Work-Related Death: A Continuing Epidemic

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A B S T R A C T

Worldwide, work-related illnesses and injuries kill approximately 1.1 million people per year. In 1992, an estimated 65 000 people in the United States died of occupational injuries or illness.

Most estimates indicate that occupational diseases account for far more fatalities than occupational injuries. However, an accurate enumeration of occupational disease fatalities is hampered by a paucity of data, owing to underdiagnosis of occupational diseases and inadequacy of current surveillance systems.

In this commentary, the authors review the epidemiology of death due to occupational disease and injury in the United States and discuss vulnerable populations, emerging trends, and prevention strategies for this ongoing public health problem. (*Am J Public Health*. 2000;90:541–545)

In the United States, approximately 65 000 workers die each year of work-related illnesses and injuries, a total of more than 180 work-related deaths each day.[1] Work-related death remains a pressing public health issue in the United States and throughout the world. The International Labor Organization (ILO) recently estimated that work-related injuries and illnesses kill 1.1 million people per year worldwide, a number surpassing the average annual number of deaths from road accidents (999 000) and war (502 000).[2] Work-related hazards are especially severe in developing countries. The occupational fatality rate in advanced industrial countries such as the United States is approximately 5.5 per 100 000 workers. By contrast, Latin America and the Caribbean have an occupational fatality rate of 13.5 per 100 000. The rate in the Republic of Korea is the highest in the world at 34 per 100 000 workers.[3]

Job-related deaths fall into 2 broad categories: (1) deaths due to workplace injuries, including motor vehicle accidents, machinery-related events, homicides, falls, and electrocution, and (2) deaths due to occupational diseases, such as cancers, asbestosis, and silicosis. The number of US workers killed annually by diseases caused by occupational exposure appears to greatly exceed the number who sustain fatal occupational injuries. Leigh et al. estimate that in 1992 there were approximately 6500 deaths due to workplace injuries and 60 300 deaths due to occupational diseases.

Occupational Disease Mortality

While all estimates strongly suggest that many more people die from work-related diseases than from work-related injuries,[1,2] there are no systematic, reliable sources of data on death due to occupational diseases. The difficulty of distinguishing most occupational diseases from nonoccupational diseases makes deaths due to occupational disease hard to track. For example, lung cancer caused by asbestos exposure does not have a unique pathology that differentiates it from lung cancer caused by cigarette smoking. Because of this difficulty and the limited training in occupational medicine that most physicians receive in medical school and during residency, occupational diseases are underdiagnosed.

Diseases that may result in unrecognized occupational deaths include leukemia in workers exposed to benzene, bladder cancer in workers exposed to dyes, lung and other cancers in workers exposed to asbestos, and nasal sinus cancer in workers exposed to wood dust. Additional potentially fatal occupational diseases include chronic respiratory diseases, such as asthma, which can be caused by any of more than 200 known occupational asthmogens; cardiovascular disease, which can be caused by exposure to toxins such as carbon monoxide or by job stress; and various infectious diseases, such as tuberculosis, to which health care workers may be exposed. Accurate ascertainment of death rates due to these disorders remains highly elusive owing to underdiagnosis and to the absence of reporting systems for occupational disease fatalities.

Only a few conditions are caused almost exclusively by occupational exposures. This group includes malignant mesothelioma, coal workers' pneumoconiosis, asbestosis, and silicosis. The National Center for Health Statistics (NCHS) maintains data on annual deaths among males due to these selected occupational diseases. In 1970, there were 2133 deaths due to these conditions, with the majority (1155) due to coal workers' pneumoconiosis, followed by malignant mesothelioma (602), silicosis (351), and asbestosis (25).[4] By 1996, the number of occupational disease fatalities recorded by the NCHS had decreased to 1547.[4] NCHS data for 1996 revealed that among men 25 years and older, there were 574 deaths due to malignant mesothelioma, 533 deaths due to coal workers' pneumoconiosis, 345 deaths due to asbestosis, and 95 deaths due to silicosis.[4] Thus, between 1970 and 1996, the number of deaths due to coal workers' pneumoconiosis decreased by 46.1%, while there was a more than 10-fold increase in the number of deaths due to asbestosis. The National Institute for Occupational Safety and Health (NIOSH) used NCHS data to look at mortality due to pneumoconioses in the

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United States between 1968 and 1992 and found similar trends.[5]

To address the paucity of data on the magnitude of the problem of occupational disease in the United States, Leigh et al. recently derived national estimates of the magnitude and cost of occupational disease and occupational injury in the United States. For occupational disease mortality estimates, a proportionate attributable-risk model was used. Estimates of the percentage of cases of each disease attributable to occupation were developed and applied to disease-specific mortality totals to obtain the approximate total number of deaths due to occupational exposures. The authors estimated that in 1992, between 46 900 and 73 700 deaths (midpoint, 60 300) occurred in the United States as a result of occupational diseases. The leading cause of death due to occupational disease was cancer, causing 31 025 to 51 708 deaths. Cancer was followed by cardiovascular and cerebrovascular diseases, estimated to cause between 5092 and 10 185 deaths per year among workers aged 25 through 64 years; chronic respiratory disease, 9154 deaths; pneumoconiosis, 1136 deaths; nervous system disorders, 269 to 808 deaths; and renal disease, 223 to 689 deaths.[1]

Leigh and Miller published aggregated workers' compensation data from the US Bureau of Labor Supplemental Data System for 7 states (Arkansas, Delaware, Iowa, New York, North Carolina, Oregon, and Wisconsin) in 1985 and 1986, with the addition of Colorado in 1985. The majority (72.5%) of compensable deaths were due to heart conditions, followed by asbestosis (6.0%); silicosis (4.8%); cerebrovascular and other circulatory conditions (2.9%); toxic system poisoning (1.9%); other pneumoconioses (1.9%); influenza, pneumonia, bronchitis, and asthma caused by toxic exposures (1.5%); cancers (1.1%); and various other conditions.[6]

Recent Trends in Occupational Fatal Injuries in the United States

The United States has 2 primary surveillance systems for work-related fatalities: the National Traumatic Occupational Fatalities (NTOF) surveillance system and the Census of Fatal Occupational Injuries (CFOI). These surveillance systems have permitted identification of high-risk industries and occupations and provide fairly detailed information on the causes of fatal occupational injuries.

The NTOF system is the most comprehensive set of data on fatal occupational injuries in the United States from 1980 through 1991. CFOI data permit detailed analysis of occupational fatalities from 1992 through 1998. The strengths and limitations of each of these data sets have been thoroughly discussed.[7–10] Overall, despite some discrepancies and probable undercounting, these 2 data sources provide compelling statistics on the persistent plague of workplace fatalities in the United States.

In 1998, *Morbidity and Mortality Weekly Report* used NTOF data to identify occupational fatality trends in the United States from 1980 through 1994.[11] A total of 88 622 workers died from work-related injuries during that period. The number of deaths per year declined from 7405 in 1980 to 5406 in 1994. The annual death rate also declined, from 7.5 per 100 000 workers in 1980 to 4.5 per 100 000 workers in 1994. Motor vehicle–related deaths were the leading cause of occupational injury deaths nationwide for the entire 15-year period, accounting for 23.1% of all deaths. Machinery-related deaths were the second leading cause of death until 1990, when homicides became the number two cause of fatal occupational injuries. Falls and electrocutions were consistently the fourth and fifth leading causes of occupational deaths.

The industries with the greatest numbers of deaths from 1980 through 1994 were construction (16 091 deaths, 18.2% of total deaths); transportation, communications, and public utilities (15 668 deaths, 17.7% of total deaths); and manufacturing (12 371 deaths, 14% of total deaths). The highest rates of occupational injury deaths per 100 000 workers were found in mining (30.5); agriculture, forestry, and fishing (20.5); and construction (15.5).[11]

Unlike earlier NTOF data, more recent CFOI data do not demonstrate consistent decreases in the number of fatal occupational injuries in the United States. There were 6217 fatalities in 1992; 6331 in 1993; 6632 in 1994; 6275 in 1995; 6112 in 1996; 6238 in 1997; and 6026 in 1998.[12–14] However, fatality rates remained steady at 5.2 to 5.3 per 100 000 workers from 1992 to 1994 and subsequently declined to 4.5 per 100 000 in 1998.[14]

Since the CFOI began collecting data in 1992, transportation incidents, about half of them motor vehicle incidents, have consistently resulted in the largest numbers of deaths, accounting for 42% of all fatal occupational injuries in 1998. Assaults and violent acts, led by homicides, have consistently caused the second largest proportion of deaths (14% of the total in 1998). However, between 1994 and 1998, the number of workplace homicides declined by 34%. Conversely, the number of occupational fatalities due to falls consistently rose, making falls the third most common cause of death in 1998. In that year, there were 702 fall-related fatalities, nearly equivalent to the number of occupational homicides (709). About half of all fatal falls occurred among workers in the construction industry.[14]

According to CFOI data for 1992 through 1998, industry groups with the highest fatality rates were mining; agriculture, forestry, and fishing; construction; and transportation and public utilities. Among individual industries, commercial fishing and logging had the highest fatality rates. The construction industry consistently had the largest number of deaths.[14]

Occupations with the highest fatality rates per 100 000 workers in 1998, when the overall national rate was 4.5, were timber cutter (148.3), fisherman (137.3), structural metal worker (82.5), and airplane pilot (80.5). Truck drivers had the largest number of fatalities in 1998, with 879 fatalities, for a fatality rate of 29.2 per 100 000 workers. Other occupations with high numbers of fatal work-related injuries in 1998 were farmer, salesperson, and construction laborer.[14]

Vulnerable Populations

Occupational Fatal Injury

Most studies in the United States have found that risk of fatal occupational injury is greater for males than for females.[15,16] Risk has also been found to be much higher for older workers.[17] Some data suggest that African American and Latino workers are at increased risk for fatal occupational injuries.[18–21] Although they have not been extensively studied, immigrant workers are likely to be particularly vulnerable, because of stratification in hiring, fear of reporting health and safety problems, language difficulties (which can limit ability to communicate with coworkers about safety or to understand safety warnings, such as signs and labels), and poor access to health care.[22,23] Additionally, workplace demographic characteristics may be a factor: workers employed in smaller firms appear to be at greater risk for fatal work-related injuries than those employed by larger employers in the same industry, and self-employed workers may be at a higher risk than workers who are not self-employed.[24]

Advanced age has consistently been associated with increased occupational injury fatality rates. Kisner and Pratt analyzed NTOF data from 1980 through 1991.[17] Workers 65 years or older had a workplace fatality rate 2.6 times the rate of workers aged 16 through 64 years. Among male workers younger than 65 years, motor vehicle–related injuries were the number one cause of death.

For workers 65 years and older, machinery-related deaths were most common. However, among females, homicide was the most common cause of death, irrespective of age.

Rates of fatal occupational injuries have generally been lower among younger workers than among older workers. However, some of this difference may be an artifact of the standard use of number of workers rather than person-years worked for denominator data. Because young workers are frequently employed part-time, use of number of workers as a denominator may deflate rates. When hour-based rates are used, fatality rates for younger workers (17 years and younger) are only marginally below those for adults.[25] The same may be true for female workers, who are less likely than their male counterparts to work full-time.

Stout et al. examined US occupational injury fatality rates for the years 1980 through 1989, using NTOF data.[15] Males, Blacks, and older workers were found to have consistently higher death rates than others. Bailer et al., who analyzed NTOF data for the years 1983 through 1992 and adjusted for effects of worker demographics, also found the fatal injury rate for males to be greater than that for females (7.91 vs 0.61 per 100 000).[16] The fatal injury rate for Blacks was slightly greater than that for Whites (4.82 vs 4.63).[16]

Other studies also suggest that ethnicity affects risk for fatal injury. Loomis and Richardson compared occupational fatality rates between Whites and African Americans in North Carolina between 1977 and 1991 and found that the death rate from fatal occupational injuries among African American men was as much as 50% higher than that of White men.[18] This difference appeared to be partly due to differences in types of jobs held. However, the effect was not wholly explained by racial stratification in hiring. There was a 13% excess risk of death among African American men, compared with White men, after adjustment for employment type. Two other studies have also found significantly greater fatality rates for African Americans than for Whites in the agricultural sector.[19,20] A study of construction workers in New Jersey found the following rates of fatal occupational injuries per 100 000 workers, stratified by age: 34.8 for Hispanic workers, 24.0 for African American workers, and 10.6 for US-born White workers.[21] Even if occupation- or industry-specific data do not show increased death rates for minorities, minority workers may be at greater risk of fatal occupational injuries as a demographic group because of their disproportionate representation in hazardous industries and occupations.

Occupational Illness Mortality

The dearth of accurate data on occupational disease mortality makes it difficult to identify populations at greatest risk of death due to occupational illness. However, there is evidence that African American and Hispanic workers may be overrepresented in the occupations and industries with the greatest toxic exposures and hence may be at greatest risk for occupational disease.[26–28] Frumkin et al. recently made a compelling argument that minority workers are disproportionately represented in high-risk jobs and that, within the same job category, minority workers have historically been assigned tasks that subject them to greater toxic exposures and hence place them at greater risk of contracting occupational diseases.[28] In addition to possible differences in exposure, social inequalities leading to impaired access to health care among minority workers may result in poorer health outcomes.

Prevention and Intervention

The majority of workplace deaths are preventable. The two leading causes of work-related fatalities, motor vehicle accidents and homicides, have proven amenable to broader (i.e., non–work-related) national prevention efforts. The technology exists to prevent the majority of other work-related fatalities. For example, feasible prevention strategies in the construction industry include using safety lines and perimeter guards to prevent falls and implementing lock-out/tag-out systems to prevent electrocutions.[29] Machine-related fatalities can be prevented by proper equipment design. Similarly, occupational disease deaths related to toxic exposure can be prevented by eliminating those exposures, either with product substitution or with industrial hygiene controls.

To prevent occupational vehicular fatalities, laws requiring the use of seat belts should be augmented by occupationally based programs to ensure that vehicles used at work are new enough to be equipped with antilock brakes and airbags. Equally important, administrative measures should be taken to prevent excessive hours of driving. Eighty-two percent of occupational homicides, compared with 13% of homicides in the general population, occur in connection with robberies or other crimes.[15] Prevention efforts for retail facilities could include enhanced security measures, such as limiting cash available during the night, installing bullet-proof enclosures, and using security guards and cameras.[30]

Enforcement of existing health and safety laws is a critical component of enhanced prevention of deaths due to occupational injuries and illnesses. Targeting prevention programs on the basis of existing surveillance data is also vital.

Focused initiatives to prevent worker fatalities can be effective. For example, in the 1980s, NIOSH initiated an electrocution prevention program comprising research and educational efforts.[15] During the same period, there were changes in the National Electrical Code and related health and safety regulations. Over the ensuing decade, work-related electrocution rates declined by 54%. These initiatives illustrate the potential for success in interventions to prevent work-related fatal injuries.[31]

International Comparisons

Occupational Fatal Injury

It is difficult to make direct comparisons of overall fatal injury rates between different nations. Regional surveillance systems differ. Differences in predominant industries may lead to different distributions of workers in high-risk occupations. Nevertheless, the ILO has recently compiled international comparison data that are useful in comparing crude fatality rates by region. Overall, the Scandinavian nations had the lowest injury fatality rates (from 2.1 in Sweden to 3.2 in Finland). The occupational fatality rate in the European Union is 5.9, compared with 5.3 in the United States and 6.9 in Canada. In developing nations, the rates are much higher. In Latin America and the Caribbean, the rate per 100 000 persons is 13.5: in Thailand, 19.2; and in the Republic of Korea, 34.[3]

Occupational Illness Mortality

Two potentially useful sources of data for identification of occupational disease deaths are workers' compensation systems and cancer registries. However, comparisons of workers' compensation data between geographic regions is difficult, both because differences in workers' compensation laws can lead to wide variations in the kinds of conditions for which compensation is sought and/or received and because workers' compensation systems are notorious for undercounting occupational disease cases. Furthermore, in the United States, workers' compensation systems are state-based; there is presently no national system for collection of workers' compensation occupational disease data.

Cancer registry data may also be of variable quality. For example, malignant mesothelioma, a rare tumor usually caused by occupational exposure to asbestos, can be difficult to diagnose accurately; misdiagnosis could

lead to inaccuracies in cancer registries. Additionally, death rates for conditions related to a particular exposure, such as mesothelioma, may vary widely because of regional differences in industry mix, such as the presence or absence of asbestos mining.

Despite these limitations, there are some scattered data on fatal occupational diseases in various nations. Malignant mesothelioma, which is virtually always fatal, is tracked in some countries. Generally, incidence rates for malignant mesothelioma have been steadily increasing in industrial nations since the 1950s. Among industrialized nations, incidence rates per 100 000 males ranged from 0.2 in France (1980–1985)[32] through 1.1 in the United States (1982)[33] to 2.1 in the Netherlands (1979–1987).[32] In asbestos-mining countries, malignant mesothelioma incidence rates per 100 000 males were 2.8 in Australian males 20 years and older (1982–1988) and 3.3 for South African males 15 years and older (1976–1984).[32]

Emerging Concerns

The effects of the rapidly changing global economy on work-related death rates and distribution have not yet been fully explored. While the global economy has the potential to improve working conditions on a worldwide scale, there is no evidence that this has occurred. A 1999 ILO report on worldwide occupational health and safety concerns stated that "in the context of globalization, industries are being set up, often informal and dangerous ones, engaging workers without previous experience of industrial work" and that "competition for scarce capital can contribute to disregard for safety, health, and environmental considerations, as the large number of fires caused by toy, textile, and similar factories in developing countries attests."[2]

Global economic integration has been characterized by a phenomenon known as "export of hazards," in which industries relocate to developing nations where they do not have to adhere to the same occupational and environmental standards as in their countries of origin. This leads to disproportionately more hazardous exposures for workers in developing nations and exerts downward pressure on health and safety standards in industrialized nations.[34] An example of the potential for downward pressure of the global economy is exemplified by a case now before the World Trade Organization, in which Canada has challenged the French government's ban on the use of asbestos.[35]

Within advanced industrial nations, other concerns are also emerging. The US workforce is becoming older and more racially and ethnically diverse. These demographic changes are likely to result in a working population that is increasingly vulnerable to fatal workplace injuries and illnesses. As manufacturing declines and the information and service economies become predominant in nations such as the United States, occupational illnesses, such as stress-related coronary heart disease, may emerge as greater public health concerns. Unfortunately, the inability of our present surveillance systems to capture such trends may preclude early recognition and prompt initiation of preventive programs.

Conclusion

The ILO's recent estimate that globally more than 1 million work-related deaths occur each year should reawaken concern about this often overlooked public health problem. Within the United States, failure to enforce existing safety laws and inadequate implementation of programs to prevent occupational injuries and illnesses contribute to the continuing problem of work-related deaths. Stronger enforcement of health and safety regulations is a critical prevention strategy.

Enhanced data collection for occupational diseases should be a public health priority, as should development of better methodologies for identifying the "elusive data" needed to characterize risks faced by immigrants and other vulnerable populations. Elucidation of the reasons for the increased vulnerability of the elderly should also be a public health priority, because of the expected increase in the population of elderly at-risk workers. Finally, as the global economy continues to grow, and as long as economic growth without attention to health and safety issues continues to be the hallmark of globalization, it is likely that the problem of work-related deaths will continue to be even more serious in developing countries than in the United States and other advanced industrial nations. In that case, global prevention efforts will be required. □

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