# Representativeness of Deaths Identified through the Injury-at-Work Item on the Death Certificate: Implications for Surveillance

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## ABSTRACT

*Background.* This research investigated the accuracy of the injury-at-work item on the death certificate for surveillance of occupational injury deaths in Oklahoma during 1985 and 1986.

*Methods.* Representativeness of occupational injury deaths identified by death certificates was assessed by comparing these deaths with all occupational injury deaths identified through death certificates, workers' compensation reports, medical examiner reports, and OSHA records for categories of occupation, industry, and external causes of death.

*Results.* Certain external causes of death (e.g., motor vehicle traffic deaths) and certain occupations (e.g., farming) and industries (agriculture and services) are more often underidentified through death certificates.

*Conclusions.* The findings of this study support Baker's observation that no single data source contains all deaths or all the data elements necessary to describe occupational injury deaths. Data sources may be combined to improve representativeness through more complete case ascertainment. (*Am J Public Health.* 1991;81:1613–1618)


## *Introduction*

Injury is the leading cause of death for persons under the age of 45, accounting for more years of potential life lost than heart disease and cancer combined.[1] Occupational injuries are an important subset of the larger injury problem and are estimated to account for one sixth of all fatal injuries to persons between the ages of 17 and 64.[2] Several private and federal agencies independently estimate the number of occupational injury deaths each year; however, there is currently no agreed-upon method for making such estimates.[3–7] For this reason, the annual number of occupational injury deaths differs widely between reporting sources. For example, the following widely discrepant estimates were made for the number of occupational injury deaths occurring in 1985: Bureau of Labor Statistics, 3750; National Institute for Occupational Safety and Health (NIOSH), 6385; and National Safety Council, 11 170.[3,5,6]

Several states and countries have used death certificates to describe occupational injury deaths.[2,3,8,9–28] They have also been used alone and in conjunction with other sources to study fatal injuries to farmers[22–24] and truck drivers[29] and homicides and suicides in the workplace.[14,25,26] The Division of Safety Research at NIOSH uses death certificates for surveillance of occupational injury deaths.[3]

The only variable on the death certificate used by NIOSH to define work relatedness is the injury-at-work item. However, the National Center for Health Statistics (NCHS) does not include this item in its vital statistics mortality tapes, there is no national guideline for its completion, and different states may define injury at work differently.

Table 1 summarizes the results of several state studies comparing case ascertainment using various data sources. These studies demonstrate that death certificates identify between 57% and 88% of occupational injury deaths. The literature indicates that occupational injury deaths are underreported using death certificates and that certain industries, occupations, external causes of death, and gender or race groups may consistently be underrepresented. For example, deaths that occur in occupations involving substantial amounts of driving of motor vehicles on public roads are often not identified as occupational fatalities.[8,29–31]

While surveillance systems often rely on sources that do not identify every occurrence of the condition under study,[32–35] the cases that are captured must be representative of the population of cases. If missing cases are distributed in occupation and industry groups similarly to cases in the surveillance system, there may be no bias in conclusions based on these data; however, if the cases missed are systematically different from those identified, then their exclusion could bias results, causing public health resources to be misdirected. Therefore, the representativeness of deaths identified by review of the injury-at-work item on death certificates is

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TABLE 1—Percentage of Work-Related Fatal Injuries Identified from Various Data Sources, Selected Studies, United States, 1976–1987

| Author, Date | State, Year(s) | Data Sources | Death Certificates Only | |
|---|---|---|---|---|
| | | | All Deaths (%) | Motor Vehicle Deaths (%) |
| Karlson, 1978[29] | Wisconsin, 1976 | DC, WC | 76 | 60 |
| Baker,[a] 1982[31] | Maryland, 1978 | DC, WC, ME, OSHA | 67 | |
| Roberts, 1983[8] | Michigan, 1980 | DC, SIC | 79 | 56 |
| Paulson, 1988[30] | Colorado, 1982–1984 | DC, WC, OSHA, MSHA | 86 | 67 |
| Robinson,[b] 1988[27] | Allegheny County, Pa, 1979–1982 | DC, ME | 57 | |
| Friedman, 1989[28] | Massachusetts, 1987 | DC, WC, OSHA, SIC | 88 | 73 |

*Note.* DC = death certificates; ME = medical examiner reports; WC = workers' compensation reports; OSHA = Occupational Safety and Health Administration fatality/catastrophe reports; SIC = State Industrial Commission reports; MSHA = Mine Safety and Health Administration.
[a]Baker's study did not report the exact number of motor vehicle deaths.
[b]Robinson's study excluded motor vehicle injury deaths.

an important issue. This study was undertaken to evaluate the representativeness of deaths identified through death certificates alone for one vital statistics reporting unit (Oklahoma).

## Methods

The study population consisted of all (resident and nonresident) workers who were fatally injured while working in Oklahoma during calendar years 1985 and 1986. Most of the analysis is restricted to males because injuries to females were too few to statistically analyze, although a brief description of these deaths is included in the results.

Work-related injury deaths were identified from four primary data sources: death certificates, Occupational Safety and Health Administration (OSHA) fatality/catastrophe reports, workers' compensation reports, and medical examiner reports. Two secondary data sources, workers' compensation court records and police accident reports, were used to confirm work relatedness when it could not be determined from the primary data sources. The working population was estimated from the Bureau of Labor Statistics Geographic Profiles of Employment and Unemployment for 1985 and 1986.[36,37]

An injury death was defined as an intentional or unintentional death resulting from an injury that can be classified by International Classification of Diseases (9th revision; ICD-9) external cause of death codes ranging from E800 to E999.[38] Work related was defined as including full-time or part-time workers as well as unpaid family members who are engaged in work activities in a work environment (e.g., family farms or other family businesses) at the time of their death.[2,39]

Death certificates on which the injury-at-work item was marked "yes" were acquired from the State Vital Statistics Office, as well as death certificates for work-related deaths that were identified from other sources and were not marked "yes" for injury at work.

Copies of the OSHA fatality/catastrophe reports for 1985 and 1986 were obtained from the state OSHA office. These reports are completed by OSHA within 48 hours of a death, the time in which employers are required to report a death to OSHA. Those regulated by other federal safety and health laws, government employers, and domestic workers are excluded from reporting requirements.

A listing for all filed workers' compensation death claims for 1985 and 1986 in Oklahoma was obtained from the State Workers' Compensation Court. These claims do not include self-employed individuals and government and domestic workers who are not eligible for workers' compensation benefits.

In most states, as in Oklahoma, medical examiners or coroners have jurisdiction over all occupational injury deaths.[40] Hand searching of medical examiners' records was required to identify occupational injury deaths in Oklahoma. Records of deaths were then matched visually by agreement of location of death, sex, external cause of death, date of birth, and name.

Demographic and external cause of death data were abstracted from death certificates. Results for the death certificate (DC) group were classified by "usual" occupation/industry, since only usual occupation/industry is reported on the death certificate. This represents the job that was worked for the longest period of time. The comparison group, all deaths (AD), was classified by the most current occupation/industry information that could be derived from any of the data sources. When workers' compensation and OSHA records were available, they were used as the primary sources of current occupation/industry information. When these reports were not available, the medical examiner reports and death certificates were studied in detail to determine whether the "usual" occupation/industry reported on the death certificate was the same as the current occupation/industry. The occupation/industry reported on the death certificate was determined to not be current when it was not consistent with the location and external cause of death. For example, a death certificate may indicate an occupation/industry of student/school, while the injury description on the death certificate and the medical examiner report indicate that the death occurred from a fall at a grain elevator while the victim was working. In this case, there is clear evidence that the "usual" occupation/industry information does not reflect the current occupation/industry.

Annual average rates were calculated by dividing the number of deaths for an occupation or industry group by the working population (i.e., the number of people employed in 1985 and 1986 in each occupation or industry group). Rate ratios were used to compare the pooled data rate and the death certificate–based rate. Rate ratios were calculated for occupation and industry for AD and DC.

## Results

Three hundred twenty-nine occupational injury deaths (299 males, 30 females) were identified during 1985 and 1986, making the annual average death rate 11.3 per 100 000 workers (2.3 for females, 18.7 for males). Twenty-eight of the 30 (93%) female occupational injury deaths were identified by death certificates. Seventy percent of the female deaths occurred in two workplace disasters: an explosion in a fireworks factory and a mass homicide at a post office. These events were highly publicized, possibly increasing the chances of the deaths being recorded as work related. Seventy-three percent of the female deaths were in the manufacturing and public administration industries. Sixty-seven percent of female deaths were in the laborers and helpers and administrative support occupations. There were no female deaths in the four highest risk industries of transportation, communications, and public utilities; construction; agriculture, forestry, and fishing; and mining. Females were excluded from further analysis because of the small numbers of deaths and the two clusters of female deaths.

Of the 299 male deaths, 82% (244) were identified through medical examiner reports, 72% (215) through death certificates, 57% (169) through workers' compensation reports, and 24% (72) through OSHA fatality/catastrophe reports (Figure 1). Cases identified through OSHA fatality/catastrophe reports were not included in Figure 1 because only one additional case was reported to OSHA and not identified in the other three data sources.

There was 86% agreement between usual and current industry for the two-digit Standard Industrial Classification (SIC) and 81% agreement between usual and current occupation when 11 broad occupation categories were used.[41]

When characteristics of deaths were compared for AD and DC, the distributions for age, race, and place of injury were generally similar. The distributions for external cause, shown in Table 2, are similar except for a discrepancy in the identification of traffic deaths (ICD-9 E810.0 to E819.9) between AD and DC. Only 60% (44/73) of these deaths were identified through death certificates (Figure 2).

The distribution of intentional injuries was similar between AD and DC except for suicides that occurred at work, with only 14% (2/14) of suicides being identified through death certificates. Since suicides account for only 5% of AD, the proportion in relation to all occupational injury deaths did not change.

Rate ratios are used to compare industry death rates for AD and DC in Table 3. Rate ratios are 1.5 or greater for four industries: finance, insurance, and real estate; agriculture, forestry, and fishing;

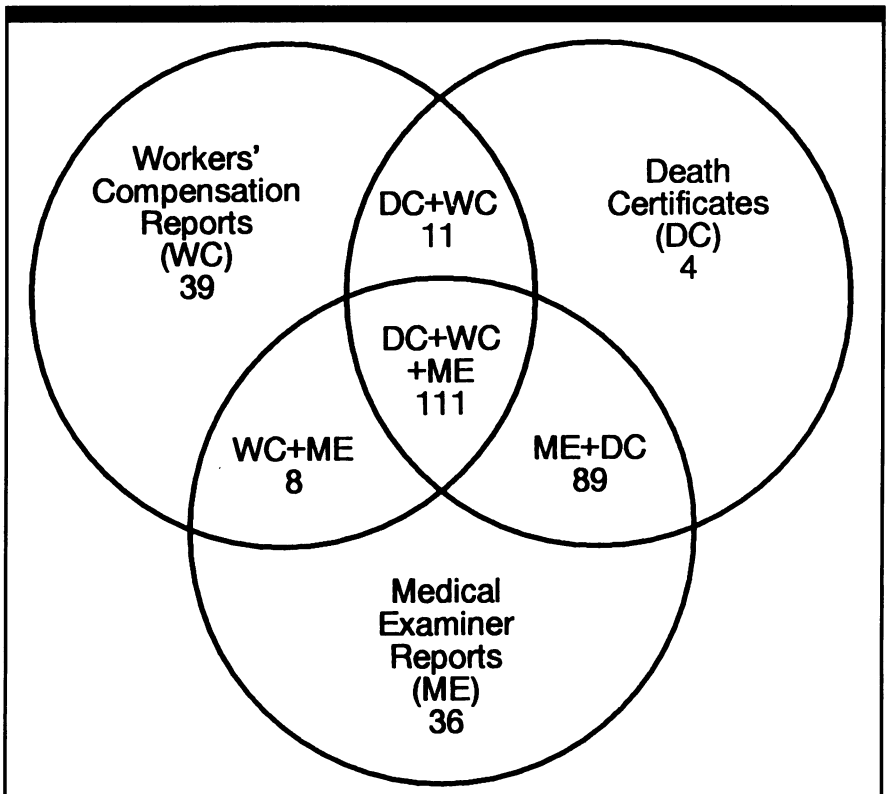


**FIGURE 1—Number of cases identified, by each data source, male work-related deaths, Oklahoma, 1985–1986.**

**TABLE 2—External Causes of Death by Ascertainment Source: Male Work-Related Deaths, Oklahoma, 1985–1986**

| ICD-9 E Code | DC (frequency) | AD[a] (frequency) | DC/AD (%) |
|---|---|---|---|
| Traffic (E810–E819) | 44 | 73 | 60 |
| Motor Vehicle Non-Traffic (E820–E825) | 8 | 8 | 100 |
| Air and Other Transportation (E826–E848) | 8 | 11 | 73 |
| Falls (E880–E888) | 12 | 14 | 81 |
| Fires (E890–E899) | 7 | 8 | 88 |
| Environment, Submersion, Suffocation (E900–E915) | 9 | 13 | 69 |
| Blunt Trauma (E916–E918) | 14 | 15 | 93 |
| Electrocution (E925) | 26 | 30 | 87 |
| Explosive Material (E923) | 11 | 12 | 92 |
| Machines (E919) | 35 | 43 | 81 |
| Other[b] | 11 | 24 | 46 |
| Suicide (E950–E959) | 2 | 14 | 14 |
| Homicide (E960–E969) | 28 | 31 | 90 |
| Total | 215 | 296 | |

*Note.* ICD-9 = *International Classification of Diseases*, 9th revision; DC = death certificates; AD = all deaths.
[a]Includes cases identified by death certificates, medical examiner reports, Occupational Safety and Health Administration fatality/catastrophe reports, and workers' compensation reports.
[b]Other includes Poisoning (E850–E869), Explosions (E921), Legal Intervention (E970–E978), Late Effects of Injury (E929), and Other Accidental Causes (E928).

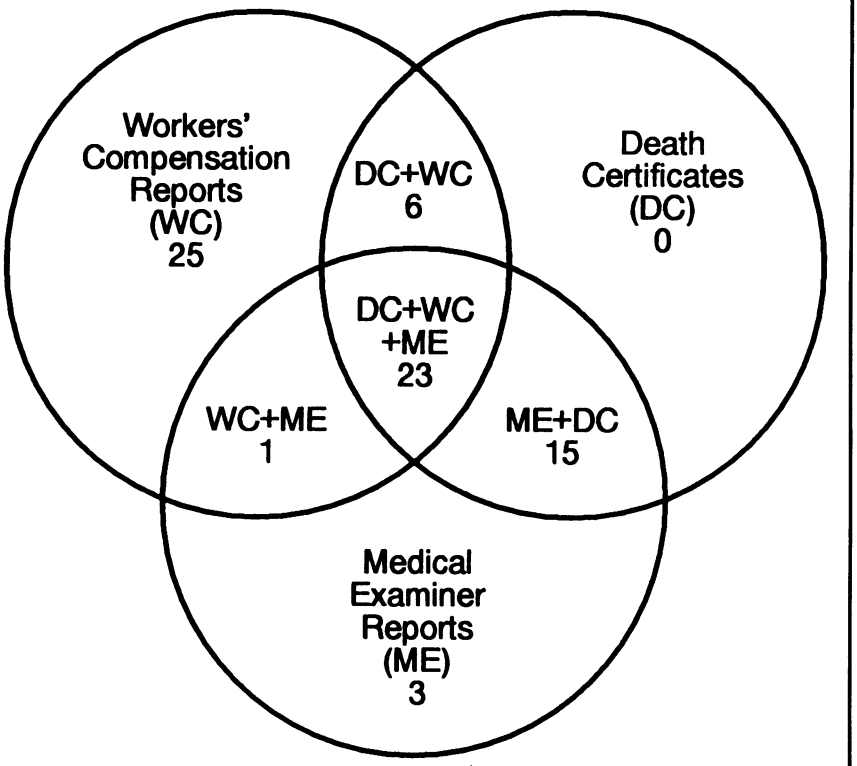


**FIGURE 2—Number of cases identified, by each data source, traffic deaths, male work-related deaths, Oklahoma, 1985—1986.**

**TABLE 3—Annual Average Death Rates per 100 000 Workers by Industry Groups and Ascertainment Source: Male Work-Related Deaths, Oklahoma, 1985–1986**

| Industry Group | Usual Industry Death Certificate Rate | Current Industry All Death[a] Rate | Rate Ratio |
|---|---|---|---|
| Transportation, Communication, Utilities (SIC 400–499) | 46.4 | 52.3 | 1.1 |
| Mining (SIC 100–149) | 37.5 | 56.8 | 1.5 |
| Construction (SIC 150–179) | 30.4 | 33.2 | 1.1 |
| Agriculture, Forestry, Fishing (SIC 0–99) | 14.9 | 34.0 | 2.3 |
| Manufacturing (SIC 200–399) | 6.5 | 9.4 | 1.4 |
| Public Administration (SIC 910–979) | 9.2 | 11.0 | 1.2 |
| Services (SIC 700–899) | 6.4 | 14.7 | 2.3 |
| Trade (SIC 500–599) | 6.0 | 11.3 | 1.9 |
| Finance, Insurance, Real Estate (SIC 600–679) | 2.0 | 7.8 | 3.9 |
| Overall rate | 15.4 | 21.4 | 1.4 |

*Note.* Industry groups are defined by the Office of Management and Budget, Standard Industrial Classification (SIC), 1987.
[a]Includes cases identified by death certificates, medical examiner reports, Occupational Safety and Health Administration fatality/catastrophe reports, and workers' compensation reports.

services; and mining. Fifty-one percent of the deaths not identified through death certificates occurred in three industries (mining, agriculture, and services).

Occupation death rates are compared for AD and DC in Table 4. Rate ratios were 1.5 or greater for five occupation categories: helpers and laborers; farming occupations; executive, administrative, and managerial occupations; technical and related support; and machine operators, assemblers, and inspectors. Fifty-seven percent of the deaths missed by death certificates were in the four highest risk occupations (helpers and laborers; transportation and material moving operatives; farming occupations; and precision production, crafts, and repairers).

In Figure 3 the distributions for death rates by industry based on the pooled data are compared with the death rates based on death certificates only. The distributions have the same shape; however, the pooled data show higher death rates per 100 000 workers and substantially higher rates for mining and agriculture.

## *Discussion*

Death certificates are shown in this research to identify 72% of the fatal occupational injuries occurring to males and 93% for females in Oklahoma during 1985 and 1986. Previous studies show that death certificates alone underestimate the magnitude of the occupational injury problem in the United States by 24% to 33%.[2,30] Although the results of this study (underestimation by 28% for males) cannot be directly generalized to the United States, they agree with results of previous studies in Colorado,[30] Maryland,[2] and Wisconsin[29] on the basis of case ascertainment using death certificates.

Certain external causes of injuries (traffic deaths) and certain industries (mining, agriculture, and services) and occupations (laborers and helpers; farmers; transportation and material moving operatives; and precision production, crafts, and repairers) were less often identified through the injury-at-work item on the death certificate than others and point to areas where estimates of death rates based on death certificates should be interpreted with caution.

Death certificates have been shown to accurately identify broad categories of occupation and industry that are at highest risk of occupational injury death when NIOSH's death certificate database was compared with the Bureau of Labor Statistics annual survey.[19] While this broad agreement is useful to draw attention to the problem and to estimate its overall magnitude, more targeted surveillance for specific external causes or occupation/industry groups is necessary to plan and implement intervention strategies. This targeted surveillance may not be possible through death certificates.

The use of death certificate data for surveillance of occupational injury deaths hinges on the assumption that usual occupation and industry, as reported on the

death certificate, serves as an acceptable proxy for the occupation/industry the person was engaged in at the time of death (current occupation and industry). This assumption appears to be valid for analysis of broad categories of industry and occupation. However, lack of current occupation and industry information is a serious limitation to any study based on death certificate data alone and intended to target interventions in a defined population (e.g., a county or state), since the occupational and industry groups at highest risk are the least likely to be identified through death certificates.

Occupation/industry is a crude method to measure the exposure of workers to harmful energy exchanges at work; therefore, accurate information on the current occupation/industry of the decedent at the time of death is critical to planning and implementation of prevention programs. Two recent studies show that the agreement for usual industry and current industry ranges from 68% to 72% and the agreement for usual occupation and current occupation ranges from 70% to 78% for the identified occupational injury deaths.[30,42] Goodman[22] found that 59% of people killed on farms in Georgia during 1971 to 1981 did not have the occupation of farmer noted on their death certificate. Furthermore, a group of potentially high-risk workers—students—are often not classified by the industry or occupation they were working in at the time of death. National death certificate data from 1980 to 1985 reveal that 16% of the deaths of persons under the age of 21 were noted with industry as student on the death certificate. The proper classification of this group of workers by the occupation they were engaged in at the time of fatal injury is important to the surveillance and prevention of injury deaths to young workers.

National surveillance of occupational injury deaths is needed to provide national estimates of fatal occupational injuries by occupation, industry, and external cause of death. These estimates can help prioritize research programs and target specific occupations, industries, and causes of death for intervention programs. Because death certificates are the only source of data that potentially includes all workers, every effort should be made to improve identification of occupational injury deaths on death certificates and improve the quality of the occupation and industry data, in addition to developing systems to link data sources for national surveillance. The findings of this study support the observation that no single data source contains all of the data elements needed to describe occupational injury deaths and plan prevention strategies.[2,43]

**TABLE 4—Annual Average Death Rates per 100 000 Workers by Occupational Group and Ascertainment Source: Male Work-Related Deaths, Oklahoma, 1985–1986**

| Occupational Group | Usual Occupation Death Certificate Rate | Current Occupation All Death[a] Rate | Rate Ratio |
|---|---|---|---|
| Helpers and Laborers (OCS 863–889) | 36.0 | 57.2 | 1.6 |
| Transportation and Material Moving (OCS 803–859) | 36.6 | 46.4 | 1.3 |
| Farming (OCS 473–499) | 15.3 | 31.6 | 2.1 |
| Precision Product, Craft, Repair (OCS 503–699) | 11.7 | 15.4 | 1.3 |
| Services (OCS 403–469) | 10.0 | 13.7 | 1.4 |
| Sales (OCS 243–285) | 6.6 | 9.3 | 1.4 |
| Executive, Administrative, Managerial (OCS 003–037) | 3.3 | 7.6 | 2.3 |
| Technical Support (OCS 203–235) | 5.5 | 12.9 | 2.3 |
| Professional Specialty (OCS 043–199) | 5.4 | 7.8 | 1.4 |
| Administrative Support (OCS 303–389) | 11.7 | 10.6 | 1.1 |
| Machine Operators, Assemblers, Inspectors (OCS 703–799) | 3.0 | 6.0 | 2.0 |
| Overall rate | 13.5[b] | 18.7[c] | 1.4 |

*Note.* Occupational groups are defined by the 1980 Bureau of Census Occupation Coding System (OCS).
[a]Includes cases identified by death certificates, medical examiner reports, Occupational Safety and Health Administration fatality/catastrophe reports, and workers' compensation reports.
[b]Twenty-four cases identified by death certificates had occupational information missing or not classified.
[c] Fifteen cases in the pooled data had occupational information missing or not classified.

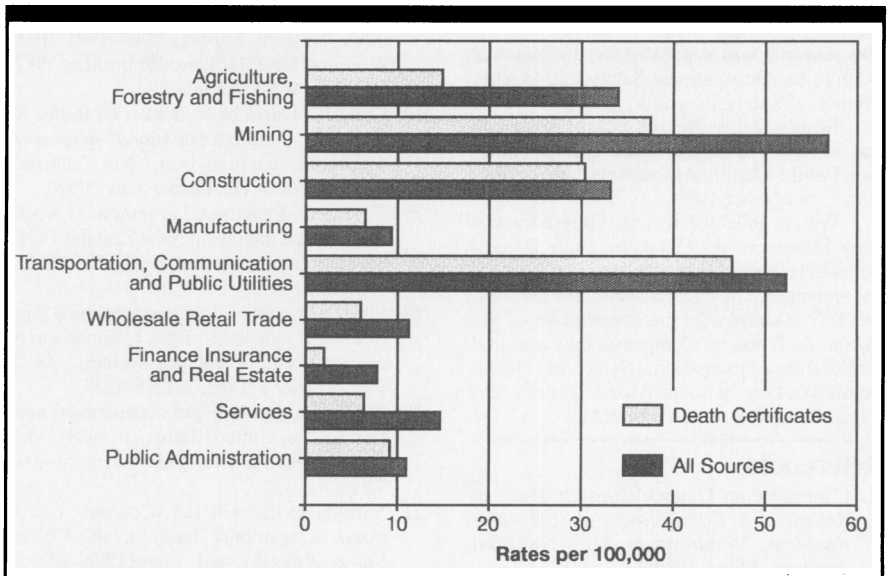


**FIGURE 3—Annual average death rates by industry, male work-related deaths, Oklahoma, 1985–1986.**

Measures to improve representativeness as well as ascertainment of occupational deaths through the use of death certificates include the following:

1. A clear definition of when a person is considered "at work" is needed for recording work-related injuries that can be used in workers' compensation reports and by coroners, medical examiners, and researchers. There is also a need for a definition of a work-related injury. For example, a woman who is killed by her husband while she is working suffered an "injury at work"; however, many death certifiers may be reluctant to call the death work related.

2. Certain classes of ICD-9 external

cause of death codes that are usually occupational (e.g., ICD-9 E919) should be identified, and state vital statistics offices should be asked to query death certifiers to confirm work relatedness when the injury at work item is marked "no" or is blank.

3. Current industry and occupation, in addition to "usual" occupation and industry, should be included on the US standard death certificate.

4. Responsibility for identifying and automating death certificates for injury-at-work deaths should be transferred to NCHS, so there will be uniform recording, quality control procedures, and timely dissemination of data.

5. Death certificates should be linked with medical examiner/coroner records in states that have a centralized and automated medical examiner/coroner system to make toxicology screening data available as well as detailed information on the nature and severity of injuries.

6. Death certificates should be linked with workers' compensation first reports of injury to improve case ascertainment, especially of occupational motor vehicle injury deaths. □

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