Costs of Occupational Injury and Illness Across States

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The objective of this study was to estimate occupational injury and illness costs per worker across states. Analysis was conducted on injury data from the Bureau of Labor Statistics and costs data from workers' compensation records. The following states were at the top of the list for average cost (cost per worker): West Virginia, Alaska, Wyoming, Kentucky, and Mississippi. The following states were at the bottom: South Carolina, Delaware, Minnesota, Massachusetts, and New Hampshire. The following variables (and signs on regression coefficients comparing this industry with manufacturing) were important in explaining the variation across states: employment in farming (+), agricultural service, forestry, fishing (+), mining (+), transportation and public utilities (+), wholesale trade (-), and finance, insurance, real estate (-). Southern and especially Western states were disproportionately represented in the high cost per worker list. A significant amount of the variation in cost per worker across states was explained by the composition of industries. (J Occup Environ Med. *2004;46:1084–1095*)

Recent estimates have demonstrated that the costs of occupational injury and illness are significant, on a par with the costs of cancer.[1–3] We are not aware of any study that estimates how these costs are distributed across states, ie, which states generate the most and the least costs. Yet information on costs across states would be useful in our era of managed care.

Data and Methods

The Bureau of Labor Statistics' (BLS) Annual Survey, which collects information on nonfatal cases, and the Census of Fatal Occupational Injuries (CFOI) were the 2 data sources that served as templates onto which we merged cost information from other sources described subsequently.[4–7] Medical cost information came from summaries of workers' compensation (WC) records in the Detailed Claims Information dataset, the National Health Interview Survey, and prior work on medical costs for fatalities.[8] We transformed work loss information from the Annual Survey into dollar values using wage data from the 1993 monthly Current Population Survey (CPS) files.[9] We used a survey of jury verdicts related to occupational injuries and illnesses to predict pain and suffering costs for nonfatal cases in the Annual Survey.[10–12]

In this section, we present a brief description of our methods. Thorough descriptions are available in unpublished Appendices A and B, available from http://phs.ucdavis.edu/Fac/Leigh/CostsAcrossIndustries.htm. The appendices are as-

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DOI: 10.1097/01.jom.0000141659.17062.4b

sociated with a companion paper analyzing costs across industries.[13]

The 1993 Annual Survey contains detailed information on 603,936 cases of nonfatal occupational injury and illness cases involving 1 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, and not in private household occupations. Our cost estimates were based on a subset of 477,643 cases of these 603,936 detailed cases. This subset was selected for 2 reasons. First, we excluded cases with days lost during the last 2 months of 1993 to minimize the bias associated with the BLS institutional requirement that days away from work would not be recorded beyond December 31 for any given year. Second, some data on days away from work could not be matched to medical cost data. So our estimates of total costs would reflect the value attributable to the 2.2 million cases, we rescaled the case weights in the original sample. Specifically, we reallocated the weight of cases with missing diagnoses to the remaining cases in proportion to their presence in the original sample (see Appendix B).

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

The costs of occupational injuries and illnesses can be divided into 3 broad categories: direct costs, indirect costs, and quality-of-life costs. Direct costs include 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 refer to: 1) victim productivity losses, which include wage losses and household production losses; 2) employer productivity losses, which is time spent by supervisors and coworkers investigating incidents, juggling schedules, and recruiting and training replacements for injured workers; and 3) administrative costs, which include the cost of administering WC programs. Quality-of-life costs refer to the value attributed to the pain and suffering of victims and their families.

The costs were incidence-based and included all costs of an injury or illness over the victim's lifespan. Whenever costs extend more than a year, we applied a discount rate of 2.5% to compute their present value.

For nonfatal injuries, medical costs were estimated separately for those hospitalized and those not hospitalized by diagnosis. The medical costs for hospitalized victims were the product of 5 diagnosis-specific factors involving the following: length of stay, hospital cost per day, ratio of professional fee payments to hospital payments, ratio of costs in the first 6 months to costs during the initial admission, and ratio of the present value of lifetime medical payments to payments in the first 6 months. The medical costs for nonhospitalized victims were the product of 5 diagnosis-specific factors involving the following: the probability that an injury or illness will require medical treatment, the number of visits to physicians' offices or emergency departments, payments per nonhospitalized visit, ratio of payments including pharmaceutical and ancillary expenses to payments for medical visits, and ratio of the present value of lifetime medical payments per nonhospitalized case to payments in the first 6 months.

For nonfatal illnesses, medical costs were computed in a simpler manner because less information was available. The annual medical spending for hospitalizations, for example, was computed as the product of length of stay, cost per day, and the ratio of hospital plus professional fee payments to hospital payments.

Indirect or productivity losses for nonfatal 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, we developed a statistical model to estimate the length of time these censored cases would have taken to be resolved (Appendix B).

For short-term wage losses, we multiplied the number of days away from work by the predicted daily wage rate received by a worker of the same age group, race, gender, industry, and occupation as the injury victim. The predicted wage rates were derived from a linear regression of hourly wages on these characteristics using the monthly files of the 1993 CPS.[9]

Long-term wage losses resulting from permanent total disability were based on probabilities of permanent partial injuries and associated impairment fraction as well as the expected lifetime loss for cases with 4 or more days away from work.

Following Miller et al.[12] we estimated household work loss duration by the number of days away from work times 365/243 times 0.9. These adjustments account for the fact that household work may be lost on days when wage work is not and also reflect results in Marquis[14] showing that 90% of the time lost to wage work is also lost to household work. Using the specialist cost approach outlined in Douglass et al.,[15] lifetime household work losses were also calculated. Pain and suffering costs were estimated using jury verdicts in tort liability[10–12] as well as estimates of the willingness-to-pay to avoid risk of fatal injury[16] (Appendix B). Punitive damages were excluded.

Linear regression was used to assess partial correlations between costs on the one hand and percent of employment in broad industry divisions on the other. Industry employment was drawn from BLS.[17]

Results

Table 1 presents descriptive statistics. States appear alphabetically and each state has subcategories for men

TABLE 1
Descriptive Statistics Across States, 1993

State	Estimated number of nonfatal occupational injuries and illnesses with days away from work, private industry*	Estimated number of occupational injury (only) deaths, private industry†	Estimated population (thousands)‡	Estimated number in labor force (thousands)§	Estimated number of non-government employees‖
Alabama	33,522	126	4181	1990	1345
Men	23,856	109	2005	1089	736
Women	9666	17	2176	901	609
Alaska	6146	—	598	298	175
Men	4537	—	316	163	96
Women	1609	—	282	135	79
Arizona	32,936	—	3945	1837	1260
Men	22,579	—	1948	1008	691
Women	10,357	—	1997	829	569
Arkansas	24,346	—	2426	1163	811
Men	15,164	—	1170	630	439
Women	9182	—	1256	533	372
California	241,461	573	31,217	15,259	9888
Men	160,420	517	15,623	8589	5566
Women	81,041	56	15,594	6670	4322
Colorado	34,943	89	3564	1904	1337
Men	23,709	83	1766	1025	720
Women	11,234	6	1797	879	617
Connecticut	35,337	—	3278	1788	1281
Men	22,687	—	1588	966	692
Women	12,650	—	1690	822	589
Delaware	6437	—	698	373	297
Men	4170	—	339	205	163
Women	2267	—	359	168	134
District of Columbia	4795	—	579	306	386
Men	2990	—	270	154	194
Women	1805	—	309	152	192
Florida	111,947	315	13,726	6628	4567
Men	73,142	291	6648	3567	2458
Women	38,805	24	7078	3061	2109
Georgia	56,173	201	6902	3467	2517
Men	36,274	183	3353	1812	1315
Women	19,899	18	3549	1655	1202
Hawaii	17,356	—	1166	583	421
Men	12,081	—	591	306	221
Women	5275	—	575	277	200
Idaho	13,143	—	1100	545	337
Men	9838	—	549	303	187
Women	3305	—	552	242	150
Illinois	90,568	230	11,686	5983	4449
Men	64,658	220	5682	3249	2416
Women	25,910	10	6003	2734	2033
Indiana	71,487	121	5706	2937	2174
Men	46,559	109	2770	1562	1156
Women	24,928	12	2935	1375	1018
Iowa	29,510	—	2821	1550	1032
Men	19,926	—	1370	848	565
Women	9584	—	1451	702	467
Kansas	25,354	86	2535	1318	898
Men	17,178	79	1245	717	489
Women	8176	7	1290	601	409
Kentucky	46,514	124	3794	1794	1249
Men	29,965	117	1838	984	685
Women	16,549	7	1956	810	564
Louisiana	27,402	—	4290	1879	1281
Men	18,380	—	2064	1046	713
Women	9022	—	2227	833	568

TABLE 1
Continued

State	Estimated number of nonfatal occupational injuries and illnesses with days away from work, private industry*	Estimated number of occupational injury (only) deaths, private industry†	Estimated population (thousands)‡	Estimated number in labor force (thousands)§	Estimated number of non-government employees‖
Maine	12,378	—	1240	631	413
Men	8105	—	604	335	219
Women	4273	—	636	296	194
Maryland	39,335	67	4958	2672	1649
Men	26,332	61	2407	1385	855
Women	13,003	6	2551	1287	794
Massachusetts	52,470	—	6018	3170	2381
Men	34,718	—	2895	1702	1278
Women	17,752	—	3123	1468	1103
Michigan	86,073	144	9460	4702	3310
Men	59,039	134	4598	2591	1824
Women	27,034	10	4862	2111	1486
Minnesota	38,235	101	4524	2466	1878
Men	25,731	95	2223	1311	998
Women	12,504	6	2301	1155	880
Mississippi	26,983	109	2640	1212	764
Men	18,226	101	1265	680	429
Women	8757	8	1375	532	335
Missouri	46,538	121	5235	2650	1960
Men	29,693	102	2527	1409	1042
Women	16,845	19	2709	1241	918
Montana	5502	—	841	427	247
Men	3623	—	418	234	135
Women	1879	—	423	193	112
Nebraska	17,360	71	1613	853	600
Men	11,633	65	787	443	312
Women	5727	6	826	410	288
Nevada	18,513	—	1382	745	568
Men	12,767	—	703	411	313
Women	5746	—	679	334	255
New Hampshire	10,685	—	1124	620	415
Men	6998	—	551	338	226
Women	3687	—	573	282	189
New Jersey	67,341	118	7859	4001	2834
Men	47,246	110	3801	2198	1557
Women	20,095	8	4058	1803	1277
New Mexico	12,705	—	1616	756	453
Men	8344	—	795	423	253
Women	4361	—	820	333	200
New York	126,216	306	18,153	8649	6268
Men	82,506	287	8723	4663	3379
Women	43,710	19	9431	3986	2889
North Carolina	56,541	188	6952	3555	2691
Men	36,564	175	3373	1873	1418
Women	19,977	13	3579	1682	1273
North Dakota	4845	29	637	318	216
Men	3565	29	317	169	115
Women	1280	0	320	149	101
Ohio	97,432	171	11,061	5488	4129
Men	67,238	161	5337	2974	2238
Women	30,194	10	5724	2514	1891
Oklahoma	30,299	79	3233	1524	950
Men	19,761	74	1576	841	524
Women	10,538	5	1657	683	426
Oregon	32,827	73	3035	1587	1056
Men	21,966	64	1495	869	578
Women	10,861	9	1540	718	478

TABLE 1
Continued

State	Estimated number of nonfatal occupational injuries and illnesses with days away from work, private industry*	Estimated number of occupational injury (only) deaths, private industry†	Estimated population (thousands)‡	Estimated number in labor force (thousands)§	Estimated number of non-government employees‖
Pennsylvania	105,820	228	12,030	5893	4385
Men	71,651	213	5774	3229	2403
Women	34,169	15	6256	2664	1982
Rhode Island	11,171	12	1000	512	361
Men	6685	12	480	268	189
Women	4486	0	519	244	172
South Carolina	23,777	80	3630	1823	1257
Men	16,432	73	1754	978	674
Women	7345	7	1876	845	583
South Dakota	8023	—	716	360	248
Men	5088	—	353	197	136
Women	2935	—	363	163	112
Tennessee	58,305	143	5094	2500	1908
Men	37,775	128	2455	1315	1004
Women	20,530	15	2640	1185	904
Texas	131,291	473	18,022	9149	6032
Men	91,558	447	8880	5095	3359
Women	39,733	26	9142	4054	2673
Utah	17,406	—	1860	910	643
Men	12,358	—	925	502	355
Women	5048	—	935	408	288
Vermont	5683	7	576	316	207
Men	3690	7	283	164	107
Women	1993	0	293	152	100
Virginia	50,214	109	6473	3376	2256
Men	34,661	94	3173	1793	1198
Women	15,553	15	3300	1583	1058
Washington	53,011	106	5259	2693	1803
Men	36,689	94	2611	1465	981
Women	16,322	12	2648	1228	822
West Virginia	22,390	—	1818	786	516
Men	15,137	—	875	448	294
Women	7253	—	943	338	222
Wisconsin	68,854	117	5044	2715	2025
Men	47,469	111	2473	1439	1073
Women	21,385	6	2572	1276	952
Wyoming	4441	—	470	239	149
Men	3272	—	236	131	82
Women	1169	—	234	108	67

Sources: * Our study.

†Census of Fatal Occupational Injuries, Bureau of Labor Statistics. The BLS does not allow numbers for publication when 1 to 4 deaths occurred in a category. This frequently happens with women. As a result, whenever female deaths number 1 to 4, we did not report male or total deaths. Our total cost analysis, however, did include all female deaths.

‡Byerly and Deardorff 1995. National and State Population Estimates: 1990 to 1994, US Bureau of the Census, Current Population Reports, pp. 25–1127. Washington, DC: US Government Printing Office; 1995.

§Statistical Abstract of the United States: 1994, 114th ed. Washington, DC: US Bureau of the Census; 1994.

‖US Bureau of the Census (1994). We assumed the same percent of men and women employed as non-government employees as were in the labor force (column 4).

and women. The first column of numbers is our estimates of the number of cases of nonfatal injuries and illnesses. Each of these cases involved at least 1 day of work loss. The next column presents data on the number of occupational injury deaths. These numbers were estimated by the BLS, not us, and were drawn from the CFOI.[4] Some fatality data are not reported for confidentiality reasons (ie, 1–4 deaths for either men or women). Columns 3, 4, and 5 present estimates for population,[18] number of persons in the la-

bor force,[19] and number of nongovernment employees[19] (ie, private sector workers who are not self-employed). We estimated gender differences in column 5 assuming the same percentage of men and women estimated for the labor force applied to nongovernment employees.

Men accounted for more nonfatal cases and far more fatal cases than women. Part of this disparity was explained by the greater number of men in the labor force and part the result of the nature of jobs selected by men and women. In general, disparities across states followed a similar pattern. States with larger populations, more in the labor force, and more nongovernment employees generated more nonfatal and fatal cases. As shown subsequently, the nature of industries in the states also explained interstate differences.

Table 2 presents the 50 states ranked according to average costs, ie, total costs divided by the number of nongovernment, nonself-employed workers. Six columns of numbers appear: costs per worker for all nonfatal cases involving work loss and fatal cases, total (not per worker) cost for all nonfatal cases involving work loss, total (not per worker) cost for all injury fatal cases, total cost for nonfatal and fatal cases, percent of U.S. GDP corresponding to total cost for nonfatal and fatal cases, and percent of total nonfatal and fatal costs contributed by deaths only. The cost per worker refers to employed worker, whether or not injured. Cost per worker is not cost per injured worker. Some numbers in parentheses are attached to the percents in column 6. These numbers indicate the rank of the state (top 5, bottom 5) according to the percent contribution resulting from deaths. For example, the (1) for Alaska in the last column indicates that Alaska ranked first in percent of all costs attributed to fatalities.

The 10 states with the highest cost per worker were: West Virginia, Alaska, Wyoming, Kentucky, Mississippi, Idaho, Oklahoma, Hawaii, New Mexico, and Nebraska. There were disproportionate numbers of southern and western states in this "top 10" list. The 10 states with the lowest cost per worker were: Ohio, Illinois, Virginia, Maryland, New York, South Carolina, Delaware (tie), Minnesota (tie), Massachusetts, and New Hampshire. There were no western states and only 2 southern states in this "bottom 10" list.

Data were available on the District of Columbia. We did not include DC in our cost per worker analysis, however. It was an outlier. It contained, by far, the highest percent of government workers (not included in the Annual Survey), the lowest cost per worker, the lowest percent employment in farming, in construction, in manufacturing, transportation, wholesale, and retail.

The second, third, fourth, and fifth column amounts (total, not per worker) were not ranked. Had we ranked them, they would have fairly closely followed the population size of the state (Table 1). For example, the states with the greatest combined (fatal and nonfatal) costs were California ($8481), Texas ($5727), and New York ($4432). These states ranked first, second, and third, respectively, in population in 1993.[18] The states with the least total costs were Vermont ($155), Delaware ($200), and North Dakota ($220). These 3 states ranked 49th, 46th, and 47th, respectively, in population in 1993.[18] Wyoming and Alaska ranked 50th and 48th, respectively.

The final column amounts, percent of total costs attributed to fatalities only, were not ranked, except for the top and bottom 5 (rankings appear in parentheses). The top 5 were Alaska (1), Wyoming (2), Montana (3), North Dakota (4), and Louisiana (5). The bottom 5 were: Michigan (46), New Hampshire (47), Rhode Island (48), Vermont (49), and Connecticut (50). We found western states disproportionately in the top 5 and northeastern states in the bottom 5.

Figure 1 presents a picture of the states with information on costs per worker. Cost, in the figure, includes nonfatal, work loss cases combined with fatal cases. The darker the state, the more costly per worker. Again, southern and especially western states generated the greatest cost per worker.

The next 2 tables attempt to answer why some states have high costs and others low costs. It is well-known that injury and illness rates (cases per worker within 1 year) vary considerably across industries. The composition of industrial employment within any given state, therefore, should partially explain why some states were high, whereas others were low. We regressed the states' cost per worker against 10 covariates representing percent of employment within major industries. Results appear in Table 3.

The 11 major industries (and mean percent of national employment in 1993) were: farming (2.7%), agricultural service, forestry, fishing (1.2%), mining (0.9%), construction (5.1%), manufacturing (12.5%), transportation (4.7%), wholesale (4.3%), retail (16.7%), finance, insurance, and real estate (6.9%), service (28.6%), and government (16.4%).[17] The dependent variable was cost per worker for each state (mean = $973). We used manufacturing as our reference industry because it is large and because it ranks in the middle of these major industries according to death rates.[4]

Statistically significant variables with P values <0.10 in a 2-tailed test (and their corresponding signs in correlation with costs) were: agricultural service, forestry, and fishing (+); mining (+); transportation and public utilities (+); wholesale (-); and finance, insurance, and real estate (-). The R^2 in the regression was 0.733, indicating that 73% of the variance was explained in this cross-section regression.

Table 4 presents the top and bottom 10 states ranked by costs per worker together with data on their rankings from each of the statistically significant covariates. For ex-

TABLE 2
Costs of Nonfatal Cases With at Least One Day of Work Loss and Fatal Injury Across States

Rank	State	Cost per employee*	Costs of nonfatal cases ($ millions)	Cost of fatal injuries ($ millions)	Combined cost for fatal and nonfatal cases ($ millions)	Percent GDP†	Percent (and top 5, bottom 5 rank) of costs resulting from fatalities only
1	West Virginia	$1979	$ 834	$ 187	$1021	0.0156%	18.3%
2	Alaska	$1978	$ 160	$ 187	$ 347	0.0053%	53.9%(1)
3	Wyoming	$1602	$ 137	$ 102	$ 239	0.0037%	42.7%(2)
4	Kentucky	$1424	$1374	$ 405	$1779	0.0272%	22.8%
5	Mississippi	$1344	$ 684	$ 342	$1027	0.0157%	33.3%
6	Idaho	$1265	$ 305	$ 122	$ 427	0.0065%	26.6%
7	Oklahoma	$1222	$ 917	$ 243	$1161	0.0178%	20.9%
8	Hawaii	$1131	$ 403	$ 74	$ 476	0.0073%	15.50%
9	New Mexico	$1128	$ 355	$ 156	$ 511	0.0078%	30.5%
10	Nebraska	$1117	$ 450	$ 221	$ 670	0.0103%	33.0%
11	Montana	$1095	$ 163	$ 108	$ 271	0.0041%	39.9%(3)
12	Kansas (tie)	$1091	$ 700	$ 280	$ 980	0.0150%	28.6%
13	South Dakota (tie)	$1091	$ 191	$ 79	$ 271	0.0041%	29.2%
14	Nevada	$1067	$ 499	$ 108	$ 606	0.0093%	17.8%
15	Wisconsin	$1046	$1726	$ 391	$2117	0.0324%	18.5%
16	Arkansas	$1022	$ 628	$ 201	$ 829	0.0127%	24.2%
17	North Dakota	$1019	$ 135	$ 85	$ 220	0.0034%	38.6%(4)
18	Tennessee	$1015	$1500	$ 436	$1936	0.0296%	22.5%
19	Utah	$1004	$ 458	$ 187	$ 645	0.0099%	29.0%
20	Louisiana	$ 995	$ 791	$ 484	$1275	0.0195%	38.0%(5)
21	Indiana	$ 992	$1772	$ 385	$2157	0.0330%	17.8%
22	Oregon	$ 965	$ 782	$ 238	$1020	0.0156%	23.3%
23	Iowa	$ 961	$ 743	$ 249	$ 992	0.0152%	25.1%
24	Texas	$ 949	$4230	$ 497	$5727	0.0877%	26.1%
25	New Jersey	$ 936	$2243	$ 410	$2653	0.0406%	15.5%
26	Rhode Island	$ 933	$ 291	$ 45	$ 337	0.0052%	13.4%(48)
27	Michigan	$ 927	$2617	$ 453	$3070	0.0470%	14.8%(46)
28	Alabama	$ 924	$ 851	$ 391	$1242	0.0190%	31.5%
29	Colorado	$ 903	$ 927	$ 280	$1207	0.0185%	23.2%
30	Maine	$ 902	$ 316	$ 57	$ 373	0.0057%	15.3%
31	Pennsylvania	$ 885	$3200	$ 682	$3882	0.0594%	17.6%
32	Washington	$ 864	$1241	$ 317	$1558	0.0238%	20.3%
33	California	$ 858	$6621	$1860	$8481	0.1298%	21.9%
34	Missouri	$ 810	$1217	$ 371	$1588	0.0243%	23.4%
35	Georgia	$ 809	$1385	$ 651	$2036	0.0312%	32.0%
36	Arizona	$ 789	$ 838	$ 156	$ 994	0.0152%	15.7%
37	Florida	$ 776	$2566	$ 977	$3542	0.0542%	27.6%
38	North Carolina	$ 765	$1453	$ 606	$2059	0.0315%	29.4%
39	Vermont	$ 750	$ 135	$ 20	$ 155	0.0024%	12.9%(49)
40	Connecticut	$ 745	$ 867	$ 88	$ 955	0.0146%	9.2%(50)
41	Ohio	$ 742	$2524	$ 538	$3062	0.0469%	17.6%
42	Illinois	$ 734	$2553	$ 713	$3266	0.0500%	21.8%
43	Virginia	$ 730	$1265	$ 382	$1648	0.0252%	23.2%
44	Maryland	$ 710	$ 938	$ 232	$1170	0.0180%	19.8%
45	New York	$ 707	$3456	$ 977	$4432	0.0678%	22.0%
46	South Carolina	$ 688	$ 619	$ 246	$ 865	0.0132%	28.4%
47	Delaware (tie)	$ 673	$ 163	$ 37	$ 200	0.0031%	18.5%
48	Minnesota (tie)	$ 673	$ 945	$ 320	$1265	0.0194%	25.3%
49	Massachusetts	$ 658	$1327	$ 241	$1567	0.0240%	15.4%
50	New Hampshire	$ 650	$ 233	$ 37	$ 269	0.0041%	13.8%(47)

*Government and self-employed workers were excluded. Nonfatal cases involved at least 1 day of work loss.
†GDP in 1993 = $6533 billion or $6,533,000 million. For example, ratio for West Virginia is 1021/6,533,000 = 0.0001562 or 0.0156%.

ample, West Virginia had the 50th highest percentage for employment in agricultural services, second in mining, ninth in transportation, 35th in wholesale, and 49th in finance. Alaska, for example, ranked first in agricultural service, forestry, and fishing, fourth in mining, fifth in transportation and public utilities, 50th in wholesale, and 42nd in finance. Finally, the least costly state, New Hampshire, ranked 23rd for agricultural service, 38th for mining, 49th for transportation, 31st for wholesale, and 19th for finance.

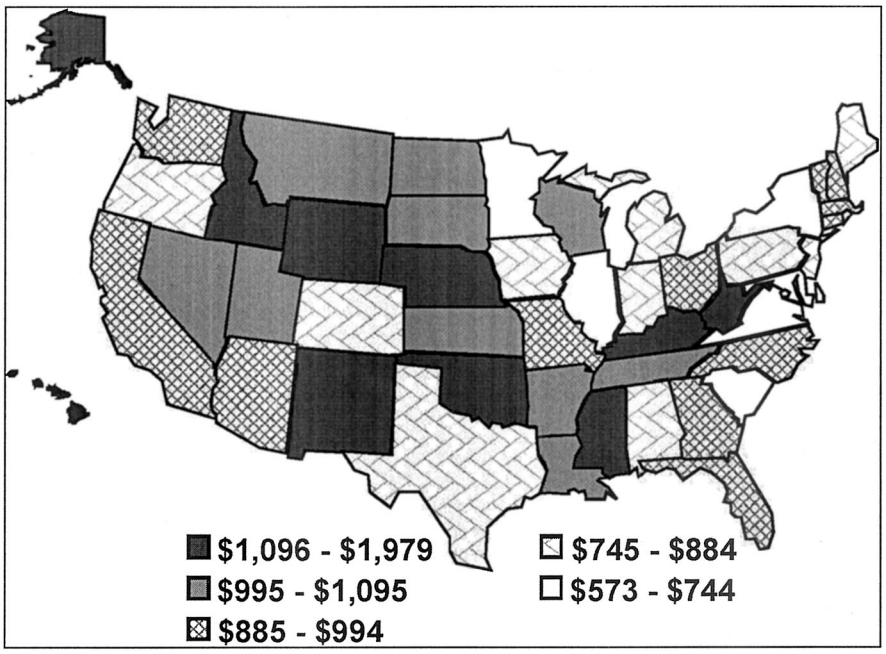

Fig. 1. Costs per worker across states.

The "positive" and "negative" words below the industry name at the top of Table 4 indicate the sign of the correlation that a particular covariate had with costs per worker. For example, farming (compared with manufacturing) was positively correlated with costs per worker. Other things equal, we would expect states high (above 25) on the ranking for farming to be in the "top 10" for costs per worker. Similarly, we would expect states high (above 25) on the ranking for finance, insurance, and real estate to be in the "bottom 10" for cost per worker. For the most part, this is what we observed. For the first columns (farming through transportation), the numbers in the top panel (top 10) are below 25; for the same columns in the bottom panel (bottom 10), the numbers are above 25. The opposite occurs for the final columns (wholesale and finance, insurance and real estate). This table is useful because it helps answer why one state was high on the cost list and another was low. In part, the ranking of states reflected the composition of industry in the state. For example, Idaho's high cost ranking was, in part, the result of its high ranking for percentage of employment in farming (7) and in agricultural service (2).

However, industry composition was not the sole answer. Twenty-seven percent of the variance was not explained.

Discussion

Our results demonstrate that some states had high costs per worker, whereas others had low costs. Moreover, a sizable amount of the variation across states was explained by variations in the industry mix within states.

Implications

The first implication applies to interstate differences in WC systems. We applied the same dollar amounts per diagnosis to injured workers across all states. We did not use WC estimates that are unique to each state.[20] Nevertheless, the variation across states likely partially reflects the substantial variation in WC systems. The United States is one among very few countries that do not have one federal WC system (Canada and Australia are two others).[21] Wide interstate variation in WC systems has been the subject of considerable debate at least since the 1972 publication of the recommendations of the National Commission on Workers' Compensation Laws.[22] On the one hand, it has been argued that wide variation will lead to a "race to the bottom" as states toughen eligibility requirements to attract business. On the other hand, business leaders have sometimes lauded the variation as evidence that state legislatures are tailoring laws appropriate to their state.[22] We cannot resolve that debate here, but because we used identical costs per diagnosed injury across states, our results suggest that the variation across WC systems not only affects costs, but also affects the types of injuries and illnesses that occur.

The second implication applies to international comparisons. Cost methodology, similar to that used here and in previous studies,[1,24] has been used on data from other countries.[25–31] However, because laws, customs, WC systems, and the composition of industries vary across countries, comparisons of estimates from the cost methodology is sometimes problematic. For example, in Lebanon, most employers do not have WC insurance; they simply pay out-of-pocket for medical expenses.[26] Law in Lebanon requires employers to pay 75% of salary to injured workers, but no data exist on the extent to which noninsured employers pay that amount. In the United States, the vast majority of employers have either public or private insurance, but some very large employers self-insure.[23] Injured workers generally receive 40% to 66% of their preinjury salary.[23] In Belgium, employers must not only have private WC insurance, but also must contribute to a national Occupational Diseases Fund, which covers diseases with long-term latencies such as cancer.[29] In the United States, there is a Black Lung Trust Fund and 2 funds for radiation and nuclear exposure, but no general fund that pays for cancers, for example.[32] This is significant because roughly 20,000 to 40,000 cancer deaths can be attributed to occupa-

TABLE 3
Linear Regression Explaining Costs Per Worker Across 50 States, DC Excluded

Independent variables (covariates)	Estimated coefficient	t-statistic	*P* value, 2-tailed test
Percent employment in industry			
Farming	1657	1.201	0.237
Agricultural service, forestry, fishing	9531*	1.950	0.058
Mining	8641†	3.563	0.001
Transportation and public utilities	10479†	2.372	0.023
Manufacturing (omitted)			
Construction	-6909	-1.625	0.112
Wholesale	-9802†	2.058	0.046
Retail	-1148	-0.411	0.683
Finance, insurance, real estate	-5438†	-2.459	0.018
Service	-46	-0.054	0.957
Government	-550	-0.459	0.649
Intercept	1698	2.509	0.016
R^2 (F)	0.733 (10773)		<.001

*Indicates significance at 0.10 level in 2-tailed test.
†Indicates significance at 0.05 level in 2-tailed test.

TABLE 4
Industry Rank by Covariate ($P < 0.10$)

Rank	State	Agriculture service, forestry and fishing (positive)*	Mining (positive)*	Transportation and public utilities (positive)*	Wholesale (negative)*	Finance insurance, real estate (negative)*
Top 10						
1	West Virginia	50	2	9	35	49
2	Alaska	1	4	1	50	42
3	Wyoming	11	1	7	49	35
4	Kentucky	27	10	23	37	48
5	Mississippi	24	16	36	44	50
6	Idaho	2	20	39	19	33
7	Oklahoma	22	3	20	38	40
8	Hawaii	12	39	3	45	8
9	New Mexico	13	7	41	43	37
10	Nebraska	14	33	11	4	16
Bottom ten						
41	Ohio	44	22	38	16	26
42	Illinois	44	23	10	3	5
43	Virginia	36	24	29	40	25
44	Maryland	28	41	32	32	11
45	New York	49	42	21	14	3
46	South Carolina	34	44	46	47	45
47	Delaware	32	50	44	48	1
48	Minnesota	11	25	27	8	14
49	Massachusetts	35	47	42	17	12
50	New Hampshire	23	38	49	31	19

*"Positive" indicates a positive correlation with costs. "Negative" indicates a negative correlation.

tional exposures each year, but WC pays for fewer than 100 of these in the United States.[32] In South Korea, WC paid for roughly 3 per 100,000 insured workers to 13 per 100,000 insured workers for circulatory disease between 1995 and 2000.[30] In the United States, WC paid for roughly 0.5 per 100,000 insured workers (Leigh JP, Robbins JA, unpublished data). Finally, we found in the United States and Larsson and Betts found in Australia[31,32] that small firms were especially prone to underreport injury and illness cases.

The best international comparisons would, first, consider only relatively rich countries such as Canada and those from Asia and Europe. Second, because of the wide variation in compensation for fatal occupational diseases, fatalities should only include injuries (such as we have done here). Third, some consideration should be given to whether wage-replacement rates (ratio of WC benefits to wages) are similar across

countries and the composition of industries across countries.

A final implication is that WC insurers might find these data, and especially this approach, useful. Whereas the insurers maintain their own records on firms and industries, they typically do not keep data on all the costs included here such as retaining costs, administrative costs, and lost quality of life.

Comparison to the U.S. Literature

We are unaware of any studies that rank states according to nonfatal injury and illness rates. We are aware of 1 study by the National Institute for Occupational Safety and Health (NIOSH) that uses the National Traumatic Occupational Fatality dataset (NTOF).[33] The NTOF is independent of the CFOI. NTOF relies only on death certificates. The NTOF "top 10" ranking for the state and corresponding death rate per 100,000 (including government and self-employed workers) from 1980 through 1995 is as follows: Alaska (rank 1, death rate = 25.2), Wyoming (2, 16.7), Montana (3, 12.4), Idaho (4, 10.8), West Virginia (5, 10.5), Mississippi (6, 10.1), South Dakota (7, 9.2), North Dakota (8, 9.0), Nevada (9, 8.4), and Arkansas (10, 8.3). Within the CFOI,[34] Louisiana and Kentucky replace Idaho and Nevada in the "top 10." Again, western and southern states are disproportionately represented for the NTOF and the CFOI "top 10." The "bottom 10" for NTOF are: Maryland (41, 3.4), Ohio (42, 3.4), Minnesota (43, 3.1), New Hampshire (44, 3.0), New York (45, 2.9), New Jersey (46, 2.6), Rhode Island (47, 2.6), Arizona (48, 2.5), Massachusetts (49, 2.1), and Connecticut (50, 1.7). Six of these states (Connecticut, New Jersey, New York, New Hampshire, Massachusetts, and Rhode Island) made it into the CFOI "bottom 10." All of the "top 10" death rate states in the NTOF and CFOI are in the top 20 on our list (Table 2) of costs for nonfatal and fatal injuries and illnesses costs per worker (where costs combine nonfatal with fatal cases). With the exception of New Jersey and Rhode Island, the bottom 20 on the death rate lists were in the bottom 20 on our Table 1 list.

When considering our ranking on percent of costs resulting from fatalities (last column, Table 1), the 3 lists (ours, NTOF, CFOI) are nearly identical: Alaska, Wyoming, Montana (at the top) and Connecticut (at the bottom).

A different list for states is generated using only nonfatal injury and illness rates. The "top 10," in order for 1998 (only year published) were[34]: Maine, Wisconsin, Washington, Iowa, Michigan, Nebraska, Kansas, West Virginia, Montana, Alaska. The "bottom 10," in order, from 41 to 50 are: Georgia, Virginia, South Carolina, Massachusetts, Delaware, Texas, Louisiana, Maryland, New Jersey, and New York. Of the "top 10" on our list (Table 2), only West Virginia, Alaska, and Nebraska made it to the "top 10" on the nonfatal list. Of the "bottom 10" of our Table 2 list, only Massachusetts, Delaware, South Carolina, New York, Virginia, and Maryland made it on the "bottom 10" nonfatal list.

We conclude that our cost rankings were more similar to the death rate rankings than the nonfatal rate rankings.

The signs and statistical significance on the covariates in Table 3 were reasonable. In 1993, the highest death rates were in mining (26 per 100,000), farming, agricultural services, forestry, and fishing combined (26 per 100,000), construction (14), transportation and public utilities (13).[4] The lowest rates were in wholesale trade (5), retail trade (4), manufacturing (4), government (3), finance, insurance, and real estate (2), and services (2).[4] In 1992, the highest industries for nonfatal injury and illness lost workday rates were: farming, agricultural services, forestry, and fishing, combined (5.4 per 100 full-time workers), mining (4.1), construction (5.8), manufacturing (5.4), transportation and public utilities (5.1), wholesale (3.6), retail (3.4), finance, insurance, and real estate (1.2), and services (3.0).[35] The results also match those in separate studies of transportation,[36] retailing,[37] manufacturing,[38,39] and construction.[39]

Limitations

One drawback to our estimates of long-term losses is the lack of information on the actual disability status of each injured worker in the Annual Survey. However, assuming that the cases in the Annual Survey are a fair reflection of permanent disability cases, conditional on diagnosis, our methods will still provide reasonable estimates of the average productivity losses by various categories.

We included only nonfatal cases that resulted in at least 1 day of work loss. We excluded cases that resulted in restricted work (light duty at work). However, no-work loss days and restricted workdays account for less than 25% of all fatal and nonfatal costs.[40]

The Annual Survey is limited by excluding federal, state, and local government workers, workers on farms with fewer than 11 employees, the self-employed, and some workers in private household occupations. These restrictions discriminate against some areas. For example, Washington, DC, is heavily populated with government workers. We excluded DC from our regression analyses. A disproportionate number of the self-employed are farmers. States with many farm workers and farmers (eg, Iowa, North and South Dakota, and Wyoming) will artificially report fewer injuries. This suggests that the correlation between agricultural employment and costs is likely to be stronger than our regression analysis suggests.

Economic incentives exist for workers to over- and underreport injuries and for employers to overreport. Whereas these limitations figure prominently in an estimate of

national total costs for all industries and states combined, they are less prominent for an state-by-state ranking, assuming these limitations apply equally across states.

Illnesses were likely to be severely underestimated. WC was paid to people who were working immediately before the time of the injury or illness. If the illness did not manifest itself until retirement, it becomes difficult, if not impossible in some states, to collect WC benefits. However, many occupational diseases are not apparent until retirement.[1] One of these is job-related osteoarthritis. Job-related injuries to joints early in life could result in osteoarthritis in these joints later in life. Job-related arthritis costs roughly $8.3 billion in 1994.[41]

Our data date from 1993. In the interim, some hazardous tasks may have been eliminated, whereas new hazards may have been created within the states studied, which could affect the incidence and cost data.

Our fatal injury data (Census of Fatal Occupational Injury) rely on many sources other than WC records. WC records, in fact, account for roughly one half of the injury deaths. The Annual Survey data are similar but not identical to WC records. In part, this explains why our state rankings do not significantly overlap with the exclusive WC cost rankings.[23] Nevertheless, varying state WC systems likely influence our results. Waiting periods for WC benefits range from 3 to 7 days.[42] Whereas there is wide agreement across states regarding injuries, there is less agreement regarding diseases.[42] Illnesses, however, comprise less than 10% of costs.[4]

Direct cost estimates rely heavily on WC costs and charges. WC medical costs are alleged to be inflated[43] because the WC system is a fee-for-service plan. However, these allegations have not fully adjusted for the costs to physicians and providers for the paperwork and litigation that accompanies WC claims.[44] In any case, WC cost data do have the advantage that costs and charges are virtually identical and that there are no copayments or deductibles that researchers have to account for.

Conclusions

States can be ranked according to the costs of occupational injury and illness. Because our methodology did not rely exclusively on WC costs, our rankings did not coincide with rankings by WC costs. Costs rankings by state more closely resembled death rate rankings than nonfatal injury and illness rate rankings. Most of the variation in cost per worker across states was explained by the composition of industries across states.

Acknowledgments

This study was funded in part by grants from the National Institute for Occupational Safety and Health (OHO3750–01, OH07550–01, and OH07338–01). The authors are indebted to Barbara Wickson and Dina McHugh for word processing.

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