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Costs Differences Across Demographic Groups and Types of Occupational Injuries and Illnesses

J. Paul Leigh, PhD,[1]* Geetha Waehrer, PhD,[2]
Ted R. Miller, PhD,[2] and Stephen A. McCurdy, MD, MPH[3]

Background *Little is known about cost differences for demographic groups or across occupational injuries and illnesses.*
Methods *In this incidence study of nationwide data for 1993, an analysis was conducted on fatal and non-fatal injury and illness data recorded in government data sets. Costs data were from workers' compensation records, estimates of lost wages, and jury awards.*
Results *The youngest (age $\leq$ 17) and oldest (age $\geq$ 65) workers had exceptionally high fatality costs. Whereas men's costs for non-fatal incidents were nearly double those for women, men's costs for fatal injuries were 10 times the costs for women. The highest ranking occupation for combined fatal and non-fatal costs—farming, forestry, and fishing—had costs-per-worker ($5,163) over 18 times the lowest ranking occupation—executives and managers ($279). The occupation of handlers, cleaners, and laborers, ranked highest for non-fatal costs. Gunshot wounds generated especially high fatal costs. Compared to whites, African-Americans had a lower percentage of costs due to carpal tunnel syndrome, circulatory, and digestive diseases.*
Conclusions *Costs comparisons can be drawn across age, race, gender, and occupational groups as well as categories of injuries and illnesses.* Am. J. Ind. Med. 49:845–853, 2006. © *2006 Wiley-Liss, Inc.*

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INTRODUCTION

Estimates of the overall U.S. national costs of occupational injuries and illnesses have appeared in the literature [Miller and Galbraith, 1995; Leigh et al., 1997; National Safety Council, 1999]. However, we are not aware of any studies that address cost differences across age, gender, and race or across categories of injuries or illnesses. Only one study attempted to rank occupations according to cost, but this study applied to only eight states in the early 1980s [Leigh and Miller, 1997]. More information on costs would be useful as policy makers need to know where limited regulatory resources would be most cost-effectively applied [Kane, 1996].

Costs data can also provide information about on-the-job risks. Such risks can take many forms including risks of back injury, carpal tunnel syndrome, fracture, burn, gunshot wound, and even death. Adding the costs for these disparate injuries and illnesses is one way to sum the risks. It is a useful summary for two reasons. First, aggregated costs reflect both incidence and severity. Second, researchers, employers, and workers alike easily understand costs expressed in dollars.

DATA AND METHOD

The Bureau of Labor Statistics' (BLS) Annual Survey, which collects information on non-fatal cases, and Census of

[1]Center for Health Services Research in Primary Care and Department of Public Health Sciences, University of California, Davis, California
[2]Pacific Institute for Research and Evaluation, Calverton, Maryland
[3]Department of Public Health Sciences, Medical School, University of California, Davis, California
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*Correspondence to: J. Paul Leigh, Center for Health Services Research in Primary Care, 2103 Stockton Blvd., Suite 2224, UC Davis, Medical Center, Sacramento, CA 95817.
E-mail: pleigh@ucdavis.edu

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Fatal Occupational Injuries (CFOI), were the two data sources that served as templates onto which cost information is merged [Toscano and Windau, 1994; U.S. Bureau of Labor Statistics, 1992, 1995, 1996]. Medical cost information came from workers' compensation records in the Detailed Claims Information data set, the National Health Interview Survey, and prior work on medical costs for fatalities [Miller et al., 1993; Miller and Galbraith, 1995]. Work loss information is transformed from the Annual Survey into dollar values using wage data from the 1993 monthly Current Population Survey (CPS) [Weinberg et al., 1999]. A survey of jury verdicts related to occupational injuries and illnesses is used to predict pain and suffering costs for non-fatal cases [Rodgers, 1993; Miller et al., 1996; Miller et al., 1998].

Further discussion of the methodology used is available at http://phs.ucdavis.edu/Fac/Leigh/CostAcrossIndustries.php. The appendices are associated with a companion paper analyzing costs across industries [Leigh et al., 2004].

The 1993 Annual Survey contains detailed information on 603,936 cases of non-fatal occupational injury and illness cases involving one or more days away from work. The Annual Survey represents a total of 2.25 million such cases reported in the United States in 1993 in private industry among those not self-employed, not in small farms, that is, fewer than 11 employees, and not in private household occupations. Cost estimates were based on a subset of 477,643 cases out of these 603,936 detailed cases. This subset was selected for two reasons. Cases with days lost during the last 2 months of 1993 were excluded to minimize the bias associated with the BLS requirement that lost work days not be recorded beyond December 31 for any year. Second, some data on days away from work could not be matched to medical cost data. In order that our estimates of total costs would reflect the value attributable to the 2.2 million cases, we re-allocated the weight of cases with missing diagnoses to the remaining cases in proportion to their presence in the original sample [Leigh et al., 2004].

Unlike the Annual Survey non-fatality data, we did not exclude any CFOI fatality data ($n = 6271$).

The costs of occupational injuries and illnesses can be divided into three broad categories: direct, indirect, and quality of life costs. Direct costs included payments for hospital, physician and allied health services, rehabilitation, nursing home care, home health care, medical equipment, burial costs, insurance administrative costs for medical claims, payments for mental health treatment, police, fire, emergency transport, coroner services, and property damage. Indirect costs referred to: the injured's productivity losses including wage losses and household production losses; the employer's productivity losses including time spent by supervisors and co-workers investigating incidents, juggling schedules, and recruiting and training replacements for injured workers; and administrative costs including the cost of administering workers' compensation programs. Quality of life costs referred to the value attributed to the pain and suffering experienced by injured workers and their families.

The costs presented are incidence-based and include all costs of an injury or illness over the injured worker's lifespan. Whenever costs extend more than a year, a discount rate of 2.5% is applied to compute their present value.

For non-fatal injuries and illnesses, medical costs were estimated separately for those hospitalized and those not hospitalized [Miller et al., 1998].

Indirect or productivity losses for non-fatal cases can be divided into short-term and long-term losses including wage and household productivity losses. To account for the censoring of reported days away from work, a statistical model was developed to estimate the length of time these censored cases would have taken to be resolved [Leigh et al., 2004].

For short-term wage losses, the number of days away from work is multiplied by the predicted daily wage. The predicted wage rates were derived from a linear regression of hourly wages on demographic and socioeconomic characteristics using the monthly files of the 1993 Current Population Survey (CPS) [Weinberg et al., 1999].

Long-term wage losses resulting from permanent total disability were based on estimates of lifetime wage loss calculated using an age–earnings model [Hodgson and Meiners, 1982]. These estimates were combined with probabilities of permanent partial injuries for cases with four or more days away from work.

Following Miller et al. [1998], household work loss duration is estimated by the number of days away from work times 365/243 times 0.9 [Marquis, 1992].

Pain and suffering costs were estimated using jury verdicts in tort liability [Rodgers, 1993; Miller et al., 1996, 1998; Leigh et al., 2004]. Punitive damages were excluded. We attributed a constant medical cost of $510 to medically treated cases without any work loss and $406 for cases with restricted work activities. These $510 and $406 were estimated from the National Health Interview Survey.

For fatal cases, medical costs were attributed a constant amount of $12,000 for each fatality [Miller and Galbraith, 1995]. Using the specialist cost approach outlined in Douglas et al. [1990], lifetime household work losses were also calculated. For pain and suffering costs for fatalities, estimates of the willingness-to-pay to avoid risk of fatal injury are used [Miller, 1990].

RESULTS

Table I presents total costs within cost categories for fatalities, non-fatal cases, and combined. To remain consistent with the Annual Survey, deaths of government employees were excluded. Total costs were $77,181 million in 1993. Selected percents appear in parentheses. For example, reading in the final column, roughly 6.0% of all

TABLE I. Total Costs Within Cost Categories (Millions $ 1993)

	Fatal	Non-fatal	Total
Medical cost	$69	$4,533	$4,602 (6.0%)
Wage loss	$3,688	$30,423	$34,111 (44.2%)
Household production loss	$706	$7,698	$8,404 (10.9%)
Pain and suffering loss	$11,812	$18,202	$30,014 (38.9%)
Total	$16,275 million (21.1%)	$60,856 million (78.9%)	$77,131 million

costs were medical and 44.2% were wage loss. Reading in the final row, fatalities accounted for 21.1% of all costs.

Table II presents cost-per-employed-worker (not cost-per-injured worker) by age and gender (government employee deaths again excluded). Costs of non-fatal injuries and illnesses that did not result in at least 1 day of work loss were excluded. Roughly 78.9%, or $60,856 million, was attributed to non-fatal cases involving days away from work and 21.1%, or $16,275 million, was attributed to fatal cases. The highest total cost-per-worker (second column) occurred among 25 to 34 year olds ($997) and the lowest to persons 17 years or younger ($655). Costs for non-fatal cases (third column) were the highest for 25–34 year olds ($803) and the lowest for ages 17 and below ($270). In the last column, persons 17 years and younger had, by far, the highest percentage of cost in the fatal cost category but after age 17, the lowest percentage of fatal costs (16.4%) occurred among 18–24 year olds. A gradual increase in the percentage (to 25%) occurred for ages 55–64 and a sharp increase (to 32.7%) occurred for ages 65 and over. Men, on average, experienced non-fatal costs roughly double that of women ($897 vs. $462), and experienced fatal costs nearly 10 times those of women ($315 vs. $33).

Table III presents data on costs within major occupation groups ranked by cost-per-worker. On the combined fatal and non-fatal list, the highest cost-per-worker ($5,163 for farming, forestry, and fishing) was over 18 times the lowest ($279 for executives and managers). On the fatality cost list, the percentage of total costs attributed to fatalities for farming, forestry, and fishing (62.7%, in last column) was far higher than any of the others (which range from 7.9% to 32.9% in last column). Farming, forestry, and fishing ranked second on the non-fatal costs list.

There were differences in the rankings for fatal and non-fatal costs. Whereas the occupation labeled handlers, cleaners, and laborers were at the top of the non-fatal list, they placed fourth on the fatal list. Whereas executives and managers ranked at the bottom of the non-fatal lists, they ranked 10th on the fatal list.

There were also similarities in the rankings for fatal and non-fatal costs. Mechanics and repairers ranked 6th on both lists. Professionals ranked 13th on the non-fatal list and 12th on the fatal list. Transportation and material moving occupations ranked 3rd on the non-fatal list and 2nd on the fatal list. Finally, the top four occupation categories were the same on both the fatal and non-fatal list, but the order differed.

Table IV presents data on total costs (not cost-per-worker) of injuries (only) according to Nature of Injury. It is

TABLE II. Differences Across Age and Gender in Fatal and Non-Fatal Cases

	Total Employed Civilians[a]	Combined cost per employed worker[b]	Costs of non-fatal cases only, per employed worker	Costs of fatal cases only, per employed worker[b]	Percent contribution by fatalities[d]
All	91,932,100	$839[c]	$662	$177	—
Age Group					
≤17 yrs.	1,715,469	$655	$270	$385	58.8%
18–24 yrs.	13,054,857	$864	$723	$142	16.4%
25–34 yrs.	25,152,692	$997	$803	$194	19.5%
35–44 yrs.	22,948,876	$918	$723	$194	21.1%
45–54 yrs.	14,681,426	$831	$647	$184	22.1%
55–64 yrs.	7,584,461	$671	$503	$168	25.0%
≥65 yrs.	1,935,593	$681	$458	$223	32.7%
Gender					
Male	47,477,815	$1,211	$897	$315	26.0%
Female	39,595,559	$496	$462	$33	6.6%

[a]Data from 1993 March Supplement of the Current Population Survey for private industry workers, excluding self-employed, private household workers, and those on farms with fewer than 11 employees.
[b]Government employees were excluded from fatalities in this table.
[c]Total Costs: fatalities and non-fatalities ($77,131 million); non-fatalities only ($60,856 million, 79% of total); fatalities ($16,275 million, 21% of total).
[d]This percent applied within the row, for example, 58.8% indicates that $385 is 58.8% of $655 for persons age 17 and younger.

TABLE III. Differences Across Occupations in Fatal and Non-Fatal Costs-Per-Employed Worker

Fatal and non-fatal combined			Non-fatal only			Fatal only		
Rank	Occupation	Cost per worker	Rank	Occupation	Cost per worker	Rank	Occupation	Cost per worker and (percent of combined)
1	Farming, forestry, fishing	$ 5,163	1	Handlers, cleaners, laborers	$ 2,166	1	Farming, forestry, fishing	$ 3,238 (62.7%)
2	Handlers, cleaners, laborers	$ 2,579	2	Farming, forestry, fishing	$ 1,925	2	Transportation, material moving	$ 849 (32.9%)
3	Transportation, material moving	$ 2,489	3	Transportation, material moving	$ 1,641	3	Construction trades, extractive, occupations	$ 569 (22.8%)
4	Construction trades, extractive occupation	$ 2,048	4	Construction trades, extractive occupations	$ 1,479	4	Handlers, cleaners, laborers	$ 414 (20.2%)
5	Machine operators, assemblers, inspectors	$ 1,533	5	Machine operators, assemblers, inspectors	$ 1,448	5	Protective service	$ 402 (26.2%)
6	Mechanics, repairers	$ 1,533	6	Mechanics, repairers	$ 1,259	6	Mechanics, repairers	$ 273 (17.8%)
7	Other precision, craft, repair	$ 1,111	7	Other precision, craft, repair	$ 1,006	7	Technicians	$ 145 (13.0%)
8	Protective service	$ 1,012	8	Other service	$ 760	8	Sales	$ 132 (13.0%)
9	Other service	$ 825	9	Protective service	$ 610	9	Other precision, craft, repair	$ 105 (12.7%)
10	Technicians	$ 685	10	Technicians	$ 540	10	Executive, manager	$ 99 (14.5%)
11	Sales	$ 402	11	Administrative support	$ 402	11	Machine operators, assemblers, inspectors	$ 85 (21.1%)
12	Administrative support	$ 317	12	Sales	$ 270	12	Professionals	$ 79 (24.9%)
13	Professionals	$ 294	13	Professionals	$ 215	13	Other service	$ 64 (21.8%)
14	Executive, manager	$ 279	14	Executive, manager	$ 179	14	Administrative support	$ 22 (7.9%)

Denominator data on employment excluded government workers and the self-employed.
Denominator data were from 1993 March supplement to the Current Population Survey.

estimated that 85.3% of fatal and non-fatal costs due to injuries and 14.7% due to illnesses. Reading down the list, ''back sprains and strains'' were first with $12.381 billion. These represented nearly 16% of all costs for injuries and illnesses. Since ''back sprains and strains'' caused no deaths, ''back sprains and strains'' contributed 20% of all non-fatal costs involving days away from work. Next on the list were ''other sprains and strains'' with a combined cost of $10.360 billion or 13% of all costs and 17% of costs for non-fatal cases. If we combine these first two Nature categories, we estimated 37% of non-fatal costs were attributed to all sprains and strains. In third position were ''fractures, crushing, and dislocations except head and neck.'' Total costs were $8.959 billion with roughly 1% of the costs accounted for by deaths. Fourth on the list were ''amputations and enucleations, including gunshot wounds.'' Of all gunshot costs, 98% were due to death. This 98% was the highest percentage due to deaths in Table IV. ''Poisonings, including snake and insect bites,'' position 14, were especially deadly: 82% of poisoning costs were associated with fatalities.

A generalization from Table IV is that apart from injuries to bones, nerves, and spinal cord, costs for any given condition were generally almost all non-fatal or almost all fatal. There was a bimodal distribution. Nature of injuries with high percentages in the fatal cost category included: gunshot; multiple injuries; other injuries including drowning; intra-cranial hemorrhage; and poisonings.

Table V provides data for the ''top 10'' cost-generating diseases. Total illness costs were $11.240 billion. The largest category was nervous system and sense organ diseases, including carpal tunnel syndrome. The cost was $4.043 billion. The percent contribution to all illnesses due to

TABLE IV. Differences Across Nature of Injury in Fatal and Non-Fatal Total Costs

Rank	Occupation	Combined costs in millions $	Non-fatal only in millions $	Fatal costs in millions $ (percent of combined cost)
1	Back sprains and strains	$ 12,381	$ 12,381	$0 (0%)
2	Other sprains and strains	$ 10,360	$ 10,338	$ 22 (0.2%)
3	Fractures, crushing, dislocations except head & neck	$ 8,959	$ 8,861	$98 (1.0%)
4	Amputations, enucleations, gunshot wounds	$ 7,975	$ 2,710	$ 5,265 (66%)
		$ 3,138 (gunshot only)	$ 50 (gunshot only)	$ 3,088 (gunshot only) (98%)
5	Open wounds, avulsion, animal & insect bites			
	$ 5,287	$ 4,900	$ 387 (7.3%)	
6	Other multiple injuries	$ 4,610	$ 404	$ 4,206 (91%)
7	Surface wounds, abrasions, bruises, friction burns	$ 3,979	$ 3,970	$9.00 (0.2%)
8	Other injuries, drowning, suffocation, electrocution, air embolism	$ 3,882	$ 1,212	$ 2,670 (69%)
9	Intra-cranial, cerebral hemorrhages, concussions	$ 3,340	$ 289	$ 3,051 (91%)
10	Burns: chemical, electrical, heat	$ 2,363	$ 1,907	$ 456 (19%)
11	Sprain, cuts & other	$ 886	$ 886	$ 0 (0%)
12	Injury to bones, nerves, spinal cord	$ 828	$ 374	$ 454 (55%)
13	Fractures and other injuries	$ 794	$ 785	$ 9 (1.1%)
14	Poisonings, including snake and insect bites	$ 582	$ 102	$ 480 (82%)

nervous system diseases was 36%; the contribution to all injuries and illnesses was 5%. These nervous system and sense organ diseases did not cause any fatalities. Second on the list were digestive disease, which included hernia. These generated costs of $1.995 billion or 17.8% of all disease costs. Third was musculoskeletal system and connective diseases, which included tendonitis. Listed 8th was ''mental disorders,'' which included alcohol and drug abuse. Listed

TABLE V. Differences Across Diseases in Fatal and Non-Fatal Costs

Rank	Disease condition	Total costs in millions $	Non-fatal only in millions $	Fatal costs only in millions $ (percent of combined costs)
1	Nervous system and sense organs disease, including carpal tunnel syndrome	$ 4,043	$ 4,043	$ 0 (0%)
2	Digestive system diseases and disorders, including hernia	$ 1,995	$ 1,995	$ 0 (0%)
3	Musculoskeletal system and connective diseases, tendonitis	$ 1,954	$ 1,954	$ 0 (0%)
4	Other symptoms	$ 830	$ 830	$ 0 (0%)
5	Circulatory system diseases	$ 823	$ 774	$ 49 (6.0%)
6	Disease of the skin (dermatitis) and subcutaneous tissue	$ 507	$ 507	$ 0 (0%)
7	Respiratory system diseases including pneumoconiosis	$ 477	$ 468	$ 9 (1.9%)
8	Mental disorders	$ 445	$ 445	$ 0 (0%)
9	Other diseases	$ 85	$ 6	$ 79 (92.9%)
10	Viral diseases	$ 81	$ 74	$ 7 (8.6%)

10th was ''viral diseases,'' which included hepatitis C. No cancers were reported in this BLS Annual Survey sample in 1993.

Table VI presents data on race and ethnic differences, but for only non-fatal costs. Because of inconsistencies across data sets involving race and ethnicity classifications, we could not calculate fatality costs or costs within all Nature and Event categories. The data in Table VI were nevertheless internally consistent and therefore allowed for within-table comparisons. These were total costs, not costs-per-worker. The first two columns of numbers belonged to distinct groups: white, non-Hispanic; and African-American, non-Hispanic. The third column combined Hispanics, Asians, and Native Americans (subjects not reporting their

TABLE VI. Differences Across Race in Non-Fatal Costs Only

	Total costs in millions of dollars (U.S.)		
Category	**White Non-Hispanic (%)**	**African-American Non-Hispanic (%)**	**Hispanic, Asian, Native American (%)**
Total	$35,077	$5,081	$6,188
Gender			
Male	$24,829 (70.8%)	$3,194 (62.9%)	$4,625 (74.7%)
Female	$10,248 (29.2%)	$1,887 (37.1%)	$1,563 (25.3%)
Age			
17 years and younger	$250 (0.7%)	$36.0 (0.7%)	$24 (0.4%)
18–24 years	$5,454 (15.5%)	$655.0 (12.9%)	$1,171 (18.9%)
24–34 years	$11,271 (32.1%)	$1,947.0 (38.3%)	$2,306 (37.3%)
35–44 years	$9,409 (26.8%)	$1,425 (28.0%)	$1,568 (25.3%)
45–54 years	$5,563 (15.9%)	$749.9 (14.8%)	$771 (12.5%)
55–64 years	$2,375 (6.8%)	$245.0 (4.8%)	$319 (5.2%)
65 years & over	$755 (2.2%)	$22.9 (0.5%)	$29 (0.5%)
Selected Nature of Injuries			
Back sprains & strains	$6,824 (19.5%)	$1,124 (22.1%)	$1,265 (20.4%)
Other sprains & strains	$5,725 (16.3%)	$855 (16.8%)	$920 (14.9%)
Fractures, crushing, dislocation	$5,708 (16.3%)	$557 (11.0%)	$828 (13.4%)
Open wounds	$2,712 (7.7%)	$409 (8.0%)	$722 (11.7%)
Amputations, internal injuries, gunshot wounds	$1,555 (4.4%)	$288 (5.8%)	$441 (7.1%)
Surface wounds	$2,030 (5.8%)	$444 (8.7%)	$424 (6.8%)
Burns	$1,077 (3.1%)	$179 (3.5%)	$231 (3.7%)
Intracranial injuries	$181 (0.5%)	$22 (0.4%)	$24 (0.4%)
Heat, cold, environment	$37 (0.1%)	$10 (0.2%)	$4 (0.1%)
Selected Nature of Illnesses			
Carpal tunnel syndrome	$2,267 (6.5%)	$220 (4.3%)	$165 (2.7%)
Digestive disease	$1,339 (3.8%)	$92 (1.9%)	$188 (3.0%)
Musculoskeletal Disease	$1,093 (3.1%)	$165 (3.2%)	$153 (2.5%)
Circulatory disease	$640 (1.8%)	$16 (0.3%)	$15 (0.2%)
Respiratory disease	$204 (0.6%)	$43 (0.8%)	$35 (0.6%)
Skin and subcutaneous Tissue diseases	$260 (0.7%)	$41 (0.8%)	$62 (1.0%)
Mental disorders	$235 (0.7%)	$34 (0.7%)	$62 (1.0%)
Selected Events of Injury			
Assaults & violent acts	$418 (1.2%)	$120 (2.4%)	$85 (1.4%)
Falls	$5,750 (16.4%)	$713 (14.0%)	$1,005 (16.2%)

Sum for total row at the top is less than non-fatal total column in Table I because over 20% of cases did not report race.

ethnicity were excluded from analysis and they comprised over 20% of cases). The contribution of total costs by whites ($35,077 million), African-Americans ($5,081 million), and Hispanics, Asians, Native Americans ($6,188 million) represented 75.7%, 11.0%, and 13.3%, respectively, of the total. The percentages in Table V apply vertically, not horizontally. For example, 70.8% of cost for whites was attributed to men whereas 29.2% of costs for whites were attributed to women. The percentages for Nature of Injury and Nature of Illness were in the same category.

Black women experienced a disproportionately high share of costs (37.1%) compared to white women (29.2%) or Hispanics, Asians, Native Americans (25.3%). Greater than age 44, there was a trend toward smaller percentages among African-Americans and Hispanics, Asians, Native Americans. This was especially true for persons age 65 and over (whites, 2.2%; African Americans 0.5%; Hispanics, Asians, Native Americans 0.5%). These smaller percentages among older workers could result from the lower employment rates, lower labor force participation, and simply fewer living people among African-Americans and Hispanics greater than age 44 [U.S. Census Bureau, 1999]. Whites and Hispanics, Asians, and Native Americans experienced a disproportionately higher cost percentage of fractures and dislocations than African-Americans. African-Americans, on the other hand, experienced a higher percentage of costs for back sprains and strains, other sprains, surface wounds, and heat, cold, and environmental conditions. Whites with a disproportionate cost share of carpal tunnel syndrome, digestive diseases, and especially circulatory diseases were found. Whites had costs roughly six times those of African-Americans for circulatory disease. Whites experienced a higher disproportionate cost for falls than African-Americans. African-Americans, on the other hand, experienced a cost percentage that was double that for whites (2.4% vs. 1.2%) for assaults.

DISCUSSION

Costs for fatal and non-fatal occupational injuries and illnesses by age, sex, and ethnicity were examined. Of the total $77 billion in costs, approximately one-fifth was attributable to fatalities. The highest fatality-associated costs per employed worker occurred among workers aged 17 and younger. Men had higher costs than women. Farming, fishing, and forestry occupations had the highest cost per employed worker of all occupational groups and the highest percentage of costs as fatalities. Specific injuries and illnesses tended to have the majority of their associated costs in either fatalities (e.g., gunshot wounds) or in non-fatalities (e.g., strains and sprains). Strains and sprains represented the greatest economic burden, comprising over one-third of total costs. One implication of these results is that pain and suffering costs were considerable and exceeded the benefits paid by workers compensation.

Comparison to Literature

Other studies find age differences similar to ours. Landrigan and McCummon [1997] and Belville et al. [1993] find young teenagers (<18 years) at especially high risks for on-the-job deaths. The National Traumatic Occupational Fatality (NTOF) data set (National Institute for Occupational Safety and Health (NIOSH, 2000) as well as the Census of Fatal Occupational Injuries [Toscano and Windau, 1994] indicate a gradual rise in death rates from age 45 to age 64 and a sharp jump (nearly doubling) at age 65 and over.

A study on non-fatal cases finds high incidence rates for teenagers, and persons in their early 20's, but lower rates for all other ages, and the lowest rate of all among persons age 65 and over [Ruser, 1994]. Apart from the finding on the low cost per employed worker among persons less than 18, our results on non-fatal costs mirror those in Ruser [1994].

Previous studies have been consistent in their findings regarding gender differences, and these are consistent with our findings. Men have 9 to 10 times the occupational fatality rates of women [Toscano and Windau, 1994; NIOSH, 1993], and 50 to 80 percent higher rates for non-fatalities [Ruser, 1994]. One study on non-fatal cases with emergency room admissions finds a 68% higher risk for men than women [NIOSH, 2000].

Ruser [1994] finds the following results for numbers of cases within the Nature of injury and illness categories: sprains and strains, including back (44%), bruises, and contusions (10%), cuts and lacerations (7%), fractures (6%), multiple injuries (3%), heat and chemical burns (2%), carpal tunnel syndrome (1%), and amputations (<1%). Our results suggested that a ranking based solely on *number* of cases was inadequate if the goal was to measure total burden, including economic. Our cost results suggested fractures and amputations should rank higher than bruises, contusions, cuts, and lacerations. Our results also suggested that carpal tunnel syndrome contributed significantly more than 1% to the total burden.

Our results compare favorably to national estimates for workers compensation (WC) costs [Sengupta et al., 2005]. In 1993, WC paid $45,330 million in medical and wage-replacement benefits. This compares to our $38,713 million for medical and wage loss. Our estimate is less for two reasons. First, we excluded government workers, roughly 14% of the workforce. Second, we excluded cases that resulted in less than 1 day of work loss even though these cases comprise the majority in the Annual Survey. Our results are consistent with the literature that suggests large duplication between Annual Survey and WC records [Oleinick and Zaidman, 2004].

Limitations

A zero dollar value was put on productivity losses among persons with restricted work (light duty at work). This was a conservative assumption since persons working on restricted or light duty were probably not producing as much as they would be if they were fully recuperated and working at their usual job.

The Annual Survey was limited by excluding federal, state, and local government workers, workers on farms with fewer than 11 employees (which effectively excludes the majority of agricultural workers), and the self-employed. Moreover, economic incentives exist for workers to over and under-report injuries and for employers to under-report. Whereas these limitations figure prominently in an estimate of national total costs for all groups combined, they are less prominent for any group-by-group ranking, assuming these limitations apply equally across groups.

The source of these data was from 1993. To the extent that our cost estimates are similar to those for WC, total real (inflation-adjusted) costs likely declined roughly 28% from 1993 to 2003 [Sengupta et al., 2005]. Similar trends are apparent for incidence of cases: non-fatal, and fatal cases decreased roughly 36% and 12%, respectively, from 1993 to 2003. (www.bls.gov/iif/home.htm). Increasing percentages of women and Hispanics joined the workforce from 1993 to 2003, likely increasing their share of costs(www.census.gov/statab/www).

Direct cost estimates relied heavily on WC costs and charges. WC medical costs are alleged to be inflated [Baker and Krueger, 1995] as the WC system operates on a fee-for-service basis. But these allegations have not fully adjusted for the costs to physicians and providers for the paperwork and litigation that accompanies WC claims [Leigh and Ward, 1997]. In any case, WC cost data do have the advantage that costs and charges are virtually identical and that there are no co-payments or deductibles to account for.

Another limitation is that the BLS method for classifying injuries and illnesses may be deficient. The BLS uses American National Standards Institute (ANSI) codes. The BLS may consider using International Classification of Disease—Ninth Edition (ICD-9) codes. The ICD-9 has roughly 80 special E-codes for injuries and hundreds of disease codes. The ICD-9 has the great advantage of being extensively used by medical researchers. ANSI codes are seldom seen in medical journals.

A final limitation involves illnesses. The BLS recorded no cancer or nervous system deaths in 1993 and only a small amount for circulatory deaths ($49 million) and an even smaller amount for respiratory deaths ($9 million). This does not compare favorably to epidemiological estimates [Leigh et al., 1997; Steenland et al., 2003]. Assuming $2 million for each death, our estimates imply there were 25 circulatory deaths and 5 respiratory deaths in the BLS data. But Leigh et al. [1997] estimated 41,367 cancer deaths, 7,638 circulatory disease deaths, 10,290 respiratory deaths, 538 nervous system deaths, and 460 renal disease deaths for a total of 60,293 deaths in 1992. Job-related injuries to joints early in life could result in osteoarthritis in these joints later in life. In addition, job-related arthritis costs roughly 8.3 billion in 1994 [Leigh et al., 2001]. This discrepancy is addressed in Leigh and Robbins [2004].

In conclusion, data on costs across demographic and socioeconomic categories as well as categories of occupational injuries and illnesses is presented. These data may be useful since costs are becoming increasing important factors in debates among employers, unions, workers, taxpayers, and policy makers regarding Occupational Safety and Health and workers compensation policies.

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