions.

Machine-related incidents accounted for the highest rate per 100,000 workers in three industry divisions: mining (7.4), agriculture/forestry/fishing (6.3), and

Table US-2. Average Annual Rate (per 100,000 workers) of Traumatic Occupational Fatalities by Cause of Death and Industry Division, * US, 1980-1989.

CAUSE OF DEATH	TOTAL*	AG/FOR/ FISH	MINING	CONSTRUC- TION	MANUFAC- TURING	TRANS/ COMM/PU	WHOLESALE TRADE	RETAIL TRADE	FINANCE/ INSUR/RE	SERVICE	PUBLIC ADMIN
Motor Vehicle (E810-E829,E846-E849)	1.61	2.88	5.27	3.72	0.62	11.44	0.93	0.39	0.30	0.54	1.87
Machine (E919)	0.95	6.28	7.39	3.50	0.85	1.24	0.26	0.09	0.10	0.19	0.28
Homicide (E960-E969)†	0.85	0.57	0.48	0.65	0.27	1.47	0.19	1.66	0.39	0.61	1.54
Fall (E880-E888)	0.67	0.90	1.89	6.56	0.36	0.85	0.17	0.11	0.13	0.26	0.27
Electrocution (E925)	0.50	1.20	2.27	3.99	0.25	1.45	0.09	0.05	0.03	0.14	0.16
Struck by Falling Object (E916)	0.46	1.32	4.33	1.95	0.64	0.70	0.10	0.06	0.02	0.13	0.13
Air Transport (E840-E845)	0.29	0.44	0.66	0.18	0.08	2.00	0.07	0.03	0.10	0.15	1.06
Suicide (E950-E959)	0.22	0.41	0.15	0.36	0.12	0.29	0.09	0.18	0.15	0.23	0.28
Explosion (E923,E921)	0.19	0.15	2.46	0.53	0.25	0.36	0.09	0.04	0.008	0.09	0.09
Other	0.17	0.36	0.45	0.51	0.17	0.34	0.04	0.07	0.04	0.07	0.30
Flying Object/Caught In (E917,E918)	0.17	0.34	1.36	0.72	0.21	0.45	0.05	0.02	0.02	0.05	0.05
Nature/Environment (E900-E909,E928)	0.17	0.92	1.42	0.59	0.14	0.31	0.03	0.02	0.01	0.05	0.10
Suffocation (E911-E913)	0.14	0.34	0.83	1.12	0.08	0.16	0.08	0.01	0.01	0.03	0.05
Water Transport (E830-E838)	0.14	1.19	0.42	0.17	0.03	0.68	0.02	0.03	--	0.03	0.12
Fire (E890-E899)	0.13	0.21	0.89	0.33	0.15	0.17	0.05	0.05	0.01	0.07	0.19
Poisoning (E850-E858,E860-E869)	0.11	0.21	0.78	0.30	0.10	0.26	0.04	0.03	0.01	0.08	0.06
Drowning (E910)	0.10	0.47	0.55	0.29	0.04	0.26	0.02	0.01	0.01	0.07	0.11
Rail Transport (E800-E807)	0.05	0.03	0.13	0.05	0.02	0.73	0.01	0.002	--	0.004	--
Unknown/Undet (E980-E989,HL/ANK)	0.05	0.11	0.17	0.10	0.02	0.14	0.01	0.03	0.01	0.02	0.07
TOTAL	6.98	18.33	31.91	25.61	4.39	23.30	2.36	2.89	1.37	2.81	6.73

*Totals include cases for which industry could not be classified (7%).

†Homicide data for New York, Oklahoma, Louisiana and Nebraska were not available for earlier years.

--Rates were not calculated for cells with <3 cases due to instability of rates based on small numbers.

Shading denotes the leading causes of death in each industry group.

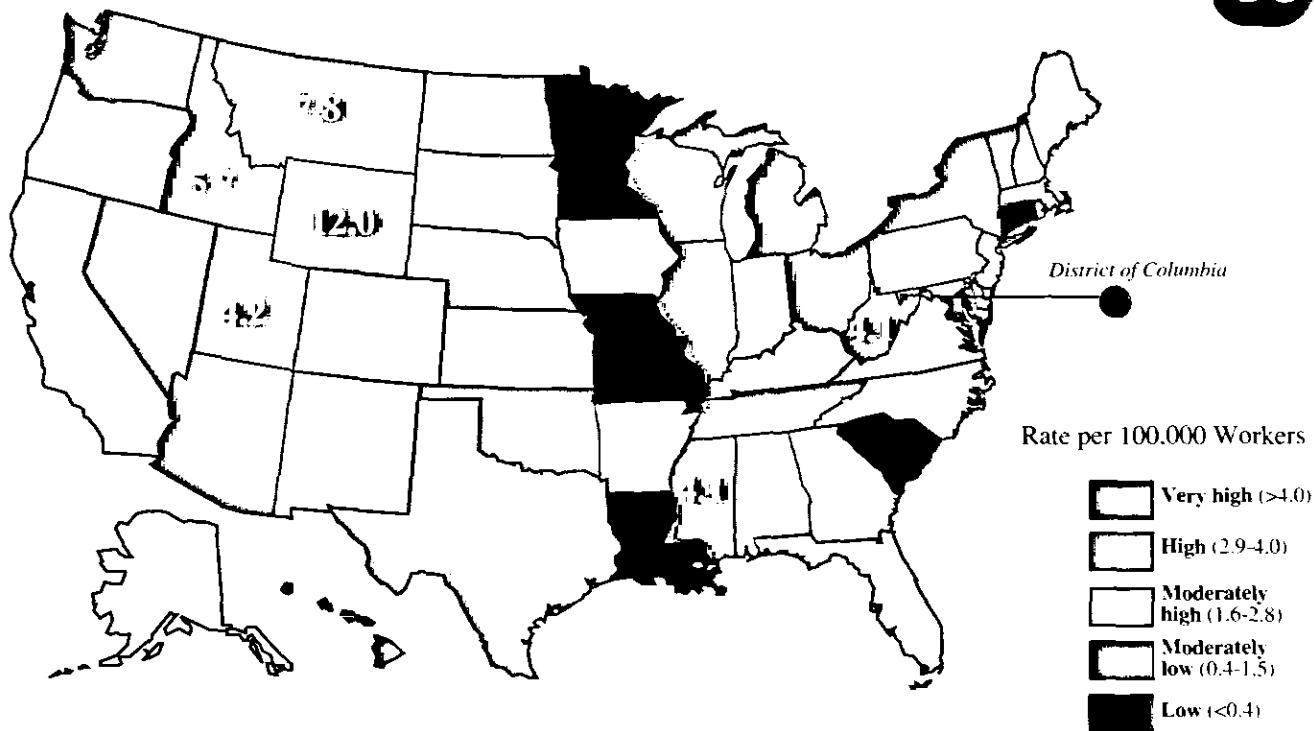


Figure US-8. Average Annual Rate of Motor-Vehicle-Related Traumatic Occupational Fatalities by State, US, 1980-1989.

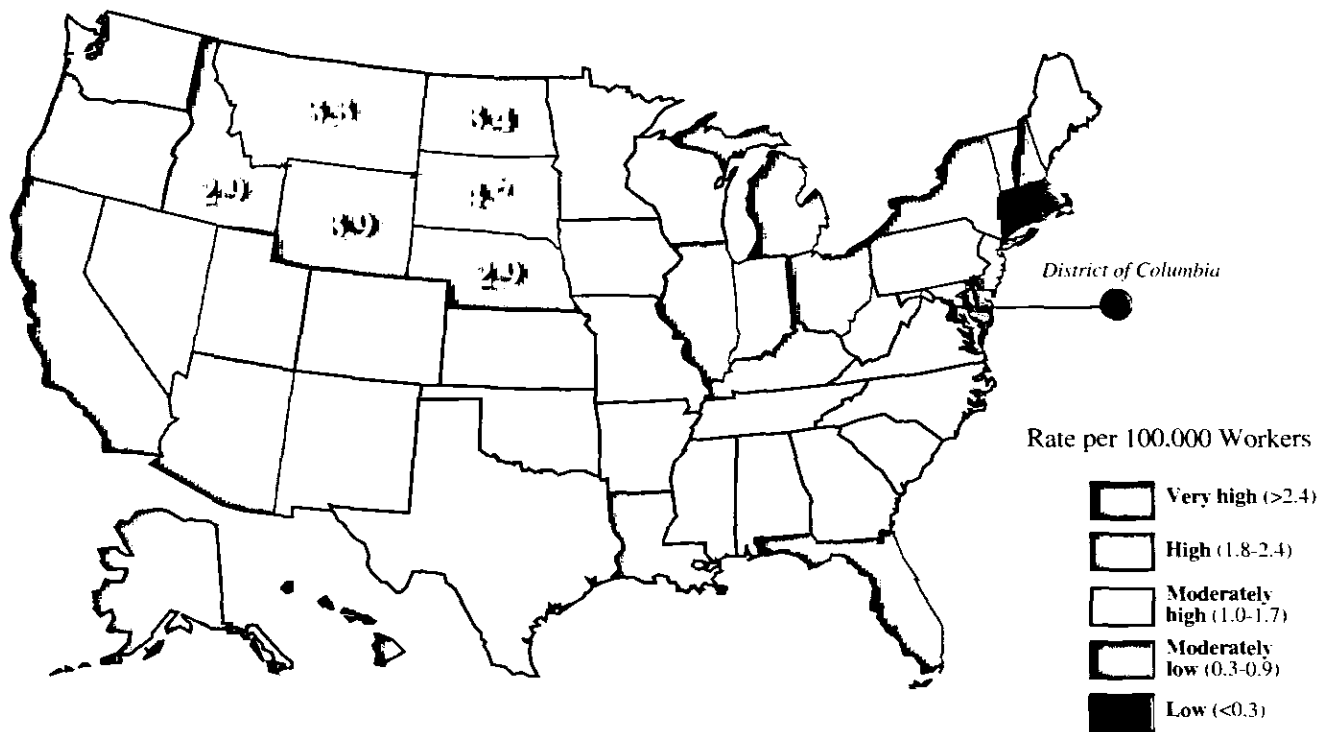


Figure US-9. Average Annual Rate of Machine-Related Traumatic Occupational Fatalities by State, US, 1980-1989.

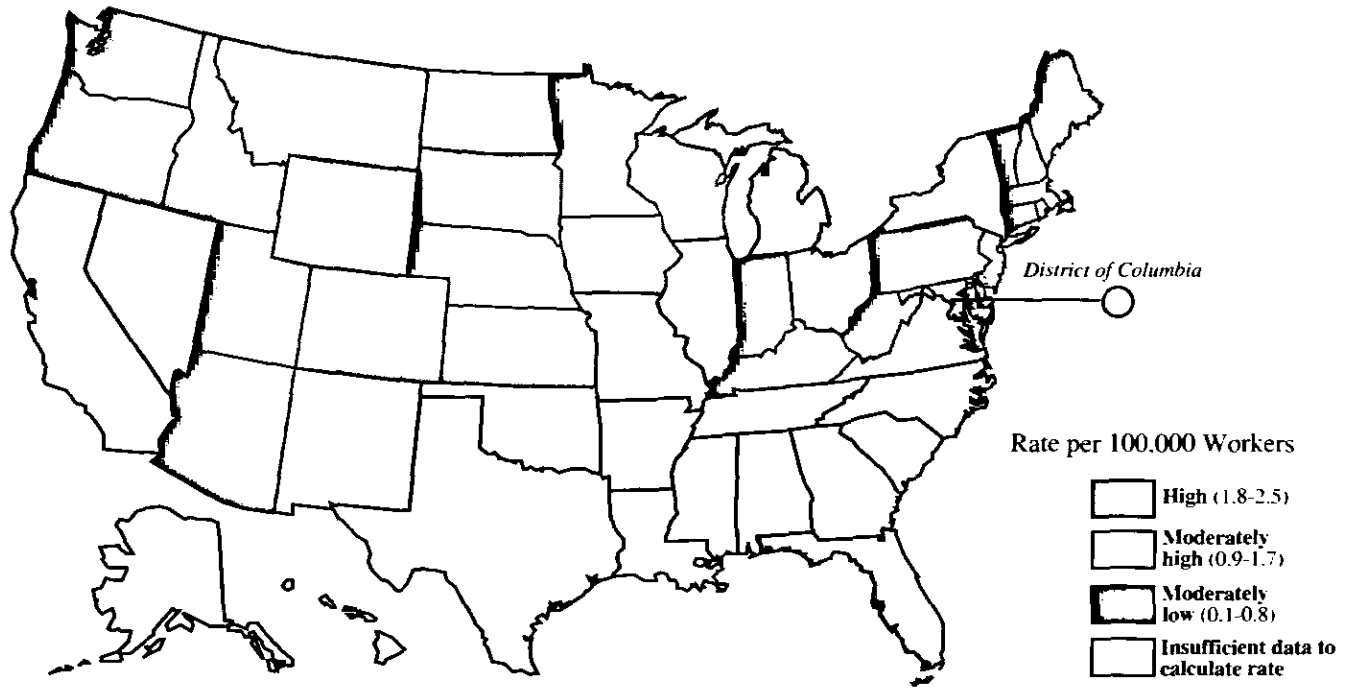


Figure US-10. Average Annual Rate of Traumatic Occupational Fatalities due to Homicide by State, US, 1980-1989.



Figure US-11. Average Annual Rate of Fall-Related Traumatic Occupational Fatalities by State, US, 1980-1989.



Figure US-12. Average Annual Rate of Traumatic Occupational Fatalities due to Electrocution by State, US, 1980-1989.



Figure US-13. Average Annual Rate of Traumatic Occupational Fatalities due to being Struck by Falling Object by State, US, 1980-1989.

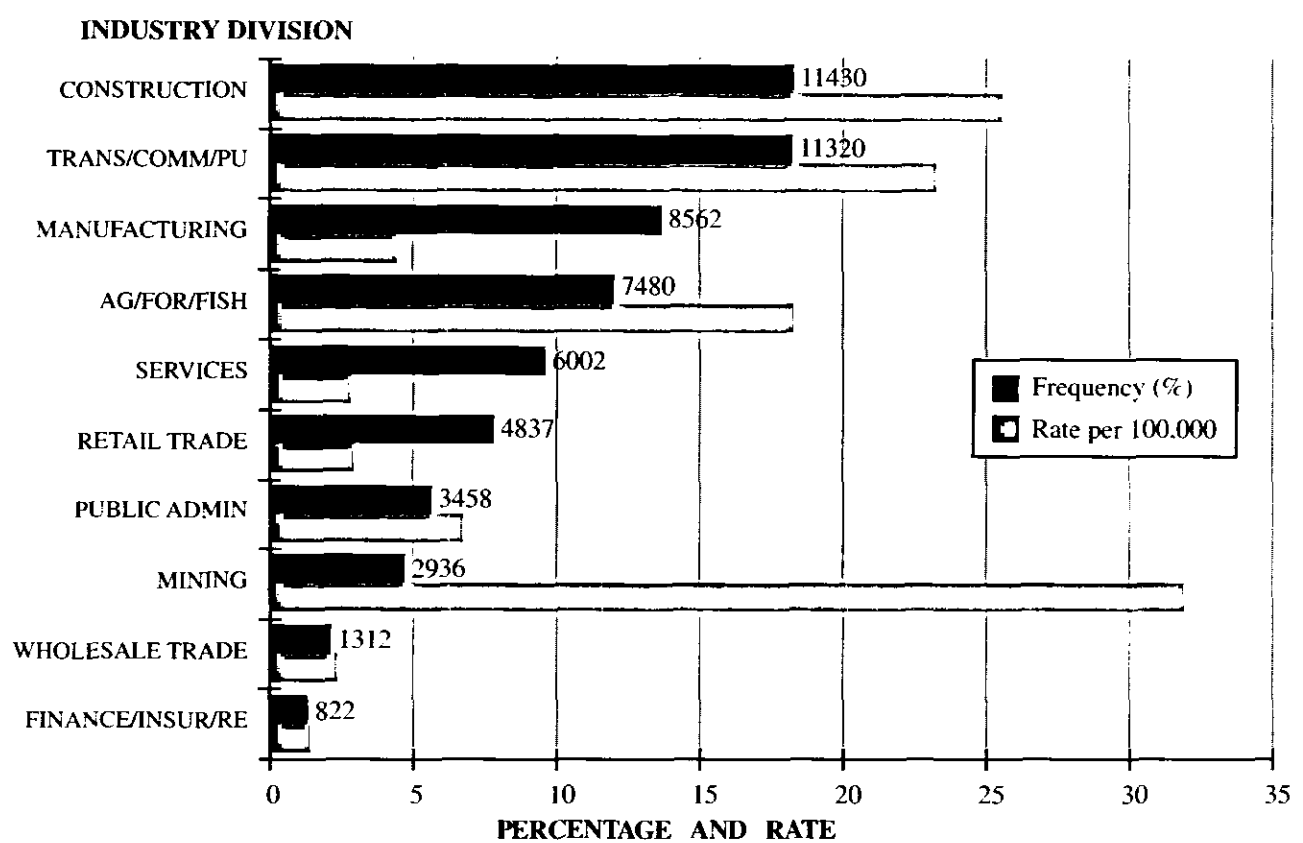


Figure US-14. Distribution and Average Annual Rate of Traumatic Occupational Fatalities by Industry Division, US, 1980-1989.

manufacturing (0.9). Motor vehicle-related incidents accounted for the second or third highest fatality rate in these industries.

Homicide and motor vehicle-related incidents, respectively, accounted for the two highest fatality rates per 100,000 workers in three industry divisions: retail trade (1.7 and 0.4), services (0.6 and 0.5), and finance/insurance/real estate (0.4 and 0.3). Fatality rates for suicide and fall incidents were the third and fourth highest rates in these industries.

Fall incidents accounted for the highest fatality rate in the construction industry (6.6). This fatality rate was followed by the fatality rates for electrocution, motor vehicle-related, and machine-related incidents.

Age group-specific rates by industry division are shown in **Table US-3**. Workers 65 years of age or

older had the highest rates of occupational injury death in every industry division except mining. In mining, workers 16 to 19 years, and 20 to 24 years and those 65 years and older, experienced high rates of work-related fatalities.

Fatality rates for each of the highest risk industry divisions are examined by state of death. **Figures US-15 through US-18** show the geographic distribution of rates for occupational injury deaths in the four highest risk industry divisions: mining, construction, transportation/communication/public utilities, and agriculture/forestry/fishing.

The rate of occupational injury death for each of the industry divisions is shown by year in **Figure US-19**. The four highest risk industries—mining, construction, transportation/communication/public utilities, and agriculture/forestry/fishing—are notably

Table US-3. Average Annual Rate (per 100,000 workers) of Traumatic Occupational Fatalities by Industry Division and Age Group, US, 1980-1989.

INDUSTRY DIVISION	AGE GROUP (IN YEARS)						
	16-19	20-24	25-34	35-44	45-54	55-64	65+
AG/FOR/FISH	8.5	18.9	17.9	17.4	21.5	26.5	52.3
MINING	72.9	50.3	32.1	26.0	26.8	26.5	60.8
CONSTRUCTION	14.4	16.6	15.3	15.5	17.5	22.6	38.5
MANUFACTURING	3.9	4.0	3.5	3.5	4.1	5.3	15.4
TRANS/COMM/PU	13.6	15.6	14.6	14.0	15.7	18.9	40.4
WHOLESALE TRADE	3.4	3.3	3.0	2.2	3.1	3.9	5.1
RETAIL TRADE	0.7	1.7	2.6	3.2	3.8	5.4	8.8
FINANCE/INSUR/RE	0.6	0.6	0.9	1.1	1.4	2.1	3.6
SERVICES	1.3	1.8	1.6	1.6	1.9	2.4	4.1
PUBLIC ADMIN	9.4	11.1	7.7	5.6	4.8	6.1	12.1

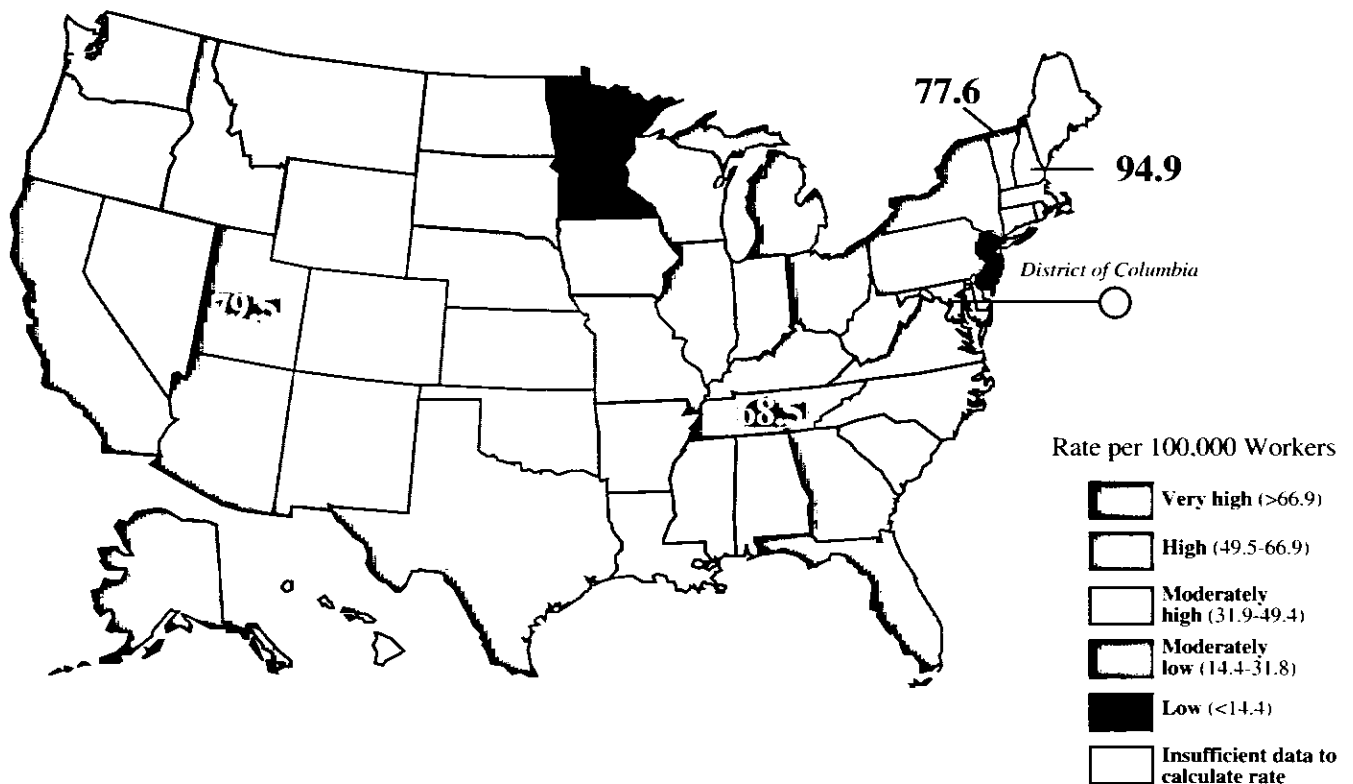


Figure US-15. Average Annual Rate of Traumatic Occupational Fatalities in the Mining Industry by State, US, 1980-1989.

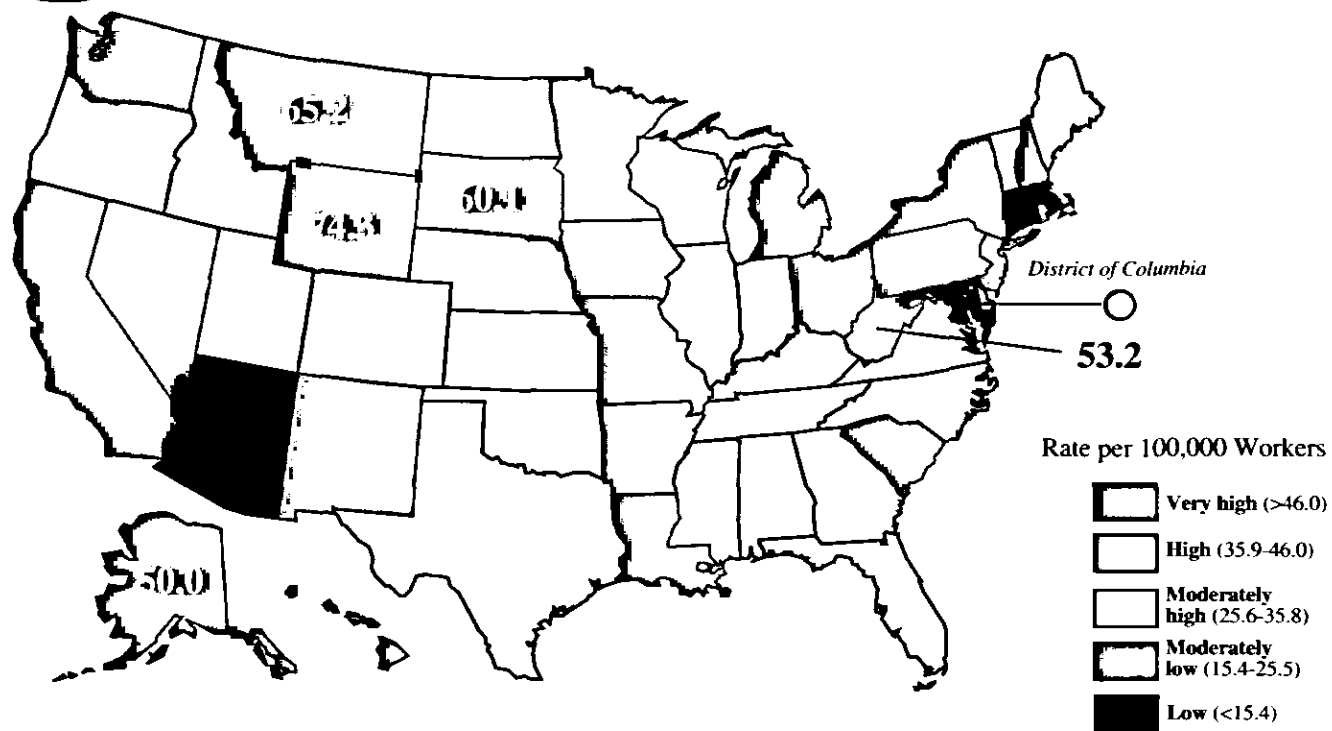


Figure US-16. Average Annual Rate of Traumatic Occupational Fatalities in the Construction Industry by State, US, 1980-1989.

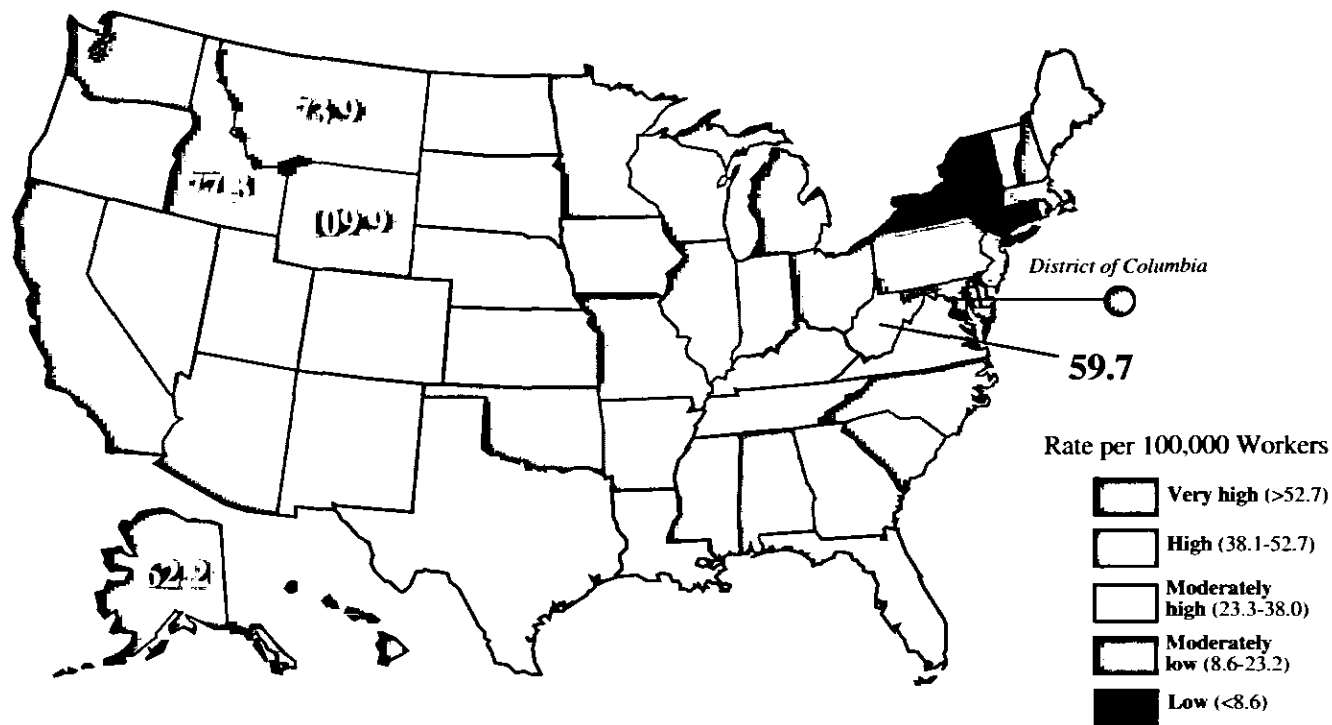


Figure US-17. Average Annual Rate of Traumatic Occupational Fatalities in the Transportation/Communications/Public Utilities Industry by State, US, 1980-1989.

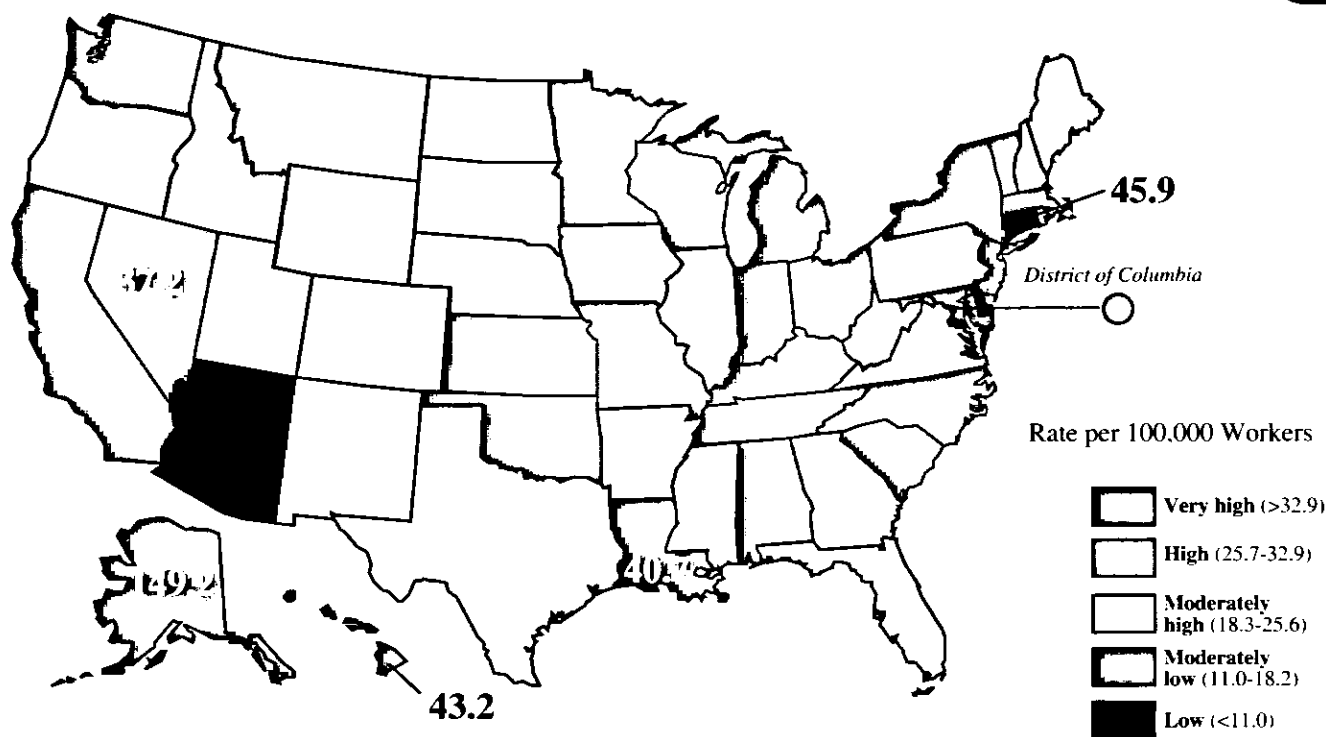


Figure US-18. Average Annual Rate of Traumatic Occupational Fatalities in the Agriculture/Forestry/Fishing Industry by State, US, 1980-1989.

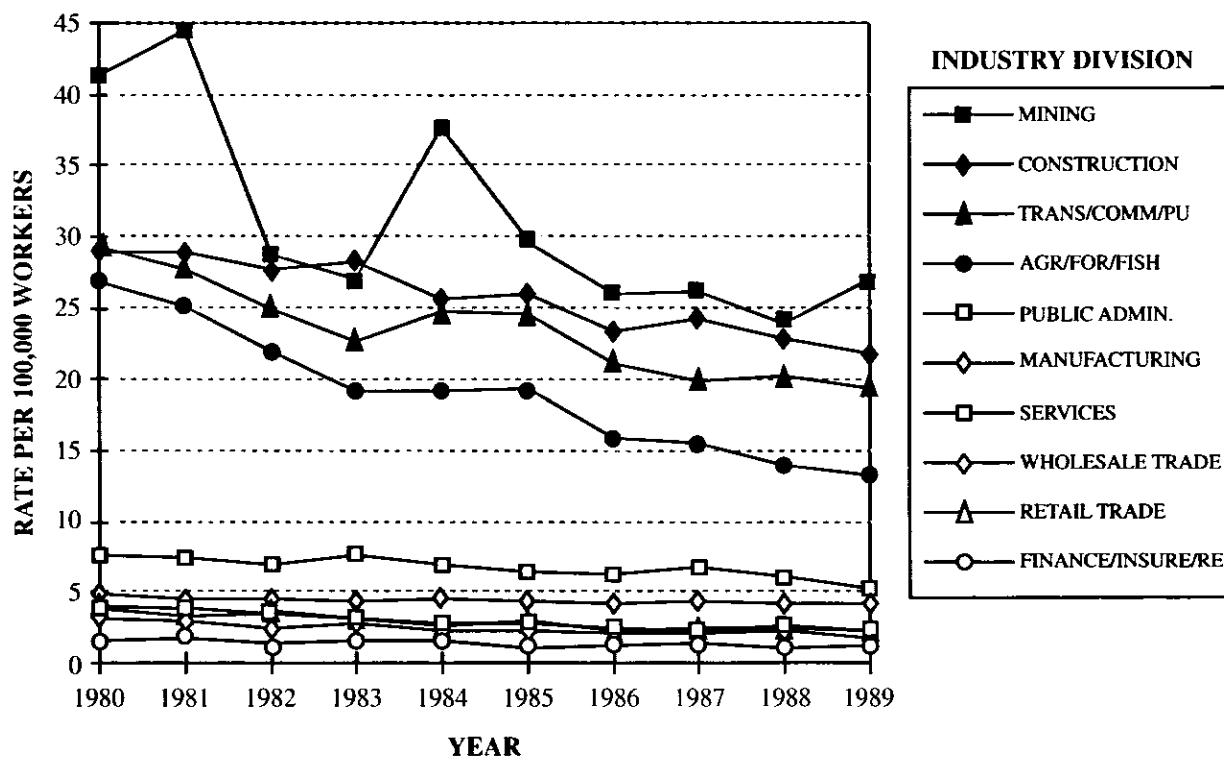


Figure US-19. Rate of Traumatic Occupational Fatalities by Industry Division and Year, US, 1980-1989.

and consistently higher than all other industry divisions. Note that most industries show a slight but relatively consistent decline in fatal injuries over the decade. The erratic pattern of fatalities in the mining industry is due in part to annual differences in the number of multiple-fatality events. In 1980, 1981, and 1984, there were substantially more incidents that resulted in three or more deaths than there were in other years during the decade. For example, a single mining disaster, which killed 27 workers, contributed to the high mining rate in 1984.

Occupation Divisions

Figure US-20 shows both the proportion and rate of work-related injury deaths by occupation division. The occupation divisions in the U.S. with the largest number of fatalities were precision production/craft/

repair (crafts) (19%), transportation/material movers (19%), laborers (13%), and farmers/foresters/fishers (12%). The occupation division of transportation/material movers had the highest average annual fatality rate per 100,000 workers with 25.6, followed by farmers/foresters/fishers (21.3), laborers (17.2), and precision production/craft/repair occupations (9.3).

Table US-4 presents the average annual rate of work-related injury deaths by occupation division and cause of death. Motor vehicle-related incidents accounted for the highest fatality rate per 100,000 workers in the occupation divisions of transportation/material movers (14.2), laborers (2.8), and professional specialties (0.4). Machine-related incidents accounted for the second highest fatality rate in transportation/material movers and laborers while

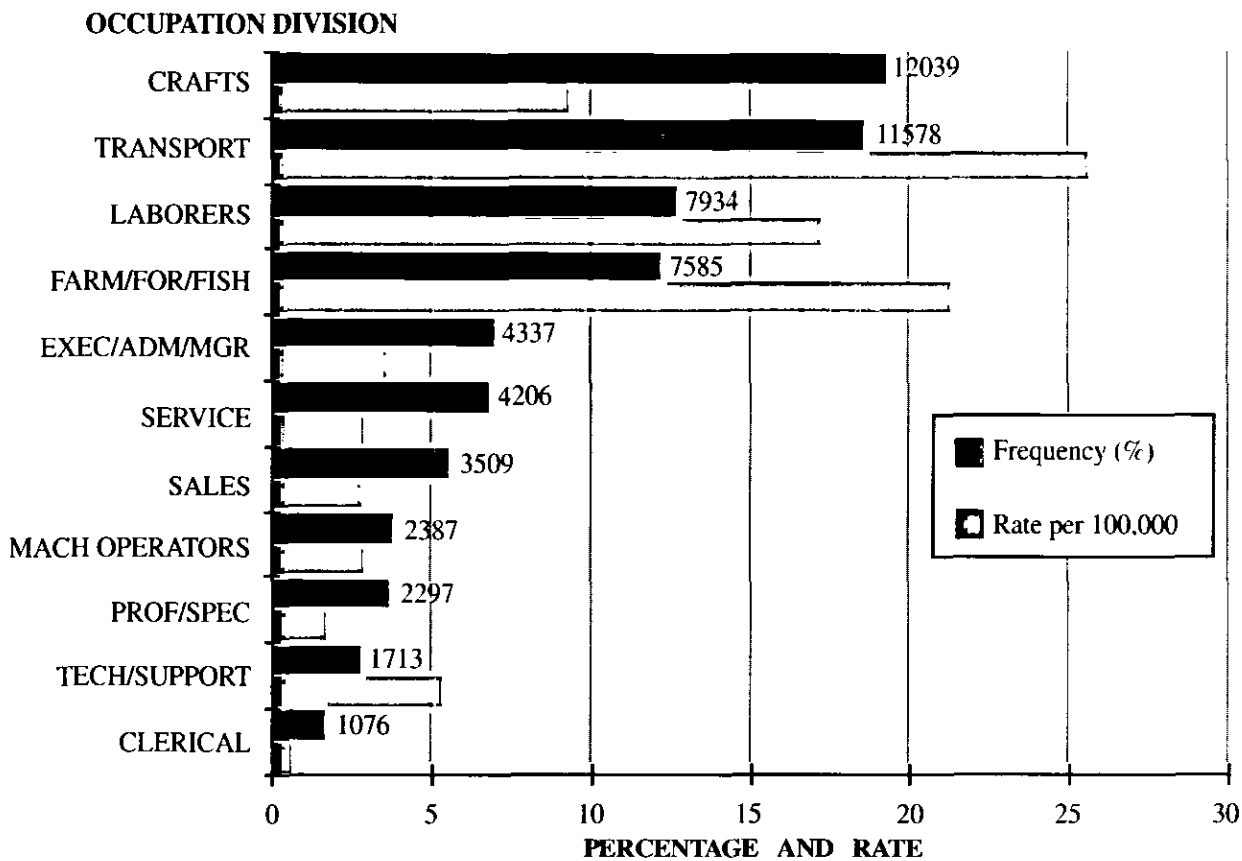


Figure US-20. Distribution and Average Annual Rate of Traumatic Occupational Fatalities by Occupation Division, US, 1980-1989.

Table US-4. Average Annual Rate (per 100,000 workers) of Traumatic Occupational Fatalities by Cause of Death and Occupation Division,* US, 1980-1989.

CAUSE OF DEATH	EXEC/ADM/ MGR	PROF/SPEC	TECH/ SUPPORT	SALES	CLERICAL	SERVICE	FARM/FOR/ FISH	CRAFTS	MACH OPERATORS	TRANSPORT	LABORERS
Motor Vehicle (E810-E829,E846-E849)	0.63	0.36	0.59	0.59	0.18	0.60	2.71	1.08	0.27	14.16	2.82
Machine (E919)	0.33	0.10	0.19	0.10	0.04	0.14	7.18	1.18	0.56	2.92	2.72
Homicide (E960-E969)†	0.90	0.26	0.12	1.36	0.18	0.97	0.49	0.42	0.20	1.50	1.48
Fall (E880-E888)	0.32	0.14	0.19	0.10	0.05	0.26	1.00	1.98	0.35	0.66	2.16
Electrocution (E925)	0.18	0.07	0.20	0.04	0.01	0.09	1.19	1.53	0.22	0.84	1.54
Struck by Falling Object (E916)	0.17	0.04	0.07	0.05	0.01	0.06	3.19	0.79	0.24	0.97	1.57
Air Transport (E840-E845)	0.23	0.24	3.26	0.09	0.02	0.09	0.17	0.13	0.03	0.16	0.10
Suicide (E950-E959)	0.24	0.13	0.10	0.23	0.04	0.16	0.42	0.21	0.06	0.27	0.25
Explosion (E923-E921)	0.10	0.04	0.14	0.03	0.01	0.05	0.18	0.40	0.27	0.44	0.54
Other	0.08	0.04	0.08	0.05	0.02	0.12	0.43	0.24	0.13	0.41	0.45
Flying Object/Caught In (E917-E918)	0.06	0.02	0.02	0.02	0.01	0.04	0.65	0.29	0.14	0.49	0.66
Nature/Environment (E900-E909,E928)	0.05	0.04	0.05	0.03	0.02	0.04	1.10	0.22	0.09	0.41	0.52
Suffocation (E911-E913)	0.06	0.02	0.04	0.02	0.003	0.03	0.36	0.17	0.07	0.26	0.88
Water Transport (E830-E838)	0.02	0.05	0.07	0.01	0.002	0.03	1.16	0.07	0.04	0.78	0.25
Fire (E890-E899)	0.07	0.02	0.04	0.04	0.01	0.11	0.21	0.21	0.12	0.23	0.34
Poisoning (E850-E858,E860-E869)	0.06	0.04	0.08	0.03	0.01	0.05	0.23	0.20	0.07	0.25	0.30
Drowning (E910)	0.03	0.05	0.05	0.01	0.01	0.06	0.48	0.09	0.04	0.20	0.37
Rail Transport (E800-E807)	0.02	0.03	0.01	--	0.003	0.02	0.02	0.04	0.02	0.46	0.16
Unknown/Under (E980-E989,BI-ANK)	0.03	0.01	0.03	0.02	0.01	0.03	0.11	0.05	0.01	0.15	0.12
TOTAL	3.59	1.70	5.33	2.81	0.62	2.94	21.28	9.30	2.94	25.58	17.22

*Unclassified occupations were not included in calculating overall rates.

†Homicide data for New York, Oklahoma, Louisiana, and Nebraska were not available for earlier years.

--Rates were not calculated for cells with <3 cases due to instability of rates based on small numbers.

Shading denotes the leading causes of death in each occupation group.

the second highest fatality rate for professional specialties was homicide.

Machine-related incidents were the leading cause of work-related death in the farmers/foresters/fishers occupation division, with a rate of 7.2 per 100,000 workers, followed by struck by falling object incidents and motor vehicle incidents. Machine-related incidents were also the leading cause of death for the machine operators division with a rate of 0.6 per 100,000 workers, followed by falls, motor vehicle incidents, and explosions.

Homicide incidents accounted for the highest fatality rate per 100,000 workers in the occupation divisions sales (1.4), service (1.0), and executives/administrators/managers (0.9). Motor vehicle incidents accounted for the second highest fatality rate in these occupation divisions, and fall incidents accounted for the third or fourth highest fatality rate. Homicides

and motor vehicle incidents each accounted for a rate of 0.2 per 100,000 workers in the clerical workers division.

In the occupation division precision production/craft/repair, fall incidents accounted for the highest fatality rate (2.0); this was followed by electrocutions, machine-related, and motor vehicle-related incidents. In the occupation division technicians/related support, air transport incidents accounted for the highest fatality rate (3.3), followed by motor vehicle-related incidents, electrocutions, machine-related incidents, and falls.

Age group-specific rates by occupation division for 1983 through 1989 are shown in **Table US-5**. Workers 65 years of age or older had the highest rates of occupational injury death in every occupation division. Note the extraordinary rates for workers 65 years of age and older working as farmers/foresters/

Table US-5. Average Annual Rate (per 100,000 workers) of Traumatic Occupational Fatalities by Occupation Division and Age Group, US, 1983-1989.

OCCUPATION DIVISION	AGE GROUP (IN YEARS)						
	16-19	20-24	25-34	35-44	45-54	55-64	65+
EXEC/ADM/MGR	4.0	2.6	2.6	2.5	3.5	5.3	10.0
PROF/SPEC	2.4	1.7	1.3	1.2	1.5	2.4	5.5
TECH/SUPPORT	3.7	3.6	4.2	6.0	5.9	6.5	10.3
SALES	0.5	1.6	2.1	2.5	3.0	4.1	7.6
CLERICAL	0.3	0.5	0.6	0.5	0.5	0.9	1.8
SERVICE	0.4	2.1	3.3	3.4	3.0	3.4	4.3
FARM/FOR/FISH	5.8	16.2	17.9	19.6	22.1	25.4	49.1
CRAFTS	6.1	8.1	7.7	7.9	8.2	10.9	22.7
MACH OPERATORS	2.1	2.5	2.5	2.5	2.7	3.4	7.8
TRANSPORT	11.9	19.5	23.4	24.1	25.7	30.3	40.6
LABORERS	6.2	13.7	18.5	19.6	21.4	24.0	28.4

fishers, transportation/material movers, laborers, and in precision production/craft/repair occupations.

(135), Delaware (146), New Hampshire (181) and the District of Columbia (191).

The rate of occupational injury deaths for each occupation division by year is shown in **Figure US-21**. While more dispersed than the distribution of fatality rates by industry divisions, three occupational groups—transportation/material movers, farmers/foresters/fishers, and laborers—have consistently higher rates than other occupation divisions.

The states with the highest occupational injury fatality rates for the private sector were Alaska (34.8), Wyoming (29.0), Montana (20.9), Idaho (16.7), and West Virginia (15.7) (**Figure US-22**). The lowest occupational injury fatality rates were reported in Connecticut (1.8), Massachusetts (2.3), and New York (2.6).

Distribution and Fatality Rates by State

The greatest number of fatal occupational injuries occurred in Texas (6,664), California (6,623), Florida (3,681), Illinois (2,853) and Pennsylvania (2,564) (**Table US-6**). The lowest number of work-related deaths occurred in Rhode Island (125), Vermont

The average annual years of potential life lost (YPLL) and YPLL rate for each state are presented in **Table US-7**. The overall YPLL rate for the U.S. civilian workforce was 175.6 years per 100,000 workers. Alaska had the highest private sector YPLL rate (1013.8 years per 100,000 workers) and Connecticut had the lowest (43.1 years per 100,000 workers).

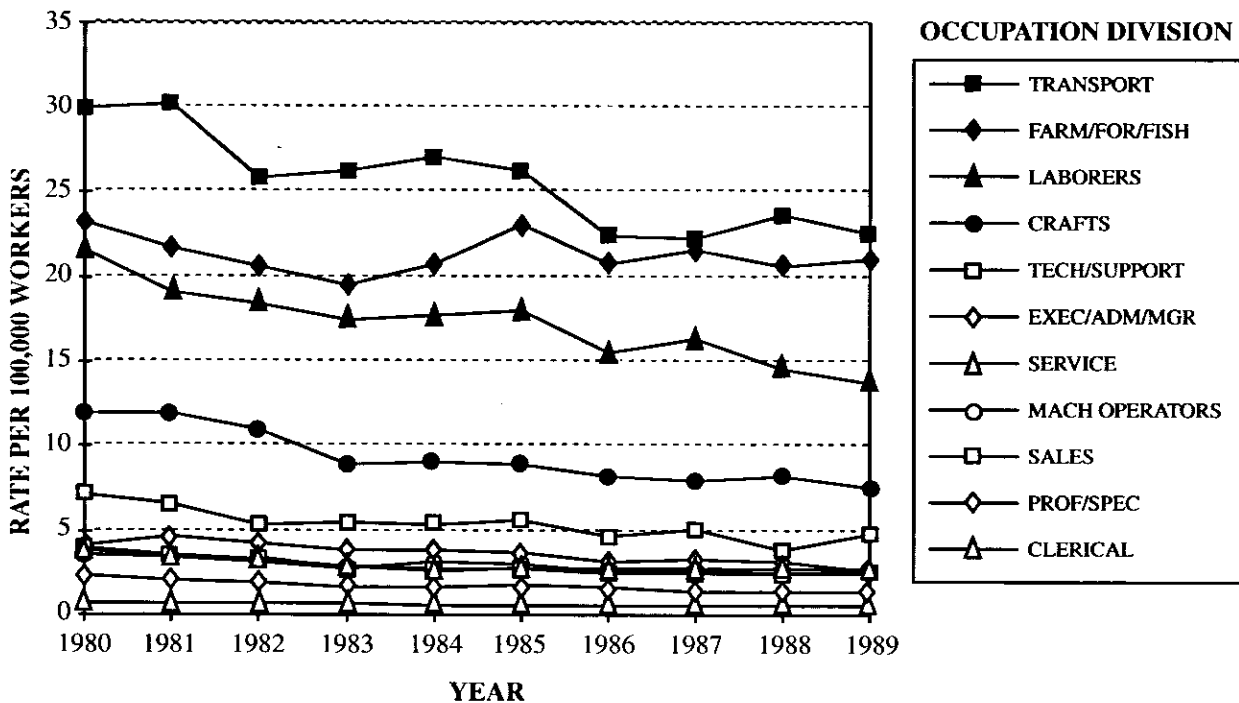


Figure US-21. Rate of Traumatic Occupational Fatalities by Occupation Division and Year, US, 1980-1989.

Table US-6. Distribution and Average Annual Rate (per 100,000 workers) of Traumatic Occupational Fatalities by State of Death, US, 1980-1989.

STATE	DEATHS	RATE
ALABAMA	1,143	9.2
ALASKA	561	34.8
ARIZONA	398	3.7
ARKANSAS	874	12.0
CALIFORNIA	6,623	6.3
COLORADO	1,110	8.9
CONNECTICUT	255	1.8
DELAWARE	146	5.6
DIST COLUMBIA	191	4.5
FLORIDA	3,681	9.1
GEORGIA	2,176	9.6
HAWAII	235	6.1
IDAHO	520	16.7
ILLINOIS	2,853	6.3
INDIANA	1,509	7.4
IOWA	962	9.0
KANSAS	784	8.6
KENTUCKY	1,392	11.6
LOUISIANA	1,438	11.0
MAINE	302	7.6
MARYLAND	862	5.3
MASSACHUSETTS	645	2.3
MICHIGAN	1,627	5.1
MINNESOTA	719	4.1
MISSISSIPPI	1,064	14.5
MISSOURI	1,052	5.3

STATE	DEATHS	RATE
MONTANA	525	20.9
NEBRASKA	653	10.9
NEVADA	504	10.8
NEW HAMPSHIRE	181	4.4
NEW JERSEY	1,009	3.3
NEW MEXICO	498	11.8
NEW YORK	1,783	2.6
NORTH CAROLINA	1,749	7.0
NORTH DAKOTA	304	13.5
OHIO	1,841	4.6
OKLAHOMA	894	8.6
OREGON	1,050	10.9
PENNSYLVANIA	2,564	5.9
RHODE ISLAND	125	3.3
SOUTH CAROLINA	784	6.8
SOUTH DAKOTA	331	14.2
TENNESSEE	1,392	7.8
TEXAS	6,664	11.3
UTAH	647	12.3
VERMONT	135	6.7
VIRGINIA	1,942	9.4
WASHINGTON	1,212	7.5
WEST VIRGINIA	770	15.7
WISCONSIN	1,156	6.2
WYOMING	454	29.0
TOTAL (CIVILIAN)	62,289	7.0

DISCUSSION

NTOF data for the decade, 1980 through 1989, provide valuable information for identifying specific worker groups at high-risk of traumatic occupational fatalities. Prevention efforts and resources should be targeted on specific, high-risk groups based on gender, age, race, industry, or occupation. Information on the leading causes of traumatic occupational fatalities and on the geographic and demographic dis-

tribution of these deaths facilitates the identification of risk factors for workplace injury deaths. Trends of fatal injuries over time, particularly within employment sectors and states, are useful in setting research and prevention priorities, for generating hypotheses for further research, and for monitoring progress. The rate of occupational injury deaths as well as the absolute number of events are important in the interpretation of these surveillance data; the rates depict the risk faced by workers and the numbers indicate

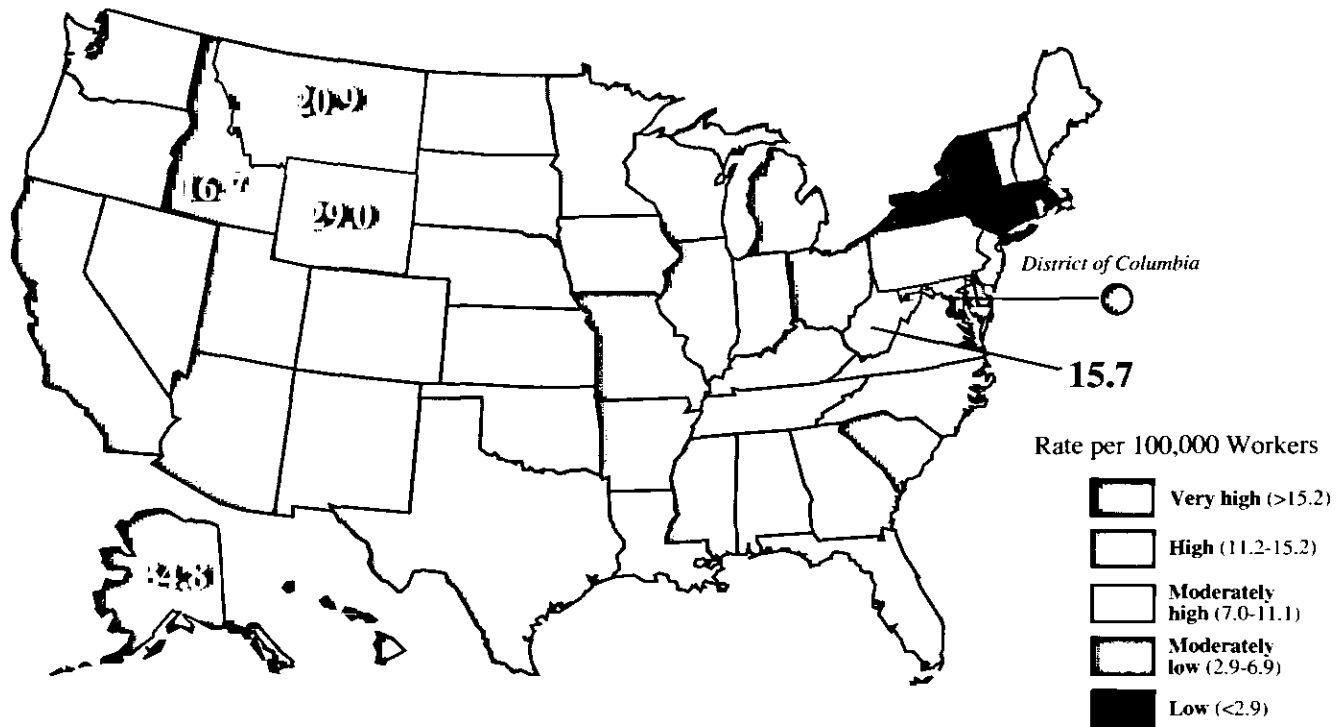


Figure US-22. Average Annual Rate of Traumatic Occupational Fatalities by State, US, 1980-1989.

the magnitude of the problem or the number of lives that would have been saved if these injuries had been prevented.

Consistent with previous findings,^{2,6} NTOF results for 1980 through 1989 indicate that males are at much higher risk than females of traumatic occupational fatality. The rates for homicide are three times as high for males compared to females, but females are more likely to be killed as the result of a homicide in the workplace than from any other cause. Rates for Black workers are consistently higher than rates for Whites and workers of Other races throughout the 10-year period. Interpreting fatal injury risk by race requires quantifying risk by racial/ethnic groups within specific industries and occupations. These efforts would be enhanced by improved employment data for racial/ethnic groups.

As previous studies have reported,^{2,6} workers aged 65 years and older have higher rates of occupational injury death than workers of other ages. The current analysis further examines age group-specific rates by gender, by industry division, by occupation division, and over time. Workers aged 65 years and older experience higher rates of traumatic occupational fatalities than other age groups for both males and females, for each of the 11 occupation divisions and in 9 of the 10 industry divisions. This disparity by age may be due, at least in part, to decreased ability to survive injury. Other factors, including reporting variations in employment data, may also play a role in the calculation of rates. Older workers are more likely to be working part time—52% of workers 65 years and older versus 17% of workers 25-64 years old are part time employees.²¹ The use of employment data

Table US-7. Distribution and Average Annual Rate (per 100,000 workers) of Years of Potential Life Lost (YPLL) due to Traumatic Occupational Fatalities by State of Death, US, 1980-1989.

STATE	YPLL	RATE
ALABAMA	27735	222.9
ALASKA	16473	1013.8
ARIZONA	10736	98.6
ARKANSAS	22046	302.5
CALIFORNIA	173089	162.6
COLORADO	30753	245.6
CONNECTICUT	6294	43.1
DELAWARE	3531	136.9
DIST COLUMBIA	4790	114.3
FLORIDA	92330	227.8
GEORGIA	54052	235.5
HAWAII	5751	152.0
IDAHO	13181	423.1
ILLINOIS	65964	145.5
INDIANA	36787	181.3
IOWA	21250	197.9
KANSAS	19483	213.5
KENTUCKY	35114	292.8
LOUISIANA	42724	326.2
MAINE	8106	202.1
MARYLAND	22113	135.1
MASSACHUSETTS	16277	59.1
MICHIGAN	40563	125.8
MINNESOTA	16296	93.7
MISSISSIPPI	25574	343.8
MISSOURI	22127	110.6

STATE	YPLL	RATE
MONTANA	12621	499.6
NEBRASKA	14616	244.7
NEVADA	13272	276.1
NEW HAMPSHIRE	4745	115.7
NEW JERSEY	23389	77.6
NEW MEXICO	12979	303.7
NEW YORK	42664	61.9
NORTH CAROLINA	42108	167.2
NORTH DAKOTA	7183	316.1
OHIO	44833	112.1
OKLAHOMA	24195	235.7
OREGON	26642	277.6
PENNSYLVANIA	59617	136.4
RHODE ISLAND	3060	80.6
SOUTH CAROLINA	19688	170.7
SOUTH DAKOTA	7295	310.9
TENNESSEE	33260	185.2
TEXAS	182815	311.6
UTAH	18136	345.8
VERMONT	3487	175.8
VIRGINIA	47772	227.9
WASHINGTON	31415	190.4
WEST VIRGINIA	20180	409.5
WISCONSIN	26002	138.5
WYOMING	12643	809.5
TOTAL (CIVILIAN)	1567756	175.6

which count each worker, without regard to the number of hours worked, may introduce bias in the calculation of age-specific rates resulting in artificially low rates. On the other hand, older workers, particularly part-time workers, may be undercounted in labor force data resulting in artificially high rates. Future research should incorporate the use of em-

ployment data based on actual hours of exposure.

Over the decade, mortality rates decreased within industry divisions, although patterns varied by industry. For example, rates for the mining industry showed peaks in years in which there were greater frequencies of multiple-fatality incidents. Rates for

the four highest risk industries—mining, construction, transportation/communication/public utilities, and agriculture/forestry/fishing—remained notably and consistently higher than rates for other industry divisions. Further research is needed to determine the reasons for the decreasing numbers and rates of occupational injury death in the United States. Economic conditions, distribution of the workforce, and changes in work practices and environments are important considerations. Changes in case ascertainment and data collection procedures, of both fatality and employment data, may have also contributed to declining mortality rates and are areas for further research.

Information on the causes of occupational injury death is essential to developing and implementing prevention programs. Motor vehicle incidents account for the largest proportion of fatal occupational injuries, with over 40% more cases than any other external causes of death. Moreover, occupational motor vehicle deaths are likely undercounted. Motor vehicle deaths rank within the three leading causes of occupational injury death within every industry division and in 10 of the 11 occupation divisions and should be considered high priority when targeting injury prevention efforts. Machinery-related deaths are the leading cause of death in two of the highest risk industries, mining and agriculture/forestry/fishing. Homicides are the leading cause of death in retail trade, services, and finance/insurance/real estate. Falls, electrocutions, and being struck by falling object incidents are other leading causes of occupational injury death.

The relative importance of each cause varies by industry and occupation division and research and prevention efforts should be focused using the infor-

mation on the leading causes of death within industry and occupation divisions. Analytic epidemiologic studies are needed to determine causative factors and to elucidate the actual circumstances at the time of worker injury.

Studies designed to evaluate the effectiveness of intervention strategies in reducing occupational injury fatalities in specific industries and from specific causes are essential for effectively preventing future deaths. Rigorous evaluations of existing technology for the design of motor vehicles and machines to prevent crashes, entanglements, and other problems which occur at the human-machine interface are required to reduce the frequency and rate of these events. Evaluations of fall protection technologies, and of personal protective equipment and work practices that may reduce exposure to electrical energy are also required. Deaths due to being struck by falling objects are due in large part (at least 30%) to falling trees. Research and prevention efforts should focus on these leading causes of death. The implementation of effective prevention strategies for fatal occupational injury will likewise have a positive impact on the prevention of non-fatal injuries.

On average, more than 17 workers die each day from an injury at work. The data presented here provide a starting point for targeting public health efforts and resources toward workers at high risk of dying from an injury on the job. Efforts to improve surveillance data and to design, implement, and evaluate intervention strategies are urgently needed. As long as families are deprived of mothers, fathers, brothers, sisters, sons, and daughters as a result of occupational injury deaths, we must work together in a concentrated effort to provide a safe and healthful working environment for every working man and woman of this country.

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APPENDIX I

Operational Guidelines for Determination of Injury at Work

Operational Guidelines For Determination Of Injury At Work

1. Complete the injury at work item if any other than natural cause of death is mentioned in Part I or Part II of the medical certification, including homicides, suicides, and accidents, including motor vehicle deaths.
2. The injury at work item **must** be completed for decedents ages 14 or over and may be completed for those less than 14 years of age if warranted. Consider possibility of work injury regardless of whether injury occurred in the course of work in "usual" or other occupation and/or industry. If decedent's "usual" occupation is housewife, student, or retired consider possible injury during other employment. If occupation is transportation-related, suspect injury at work and evaluate per criteria.
3. Consider available information with regard to location and activity at time of injury. If location is farm, suspect work-related and evaluate per criteria.

CRITERIA	INJURY AT WORK	
	Yes	No
<i>On Employer Premises</i>		
• Engaged in work activity, apprentice, vocational training	✓	
• On break, in hallways, rest room, cafeteria, storage area	✓	
• In employer parking lots while working, arriving, or leaving	✓	
• Engaged in recreational activities on employer controlled facilities (games, etc.) for personal enjoyment		✓
• As a visitor for non-work purposes, not on official business		✓
<i>Off Employer Premises</i>		
• Working for pay or compensation, including at home	✓	
• Working as a volunteer EMS, firefighter, or law enforcement officer	✓	
• Working in a family business, including family farm. Activity should be clearly related to a profit-oriented business.	✓	
• Traveling on business, including to and from customer/business contacts	✓	
• Engaged in work activity where vehicle is considered the work environment (e.g., taxi driver, truck driver, etc.)	✓	
• Homemaker working at homemaking activities		✓
• Working for self—non profit, i.e., mowing lawn, repairing own roof, hobby, or recreation activities		✓
• Student engaged in school activities		✓
• Operating vehicle (personal or commercial) for non-work purposes		✓
• Commuting to or from work site		✓

These guidelines were developed jointly by: The Association for Vital Records and Health Statistics (AVRHS), the National Institute for Occupational Safety and Health (NIOSH), the National Center for Health Statistics, (NCHS), and the National Center for Environmental Health and Injury Control (NCEHIC).



APPENDIX II

Abbreviations for Standard Industrial Classification (SIC) Industry Divisions and Bureau of the Census (BOC) Occupation Groups



**Abbreviations for Standard Industrial Classification (SIC) Industry Divisions and
Bureau of the Census (BOC) Occupation Groups**

Industry Abbreviation	Description (SIC)
Ag/For/Fish	Agriculture/Forestry/Fishing
Mining	Mining
Construction	Construction
Manufacturing	Manufacturing
Trans/Comm/PU	Transportation/Communication/Public Utilities
Wholesale Trade	Wholesale Trade
Retail Trade	Retail Trade
Finance/Insur/RE	Finance/Insurance/Real Estate
Services	Services
Public Admin	Public Administration

Occupation Abbreviation	Description (BOC)
Exec/Adm/Mgr	Executives/Administrators/Managers
Prof/Spec	Professional Specialties
Tech/Support	Technicians/Related Support
Sales	Sales
Clerical	Clerical
Service	Service
Farm/For/Fish	Farmers/Foresters/Fishers
Crafts	Precision Production/Craft/Repair
Mach Operators	Machine Operators
Transport	Transportation/Material Movers
Laborers	Laborers

APPENDIX III
ICD-9 E-Code Rubrics for Cause of Death Categories

ICD-9* E-Code Rubrics for Cause of Death Categories

Category	ICD-9 Rubric
Rail Transport	E800-E807
Motor Vehicle	E810-E829, E846-E849
Water Transport	E830-E838
Air Transport	E840-E845
Poisoning	E850-E858, E860-E869
Fall	E880-E888
Fire	E890-E899
Nature/Environment	E900-E909, E928
Drowning	E910
Suffocation	E911-E913
Struck By Falling Object	E916
Flying Object/Caught In Machine	E917, E918 E919
Explosion	E921, E923
Electrocution	E925
Suicide	E950-E959
Homicide	E960-E969
Other	E870-E879, E914, E915, E920, E922, E924, E926, E927, E929, E930-E949, E970-E978, E990-E999
Unknown/Undetermined	E980-E989, Blank

*International Classification of Diseases, Ninth Revision.
