AMERICAN JOURNAL OF INDUSTRIAL MEDICINE 47:518–527 (2005)

Societal Cost of Workplace Homicides in the United States, 1992–2001

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Background *The Census of Fatal Occupational Injuries (CFOI) reported 8,672 workplace homicide victims between 1992 and 2001. Although rarely calculated, cost estimates are important for prevention and research efforts.*
Methods *Societal costs were estimated using the cost-of-illness approach applied to CFOI data. The cost calculation model incorporated medical expenses, future earnings summed from the year of death until the year the decedent would have been 67, and household production losses (includes activities such as child care and housework).*
Results *Workplace homicide had a total cost of nearly $6.5 billion dollars and a mean cost of $800,000 between 1992 and 2001. The retail trade industry division had the highest number of homicides and total cost, $2.1 billion, for males and $556,000 for females.*
Conclusions *Estimates of the cost of work-related homicides can be used to improve occupational injury prevention and control program planning, policy analysis, evaluation of safety and health interventions, and advocacy for a safer work environment.* Am. J. Ind. Med. 47:518–527, 2005. *Published 2005 Wiley-Liss, Inc.*†

KEY WORDS: workplace violence; workplace homicide; societal costs; intervention research; evaluation research; NIOSH

INTRODUCTION

Over the past two decades, violence in the workplace has received growing attention among the global safety and health community. This increased world-wide attention demonstrates that workplace violence is a priority area of concern in both industrialized and developing countries [International Labour Office, 2002]. No longer is violence considered something that only the police and criminal justice systems must deal with, but instead it either has or will affect almost every workplace [Guerrero, 2002].

According to the National Crime Victimization Survey (NCVS) conducted by the Bureau of Justice Statistics, during 1993 through 1999, an average of 1.7 million nonfatal violent victimizations occurred in the workplace each year—a rate of 13 per 1,000 persons in the workforce [BJS, 2001]. The Bureau of Labor Statistics' Census of Fatal Occupational Injuries (CFOI) reported 8,672 workplace homicide victims between 1992 and 2001 [CFOI, 1992–2001]. Averaging just under 870 fatalities per year with an average rate of 0.7 per 100,000 workers, workplace homicide was the second leading cause of workplace fatalities in the United States. In total, workplace violence accounted for 18% of all violent crime in the U.S. [BJS, 2001].

Establishing the number and rate of occupational violent incidents provides valuable insight into this public health problem. Independently, these measures do not fully demonstrate the societal impact of such events. Combined with magnitude measures, the economic costs of these occupational incidents afford decision makers additional insight to focus research for violence prevention and control initiatives.

The substantial burden of occupational fatal injuries on the U.S. economy was presented in a 1992 study by Leigh

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Accepted 2 March 2005
DOI 10.1002/ajim.20171. Published online in Wiley InterScience (www.interscience.wiley.com)

et al. that estimated the cost of all occupational fatal injuries in a single year at nearly $4 billion [Leigh et al., 2000]. In 2002, the National Safety Council estimated the average cost of an occupational fatal injury at just over $1 million [NSC, 2002]. However, neither of these studies provided specific cost estimates for occupational fatalities associated with violent acts.

A limited number of studies have estimated the societal cost of nonfatal workplace violent incidents, but have not provided comprehensive estimates of workplace violence in the U.S. For example, Lanza and Milner [1989] and Yassi [1994] estimated the cost of workplace violence for specific institutions. Liss and McCaskell [1994] estimated first-year costs of physical assaults for a single occupation—nurses. McGovern et al. [2000] provided estimates of long-term costs of nonfatal physical assaults in Minnesota using 1994 incidence data. Foley and Silverstein [2003] presented estimates of workers' compensation costs for nonfatal workplace assault claims occurring in the state of Washington during 1995–2000.

To fully measure the impact of workplace violence on society, the burden of both fatal and nonfatal incidents should be estimated. This research presents one portion of the burden—societal cost estimates of occupational homicides by worker and case characteristics. These detailed estimates will allow policy makers to refine workplace violence research and prevention efforts that have traditionally employed only magnitude measures as the basis for research and prevention.

METHODS

This study utilizes occupational homicide data from CFOI for the period 1992, the first year of comprehensive collection, through 2001. The CFOI system compiles data from 50 States and the District of Columbia using multiple sources, such as death certificates, medical examiner records, workers' compensation claims, and reports to OSHA for decedents of any age as long as the death was a work-related fatal injury. Work relationship must be substantiated by two or more independent source documents or a source document and a follow-up questionnaire.

The NIOSH CFOI research file used in this study excludes fatalities occurring in New York City for the 1992–2001 period and those fatalities resulting from the terrorist acts of September 11, 2001. Homicides were identified using the ANSI Z-16.2 [ANSI, 1996] event or exposure classification structure codes 6100–6190, assaults and violent acts by persons. Cost estimates for workplace homicides in the private and nonmilitary public sectors reported by the NIOSH CFOI research file are the focus of this study.

The cost of a workplace homicide to society was estimated using the cost-of-illness approach, which combines direct and indirect costs to yield an overall cost of an occupational fatal injury. For this study, only medical expenses were used to estimate the direct cost associated with the fatality. The single nominal value for medical expenses was obtained from the Detailed Claims Information (DCI) database from National Council on Compensation Insurance [Detailed Claims Information, 1992–1995]. This database provides estimates of the costs of injury and fatality to workers based on a nationally representative sample. The indirect cost was derived by calculating the present value of future earnings summed from the year of death until the decedent would have reached age 67, accounting for the probability of survival were it not for the premature death. Mathematically this is represented as follows:

$$\text{Total Costs} = \text{Indirect Costs} + \text{Direct Costs}$$

where Direct Costs = Medical Costs and

$$\text{Indirect Costs} = \sum_{n=y}^{67} P_{y,q,s}(n)\left[Y_{s,j}(n) + Y_s^h(n)\right] * (1+g)^{n-y}/(1+r)^{n-y}$$

where, PVF, present discounted value of loss due to occupational fatal injury per person; $P_{y,q,s}(n)$, probability that a person of age y, race q, and sex s will survive to age $y+1$; y, age of the individual at death; q, race of the individual; s, sex of the individual; j, occupation of individual at death; n, age if the individual had survived; $Y_{s,j}(n)$, median annual earnings of an employed person of sex s, occupation j, and age n (includes benefits and life-cycle wage growth adjustment); $Y_s^h(n)$, mean annual imputed value of home production of a person of sex s and age n; g, wage growth rate attributable to overall productivity; r, real discount rate (3%).

Average annual employment data used to calculate occupational fatality rates were obtained from *Employment and Earnings* [BLS, 1993–2002], a publication of the Bureau of Labor Statistics. Employment data used for rate calculations were taken from the Current Population Survey (CPS), a monthly household survey of the civilian noninstitutional population aged 16 years and older conducted by the Bureau of the Census.

Worker and case characteristics used for these cost estimates included: sex, race, and age of the worker; employer industry; worker occupation; event or exposure; state of injury; and year of death. CFOI coded industry and occupation at the time of death. The 1987 Standard Industrial Classification (SIC) system was used to categorize industry [Executive Office of the President 1987, 1987]. Occupation was categorized according to the 1990 Bureau of the Census Occupational Classification System [BOC, 1992].

The wage component of the cost model consists of four parts: base wage, benefits, economy-wide productivity growth, and life-cycle wage growth. The base wage value was derived from the CPS, a monthly household survey of the

noninstitutional population ≥16 years of age collected by the Bureau of the Census for the Bureau of Labor Statistics [BLS, 2003] using the decedent's occupation at the time of death. The value of employee benefits was added to the base wage using data from the U.S. Chamber of Commerce annual survey of employee benefits administered to a sample of employers based on the distribution of U.S. employment [U.S. Chamber of Commerce, 1981–2002]. The Employment Cost Index (ECI) was utilized to estimate the amount that wages rose in concert with the growth of the U.S. economy as a whole [BLS, 2003a]. To account for the final component of wage growth, estimates of the life-cycle growth, or the salary growth due to experience of the individual worker, were employed. This rate was based on mean wages, presented in constant dollars by sex, race, and age group for each year, from the historical income tables of the BLS CPS. The rate of change for mean wages was determined for each sex and race within a specific age group.

Nonmarket losses or losses of household production were derived from time-diary data captured in The National Human Activity Pattern Survey (NHAPS) study commissioned by the Environmental Protection Agency [Expectancy Data, 2000]. The single nominal value for medical costs was obtained from the DCI database from National Council on Compensation Insurance [Detailed Claims Information, 1992–1995]. This database provides estimates of the costs of injury and fatality to workers based on a nationally representative sample. More detailed information regarding this method has been published previously [Biddle, 2004].

Both mean and median cost estimates were provided as measures of central tendency. The median costs identify specific areas that experienced greater variability in the estimates. Confidence intervals on the mean and median costs per group were obtained through bootstrapping [Efron and Tibshirani, 1993]. Each bootstrap sample (n = 59,017) was obtained by randomly selecting with replacement from the CFOI data set for the years 1992–2001. The mean and median for each subgroup under consideration were calculated for each bootstrap sample. A total of 1,000 bootstrap samples were selected; the 2.5th centile and 97.5th centile of the means and medians of these 1,000 bootstraps were used to estimate the 95% confidence intervals, which are presented here. However, these confidence intervals only account for the variation and uncertainties inherent in the CFOI database. Errors associated with the other components of the cost model are either not available or minimal and, therefore, are not accounted for in these measures.

RESULTS

For 1992 through 2001, the total cost of the 7,925 workplace homicides was estimated at nearly $6.5 billion dollars, ranging from $470 million in 1999 to $768 million in 1994 (Table I). While the annual number of homicides has decreased over the years in this study, the highest mean and median cost per fatality were found in 2001.

Over this time period, the mean cost of an occupational fatal injury (all events or exposures) was estimated at $787,000 compared to the estimated mean cost of $800,000 for a workplace homicide (Table II). However, the median cost of an occupational fatal injury was higher than the median cost for an occupational homicide—$796,000 compared to $783,000. The mean cost of an occupational fatality resulting from other events or exposures ranged from a high of $1.3 million for aircraft incidents to a low of $432,000 for fatalities associated with attacks by animals. These same events also experienced the highest ($1.3 million) and lowest ($399,000) median costs for the study period.

TABLE I. Number and Costs of Occupational Homicides by Year of Death in the United States, 1992–2001

		Costs (1999 dollars)		
Year of death	Number of homicides	Total (millions)	Mean (thousands)	Median (thousands)
1992	919	735	799 (776–822)	770 (755–788)
1993	923	747	809 (785–832)	785 (765–809)
1994	965	768	795 (775–817)	783 (767–809)
1995	941	754	801 (778–825)	787 (768–803)
1996	847	636	750 (728–772)	742 (723–765)
1997	811	636	785 (762–809)	769 (752–801)
1998	672	551	820 (793–846)	813 (794–829)
1999	603	470	780 (753–807)	779 (746–811)
2000	627	513	818 (791–845)	792 (773–819)
2001	617	527	855 (826–882)	846 (812–886)
All years	7,925	6,337	800 (792–807)	783 (777–791)

Note: 95% confidence intervals are presented in parenthesis.

TABLE II. Number and Costs* of Occupational Fatal Injury by Event or Exposure in the United States, 1992–2001

Event or exposure	Number of fatalities	Costs (1999 dollars)		
		Total (millions)	Mean (thousands)	Median (thousands)
Contact w/objects & equipment	9,722	6,974	717 (711–724)	749 (743–755)
Falls	6,668	4,772	716 (707–724)	760 (753–767)
Bodily reaction and exertion	172	128	745 (691–797)	780 (686–816)
Exposure to harmful substances or environments	5,465	4,695	859 (851–868)	856 (842–867)
Transportation incidents	24,772	19,968	806 (801–811)	822 (816–828)
Aircraft incidents	2,340	2,998	1,281 (1,259–1,301)	1,325 (1,305–1,357)
Highway Incidents	13,271	10,839	817 (811–822)	870 (866–876)
Fires and explosions	1,883	1,598	848 (833–864)	881 (863–901)
Assaults and violent acts	10,229	8,243	805 (799–813)	789 (782–796)
Homicides	7,925	6,337	800 (792–807)	783 (777–791)
Suicide	1,996	1,767	869 (868–901)	869 (845–889)
By animals	293	127	432 (386–483)	339 (258–452)
All events or exposures	59,017	46,453	787 (784–790)	796 (793–798)

Note: 95% confidence intervals are presented in parenthesis.
*Number and costs not reported for "Nonclassifiable" category (N = 106).

Worker Characteristics

During the study period, the most frequently occurring fatal workplace event was a motor vehicle incident for males and homicide for females. Although workplace homicide was the leading event for females, over 80% of the victims were male workers. Furthermore, males, with a rate of 0.9 per 100,000 workers, were three times more likely to be victims of workplace homicide than were females. The estimated mean costs for males, $800,000, was only slightly higher than the $799,000 estimate for females (Table III). Similarly, the median cost for males, $784,000, was nearly equal to the median cost for females of $783,000. While there is little difference between the mean and median cost for males and females, the total cost shows a substantial difference in burden. The total cost of the 6,314 male victims of workplace homicide was estimated at $5.1 billion while the total cost of the 1,611 female victims of workplace homicide was estimated at just under $1.3 billion.

The retail trade and service industries accounted for over two-thirds of the male and three-fourths of the female workplace homicide victims (Table IV). Additionally, the public administration and the transportation/communication/public utilities industries employed another one-fifth of the male workplace homicide victims. The industry division with the highest total cost of workplace homicide was the retail trade industry—$2.1 billion for males and $556 million for females. For males, the highest mean cost of $1,107,000 and median cost of $1,172,000 were recorded in the public administration industry. For females, the highest mean cost was for construction workers, $1,040,000, and the highest median cost, $1,025,000, was recorded in the public administration industry. The mean and median costs for both males and females working in the retail trade and service industries ranked near the bottom of the category.

White workers experienced the majority (69%) of the workplace homicides, had the highest mean cost ($810,000) and the highest median cost ($798,000), but had the lowest rate (0.5 per 100,000 workers) of any of the race categories. Comparatively, black workers accounted for 17% of all workplace homicides, had a rate of 1.0 per 100,000 workers, and a median of $764,000, all of which ranked second among the three race categories for these measures. With a mean cost of $771,000, the black race category experienced the lowest mean cost. Black males had the lowest mean and median cost per workplace homicide of $759,000 and $751,000, respectively, while black females had the highest mean cost of $832,000 and median cost of $814,000 per workplace homicide. Although only 14% of all workplace homicides were attributed to all other race categories combined, this group experienced the highest rate, 2.0 per 100,000 workers.

The largest numbers of workplace homicides occurred among workers aged 35–44 (2,061 homicides) and those aged 25–34 (1,911 homicides). The 35–44-year-old age group had the highest mean and median costs of occupational homicides of $986,000 and $963,000, respectively. The highest rates for workplace homicides occurred among workers aged 65 years and older. The rate for this group was twice the magnitude of the rates for those 35–44 years of age—1.3 compared to 0.6 per 100,000 workers. Although the workers in the 65 years and older age group had the highest rate, they experienced only 6% of occupational homicides and had the lowest mean, $74,000 and median cost $61,000 for workplace homicides. Workers in the 55–64 years of age category experienced the next highest rate (0.8 per 100,000 workers), which was two-thirds the magnitude of the rate for

TABLE III. Number, Rate*, and Costs of Occupational Homicides in the United States by Selected Characteristics, 1992–2001

Characteristic	Number of Homicides	Fatality Rate (per 100,000 workers)	Costs (1999 dollars)		
			Total (millions)	Mean (thousands)	Median (thousands)
Sex					
Male	6,314	0.9	5,050	800 (791–808)	784 (775–794)
Female	1,611	0.3	1,287	799 (786–812)	783 (774–793)
Race of decedent					
White	5,434	0.5	4,400	810 (800–819)	798 (789–810)
Black	1,386	1.0	1,069	771 (754–788)	764 (751–774)
Other	1,105	2.0	868	785 (766–803)	757 (731–772)
Age of decedent					
16–19	224	0.3	146	651 (633–668)	627 (605–659)
20–24	596	0.5	475	797 (781–813)	740 (731–758)
25–34	1,911	0.6	1,848	967 (956–978)	940 (921–962)
35–44	2,061	0.6	2,031	986 (974–997)	963 (948–976)
45–54	1,653	0.6	1,362	824 (812–837)	793 (773–810)
55–64	980	0.8	438	447 (436–458)	421 (406–433)
65+	500	1.3	37	74 (71–77)	61 (60–62)
Industry					
Agriculture, forestry, & fishing	150	0.5	92	612 (568–658)	645 (627–664)
Mining	13	—	14	1,098 (971–1,228)	1,074 (914–1,210)
Construction	159	—	137	864 (812–914)	867 (820–921)
Manufacturing	347	—	316	911 (877–946)	886 (849–913)
Transportation, communication, & public utilities	733	0.8	561	766 (744–786)	792 (775–802)
Wholesale trade	192	0.4	154	804 (751–857)	821 (777–894)
Retail trade	3,637	1.7	2,649	728 (719–739)	726 (714–736)
Finance, insurance, & real estate	303	0.4	262	863 (815–907)	933 (862–971)
Services	1,526	0.3	1,225	803 (784–823)	771 (760–779)
Public administration	815	1.4	890	1,091 (1,071–1,113)	1,161 (1,135–1,181)
Occupation					
Managerial & professional specialty	1,475	0.4	1,474	999 (978–1,022)	1,011 (999–1,029)
Technical, sales, & administrative support	2,827	0.7	2,082	736 (725–747)	743 (731–755)
Service	1,768	1.0	1,424	805 (790–821)	754 (744–764)
Farming, forestry, & fishing	151	0.4	87	577 (536–615)	637 (623–649)
Precision production, craft, & repair	380	0.3	320	842 (811–872)	898 (874–923)
Operators, fabricators, & laborers	1,257	0.7	906	721 (709–733)	758 (749–769)

Note: 95% confidence intervals are presented in parenthesis.
*Dashes indicate a rate of less than 0.3.

workers 65 years of age and older; yet the mean cost for the group—$447,000 the second lowest overall—was six times higher. It is worth noting that the frequency, mean, median, and total costs for the age group characteristic rank the same three groups as the highest priority for further research (Table III).

Case Characteristics

At just over $1 million, the mining industry division experienced the highest mean cost of occupational homicides. However, during the study period, this industry division had the lowest number of homicides, yielding the lowest total cost of $14 million. The retail trade industry division had the highest frequency (3,637), the highest rate of 1.7 per 100,000 workers, and the highest total cost of $2.6 billion for work-related homicides. However, the estimated mean cost of $728,000 and median cost of $726,000 per workplace homicide in the retail trade industry ranked next to the lowest. The only industry division with a lower mean and median cost for this period was the agriculture, forestry, and fishing industry, which had an estimated mean cost of

TABLE IV. Number and Costs of Occupational Homicides in the United States by Industry and Sex, 1992–2001

Industry division and sex	Number of homicides	Costs (1999 dollars)		
		Total (millions)	Mean (thousands)	Median (thousands)
Agriculture, forestry, & fishing	150	92	612 (568–658)	645 (627–664)
Male	134	81	602 (557–650)	642 (625–652)
Female	16	11	698 (557–855)	729 (553–791)
Mining	13	14	1,098 (971–1,228)	1,074 (914–1,210)
Male	—	—	—	—
Female	—	—	—	—
Construction	159	137	864 (812–914)	867 (820–921)
Male	147	125	850 (795–906)	855 (800–902)
Female	12	12	1,040 (953–1,125)	990 (957–1,133)
Manufacturing	347	316	911 (877–946)	886 (849–913)
Male	274	251	915 (870–958)	886 (846–936)
Female	73	65	893 (842–953)	885 (833–918)
Transportation, communication, & public utilities	733	561	766 (744–786)	792 (775–802)
Male	679	512	754 (734–775)	783 (772–798)
Female	54	50	917 (849–984)	911 (858–976)
Wholesale trade	192	154	804 (751–857)	821 (777–894)
Male	167	134	804 (746–859)	826 (777–895)
Female	25	20	805 (705–899)	889 (727–931)
Retail trade	3,637	2,649	728 (719–739)	726 (714–736)
Male	2,867	2,094	730 (718–742)	707 (691–724)
Female	770	556	722 (703–739)	745 (736–753)
Finance, insurance, & real estate	303	262	863 (815–907)	933 (862–971)
Male	194	163	838 (776–894)	902 (757–964)
Female	109	99	907 (843–970)	962 (886–1,027)
Services	1,526	1,225	803 (784–823)	771 (760–779)
Male	1,090	867	795 (772–818)	759 (746–769)
Female	436	359	823 (792–854)	805 (780–833)
Public administration	815	890	1,091 (1,071–1,113)	1,161 (1,135–1,181)
Male	706	781	1,107 (1,085–1,129)	1,172 (1,157–1,197)
Female	109	108	994 (937–1,052)	1,025 (955–1,063)
All industries	7,925	6,337	800 (792–807)	783 (777–791)
Male	6,314	5,050	800 (791–808)	784 (775–794)
Female	1,611	1,287	799 (786–812)	783 (774–793)

Note: 95% confidence intervals are presented in parenthesis.
Dashes indicate a rate of less than 0.3.

$612,000 and median cost of $645,000 per workplace homicide (Table III).

Within the occupation division classifications, the highest estimated total cost of work-related homicides was in the technical, sales, and administrative support classification with a total cost of just over $2 billion. This occupation classification experienced the largest number (2,827), the fourth highest mean cost ($736,000), and the second highest rate (0.7 per 100,000 workers) of work-related homicides.

The highest mean cost of $999,000 and median cost of $1,011,000 per workplace homicide were in the managerial and professional specialty division occupation classification, which also had the second highest total cost, $1,474,000,000. However, the managerial and professional specialty occupation classification rate of 0.4 per 100,000 workers was among the lowest rates of the six occupation division classifications. Farming, forestry, and fishing had the lowest mean cost ($577,000), the lowest total cost ($87,191,000), and the lowest frequency (151) associated with workplace homicides.

DISCUSSION

Understanding the magnitude of workplace homicides is one of the first steps in formulating prevention programs.

Knowing the economic impact of these fatalities on society helps in making appropriate resource allocation decisions for directing prevention programs and for evaluating intervention efforts. This study provides the ability to determine the loss to U.S. income resulting from the deceased workers' lost contribution. These costs are a conservative estimate because they do not include measures of the value of pain and suffering by family, friends, or co-workers. Even without these intangible costs, a total loss of productivity in the billions—nearly $6.5 billion for workplace homicides—demonstrates the substantial loss of human capital that directed programs could prevent. With over 15 workplace homicides occurring weekly at a mean cost of $800,000, the cost to society is nearly $12 million per week or $1.7 million per day.

Costs in Decision Making

Costs assist in setting prevention priorities by providing a single measure that can be compared between demographic and case characteristics to determine where prevention efforts should be directed. Moreover, decisions to allocate scarce safety resources can be improved by using costs and cost savings as a basis.

The need for preventing workplace violence is evident from the burden on society as measured in this study. This overall cost is important for general research direction, but costs by case and worker characteristics are needed to allocate resources for specific research areas. Consistent with previous studies based on magnitude and risk measures, examination of the total costs by industry division suggests that prevention efforts in the retail trade industry present the most pressing research need. Similarly, analysis of total costs point to the need for attention in the technical, sales, and administrative support occupations. The total cost of workplace homicide was the highest for white males aged 35–44 years old working in the retail trade industry division within the technical, sales, and administrative support occupation division classification.

However, total costs are only one way to quantify the burden for targeting resource allocation. Mean and median costs per homicide often suggest alternative funding strategies. For example, if mean costs were the only decision criterion, efforts would be concentrated in the mining industry and the managerial and professional specialty occupations. In this study, the mean costs of fatal occupational homicides vary substantially within worker and case characteristics. The mean costs by age group, ranging from $74,000 to $986, 000, illustrate the wide variability. These variations are partially explained by the model specification; the value of lost productivity (potential earnings) due to the fatality is based on the wages of the individual at the time of death. Wages, in turn, are based on the age, sex, race, and occupation of the decedent.

For example, the highest mean cost for any age group (35–44 years of age) was just over 13 times greater than the group with the lowest cost (65 and older). The estimates are net present values of discounted cash flows of lost earnings, which help explain some of this difference. By definition, the higher the number of discount periods, all other things equal, the larger the estimate produced. Because decedents 67 years of age or older have only one discount period, their mean costs are lower than those decedents aged 35 who have 32 discount periods in this model. A decrease in the number of workers aged 65 and older who were victims of work-related homicides would contribute to higher mean and median cost estimates during the study period, despite the overall reduction in the number of victims.

In certain instances, the cost-of-illness method undervalues the loss associated with working minority groups, [Dorman, 1996; Rice and MacKenzie, 1989] females, and younger workers, particularly those who have not completed their education or training. The effect on these worker groups can be demonstrated by examining the impact of changing one variable while holding all others constant. Victims 38 years of age, the age with the highest mean cost for homicide victims, were chosen to demonstrate the differential between female and male decedents mean costs. The single occupation with the largest number of 38-year-old homicide victims, supervisory sales occupations classification, had a mean cost of $1,110,044 for white victims. The mean cost for male homicide victims, $1,160,283, was over 15% greater than the mean cost of $979,420 for females. This is largely a result of the wage variation between the two sexes—a mean wage of $32,646 for males versus a mean wage of $22,318 for females during 1992–2001. The disparity for younger workers can be demonstrated by holding all characteristics constant except age. For example, 38-year-old white male decedents in the supervisory sales occupations classification had a mean value 10% higher than 23-year-old victims (the youngest age meeting reporting requirements) with the same characteristics.

Some of the differences within case characteristics can be explained by using cross tabulations to analyze the data on a more indepth level. For example, the technical, sales, and administrative support (TSAS) occupation classification had the most homicides during the study period. The mean and median cost for this division ranked fourth of the six occupation divisions. Within the TSAS occupation division, supervisory sales occupations had the highest frequency of homicides. The mean cost for this group, $789,000, was 7% higher than the mean cost for the TSAS occupation division, while the median cost of $903,000 was 25% higher than the classification as a whole. The large difference between the mean and the median costs can be at least in part explained by the distribution by sex and age group for the victims in this occupation. Almost 60% of the males and over 50% of the females were 45 years of age or older. The mean cost for

males in this group was $568,000, while females had a mean cost of $497,000. This suggests that there are several outliers on the lower end of the income scale, which skew the distribution toward a lower mean and a higher median.

Costs in Intervention Evaluation

Occupational safety and health interventions are designed to prevent injury and disease using methods such as behavioral, engineering, and administrative controls. ''The goal of intervention research is to determine the efficacy and effectiveness of these techniques and programs. New intervention research will assure better use of limited resources in workplace applications of prevention and control strategies'' [NORA, 1996]. Cost estimates can be used to retrospectively evaluate whether the benefits of the intervention designed to reduce the number of workplace homicides outweigh the costs.

Prior research has identified that the risk of workplace violence is associated with various workplace factors such as dealing with the public, the exchange of money, and the delivery of services or goods [NIOSH, 1996]. ''Great potential exists for workplace-specific prevention efforts such as bullet-resistant barriers and enclosures in taxicabs, convenience stores, gas stations, emergency departments, and other areas where workers come in direct contact with the public; locked drop safes and other cash-handling procedures in retail establishments; and threat assessment policies in all types of workplaces'' [NIOSH, 1996, p. 2]. The following scenarios illustrate the utility of cost estimates generated by this model.

Taxicab drivers are exposed to a number of risk factors for homicide including working alone, driving late at night, carrying cash, and are often being required by local regulation to work in high-crime areas. Two violence-prevention interventions for this occupational group have attracted the attention of the safety and health community in recent years—shield barriers and onboard security cameras. At a cost of approximately $500 each, either of these interventions could prevent a taxicab driver homicide, which has an estimated mean cost of $688,000. To illustrate the relative magnitude of these estimates, if society opted to provide interventions at $500 each, they could provide over 1300 of either the shield barriers or the onboard security cameras for the mean cost of one homicide in the taxi-cab industry.

The convenience store industry is another example where workers routinely deal with the public and handle large sums of money daily. Convenience store industry statistics indicate that an estimated two-thirds of convenience store homicides occur in robbery situations [Amandus et al., 1995]. In the 1990s, NIOSH conducted a series of studies on reducing the risk of robbery in the convenience store industry. Recommendations resulting from these studies include: installing proper drop safes and posting signs that drop safes are used; training employees in robbery prevention; installing and maintaining security systems; making cashiers visible from outside the store; and keeping windows free of signs, advertisements, and other obstructions [Hendricks et al., 1999]. Nominal costs are associated with implementation of many of these recommendations. In fact, the latter intervention could be implemented with no expense to either society or employer, as compared to a mean cost of $728,000 per fatality in the retail trade industry.

There have been numerous suggestions for reducing the incidence of workplace violence in the health care industry [NIOSH, 1996, 2002]. Prevention strategies include administrative controls, such as restricting access to treatment areas, and behavioral strategies, such as recognition of warning signs for violence and accompanying de-escalation techniques. Providing security escorts to the parking lots at night, installing enclosed nurses' stations, and arranging furniture and other objects to minimize their use as weapons are examples of environmental designs that have been recommended. A Detroit hospital installed a security screening system that included stationary and hand-held metal detectors, which prevented the entry of 33 handguns, 1,324 knives, and 97 mace-type sprays during a 6-month period [Thompson et al., 1988]. Although the number of workplace violence incidents prevented by these interventions is unknown, the $6,000 cost of a stationary walk-through metal detector and the $200 cost of a hand-held metal detector combined is substantially less than the estimated $952,000 estimated mean cost of a homicide in the health care industry. If society opted to provide both metal detectors at a combined price of $6,200, they could provide over 150 combinations of stationary walk through metal detectors and hand-held metal detectors for the mean cost of one homicide in the health care industry.

CONCLUSION

Estimates of the cost of work-related homicides can be used to improve occupational injury prevention and control program planning, policy analysis, evaluation of safety and health interventions, and advocacy for a safer work environment. However, resource allocation should not rely on costs alone but should consider all measures of impact—frequencies, rates, and costs. These three measures do not always identify the same worker or employment characteristic as having the greatest risk or as the highest priority. For example, using mean cost data based on CFOI fatality counts, occupational homicide ranked 14th of the 34 events that had five or more fatalities during the 1992 through 2001 time period. During this same period, workplace violence was the second leading cause of death based on total cost figures calculated using CFOI fatality data, as well as counts and incidence rates.

The frequency of workplace homicides is not distributed randomly across all workplaces but is rather clustered in particular occupational settings. Over two-thirds of workplace homicides occurred in retail trade (46%) and service industries (19%). The 3,637 homicides in the retail trade industry had an associated total cost of $2.6 billion or 40% of the cost of all workplace homicides during the 10-year period of this research. The total costs in the retail trade industry were more than double the costs of workplace homicides in the services industry, the industry division with the second highest costs of $1.2 billion. Using these two measures—frequencies and total costs—as targeting criteria, strongly suggest that research efforts should focus on these two industry sectors. As the U.S. economy continues to shift toward the service and retail industries [BLS, 2003b], fatal and nonfatal workplace violence will be an increasingly important occupational safety and health issue.

''Workplace violence affects us all. Not only do victims of violence bear the toll but so do their co-workers, families, employers, and every worker at risk of violent assault—in other words, virtually all of us. However, understanding the burden of workplace violence is still in its infancy'' [Merchant and Lundell, 2001, p. 138]. No single organization has either the financial or human resources necessary to conduct occupational safety and health research to adequately serve the needs of workers. Collaborative efforts between diverse partners such as, employers, labor organizations, academic researchers, consulting firms, special interest organizations, and governmental research agencies are needed to address the research and prevention challenges posed by the complex issue of workplace violence. This study provides additional insight into the economic burden of workplace homicides. . .providing decision criterion for intervention evaluation and policy analysis.

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